The Augmented Learner

The pivotal role of multimedia enhanced learning within a foresight-based learning model designed to accelerate the delivery of higher levels of learner creativity

Derek Woodgate

The Augmented Learner

The pivotal role of multimedia enhanced learning within a foresight-based learning model designed to accelerate the delivery of higher levels of learner creativity

Dissertation for the Degree Doctor Philosophiae

University of Agder
Faculty of Engineering and Science
2022

Doctoral Dissertations at the University of Agder 374
ISSN: 1504-9272
ISBN: 978-82-8427-084-5

Print: Kristiansand

University of Agder

Abstract / Sammendrag

The central theme for this dissertation lies at the intersection of multisensory technology enhanced learning, the field of foresight and transformative pedagogy and their role in helping to develop greater learner creativity. These skills will be key to meeting the needs of the projected growing role of the creative class within the emerging global workforce structure and the projected growth in R&D and the advancement of human-machine resource management. Over the past two decades, we have traversed from the Industrial Age through the Information Age into what we now call postnormal times, manifested partly in Industry 4.0. It is widely considered that the present education system in countries with developed economies is not optimised for delivering the much-needed creative skills, which are prominent amongst the critical 21st C skills required by the creative class, (also known as creatives), which will be increasingly dominant in terms of near future employability. Consequently, there will be a potential shortfall of creatives unless this issue is rapidly addressed.

To ensure that the creative skills I aimed to enhance were relevant and aligned with emerging demands of the changing landscape, I deconstructed the critical dimensions, context, and concept of creativity in postnormal times as well as undertaking in-depth research on the potential future workscape and the future of education and learning, applying a comprehensive foresight approach to the latter using a 2030-2040 horizon.

Based upon the outcomes of these studies I designed an experimental integrative learning system that I have applied, researched, and evolved over the past 4 years with over 150 students at PhD and master’s level. The system is aimed at generating higher levels of creative engagement and development through a focus on increased immersion and creativity-inducing approaches. The system, which I call the Living Learning System, is based upon eight integrated elements, supported by course development pillars aimed at optimizing learner future skill competencies and levels of creativity for which I apply several evaluation techniques and metrics.

Accordingly, as the central hypothesis of this dissertation, I argue that by integrating the critical elements of the Living Learning System, such as emerging multisensory technology enhanced learning coupled with optimised transformative and experiential learning approaches, framed within the field of foresight, with its futures focus and decentralised thinking approaches, students increase their ability to be creative. This increased ability is based on the student attaining a richer level of personal ambience through deeper immersion generated through higher incidence of self-direction, constructivism-based blended pedagogy, futures literacy, and a balance of decentralised and systems-based thinking, as well as cognitive and social platforms aimed at optimizing learner creative achievement.

This dissertation demonstrates how the application of the combined elements of the Living Learning System, with its futures focus and its ensuing transdisciplinary curricula and courses, can provide a clear path towards significantly increased learner creativity.

The findings of the quantitative, questionnaire-based research set out in detail in Chapter 9, together with the performance and creativity evaluation models applied against the selected case studies of student projects substantiate the validity of the hypothesis that the application of the Living Learning System with its futures focus leads to increased creativity in line with the needs of the postnormal era.

Abstrakt (sammendrag)

Det sentrale temaet for denne avhandlingen ligger i skjæringspunktet mellom multisensorisk teknologiforbedret læring, fremtidsstudier og transformativ pedagogikk med særlig vekt på deres rolle i å bidra til å utvikle større læringskreativitet blant studenter. Disse ferdighetene vil være sentrale for å møte behove hos den kreative klassen og dennes stadig større rolle innenfor den fremvoksende globale arbeidsstyrkestrukturen. Slike ferdigheter blir også avgjørende i møtet med den anslåtte veksten i FoU og fremskrittene i menneske-maskin ressursstyring. I løpet av de siste to tiårene har vi gått fra den industrielle tidsalderen gjennom informasjonsalderen til det vi nå kaller postnormale tider, delvis manifestert i industri 4.0. Dagens utdanningssystem i økonomisk utviklede land er allment ansett for å ikke være optimalisert for å levere de kreative ferdighetene som sårt trengs, som er fremtredende blant de kritiske 21. århundre -ferdighetene som kreves av den kreative klassen (også kjent som «creatives»). Disse ferdighetene vil bli stadig mer dominerende i fremtidige ansettelsesprosesser. Som en følge av dette vil det kunne oppståen mulig mangel på «creatives» med mindre problemet løses raskt.

For å sikre at de kreative ferdighetene jeg hadde som mål å forbedre var relevante og i samsvar med nye krav fra det skiftende læringslandskapet, dekonstruerte jeg de kritiske dimensjonene, konteksten og konseptet til kreativitet innenfor den postnormale tidsalder. I tillegg foretok jeg dyptgående forskning på det potensielle fremtidige arbeidslandskapet og benyttet en omfattende fremsynsmetode med en 2030-2040 horisont for å studere den mulige fremtiden for utdanning og læring. Basert på resultatene av disse studiene, designet jeg et eksperimentelt integrativt læringssystem som jeg har brukt, forsket på og utviklet i løpet av de fire siste årene med over 150 studenter på PhD og masternivå. Systemet har som mål å skape et betydelig større kreativt engasjement og utvikling gjennom fokus på økt fordypning og kreativitetsfremkallende tilnærminger. Systemet, som jeg kaller «det levende læringssystemet», er basert på åtte integrerte elementer, underbygget av kursutviklingspilarer som tar sikte på å optimere studentenes fremtidige kompetanser og kreativitetsnivåer. I utvklingen av systemet bruker jeg flere evalueringsteknikker og beregninger.

Som en konsekvens av dette er den sentrale delen av hypotesen for denne avhandlingen, en argumentasjon for at vi ved å integrere de kritiske elementene fra «det levende læringssystemet», slik som fremvoksende multisensorisk teknologi, forbedret læring kombinert med optimaliserte transformative og erfaringsbaserte læringstilnærmelser, innrammet i fremsynsfeltet, med dets fremtidsfokus og desentraliserte tilnærmelser til tenkning, øker studenters evne til å være kreative. Denne økte evnen er basert på at studenten oppnår et rikere nivå av personlig læringsatmosfære gjennom fordypning skapt gjennom høyere forekomst av selvregi, konstruktivismebasert blandet pedagogikk, fremtidskunnskap og en balanse mellom desentralisert og systembasert tenkning. I tillegg spiller kognitive og sosiale plattformer rettet mot å optimalisere studenters kreative prestasjoner en viktig rolle.

Denne avhandlingen viser hvordan anvendelsen av de kombinerte elementene i «det levende læringssystemet», med dets fremtidsfokus og påfølgende tverrfaglige læreplaner og kurs, kan vise vei mot en betydelig økt læringskreativitet. Funnene fra den kvantitative, spørreskjemabaserte forskningen som er beskrevet i detalj i kapittel 9, sammen med ytelses- og kreativtetsevalueringsmodellene brukt mot de utvalgte casene av studentprosjekter,

underbygger validiteten av hypotesen om at bruken av «det levende læringssystemet» med dets fremtidsfokus fører til økt kreativitet i tråd med behovene til den postnormale æraen.

Acknowledgements

No project of this magnitude is achieved without a considerable degree of support and guidance. I would like first to thank my supervisors, Prof. Dr. Andreas Prinz, Professor in System Development, and Dr.Ghislain Maurice Norbert Isabwe, Associate Professor, Multimedia & eLearning, both from the Faculty of Engineering and Science at the University of Agder, Grimstad, Norway, and Dr. Stephen W. Harmon, Director of Education Innovation, Center for 21st Century Universities, Associate Dean of Research, Professional Education at Georgia Tech (Georgia Institute of Technology) Atlanta, GA USA. Each in their own very special way expertly led me through the dissertation process and guided me as to how to approach the specifics of research at this demanding academic level in a most insightful, encouraging and inspirational manner.

I would also like to thank various other faculty colleagues from both the University of Agder (Frank Reichert, Rector, Folke Haugland, Head, Department of Information and Communication, Einar Duenger Bøhn, Professor, Coordinator in philosophy, Michael Rygard Hansen, Bernt Inge Ohrn, CEO, Mechatronics Innovation Lab), for their support and collaboration, as well as Dr. Andy Hines, Department Head at the University of Houston. Similarly, I would like to express my gratitude to the many interviewees, who are individually named in the dissertation, all of whom graciously gave their time, expertise and encouragement.

During the course of my research, four of my papers that ultimately helped shape certain aspects of this dissertation were accepted for publication in multiple peer-reviewed academic books and journals, and I would like to thank the editors and peer reviewers in this regard. These include: Dr. Andy Hines, Editor of Foresight (Emerald Group Publishing), Dr. Nevenka Ackovska and the editors at Springer Publishing and Dr. James Dator and Dr. Maree Conway, at the World Futures Review|Sage Publishing.

Finally, I would like to thank my wife Helga Veigl, a fellow futurist for her many years of dedicated support in all aspects of my life, not least my futures consulting and academic endeavors. The knowledge and experience embedded in this work did not start with the first lines of the original prospectus, but over many decades of what continues to be a most rewarding life. Consequently, I dedicate this work to my son Andrei and his family, and to my daughter Tessie and her family.

Table of Contents

1 Introduction and Background

The main scope of this dissertation centres on finding a solution to the problem of how to transform the learning process to increase learner creativity, given that the present system is considered to be failing in that endeavour. This issue is important since creativity is seen as a critical component of the skill repertoire required for the emerging and future workspace. So, while my deeper interest into this problem became evident in the Spring of 2016, the foundation for this dissertation started in late 2013, early 2014, prior to my joining the University of Agder (UiA) faculty. The ICT Department of the Faculty of Engineering and Science at UiA was in the process of establishing a two-year Masters' level, Multimedia and Educational Technologies Program. The program essentially emphasises knowledge of existing and emerging technologies, new tools, and methods for dissemination of knowledge. I was invited to create and teach a 7.5 ECTS course on Mobile Learning for Education (MM 402). I was selected by the then Department Dean, later Rector, Frank Reichert, because of the work I had undertaken as a professional futurist and President of The Futures Lab, Inc. on the future of learning, as well as the fact that I was at the time teaching a PhD class in the Learning Technologies Department of Georgia State University's College of Education and Human Development. I was given substantial freedom in every aspect of the course structure and curriculum development and developing the course content accordingly.

The course was originally designed as a fully self-contained, on-line, self-directed course. In the initial phase, my design architecture was founded on teaching the history and background to mobile learning, the philosophies behind it, the complexities of implementing the various digitalisation and visualisation formats, the changing communications and learning tools and emerging device and supporting technologies influencing the domain's advancement, pedagogical influences and approaches and a brief intro to how to create the future by means of the foresight methods.

Although seemingly very structured, an open-ended learning design approach was preferred, particularly because at the time the University of Agder had limited experience in digital learning design and practice. Permission was given to select my own Learning Management System (LMS), namely Moodle. Even though, I had already designed and was teaching a blended course at Georgia State University, titled the Future of Education and Learning, I decided to explore emerging developments in digital learning design, which was especially inspired by the learning design framework offered by "the STREAM model" (Godsk, 2013). "STREAM" is an acronym for "Science and Technology Rethinking education through Educational IT towards Augmentation and Modification", where the terms "augmentation" and "modification" refer to two different levels of blended learning (Godsk, 2014a; Puentedura, 2010).The model placed considerable focus on individual exploration of online materials, which I had been asked to make a key feature, as well as participatory learning, such as asynchronous discussions and peer-feedback. This would be introduced as the course took shape and the students grew into the on-line approach. Testing and evaluation of the STREAM Model up-to-that-point, especially at Aarhus University in Denmark had indicated that there was a strong balance between providing acquisition of new knowledge, and collaboration and participation (J. S. Brown et al., 1989; Lave & Wenger, 1991; Sfard, 1998). This would be critical given that the course would focus significantly on the future rather than just the present.

I also considered the implications arising from the Herrington, A. and Herrington, J. (2007) paper on Authentic Mobile Learning in Higher Education in which they discussed the changing theoretical foundations of learning in terms of the shift from behavioural to cognitive to constructivist, and the affordances that emerging technologies offered in line with this philosophical transformation. The table below simplifies the key implications of this transition (Herrington & Herrington, 2007).

Table 1 Implications of the transition from Instructivist to Constructivist learning

Dimension	*Moving from*	*Moving to*
Philosophy	Instructivist	Constructivist
Theory	Behaviourist, cognitivist	Situated, socio-constructivist, andragogical
Course design	Bounded scope and sequence	Open-ended learning environment, flexible content
Time and place	Fixed in educational institutions	Distributed, to suit the contexts of the learners
Knowledge base	"Objective knowledge, largely determined by experts	Knowledge built and shared among the community
Tasks	Decontextualised, concise, self-contained	Authentic, reflective, complex and sustained
Resources	Fixed, chosen by teacher	Open, chosen by learners with access to search tools
Support	Teacher	Community of learners
Mode	Individual, competitive	Collaborative, networked
Technology tools	Fixed, located in learning spaces	Mobile, portable, ubiquitous, available
Knowledge outcomes	Facts, skills, information	Conceptual understanding, higher order learning
Products	Academic essays, exercises, or no tangible product	Authentic artifacts and digital products
Assessment	Standardised tests, examinations	Performance-based, integrated and authentic assessment
Transfer of knowledge	Stable knowledge adapted to different contexts	New and changing knowledge acquired when required
Professional learning	Courses, group events, workshops	Personal, just-in-time, community-based

In parallel special attention was given to the work of Sharples, Taylor, and Vavoula (2016) which identified the implications of the then mobile technologies themselves, not purely from the communications and mobility standpoints, but moreover the opportunities they offered in terms of approaching complex problem solving more efficiently. Their approach dealt more with generational learning styles and the ability for emerging learning technologies to help students to use multi-source and multi-layered approaches to academic tasks, as well as inter-device peer collaboration, which became further accelerated with the advent of smart devices. An important overlay on this philosophical transition to constructive learning has been a theory called connectivism (Siemens, 2004) which has been described as "a learning theory for the digital age". Its characteristics include:

• Learning and knowledge rests in diversity of opinions
• Learning may reside in non-human appliances
• Capacity to know more is more critical than what is currently known
• Nurturing and maintaining connections is needed to facilitate continual learning
• Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

Also, I found several useful insights from Keith Sawyer's work over the previous decade and in particular his 2005 seminal paper on The Future of Learning in the Age of Innovation, which dealt with learning needs in the light of the transformation from an industrial to a knowledge economy (D. Bell, 1973; Drucker, 1993). The knowledge economy is based on "the production and distribution of knowledge and information, rather than the production and distribution of things" (Drucker, 1993, p. 183). To clarify this point, knowledge workers manipulate symbols rather than machines and create conceptual artefacts rather than physical objects (Bereiter, 2002; Drucker, 1993; Reich, 1992). The shift to the knowledge economy and the new jobs and skills arising from this transformation underlined the importance of creativity, innovation, and ingenuity in the knowledge economy; which is now frequently referred to as the creative economy (R. Florida, 2002a; Howkins, 2001). Even though, my dissertation discusses time horizons beyond the knowledge economy, many of the characteristics, in particular the need for increased creativity will be paramount in the emerging eras with their new transformative signifiers and paradigms.

At the time I was cognizant that we were on the threshold of the third revolution in education (UNESCO Bangkok and Commonwealth of Learning, 2004). The first of these revolutions occurred around 5000 years ago with the invention of writing and the use of graphic symbols. The second revolution came about with the invention of books firstly in China around 1000 A.D and then in Europe in the mid- 1400s. In this way writing became scalable and with computer technology (Swarts, 2010) we witnessed a shift towards distributed learning and more recently ADL (Advanced Distributed Learning), which is offering us decentralised education and learning which denotes affordable, adaptive, interactive, on demand instruction anytime and anywhere. This has had a major impact not just on institutions, techniques, goals and approaches, (Wilber, 2000) but moreover on the role of the learner. Although personalised or individualised learning has long been viewed as an imperative, it has also been thought to be both impossible and unaffordable (Galiani & Schargrodsky, 2002).

In 2013/2014 when I designed the original MM 402 course the vision of the third revolution was well underway with an extensive deconstruction of the education market with a wide variety of eduenterprises, learning management systems, online communications tools, social collaboration, access to hitherto unavailable data sources, immersive and collaborative experiential learning platforms and environments and much more, which meant that there was adequate opportunity to introduce a holistic blended teaching and learning approach. This included the need for students to be more active and self-directional by shaping their knowledge in relationship to their own abilities and own sense of their world. This involves viewing the learner's lifeworld framed both as challenge and as an environment and a potential resource for learning. Margit Böck, Department of Communication

Studies at the University of Saltzburg (2004). She points out how contemporary forms of text for example are dynamic, fluid, and above all, contingent; they are ever more frequently multiple authored, with 'shared'/distributed power and consequently provisional. In their form they realise contemporary forms of social organisation: distributed resources, distributed information, distributed power, distributed across life-worlds organised as lifestyle. These are some of the key attributes of emerging, decentralised education and learning and were fundamental to the course and its design.

At the time, decentralised education reflected a landmark of how the industrial world had traversed from the Industrial Age through the Information Age into the Innovation Age (Sawyer, 2008) or what is referred to throughout this dissertation as postnormal times (Sardar, 2009), which describes the changing dynamics of the era. While normal is dependent upon context and can be interpreted differently according to spatial development, in this context it is seen as a signifier of increasing confrontation with a host of old, dying orthodoxies: “modernity; postmodernity; neoliberalism; hierarchical structures of society, institutions, and organisations; top-down politics; and everything else that has shaped and defined the ‘modern world’.” The concept of postnormal times reflects the in-between period where significant complexity, confusion and sometimes chaos rule as we have yet to adequately replace many of these orthodoxies. Postnormal times has meant that will need to prepare individuals to generate new knowledge and to optimise and extend their learning and knowledge application abilities beyond what we expect from humans today, given the potential power of emerging interfaces, aids and interactive sources etc. and as I will discuss, the massive impact of multisensory augmented reality. This is not possible unless we fully reconceptualise notions such as knowledge, schooling, teacher, curriculum and assessment, to which to be expanded with environment and delivery systems (Sawyer, 2008). Accordingly, it was clear to me in 2014 that the emerging age required learning systems that inspire creativity and innovation and that the creative process is not a matter of the mystical moment, but a punctuated process of creative insights that are deeply embedded in a broader social process (Csikszentmihalyi & Sawyer, 1996) and Keith Sawyer’s work Zig Zag (Sawyer, 2013). One of the key challenges in creating the original course was how to include experiential learning and design thinking, especially referencing Kolb’s Experiential Learning Theory and the principles of the D School at Stanford.

Various papers have criticised Kolb for lack of empirical foundations and attempted to create alternative models for “experiential learning” (e.g. Bergsteiner & Avery, 2014; Miettinen, 2000; Schenck & Cruickshank, 2014). Kolb claimed that his model was based upon what he considered to be the common themes in the seminal works of Kurt Lewin, John Dewey, and Jean Piaget and true, we have still not resolved the issue of sound empirical evidence and nor have those that have attempted to build alternative models. Kolb’s Experiential Learning Theory still remains the yardstick (Seaman et al., 2017).

Back in 2014 I did not give much consideration to future jobs or workforce transformation, more emphasis was placed on the domain content (Mobile Learning for Education), pedagogical structure, creativity, and innovation. I did explore how society was reassessing and expanding its view of the concepts and purposes of creativity and innovation and in particular collaborative creativity, where much of the innovation is now being generated (Peters, 2004).

In a period when these expanded concepts of innovation and creativity were being considered to be of primary value, fuelled by advancements in our ability to navigate complex social systems, with constant communication, collaboration, and knowledge sharing, from which innovations tend to emerge, it was critical to be able to introduce more creativity into the curricula, but the students were still deeply challenged by the online learning environment and the alternative thinking methods included in the course learning systems that were developed to facilitate and accelerate the creation of novel ideas. Despite its limitations in 2013/2014 we could see the application of emerging multimedia technologies in this domain as having the potential to provide the perfect partner to not just expand creative and innovative output, but to transform the essence of the concept of creativity in a similar way to how concepts such as "social" have been radically extended and revolutionised over the past couple of decades.

In developing the original course, prior to developing the pedagogical structure and syllabus, I examined:

a) The student cohort: twelve M/F master's students, mainly with multimedia background and development experience, but with no knowledge or experience of deep theory or studies of the future (foresight);
b) The department need, specifically to integrate the Mobile Learning for Education course with the other new courses. (These consisted of Interaction Design, Communication, Cooperation and Research Methods, eLearning and Games, eTeaching, eCourse development and Education, Visualisation and Animation);
c) Technology resources relevant to the future of mobile learning: augmented reality, virtual reality and 3D/4D worlds, holograms, simulation, new devices technologies, frameworks and platforms, structures, materials, batteries, and interfaces, xAPI, avatars and learning agents, apps, Web 4.0., GPS, LMS, etc. Originally most of these technologies were unavailable and the department did not have a learning or multimedia lab.

The course encompassed some multimedia elements, including video mentoring and content, video-making, collaborative watering holes, the learning of some multimedia tools and testing existing platforms, framework and authoring software. In its initial iteration, it was limited in its requirement for experiential creativity, but high on alternative thinking techniques, creative imagination, basic foresight processes and academic intensity. In the first semester the UiA students, while happy at first with the course's high level of self-direction and self-management, found the bridging of the contemplating the future of mobile learning too complicated and their outputs and grades were lower than expected.

For the second year, 2015 weekly on-line discussion groups and some off-line tutoring were introduced to supplement the self-learning approach. While overall student performances and outputs improved, they were still far from optimal, but seeds of increased creativity were germinating. While the ability to think in a more nomadic way and to produce hitherto unthinkable insights had increased, it seemed that one critical element that was lacking revolved around the broader social process in which creativity is deeply embedded (Csikszentmihalyi & Sawyer, 1996) and the learners' ability to transfer those insights into truly meaningful multimedia-based, future-relevant projects.

After the Fall semester 2015, namely the end of the second year of teaching the course, in addition to UiA's internal evaluation requirements, both at student and faculty level, an evaluation maturity model was undertaken both for the course and the student. Firstly, by using the Philip Spies' model and some elements of (Spies, 2019) and Ian Miles' *Dynamic evaluation approach,* but mainly the Capability Maturity Model Integration (CMMI) adapted from Georghiou and Keenan, Popper et al. (2010).

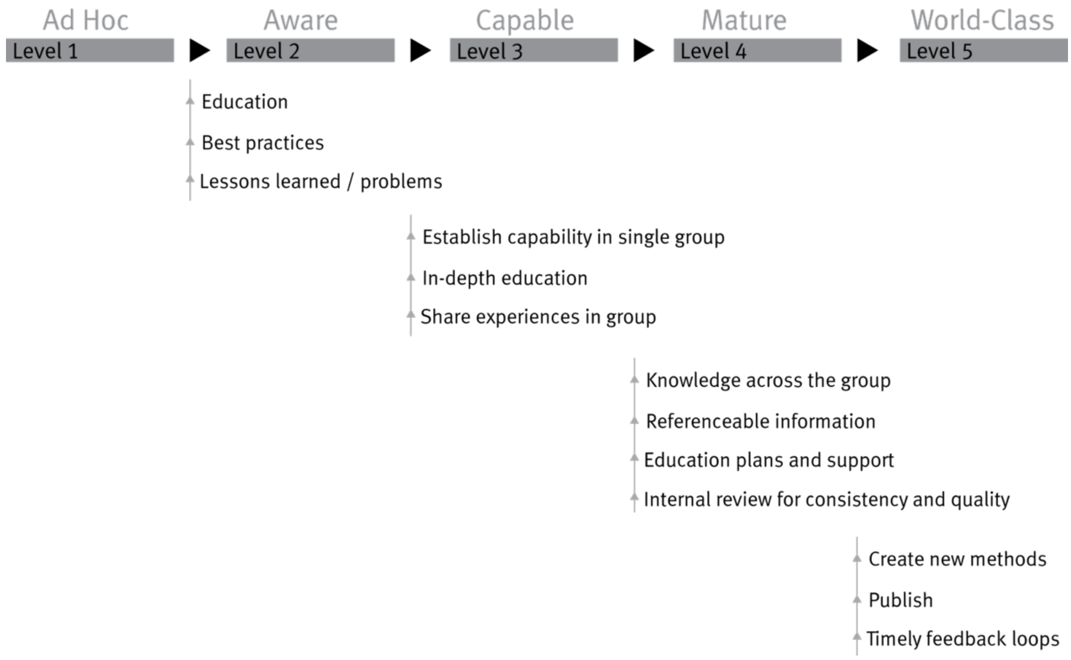


Figure 1 Capability Maturity Model Integration

The reason for choosing to undertake this evaluation for students of MM402, was to better understand their and ultimately my performance, the content relevance and the strengths and weakness as I was dissatisfied with the student's outputs over the previous two years. Application of the CMMI involved rating students on a scale of 1-5 as well as individual interviews with the 27 graduate students who had completed the original future of mobile learning course in the Fall of 2015. The 1-5 evaluation ranged from Excellent, good, neutral, poor, to no value added.
The model considered the following elements and objectives:

a) The goals and boundaries of the course, both inputs and outputs, effects vs. objectives,
b) Progress tracking based upon the key course performance evaluation criteria, namely
c) Student interaction and participation
d) Adaptability and adoption of new content, learning structures and approaches
e) Contribution to the methodologies used by the class

f) Team involvement and collaboration
g) Individual interest and progress against each unity
h) Teacher performance

The CMMI evaluation, demonstrated that while the students had relatively little difficulty in understanding the overall content of the course, they were generally unable to think beyond the very near future and had underlying difficulties in imagining in the abstract, considering and discussing discontinuity, unstructured and undiscovered knowledge and non-linear thinking. Further evaluation identified some obvious problem areas, such as: learner difficulty in dealing with complexity, sense of isolation, lack of real peer and mentor collaboration and social perspectives, leading to relatively limited engagement and creativity. Consequently, I immediately revisited the course design to examine and rectify these student-learning difficulties.
A critical finding in my examination of the learner issues was that it was their first experience of both a fully self-directed course and moreover, deep theory and non-linear thinking consequently they were unable to contribute significantly to the course development, even though their involvement was reasonably high.
Upon deeper reflection, my analysis of those performance weaknesses led me to the conclusion that the course needed to be redesigned using a more relevant learning system and course structure and two key objectives of the course and moreover the system that the course was built around did not seem to be optimised.
This pertained to two specific aspects: 1) the course did not fully leverage multimedia-based mobile learning to improve the experience, learning and adoption of a strong range of dynamic future skills, especially creativity; 2) was not sufficiently future-oriented in terms of content, process and the changing education and work environment.

1.1 The Motivation, Purpose and Objectives

These findings motivated me to not just consider an overall redesign of the course, but moreover the fundamental thinking and platform on which the course was built. Consequently, I took the decision to apply an open experimental approach to first understand what the potential changes to the emerging and future workscape would be and resulting needs for new skills, particularly, greater levels of creativity as well as the gap between the current teaching of such skills within educational institutions and the vision for a future education system that could deliver such needs. Those findings would hopefully provide the necessary platform and thinking for a transformative learning system on which to base the redesign of the MM 402 course, with future employability as a salient ingredient. This approach required taking a foresight view of the issues, whilst fully exploring existing research and other scholars' work and conclusions, as well as understanding the theoretical background to the mission. It was critical to find an approach to get the students to project themselves into the future to be able to develop more futures-related outcomes provided fresh motivation to understand how this could possibly benefit the students and their preparedness for their future workforce.

Another motivation came from the fact that in 2016, the department decided to embark upon investing into two student laboratories. The Learning Lab and the Multimedia lab. As part of the Labs' design team, together with Rune Andersen, Maurice Isabwe, we studied similar labs around the world, which included our visiting four labs in the USA linked to the universities, namely Georgia State University (Creative Media Industries Institute), Georgia Institute of Technology (Expressive Machinery Lab), University of Texas, Austin and University of Houston, plus conversations with Dr Elaine Raybourn a renowned expert in transmedia from Sandia Labs, Patti Maes, Head of the Fluid interfaces Lab at MIT, Frank Eichardt at NASA and Ronald Kander, the Executive Dean of Kanbar College of Design, Engineering and Commerce from Jefferson University in Philadelphia, specifically regarding their Nexus Learning Program.

Being prepared for the future after university, to me did not mean just having the skills for immediate employment but also the understanding of near and medium-term potential and requirements and to anticipate the challenges. It was necessary to give the students a context that would inspire and challenge them to increase the skills and understanding of the broader opportunities ahead. This could be seen as personal futureproofing for each student. To do that, it was necessary to first understand how that future context was evolving in terms of the workforce structure, management, skills, and the future working environment.

I needed to be clear how the future workforce, skills and education could be integrated within a course that was ultimately about mobile learning, while ensuring that the new system would be applicable to any course.

Accordingly, in Spring 2016, considering the CMMI valuation, rather than tweak the course content and approach, the development of a new learning system optimised to meet the original criteria that I had set for the course and to integrate and improve those areas where the students were either underperforming or having radical difficulties. Emphasis was given to the introduction of new currencies of knowledge and new levels of excellence within the domain, given the potential offered by the emerging multimedia technologies and tools as well as to the changing workforce ecosystem. Before embarking on fundamentally redeveloping the learning system, including the use of multimedia learning tools, I would undertake a deep investigation of the future of jobs, work styles, workforce, emerging skills, and needs, and employability, in particular the growing needs for creatives and greater levels of creative thinking and creativity.
This latter point was substantiated by the Mercer Report (2020) which placed creativity, which indicated that creativity would be most important skill needed for future jobs.

With these CMMI performance weaknesses in mind, the following actions were determined to be the best means of upgrading or moreover redesigning the course to help optimise its potential:

a) to expand the relevance of the course in terms of acquiring postnormal skills (Woodgate, 2017) in line with the rapidly changing economic environment and the emerging and future needs of the workforce as determined by multiple reports emerging at the time (McKinsey Global Institute, 2017; Mercer, 2020). The McKinsey Report (Fig. 2) envisaged potentially 50% of current jobs being automated by 2030.
b) To clarify the concept, context, and relevance of creativity in the postnormal era.

c) To undertake a foresight project to explore the potential future of learning and new opportunities resulting from its transformation from the present education system.

d) To develop a new learning system to increase with greater clarity the level of learner creativity, creative skills, and visionary thinking that the course structure could deliver, especially in terms of the use of multimedia learning and the quality, relevance, and novelty of outputs/artefacts potentially generated by the learners.

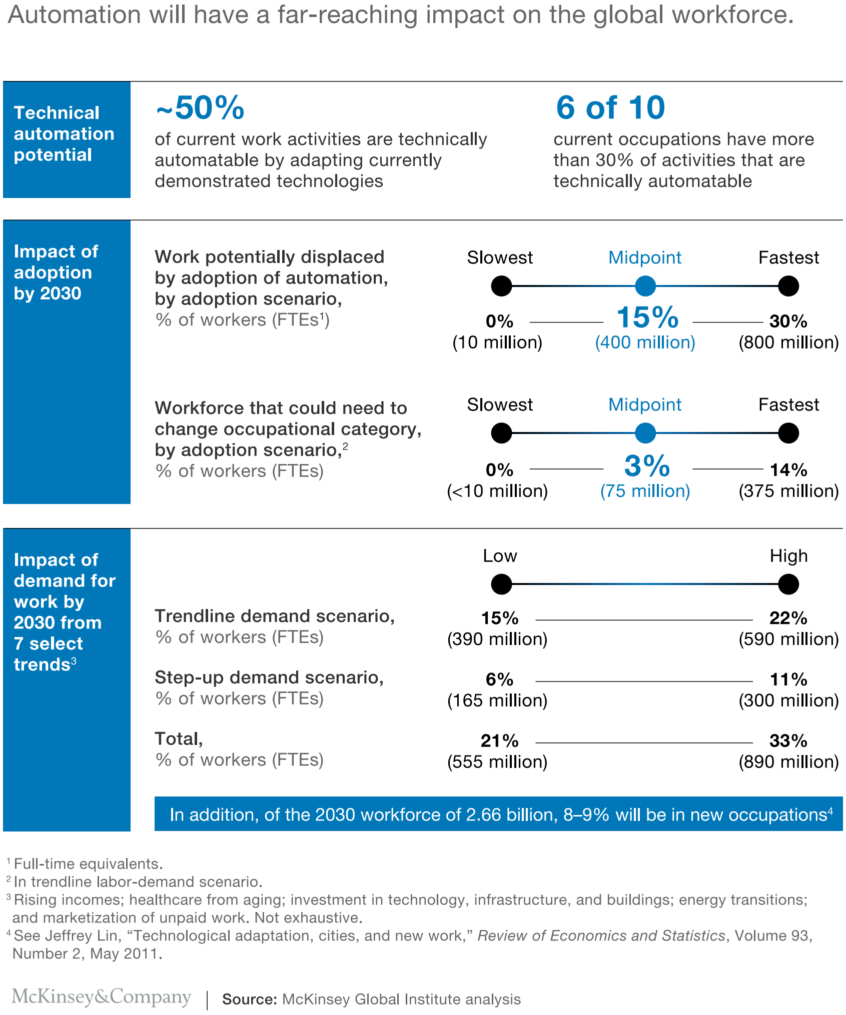


Figure Potential impact of automation on the future global workforce (McKinsey Global Institute, 2017)

The importance and rationale behind this research/dissertation are that by taking the approach outlined above will not only provide a far more effective course for my future students, but moreover deliver a new learning system that is anticipated to be flexible, robust and salient enough to be used across a broader spectrum of future higher education. The dissertation will also demonstrate that the new learning system by integrating necessary emerging skills is able to deliver a higher number of creatives (who are increasingly necessary for the future workforce) and that the combination of multimedia learning tools when integrated into a foresight-based-curricula can increase creativity and creative thinking skills, which is the critical objective of this dissertation.

1.2 Problem Statement (Rationale)

In developed economies, the workforce structure and skill requirements have dramatically changed over the past 25 years. This has led to a significant growth in

the need for the creative class - a trend projected to be maintained over the next 15 years (R. Florida et al., 2015). Current projections foresee a major shortfall of creative talent to meet the projected growth levels. This need is being fuelled additionally by the projected, continuing increase in funding of innovation as a percentage of GDP as a central factor to economic stability and growth.
The ability to be creative (Amabile, 2013) is considered a critical component of the emerging skill repertoire (World Economic Forum, 2016a) required to meet these future workforce needs. Another 2016 WEF report cites that 65% of the jobs existing in 2030 do not exist today (World Economic Forum, 2016b). The present learning systems of the developed economies are considered non-conducive to the development of creative skills (Sawyer, 2008). In view of this projected workforce shortfall and the failure of the present system to deliver adequate numbers of creatives, there is a need for an accelerated effort to develop a new learning system that is capable of increasing learner creativity levels while contributing to the future of the education system, which is rapidly moving towards a student-centred, competency-based education (CBE) system (Camacho & Legare, 2016).

1.2.1 Research Questions

This dissertation seeks to answer the key question of how to deliver increased levels of learner creativity to meet the growing needs of the future workforce.
From the problem statement, three main research questions arise.
(1) How are jobs, skills, and workforce structures, projected to change over the coming decade?

This can be divided into three sub questions, namely:

(1.1) What will be the key skill needs of the future workforce?
(1.2) How important and what will be the role of creativity in the future workforce?
(1.3) What do we mean by creativity in the context of postnormal times and how can it be delivered and evaluated?

(2) What type of education system and learning approaches would be best suited to meet the changing needs of the future workforce, especially in terms of delivering increased creativity?
Again, this can be split into three sub questions:
(2.1) What are the weaknesses in the present education system in terms of delivering the level of creativity required to meet the needs of future jobs and workforce?
(2.2) What potential future approaches to education would best meet the changing demands of the future workforce?
(2.2) What type of learning system from such approaches could potentially deliver a higher level of creativity and a greater output of creatives?

(3) How can we apply such a system to the design of future courses to increase learner creativity?
(3.1) How can we prove/verify that the application of such a system can lead to higher levels of student creativity?

1.3 Structure of the dissertation and approach

In designing the structure and approach for this dissertation, it was necessary to apply a knowledge integration process, which could deal with the relationship of dialectical synthesis among multimodal concepts and knowledge. The framework needed to consider the knowledge integration dynamics framework from the viewpoints of future contextualisation, reconceptualisation and concept creation, source harmonisation, dynamic practical knowledge development with a focus on radical innovation and moreover how to shift the thinking from the present self to the future self. It meant also transitioning amongst domains to establish a valid causal loop from emerging workforce needs through a new education structure and strategy, that drives a new learning system which delivers the creatives that loop back into the targeted workforce. I first created a Concept Map to better understand the interrelated elements that could underpin the dissertation framework.

Along the route, in addition to the explicit knowledge both researched and developed, the framework was required to account for latent factors and their mechanisms from surrounding STEEP factors which have brought about new value opportunities, especially in terms of transdisciplinary technologisation, and emerging economic models and neuro and cognitive analytics.

To leverage the inherent benefits of the knowledge integration framing of the critical components of this dissertation, combined theoretical and methodological approaches were applied that included: the foresight process, auxiliary projects, multiple modelling approaches, mapping, and quantitative and qualitative research, as well as several expert and Frontline Panels and interviews. These helped determine the critical criteria, parameters and qualifiers for the potential influences and future drivers presented within the knowledge enquiry.

As a model for both the dissertation and the accompanying research, I created a practitioner-oriented model, as a procedural and conceptual guide for the application of research in practice, an amplified version was used to illuminate how the dissertation would take us forward from the knowledge enquiry, or in foresight terms horizon scanning and context development stage to the ultimate outcome and conclusion.

Specifically, this model uses a series of critical-thinking and decision-making steps designed to facilitate safe and effective use of research findings to ensure that the transition through the knowledge enquiry process is robust and salient. The model includes a set of relevance criteria and affordances that help to determine the desirability and feasibility of applying the individual and combined sections of the research to the target issue or in this case the learning system that acts as a catalyst in delivering the target issue.

These criteria determine the parameters for in depth understanding of current practice, for substantiating evidence; and the extent of the need or desire to change, namely the gap; the contextual relevance of the research and the feasibility, risk, challenges, and flexibility of implementing the substantiated findings. The model (Fig. 3) applies the critical assumption that experiential and theoretical approaches are to be used in parallel. It also leaves plenty of room for critical thinking and expanded consideration and interpretation of the findings by adding subjective experiences and knowledge based upon research - a compilation of evidence, including consensus, as well as other information, such as a reconceptualised and re-contextualised notions that reflect emerging environments and potential future situations.

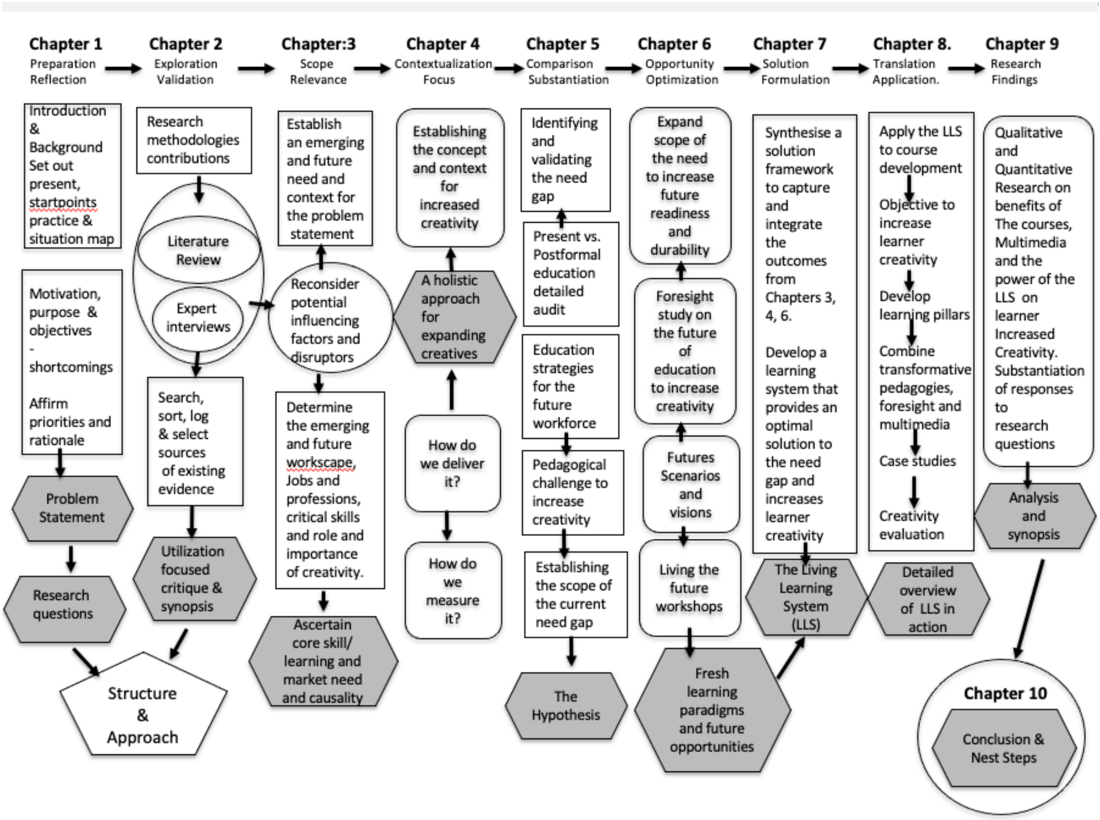


Figure 2 The dissertation development model

The model determined the flow of the chapters which were used instead of phases, which are commonplace in such models. Chapter 6 was added, namely Opportunity Optimisation which is aimed at establishing a future-oriented, optimised solution for the need gap by undertaking additional deep exploration to extend the relevance of the overall research beyond the realm of the present and into a future horizon to reduce short term redundancy. This additional step of analysis also expands the role of the probabilistic factors and increases the power of the assumptions by providing a platform, for later refinements, particularly at the utilisation stage. This additional step provides not only a guideline, but concrete concept platforms on which to build a more robust application of the model.

In summarizing the application of this approach, I first determined the scope and goal of the dissertation/research and a concept map and conceptual framework of the research areas. I then developed an in-depth understanding of the emerging and potential future of work, jobs, the workforce, working environment and the skills needed for the upcoming working ecosystem, which underpinned the need for increased creativity. This was followed by a study of the gap between the present education system and the needs of the future workforce. The nest step involved deciding what the future of education could look like 2030-2035 and what type of system would best deliver the needs of the future job market, namely skills, specifically creatives and well as a robust education infrastructure. From this outcome, I built a new learning system and taught and tested it. Qualitative and quantitative research were undertaken to evaluate the system's ability to deliver against the said goals of increasing the level of creativity and creatives. In the conclusion I discuss the broader impact and implications of both the new learning system and this research in terms of its contribution to the future of the field.

2 Research Methodologies and Contributions

While the central problem in this dissertation is increased creativity and ways to develop a higher number of creatives, through the education system, the broader domain reflects the contextualisation and need for creativity within the future workforce, which is facing radical transformation as a result of the shift to industry 4.0, understanding the limitations of present education systems in this regard, as well as potential opportunities fostered by the emergence and increasing development of multimedia learning technologies.

2.1 Literature Review

My initial literature review involved a comprehensive exploration of the broader domain of my research as referenced in the background and introduction in the Chapter 1 above. It included multiple perspectives on education and learning, creativity and innovation and the development of the creative class; future economic indicators and projected movements, changing workforce structure and approaches, emerging jobs and matching skills, multimedia technologies and their interface with learning, engagement, immersion, interaction and sensory augmentation, pedagogical models and numerous underpinning theories, such as self-determination, engagement, change, creativity, social interaction, constructionism, dependency, and learning.

I considered the essential physical, emotional, and psychological elements that increase student engagement, such as immersion. And those that provide a deeper and layered platform for the enhancement of personal learner creativity. These were prominent inputs into the system and curricula developments.

Finally research the value of the foresight-based learning system and the power of multimedia to increase levels of creativity. In attempting to develop a program for my initial Literature Review for this dissertation, I structured my initial review around 5 key topics, namely:

1. The changing economic and industrial era, jobs, workforce and workplaces and the need for creatives and creativity
2. Understanding and unlocking creativity and creative energy
3. Tendencies in post-formal education and learning approaches and pedagogical systems and their relevance to the changing needs of the potential future workforce
4. The role for multimedia and other emerging technologies in enhancing pedagogical approaches, systems, methods, and environments and their impact on student and teacher models and performance
5. Types of multimedia and their effect on the development of creativity through sensory enhancement effect and cognition and their impact upon creativity and skills development.

2.1.1 Data scanning, logging, and analysis

Throughout the literature review I reviewed in excess of 1000 academic works of which more than 300 identified in the bibliography provided relevant input for this dissertation. Each reviewed work was entered into a customised interactive repository, categorised, mapped/analysed, and developed using a "data: information: knowledge: wisdom" hierarchic system. Each review was immediately considered against a series of criteria as demonstrated in the example below, which is an updated version of the original futures scanning matrix (Woodgate & Pethrick, 2004).

Title	The title of the piece			**Author**	The primary author of the piece		
Source	Citation and link (if available)			**Date**	The date the piece appeared		
STEEP Categories	The one or more STEEP categories the piece relates to			**Keywords**	Other important terms that describe the piece		
Type	**Actual event**	**New trends**	**New cycle**	**New plan**	**Potential event**	**New info**	**New issues**
	Already happened, but few know about and implications not fully developed	Consistent increase or decrease, more or less of something over time	Recurring increase and decrease, more and then less of something over time	**Publicly announced intentions**	A potential happening or occurrence	Information that has just been released	Debate, conflict, decision, "Should we/they…"
Brief description of the item	A short paragraph describing the event or the new piece of information. What happened or what new information appeared?						
How could the future be different as a result?	A brief comparison about the future before and after this event. How does the future change a result?						
What are the potential implications for …?	**…Stakeholder name:**	The name of the person, group, organization, community, country or domain					
	Future consequences of this event for a specific person, group or domain. State the person, group or domain that would be affected.						
Overall effect (bold one)	Confirming (baseline scenario) confirms the baseline future; supports an existing condition, trend or plan	Creating (new scenario) creates a new scenario or plausible alternative future	Resolving (between two scenarios) shows one scenario becoming more probable compared to others	**Impact (0-5)** How much is this event or information likely to change the future for that person, group or domain	**Plausibility (0-5)** How likely will this change actually affect the future?		
Baseline, new or resolved scenario(s)	The scenario that is confirmed (baseline) or created (new) or made more probable (resolved) by this scanning hit			**Novelty (0-5)** How new is this event or piece of information to those involved?	**Timeliness (0-5)** How much time do those involved have before this item becomes public or is framed in some way?		
Scanner	The person submitting the hit	**Date Submitted**					

Figure 3 Futures Scanning Matrix

This Futures Scanning Matrix (Fig.4) feeds into an interactive digital scanning repository that I developed with fellow futurist Helga Veigl to cross-map data inputs to key concepts or what I term future leverage points from which to extract dominant themes, weak signals, wildcards, disruptors, and critical trends to establish transformative discontinuities. These act as start points for expanded inspiration and exploration into the relevant avenues of potential within the domain, both through evolution of the present and the science of foresight.

Given the wide variety of disciplines, subjects, crossovers and the need for a deep analysis of present, as well as future landscapes, the literature review generally followed a very disciplined deep scanning approached following the topics 1-5 set out earlier in the Chapter. The findings were logged and analysed in the matrix and cross-mapped where appropriate to create new scanning areas.

As time went on, I took a less linear direction and I added a more rhizomatic/nomadic approach by exploring what I term "black holes" (large missing concepts), "missing colours" (affective elements) "white spaces" and "hidden worlds" (adjacent and overlapping influences), which are all part of a proprietary foresight method I created and call "Imagine in the Abstract". This helped to identify and examine alternative perspectives. Naturally, as the literature review progressed several hybrid areas of exploration unfolded, particularly related to immediate past, near, medium and longer-term visions and potential scenarios.

2.2 Literature Analysis

Below I reference those works from the initial Literature Review that provided the most influential contributions to the research. The full details of each work are in the bibliography along with other sources I used for this dissertation.

In addition to the various reports, academic and conference papers on the future of jobs including those from global and government organisations, such as the World Economic Forum, Forrester, US Government, McKinsey, etc., all underscoring the massive scale of anticipated disruption, I found Sardar's and Marin's joint and independent continuing work on postnormal times and industry 4.0 offered greater reasoning and therefore a more substantial backdrop to the complexity, confusion and contradictions identified and embedded in this highly chaotic and transformative economic landscape. Maloney and Molina (2016) work on the possible implications of value change deriving from emerging, distributed economies and reimagined values of progress helped me reframe the plausible impact of the changing economic and industrial era with its emerging jobs, workforce and workplaces, on the need for newly emerging future skills, many identified in the literature of Siemens and Tittenberger (2009) and Rotherham and Willingham (2009) which included a radical rethinking on how to teach and educate learners in those often transdisciplinary skills. This area was studied more deeply in Morin's (2008) piece on the reform of thought, transdisciplinarity, and the reform of the university.

A key aspect of thinking in this area, especially related to the relevance of creativity was substantiated in the work of Jang (2015). His work on unlocking creativity and creative energy as critical skills in the workplace and education illustrated a strong start point as did Kelley, T., & Kelley, D. (2013) work on *Creative confidence: Unleashing the creative potential within us all*. Deutsch, 2011, writing on creativity and imagination provided a structure for framing the role of creativity for future work and Dollinger et. al. (2005) and Desailly (2016) provide greater understanding of the critical element of learner identity and creativity to the mix. Amabile (2013) and her Componential Theory of Creativity provided the theoretical baseline as did the work of Csikszentmihalyi & Sawyer (1996) in terms of creativity as a concept and engaging thinking skills and the later work from Sawyer such as *Zig Zag* (Sawyer, 2013) demonstrated approaches to increasing creativity. Chen and Chen (2011) , offered a view of options for creative strategy selection.

I undertook considerable literature research on the development, application, and assessment of creativity and levels of creative achievement both in education and the workplace for which the works of Almeida et al. (2008), and Bull and Kay (2010) and Cropley (Tan, 2015) and Patston et al. (2021), provided clear and comparative direction, while Jung et. al. (2010) outlined the developments connecting neuroscience and creativity, while Persaud (2007) provided decisive input on teaching creativity and Selvi (2007) on learning and creativity.
Conceptually postnormal times are challenging the current orthodoxies while manifesting pathways towards uncertain futures. Making sense of these

potential futures, their impact on the future workforce and likely skill need became a sequential research area. As such, I explored deeper into the types of skills where there was a general agreement that creativity would be the dominant the human workforce asset, substantiated specifically by Montuori's work *Beyond postnormal times: The future of creativity and the creativity of the future.* This brought me to the need to reassess humans and machines and their intellectual assets, their integration and was supplemented with a study of the changing human and the interplay, collaboration and mutual intelligibility between humans and machines in the future workforce for which Barfield (2015) together with my own writings underpinned the key directions of study about the changing human, on self-construction and life design.

Given the assumption that a human-machine workforce will require a collaborative HMR ecosystem and a new environment to drive the system such as CPS (Cyber-Physical Systems) architecture, I explored the work of Lui et. al. (2011) and Yin et al. (2012) regarding developments in Human Machine Resources (HMR) ecosystem design, asset evaluation and allocation, integrated thinking processes and approaches to mutual intelligibility based focused upon human centredness. This in turn led to a more comprehensive understanding of how to deal with the multiplicity of thinking and knowledge formats and currencies described by Michael Williams (Williams, 2011) and moreover the importance of non-linear thinking techniques and abstraction, and the reconceptualisation of the notion of knowledge inferred by David Weinberger (2010) and the importance of imaginal thinking. In this connection, I found in Puccio & Cabra (2019) a chapter on organisational creativity as essential research contribution.

In terms of potential transformative education and learning, Gidley (2016) writing on post-formal education provided a dynamic landscape for change as did Schejbal (2012) in his work on new paradigms for higher education in which he sets out new models and prototypes for education and its impact on the future education marketplace and policy. The multiple works of Sawyer (2008, 2013, 2014) ultimately established an excellent overview, on present issues in education, transformative approaches, and mobile learning especially in relationship to innovation and creativity, subjects expanded upon by Camacho and Legare in their explorations into personalised learning and competency-based education (2016). Godsk (2014) proved to be an excellent source on efficient learning design and Herrington & Herrington (2007). Expanded upon the role of mobile learning in a blended learning set up. From a theoretical perspective Sharples, Taylor & Vavoula (2016) contributed substantial insight on the theory of learning for the mobile age. Bergsteiner & Avery's (2014) discussions on the twin-cycle experiential learning model as well as Reijo Miettinen's reconceptualisation of the work of Kolb (1984) added new perspectives to the seminal works of Papert (1993), Kurt Lewin, Jean Piaget, Freire (1989) and Dewey (Dewey & Deledalle, 1994). Equally, Barman with Bhattacharyya (2015), and others provided excellent contributions on the effectiveness of constructivist teaching and learning.

My Literary Review of emerging and potential future multimedia included detailed investigation into learning tools, transformative media and transmedia and combinations of thereof and their applications in interactive learning both as input and output tools, including their impact on course design, learning environments, styles, and structures. Crucial contributions can be attached to Dede (2010) and his research on the future of multimedia and multimedia-based learning styles, especially when considered in contrast to Mayer's earlier work with Roxana Moreno on the cognitive theory of multimedia learning in which he sees multimodal media dynamically connecting to form logical mental constructs. Equally, Mayer's *Multimedia Learning* (2009) placed multimedia learning eloquently within the science of instruction and the science of learning explained through his set of principles covering areas such as knowledge processing and multimedia design. Mayer's work with Estrella (2014) were also critical as it considers the benefits of emotional design in terms of flow and transformation in multimedia instruction through the lens of theory and experiments. This work was studied in conjunction with Mayer's (Mayer & Estrella, 2014) piece that describes his approaches to introducing motivation into multimedia learning, as well as Mayer's earlier cooperation with Moreno (2007) on interactive multimodal learning environments. Similarly, Babette Park et al. (2015) expands upon cognitive, and affective design in multimedia learning processes and the importance of learner characteristics, spatial ability, and the importance of designing for positive emotions These and other works assisted the understanding of the critical aspects of sensory enhancement, affect and cognition and their impact upon creativity and skills development. It provided me with a platform from which to explore and assess the possible skill gap between present jobs and skills and future jobs and their skill requirements and the need for an increase in the creative class.

In a similar vein, I studied the work of Miliszewska & Horwood (2006) and Wankel, & Blessinger (2013) on approaches to increasing learner engagement and knowledge retention using multimedia and with it the potential to increase creativity.

These authors provided the groundwork for research into the types of multimedia and their effect on the development of creativity as well as the role of multimedia and other emerging technologies in changing pedagogical approaches, systems, methods, and environments and their impact on learner and teacher models and performance. Subsequently I was able to investigate the power, relevance and role of differing individual types of multimedia and their potential to increase creativity, such as Chirico et al. (2016) work on the expanded potential of virtual reality, Dannenberg & Fischer (2017) with game-based learning and gamification and their role in increasing sense-making, compared with serious games for leaning, Rooney (2012) and Rankin and Sampayo (2011) and Wouters et. al. (2013). I also conducted considerable research on the power and role of augmented reality in increasing creativity through learning and training (Gutiérrez & Meneses Fernández, 2014), Squire and Klopfer (2008) and the seminal early work of Milgram and Kishino (1994). Additionally, I considered simulated learning environments, Lean et al. (2006), as well as AI leaning agents and wearables for learning (Lamb & McMahon, 2015) and advancements in a full spectrum of emerging learning tools (Cowan, 2018a) and Czerkawski (2014), especially for creative training and learning (Scott et al., 2004) and those targeted at increasing creativity.

Ultimately, the Literature Review cycled back towards increasing creativity through transformative approaches to learner-centred teaching (Weimer, 2013) and learner-centred learning (Wright, 2011) and the education of the skills and mind-set required to meet the needs of the future workforce.

The reason why I have identified these works is because they are either considered seminal works in their field or clearly demonstrate a strong theoretical and practical understanding of the recently established or potential paradigm shifts emerging that could underpin the core dimensions of the problem statement and/or provide directional input towards answering the research questions. Many of these works also provided a robust insight on what others have done to solve a similar problem.

Once a foundational knowledge base was established and framed, I determined that the following studies were necessary to fully comprehend the critical issues that needed to be dimensionalised and analysed to fashion the full vision and arguments determined within the hypothesis that stands at the core of this dissertation.

2.3 Expert interviews

Of course, I appreciate the importance to which seminal, generative theoretical and experiential works or a priori knowledge provide critical background and guidance if understood from a contextual relevance and more recent academic books and papers offer a broader canvas of vision on one's topic and directional integrity. However, I also think it is inappropriate in this postnormal era of converged media sources and multi-layered influences, frequent discontinuity and constant re-contextualisation and reconceptualisation of commonly accepted meanings and structures, as well as expansive socio-professional networks, that we put our trust solely in the less dynamic currency of peer-reviewed academic literature to ascertain what is already known about the subject and its surrounding issues. It was critical to have access to state of the art knowledge and developments on the topics I was exploring. Ultimately, one is looking for optimised insights in an increasingly complex, fast-changing world where a tailored interview with the top expert in the field, or the inventor of a life-changing artefact, or an intellectual debate with a panel of fellow transdisciplinary practitioners at a top global forum may generate an equally meaningful and transformative contribution to one's project as well as new currencies of knowledge about the topic. Consequently, I undertook several detailed interviews with domain experts to access the latest thinking and developments in their disciplines.

In this context, I am referring to a combination of qualitative interview approaches for investigating implicit expert knowledge. Meuser and Nagel (2009) describe the expert interview as a qualitative interview, focusing on the knowledge of the expert, which is broadly characterised as specific knowledge in a certain domain. Such interviews provide a broader understanding of expert knowledge and direct inventive experience that extends beyond technical data and available facts by highlighting the implicit dimension of expert knowledge (Van Audenhove & Donders, 2019). What I mean by this is the opportunity to discuss projects in progress at key university labs, research pending publication, inventors and world leading developers of their field, internationally award-winning creatives, etc.

In terms of knowledge gleaned from expert interviews included in this research, I have used a mixture of exploratory expert interviews (Döringer, 2020), which are frequently used to gain knowledge and provide structure and context around developments in lesser known or emerging fields, theory generating expert interviews (Bogner & Menz, 2009, 2018) with those that speak with authority and have a track record of developing and contributing progress to their specific and adjacent fields, and problem centred interviews (Leder, 2019; Murray, 2015; Shirani, 2015; Witzel, 2000). The latter presupposes a specific research design and tools for conducting the interviews usually through an egalitarian dialogue. In this context, I conducted 23 interviews with leading global experts all of whom are referenced throughout the dissertation where appropriate.

Relevant interviews were conducted with the following experts: They were the following, listed by topics.

Creativity

a) Dr Brian Magerko, Professor and Head of the Impressive Machinery Lab, Georgia Tech, Atlanta, USA
b) Steve Tanza (Stanza), Lecturer and digital artist, Explorations in creating mixed media immersive realities
c) Dr.Henry Jenkins, Provost Professor of Communication, Journalism, and Cinematic Arts, a joint professorship at the University of Southern California Annenberg School for Communication and Journalism and the USC School of Cinematic Arts. Transformative multimedia theory.
d) Dr.Howard Gardner, Developmental psychologist and the John H. and Elisabeth A. Hobbs Research Professor of Cognition and Education at the Harvard Graduate School of Education at Harvard University. The future of Creativity.
e) Paul D. Miller, aka Dj Spooky, electronic, and experimental hip hop musician, Professor of Music Mediated Art at the European Graduate School, Alternative thinking techniques.
f) Patrick Lichty, Artist, Writer, Contemporary Arts & Culture Advocate, VR, AR, & AI researcher, Professor @ Winona State University – Creative tools and technologies for learning
g) Michael Shanks, British archaeologist. Chair in Classics at Stanford University

Multimedia and social learning

h) Howard Rheingold, Critic writer, academic at UC Berkeley and Stanford University created the concept of virtual communities and smart mobs, Mind amplification and learning, Berkeley, USA
i) Clay Shirky, Writer, consultant, and educationalist - The effects of multimedia on teaching, audience theorist, NYC, USA
j) David Coulter, Composer and multi-instrumentalist and theatre director, Immersion and sonification, London, UK.
k) Douglas Rushkoff, Media theorist, writer, columnist, lecturer and Professor of Media Theory and digital Economics at the City University, NYC, USA, invented the terms viral media, digital native and social currency.
l) Dr. Pattie Maes, Professor & Head of Media Arts and Sciences at MIT. She Founder- and runs the Media Lab's Fluid Interfaces research group

m) Dr Helen Papagiannis, World-leading expert in the field of Augmented Reality (AR). The author of Augmented Human - How Technology Is Shaping the New Reality
n) Dr. Nevena Ackovska, Professor Faculty of Computer Science and Engineering, St. Ciril and Methodius University, Skopje, N. Macedonia. Human-Robot interaction, designer of learning and teaching robots

Future of work

o) Dr. Natasha Vita-More, Professor (Singularity University), strategic designer, author, speaker and innovator within the scientific and technological framework of human enhancement and life extension, Author of the Transhumanist Manifesto, Executive Director of Humanity+ Inc.
p) Frank Eichstadt, Chief spacecraft and space habitat designer at Orion design, Houston, USA – future workplace design
q) Prof. Dr. Aleksander Rodić, Head of the Robotics Center and Vice-President of the Mihailjo Pupin Institute in Belgrade, Serbia Work and robotics
r) Richard Florida, University professor at the University of Toronto's Rotman School of Management and School of Cities. Expert on the creative class.

Future Pedagogy

s) Elizabeth Strickler, Professor and Head of the Institute for Creative Industries, Georgia State University, Atlanta, Georgia, multimedia development for multimedia learning and entertainment.
t) Dr.Elaine Raybourn, Senior scientist at Sandia Labs, Transmedia learning and serious games, Hexa computing member, USA.
u) Jennifer M. Gidley PhD is an Australian psychologist, innovative educator and futurist. She is an Adjunct Professor at both the Institute for Sustainable Futures at UTS Sydney, and Southern Cross University, Lismore, NSW. Author numerous books including Postformal Education (2016).
v) Greg Bear, SciFi Writer (Star Wars, Darwin's Children) The importance of futures literacy and transdisciplinary learning.
w) Dr. Damon Yarnell, Associate Provost and Executive Director of the Center for Advising, Internships, and Lifelong Career Development, Dickinson College.

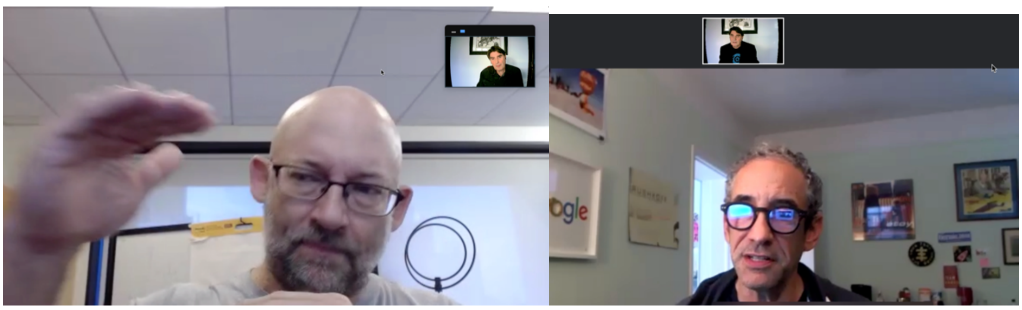


Figure 4 Interviews with Clay Shirky and Douglas Rushkoff

The scope of exploration in these interviews covered topics such as:

a) Potential learning systems, interfaces, and mentoring; including virtual, agents, robotic, human-machine integration and holograms
b) The power of artificial intelligence, data and systems, cognitive and emerging computing
c) Financing models and operational structures
d) Adaptive management systems and support structures
e) The philosophy dilemma: demand and responsibilities
f) The learning experience and tools, gamification, serious games, transmedia, etc.
g) The unique characteristics for each potential future point of differentiation and desirability.

While references to these interviews are sprinkled throughout the dissertation as and where appropriate, the aggregated benefits of these interviews were definitive in understanding the state-of-the-art developments and future thinking in each of the four topic areas mentioned above. I gained a far deeper understanding of current and impending changing concepts and contexts for creativity, particularly from the interviews with Magerko, Tanza, Strickler, and Jenkins. Those conversations gave me a deeper understanding of the advances and benefits of combining AI, multimedia, and art for creativity development alongside the use of unfinished artefacts as a pathway to challenging higher levels of creativity. Our conversations also treated multiple approaches to deepening immersion through experiential media and ways of linking techarts with real-world development and creative representations of future worlds. Jenkins expanded my knowledge in this regard through conversations around the embellishment and changing roles of narrative influenced by interactive game design, emerging UX interfaces and new modes of storytelling from transmedia to integrated interactive physical-virtual jouissance or free-play. Stricker focused on the power of volumetric video and the work of colleague Illya Szilak and the ability to create deeper emotional connection and intimacy through 3D "true" immersion even on a flat screen using customised avatars that allows for VR personalised expression, communication, and interaction.

My interview with Howard Gardner was particularly rewarding insomuch that it provided a deeper insight a variety of possible approaches to developing and increasing creativity. We discussed the importance of integrating cognitive dissonance, complex challenges and ambiguity or opposing unexpected notions as drivers for that inner need to create new beliefs. Gardner mentioned the point that artists define the spirit of an era and provide early signposts of change and early detectors of trends and that creating mental, visual, and sonic representations of the unexpected. In this context, Gardner believes that the new digital media (NDM) will change our minds through the interaction of multimedia, multi-personalities, and multi-intelligences. Equally, NDM will increase creative capacity, sensation and future positive experiences and ideas, which he elucidates through the three levers of representational re-descriptions, resonance, and resistance.

Not unlike Paul D. Miller, one of the other interviewees, Gardner believes that the essence of creativity lies in the transitional spaces between ideas, in the nuances where emotion and sense flow are increased. He also draws attention to the importance of Transdisciplinarity, a point also emphasised by the other interviewee

Elaine Raybourn, specifically the connection or integration of different disciplines or spheres into a coherent whole, releasing new areas of change and paradigm-shifting ideas. Raybourn explained that the essence of her work has been about making the Internet more of a real place, where one can manipulate data in real-time. In her view this means bringing together emotional cues, positive behavioural stimulation, and ideas in a participative manner. Her provocation came from the desire to prove that one can be in two different places at the same time, expressing multiple modalities of a single identity. In this context she feels that there is a need for imaginative environments that enact creative behaviours to enable expression of one's identity and power. Here she sees the need to create an environment that allows learners to use performative roles to attach themselves to each channel of their expression to convey a comprehensive and harmonised message that is persistent yet open to critique. Here Raybourn places deeper emphasis on learning experience design (LX) through serious games and transmedia leaning as a means of creating new horizons and paradigms of teaching and learning. Unquestionably, Raybourn believes transmedia learning to be strong candidate as a substrate for leaning in the future. As the founder of transmedia leaning, she believes that transmedia affords the benefits of cross-cultural communication and awareness, critical thinking, mental agility, and creativity, but only if we can maximise the power of integrated tools with connected operability. Where this integration is successful and can disambiguate the roles of each medium, she sees a dramatic increase in the emotional engagement of learners, effectiveness, and creativity.

Raybourn places considerable important on the social construction of knowledge, especially the multimedia coproduction of knowledge. She sees the near future growth of augmented reality, virtual reality, serious games, and simulation design and other xMedia as well as scientific visualisation as research and development endeavours that are critical to our dealing with perceptions of knowledge in our fast-changing world. Raybourn told me that future experimentation and exploration in virtual environments will expand learner thinking and leader to them experiencing unexpected realities. Given her present work on the design of Aurora, the exascale supercomputer due to be launched in 2021, Raybourn believes that high performance computing will create new paradigms in terms of how technology unleashes novel human capabilities. Consequently, she sees preparing humans for the future as a key aspect of her work to maintain human control in the light of progress with self-directing AI and other forms of human-machine collaboration.

In exploring further, the potential roles of multimedia and social learning through interviews with a variety of experts, I was able to examine the broad gambit of state-of-the-art change agents in this arena, both from the theoretical and application of emerging tools. In this regard, Clay Shirky whose expertise focuses mainly on the economic and social effects of multimedia and the way that the human adapts to the machine, echoes Raybourn when he told me "We create technologies and afterwards they create us". Shirky talks about the end of audience and the *prosumer*, those that both produce and consume media simultaneously, and have transformed media culture by the practices of creating and sharing images, real-time media coproduction of artefacts, the develop of new communication languages and symbols such as emoticons, leading to a consolidated culture. Shirky sees the new cultural norms being created by youth and are not easily native to preceding generations. He sees such practices enhanced by AR overlays on real-world situations and the role of multimedia immersion for learning and teaching, with the affordances of these technologies able to increase access to new forms of knowledge and fluency in communication. These new forms arise from the conflict between conversation and consumption and the ability to overlay both in multiple formats and genres on top of the technologies. Shirky quoted examples such as Reddit, Slack, EL5 and EL6 packages (EL5 stands for Enterprise Linux 5, Red Hat Enterprise Linux version or CentOS version, and EL6 accordingly for Enterprise Linux 6). He considers that the social genre and social learning will become the new norm and that general purpose social tools and software will be more important than specific learning software and tools. It will be a strong mix of collaboration and education tools. Shirky believes that we have reached a new cultural crossroads where group work will be more important than learning alone and more global fluidity in learning groups. Such groups or teams thrive on friction and need to be assembled with care and should be stickier, otherwise they lack sustainability even over short periods.

In the interview with Douglas Rushkoff, I focused on the changing human the role of humans in the postnormal society, how humans manage to flourish and how can we shift the conversation away from systems, interaction and interfaces back to human, away from alienation and towards collective human progress to fulfil the dreams of late 20th Century psychedelic renegades in their wonderful weird and wonderful ways. Rushkoff sees creativity essential and emphasizing the need for creativity to race to the centre of educational policy. His believe is that we need to retrieve to the "medieval" in the digital to develop simplification techniques in teaching the fundamentals specially to give the human the sense of control rather than the opposite. Rushkoff believes this requires a greater level of experiential learning and a futurisation of subjects such as media theory. This simplification could help learners better challenge the underlying assumptions and complexity of their world and to think critically about the micro content to contrast the technology ecosystem against the importance of humanity and social justice. In addition to experiential learning, Rushkoff sees interactive narrative and storytelling as a crucial contribution to increasing creativity supported by the "magic" of immersive media formats. Rushkoff himself uses an approach he calls media archaeology – digging for artefacts that express human creative wisdom that distinguish the effective productivity of the human separately from the technology.

Talking of psychedelic renegades, the interview with Howard Rheingold, a prime example of that incredibly innovative generation provided a purposeful conversation on social learning. I first met Howard in the 1980s, when we were both active on The Well, which is considered the first online community. Later Rheingold took on the role of editor-in-chief for the Millennium Edition of the Whole of Earth Catalog, the American counterculture magazine and product catalogue published first by Stewart Brand. Having coined the phrases "virtual community" and "smart mobs" in his seminal books of the same names, Rheingold who teaches at both Stanford and Berkeley believes the key is building courses in situ, to trust students and to give them responsibility to adapt the role of co-teacher. Rheingold uses role-playing to enhance learner agency. He claims about a third of the class help teach the others. Rheingold has undertaken considerable research on mind amplification, and he uses mind-mapping, lexicon-building, re-contextualisation as successful tools for co-learning, course co-development, co-evolution of tools and cooperative learning. Rheingold, not unlike Rushkoff, believes we are hypnotizing ourselves with technology. Unsurprisingly, he recites McLuhan ("We shape our tools and thereafter our tools shape us"), as the prophet behind our dilemma behind the pertinent levels of media technologies in pedagogy and social learning. Rheingold believes that digital literacy is the emerging digital divide – what he terms the "next smart". Rheingold sees the fine balance between attention and tension as central to learner success coupled with "crap" detection and the ability to sift out bad information and to determine the essential points of intervention. In this context he sees the necessity for simultaneous content and tool development.

During the interview with Helen Papagiannis, she picked up on storytelling as one of the three key attributes of augmented reality (AR), along with visualisation and annotation. She also pointed out the definitive purpose of augmented reality in terms of its ability to augment human intelligence and extending human capacity, which takes place across knowledge, connectivity, and creativity. AR facilitates the understanding of knowledge that is difficult to grasp and makes the invisible visible, rather like x-ray vision. According to Papagiannis, at the core of AR are spatial dynamics and multidimensional structures, transformed into annotated environments and surroundings, which makes it excellent for co-learning and virtual teaching with remote experts in real-time, during and external to usual class times.

While many of the other interviewees had placed their focus on the human dynamic within the human-machine ecology, Natasha Vita More, who wrote the *Transhumanist Manifesto* in 1983 (Vita-More, 2020), in which she talked about the possibility for overcoming disease and extending lifespans, emphasised the power of technology. Vita-More demands we discuss challenging questions that try to unravel where humanity is headed and its purpose, to explore this potential through new angles to create new dimensions and landscapes to understand which myths determine our constraints to human progress.

Vita-More work evolved Manfred and Nathan Klein's cyborg concept, immortalised in Donna Haraway's Cyborg Manifesto. Vita-More sees transhumanism as the sensibility of emergence. However, she mentioned that Manfred Klein told her that the difference between the cyborg and the transhuman is anchored in evolution and personal identity. The cyborg is an appendage, a human with added technology, which flows together. Whereas the transhuman is a point in human evolution using emerging science to improve health, performance, and life-extension, by augmenting what we already are.

Where are we today? Life-extension, aging can be forestalled both from the medical perspective and through the transhumanist approach of human augmentation and extension. Vita-More claims she worked on full body prosthetic relates to an alternative body protective skin – designed as extension of prosthetic limbs, etc. (physical embodiment), but it also includes a metabrain, which is very similar to brain implants, mind to mind and similar current developments, such as disembodied agents, to back up ideas and store memories and improve our cognitive and learning skills. She sees these synthetic environments as a natural upload, download or cross-load of transdisciplinary, such as nanotech and biotech combinations, supported by social ethics.

Vita-More specifically works on transforming education programs to take account of the integration of these technologies for the benefits of HMR integration education. She believes that technology students should learn from the arts and anthropology and art students need to know how the tools they use were conceived, what the technology designers were thinking. To do this she is heavily attached to visualisation, immersion, and gamification. While a decade or so ago, such discussions may have seemed simply irrelevant, today, they are very present and help form our understanding of the developments in cyborg and transhumanist concepts which are already in the works and are important from the perspective of gaining deeper insights into the potential future of both education and work and their integration.

My conversations with MIT's Pattie Maes over the past two decades or more have frequently dealt with a broad span of human-computer interaction and software agents often under the umbrella of our alternative selves. Much of her work and that of her team has centred on the sixth sense or how to create sensory and emotional augmentation with the help of intelligent devices, particularly wearables or implants. such as advice mentors with reasoning AI assistance or the use of interoceptive technologies. I spoke with her in depth about her work on human-centred AI (HCAI) both as active process leaders and collaborators, also about simulating future worlds through sensory stimulation, which is key to the in-class "Living the Future" programs.

Eichstadt and Rodić both discussed the emerging power of robotics and machine learning both for humans for training in complex environments and for the machines to teach themselves how to better support human endeavour in the workplace including teaching and learning. Eichstadt who has spent the last three decades designing spacecraft for NASA and more recently, space habitats to support commercial space stations, space travel and exploration spoke about the need to upgrade the status of the human in the architecture of the space workplace to extend human capabilities improve human effectiveness and performance and to expand human thinking and imagination for which he believes futures literacy is a key component. Eichstadt sees futures literacy as a future-compatible alternative to traditional engineering and design environments and learning. Their research goal is to use that development environment to produce immersive/interactive tools through which the resulting complex systems would be supported, evolved, maintained, and expanded over time. He also believes that neuro-feedback capabilities might be integrated into the overall system such that actual data could be used to help monitor user engagement, immersiveness, evaluate effectiveness of alternative immersion techniques and interfaces, and inform enhancements for learners and for the immersive learning environment itself.

Rodić, who is a designer of humanoids provided me with an update on progress in humanoid development compared to the powers of a human being. His estimation is that in a laboratory environment, the humanoid is now 70% human, missing mostly emotional and cognitive abilities, but that this falls below 50% in the real world. However, he believes that all students should begin to learn to interact with humanoids both to learn more about their own potential and to become more familiar with the likely workspace they will have to deal with in the near future.

Keeping with human-robot interaction, in the interview and on-going discussions with Dr. Nevena Ackovska, we discussed advances in learning and teaching robots, especially those she and her team have designed to work with students with learning difficulties. More recently she has seen major advances in agile robots that are able to adapt to learner characteristics and behaviours, as well as new levels of self-learning and greater potential for directed interactivity, especially where learners can determine a preferred action and the robot learns to respond in an augmented manner.

All these experts and more helped me to garner a deeper understanding for the potential of new worldviews and shifting paradigms in education on a broad spectrum of possibilities and contexts regarding the changing human, future communications and interaction with machines in the broader context, fresh learning and teaching approaches, social interaction and social learning and the power of emerging xMedia, hybridisation of approaches to education and the growing role of transmedia and transdisciplinarity, the future of work and its influence on the future of education, all in the context of increasing learner creativity.

2.4 Foresight study on the future of education

Having studied the essential problem and the need gap, I undertook a comprehensive six-stage foresight study (based on the TFL internationally recognised approach) over a period of four months to determine potential discontinuous futures for education and learning with specific emphasis on Norway. The purpose of the research was to provide future context for the need and to expand the understanding of the scope and dynamics of the gap. The Research also considered the future of universities as another dimension of the future of education and learning. There is no single driver of change, nor is there one plausible future, but multiple with different dimensions and perspectives. The six-stage foresight process works like a funnel, starting with a very broad range of potential influences and influencers both directly connected to the domain and from adjacent and seemingly unconnected spheres of activity and ending with a range of potential diverse futures scenarios based upon extremely thorough research, using around 30 different scanning, mapping, modelling, thinking, creating, evaluation and strategic techniques. A comprehensive review of this research is covered in Chapter 5.2. The process includes multiple proprietary techniques created by TFL. The outcomes became a critical input for the design considerations (Chapter 5.3) for the learning system I developed as a framework for the courses.

2.5 Frontline Panels and workshops

a) The *Frontline Panel* was used at the end of Stage 3 of the Foresight Process to research the future of education and learning. The panel consisted of an eclectic group of 10 leading future-thinkers and was conducted via Zoom over a continuous three-hour period. The panellists are identified in Chapter 5.2. They consisted of a user-experience specialist for learning technologies, a pedagogy theorist, a university administration director, a programs designer from the Norwegian Ministry of Education, a director of expert systems and decision-making from UAE, an innovative learning specialist and inventor from Kimberly Clark Worldwide, Consulting Futurist, the founding director of the Institute of Design Studies, a director of immersive media research, and the founding partner of an innovation academy.

It was not an expert panel, in the conventional sense, but a panel of multidisciplinary experts seeking to open new gateways to the domain topic and explore and analyze future-relevant ideas. I designed the questionnaire, selected, and engaged the participants and facilitated the Frontline Panel using a variety of discussion formats, stimulus boards, video and some proprietary creative tools as well as an online whiteboard, Miro and Kumu software.
The panelists attempt to hijack unexpected signals and breakthrough ideas rather than the sort of incremental thinking often associated with more typical expert panels and focus groups. The panel is intended to provide an array of start points for the next foresight stage in the development of paradigm-shifting concepts.

The topics discussed included:

- Integrated multimodal learning spaces
- Self-managing educational institutions
- Optimizing learner potential
- Delivering future concepts and contexts of knowledge
- Transdisciplinary creatives
- Alternative knowledge suppliers
- New worldviews and paradigms for education
- The roles of AI, robotics, agents, implants, and neuroscience
- Gamification and serious games
- Futures literacy and workforce needs

b) A *living the future* workshop was conducted over two days in Stage 5 of the foresight process to synthesise, expand and evaluate the futures scenarios developed in Stage 4. These workshops are about bringing to life the scenarios by extending the concepts, rethinking the contexts, and expanding upon the deeper details of the core scenario concept and ultimately evaluating their completeness and power against a set of criteria. The workshop, which I designed and conducted, involved 7 professors and 10 doctoral students from the University of Agder in Grimstad. The workshop dealt with each scenario in various combinations of individuals and teams, enabling at least two teams to separately work on at least two scenarios. Fuller details of the *living the future* workshop, complete with the environment, approach inputs and outcomes are described in Chapter 5.2.4.

2.6 Field Research

Field Research is a mostly qualitative method in which the researcher emerges into an everyday life setting of the participants with the goal of collecting data. This approach was formed in the professionalisation of anthropology and sociology and was later formalised in human studies fields. Methods of field research are participant observation, interviews, and conversations as well as the use of personal documents. I applied field research at critical times while writing this thesis to discuss, observe and evaluate learner performance, both during classwork (on and off-line) and during experiential learning sessions, and for final project submissions. Firstly in 2015, for evaluating the graduate students' evaluation and performance over the first two years of the original course and again in 2017, prior to the commencement of the new course. This involved in-depth interviews with first 18 graduate students (2015) and then a further 17 students in 2017, namely 35 in total, all of whom had taken the original MM402 graduate class and its revisions. In addition to the interviews, I applied Ian Miles' *Dynamic evaluation approach,* as well as the *Capability Maturity Model Integration (CMMI)* adapted from Georghiou and Keenan (2006), Popper et al (2010) for learner performance analysis.

Secondly, I conducted creativity evaluations using the Creative Solutions Diagnostic Scale (CSDS) for all the final project submissions for MM402 Fall semesters 20181 and 2019. Case studies of assorted projects are included in Chapter 6. The CSDS measures functional creativity based upon multiple sub-criteria for four primary considerations: relevance and effectiveness, novelty, elegance, and genesis. I prefer the CSDS over the Torrance Test for Creative Thinking, or the short form Vast Creative Abilities Indicator (VCAI) both for evaluating student creativity on their own specific project output and for the evaluation of the outputs from foresight study. The reason for this that the TTCT and similar tend to rely on responses to predefined visuals.

2.7 Questionnaires and student interviews

I conducted quantitative research among the students who attended my classes at the University of Agder in the period since I revised the course Fall 2017 under the guidelines of the Norwegian Centre for Research Data (NSD) approval from November 2018. I received 47 completed responses as indicated in the results shown below. I also conducted five qualitative research interviews using the same questionnaire with students who did not complete the questionnaire for reasons of personal privacy. The respondents had an average age of 24. Gender split: Male 58%, Female 42%.

2.8 Ethical Considerations

All interviewees, panelists and workshop participants referred to above were made aware that the outputs from those specific activities would be used for purpose of this dissertation and where appropriate were advised that the interviews were being recorded.

3 Establishing relevancy and Validation of problem statement

This chapter deals with establishing the relevancy and validation of the problem statement set out in Chapter 1.2. Its purpose is to determine the areas and level of change arising in the postnormal era as it pertains to discontinuous transformation of the emerging workscape, the potential structures, environments, jobs, roles and skills, including the impending shift towards human-machine resources, and the ability of the current education system to meet those changing needs.

3.1 The Changing Workscape

The World Economic Forum in its 2016 report *The Future of Jobs* concluded that 65% of children entering primary school in 2016 would be employed in jobs that do not yet exist. A paper, previously published by the U.S. Government (Executive Office of the President (USA), 2016) on the possible economic impact of artificial intelligence and automation, viewed the issue "through a policy prism". It stated that "whether AI leads to unemployment and increases in inequality over the long run depends not only on the technology itself but also on the institutions and policies that are in place." The report continues that it is not robots that will be taking our jobs rather, technology is changing the spheres of possibility. Albeit the Forrester Report predicts that 6% of US jobs will be lost to robots and automation by 2021, with the main losses being felt in transportation, logistics, customer services, banking, retail, and healthcare. In a 2019 paper Carl Benedikt Frey and Michael Osborne, estimated that 47% of American jobs are at high risk of automation by the mid-2030s (Frey & Osborne, 2017).

Many jobs are projected to disappear or be totally re-vamped and new unforeseen professions and jobs will evolve in the same way that they have over previous decades (Nesbit, 2015). However, the real risk in the next economy will be missing the opportunity to future-proof ourselves, both through reconsidering our education needs and tools and understanding what we need to prepare for. In a keynote presentation I gave in February 2020 at the MOI Innovation Summit, in Abu Dhabi, I pointed out that the following jobs had not been fully established only a decade ago (Woodgate, 2020):

1. AI integrator
2. Saas designer
3. Cloud solutions expert
4. SEO specialist
5. Cyber forensics expert
6. Uber driver
7. Big data miner
8. Personal social profile builder
9. Mobile app developer/sales
10. Blockchain developer
11. Driverless car engineer
12. Telemedicine physician

Another McKinsey Report (Manyika et al., 2017) identified that globally up to 375 million workers may need to change their occupations and that does not include upskilling (Fig 6)

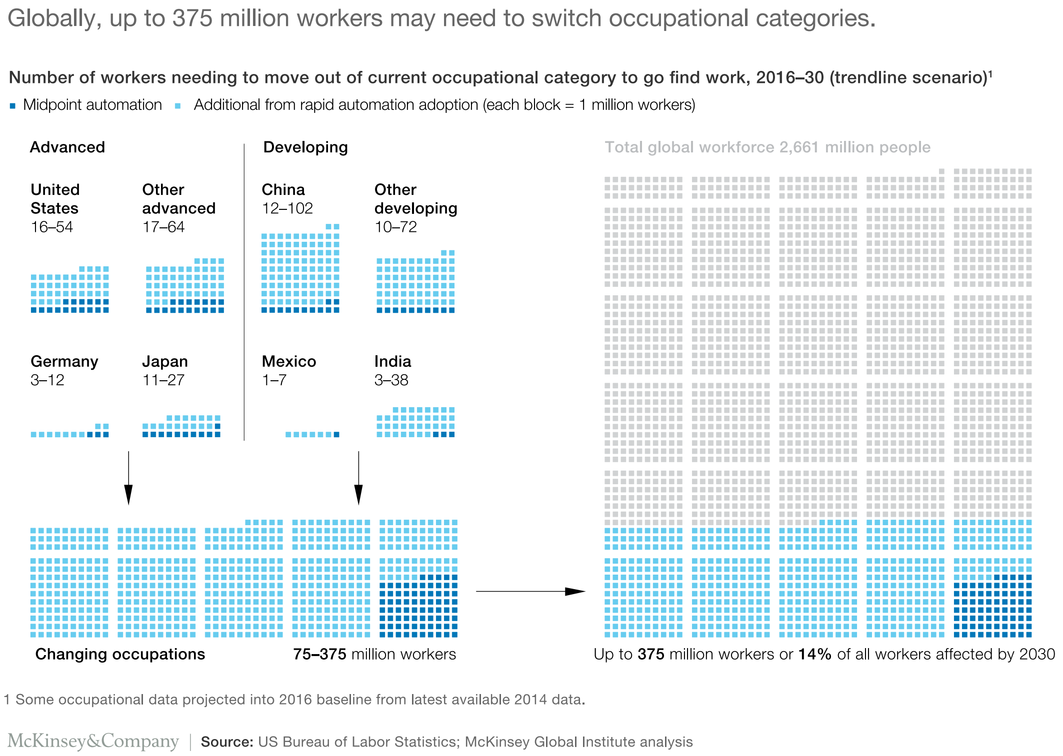


Figure 5 Shifting occupations (Manyika et al., 2017)

Between 1980 and 2015, we had witnessed a significant shift in the structure of the global workforce, particularly in developed western countries. As such, we have experienced the Fourth Industrial Revolution and witnessed a significant shift in the structure of the global workforce, both in developed western countries and the major economies of China, Japan, South Korea, India, Brazil, Russia and South Africa. This shift has been driven primarily by the emergence of digital technologies, globalisation, expansion of the service industry in line with considerable social and lifestyle changes, the migration from rural areas to cities, (especially mega cities), growth in alternative economies, growth in non-routine cognitive jobs, women in the workplace, increase in gained bachelor and advanced degrees, etc. (Woodgate, 2017).

The success of this revolution will ultimately depend upon whether all concerned stakeholders can agree and implement transformational change in the current approaches and structure and roles of education, training, skill development and upskilling, which are key drivers of the outputs of this dissertation. In addition, we can expect to see a broad simultaneous revision of labour market policies, employment arrangements and existing social contracts (World Economic Forum, 2018), many of which will demand considerable debate and legislation reform over issues of ethics and values. These demands will be centred around our relationship with machines and areas ranging from the boundaries of application of emerging technologies such as self-organizing artificial intelligence and the convergence of the potential and benefits of biotechnology, nanotechnology, neuroscience and quantum computing to privacy, cryptology, identity, profiling, and data ownership.

To gain a view of the changing industry categories, it is enough to consider a Forbes global 500 list or an animated visual of the top global companies in 1980, 2000 and 2018.In 1980, the top 10 were mainly American covering oil and gas, automobile manufactures, steel, and power generation equipment. IBM was up and coming.

By 2018, the global leading companies' landscape had changed dramatically, with US automobile manufactures still important, but joined by banks and financial institutions, large-scale retailers and telecommunications and computer manufacturers. In 2018, the Fortune Global 500 contains 129 Chinese companies, 121 (USA), 52 (Japan), and around 30 each France and Germany. The breakdown of the top companies shows the growing importance of on-line consumer purchases and "big box stores" with the Chinese and US continuing to lead the way, banks and financial institutions, whose trading scope and practices have changed dramatically over the past two decades and hi-tech companies such as Alphabet (Google) and Apple prominent. Oil and automotive are still strong, thus reflecting the current slower than projected progress in alternative energy and non-internal combustion engine vehicles. Eight of the top 10 global companies are non-American. It is of course difficult to make direct comparisons because of the numerous acquisitions, mergers and consolidations over the period that have involved many of these leading companies, but the tendencies are indicative of the growing power of China, continuing future focus of the USA, globalisation, lifestyle shifts and the evolution of technologies that have provided completely new platforms and architectures enabling new industries and marketplaces. The Internet is an obvious example.

Even a cursory look at the broader landscape painted by the Fourth Industrial Revolution, quickly shows both the growing power of the leading tech companies, but also the major impact of the integration of hi-tech technology processes, production architecture, distribution and management structures and networks in traditional industries. Here we can witness the advances in industries such as the construction industry with its self-managed operations, self-building and 3D printed equipment, nanotech-infused and shape-shifting materials and connected, communicating, situation and context aware structures and mobile robots. Or agriculture with its energy independent farming, autonomous biodiesel or hydrogen fuelled equipment or the automotive industry where in many cases there are more robots employed than humans. While some of these advances require a long period for general implementation, they are all currently in progress, either as pilots or on a broader scale and some are direct outcomes of my foresight work in these specific industries.

To harness the transformative potential of the Fourth Industrial Revolution, business leaders across all industries and regions will increasingly be called upon to formulate a comprehensive workforce strategy ready to meet the challenges of this new era of accelerating change and innovation. In parallel, as educationalists it is part of our role to ensure that the education provided to our students reflects the intricacies of that transformation.

While there are many government and industry projections of the extent of these structural changes in the global workforce market depends significantly on the time horizon taken into consideration. The adoption of this workforce transformation will be widely influenced by emerging technologies and their rate of advancement, organisation and stewardship change, economic systems and well-being, human adaptation, trust and culture, labour laws and stakeholder roles, ethics, policies and student-mentor relationships but will ultimately be driven by emerging industries, marketplaces, jobs and skill needs.

There is a major need to proactively explore the plausible scenarios under which this transformation could play out. All stakeholders including individual workers need to be aware and prepare for the oncoming disruption that workforce transformation will incur, not least educationalists and education policy makers before the changes are too far underway. We need to understand the scale of potential occupational change by documenting likely future industries, markets, and jobs, highlighting opportunities for both humans, augmented humans and new technologies to augment human work to improve performance, efficiencies employee well-being upskilling, and evolution of job-relevant skills. Understanding optimisation on all levels will lead to greater investment, trust and controlled implementation and progress.

As a practicing futurist with 25 years of experience of global consulting for many of the world's largest industrial enterprises, government institutions, agencies and ministries, educational authorities and city authorities and academic experience teaching masters and doctoral students I have witnessed first-hand the disharmony between the pace and directions of educational change and emerging workforce needs. I believe teaching for both today and tomorrow is a salient contribution to a student's post-education success in the world of work. This disharmony has had an accumulated effect on the availability of the types of skills, approaches and potential needed to meet the impending changes in the emerging workforce. It has left a major gap between the projected workforce needs and structures over the coming decade, fuelled by an array of transformative technologies, transdisciplinary approaches and completely new fields and opportunities. The role of a practicing futurist is to create the future for a variety of time horizons, but most frequently between 10 and 15 years out. When viewed from the future and through the lens of discontinuous change, this challenge seems more acute, given that the road and strategic direction towards that future, while it will be regularly disrupted or enhanced by wildcards and unexpected events, needs clear yet flexible milestones and resource distribution to make it a reality. While one of the roles as an educator is to develop curricula and pedagogical approaches that amongst other things help reduce this gap, not just in terms of numbers of students educated with the appropriate domain knowledge, but moreover with the broader vision and capability of dealing with transformative change in the impending era of increased human-machine work integration and the increasing need for human creativity.

Unsurprising for a professional futurist, tasking himself to develop a new learning system that will be appropriate to current and at medium-term learners and that is specifically aimed at increasing creativity in the workplace, I felt the need to leverage the existing research and embark upon new foresight research that would provide a more holistic context in which to anchor "the purpose" aspect of the system. One of the central issues revolves around what is fast becoming known as HMR (Human-machine Resource Management) is replacing HR (Human Resources) in progressive organisations. It is a critical element in terms of our understanding of which potential jobs will arise and which jobs are likely to become redundant or replaced by machines. It is a particular area in which clarity is needed if we are to harmonise and optimise resources, efficiencies, and performance. Despite significant advances in the last couple of years in self-developing AI, we still seem to be a few years away from the Artificial General Intelligence (AGI) or Singularity which is the point at which machines have superior intelligence to humans. This point was recently reconfirmed by the personal conversations over the years with the futurist colleague Ray Kurzweil, author of The Age of Spiritual Machines and Michael Bess, author of Make way for the Superhumans. However, in the discussion on Superintelligence in Asilomar, Pacific Grove, California in 2017, between Musk, Kurzweil, Selman, Russel, Bostrom, Chalmers, Hassabis, Harris and Tallin there was full agreement that the Singularity was on its way, but that full AGI was unlikely before until 2050 (Future of Life Institute, 2017). However, considerable research project work on AI surpassing Higher-level Human Intelligence (HLHI) is well underway with 84 cognitive architectures having been developed over the past 40 years of which 49 are currently being used on over 1000 projects (Jackson, 2018).

However, we are seeing major advances in cybernetic organisms: brain inspired algorithms, artificial intelligence, IoT (Internet of Things) & data analytics, autonomous & robotic process automation, self-directed and self-creating intelligence using algorithms that combine of tree-based search and learned models, tools & cognitive machinery, molecular machines & automatic precision & self-assembly, quantum computing, communications & cryptology. However, it is the transdisciplinary sciences where combinations of nanotechnology, biotechnology, robotics and artificial intelligence, neuroscience, and quantum computing that we are seeing extraordinary inventions and progress. These inventions are demanding considerable debate and legislation over the ethical questions of both their development and application. There is a particularly worrying threat coming from the combination of robotics, genetic engineering and nanotechnology as the resulting amplification achieved through their combined powers is leading to the design of high value applications that are not always society-friendly, even taking into account the high levels of human change in terms of values and morality (Agar, 2010; Allhoff et al., 2007; Mulhall, 2007; Sandler, 2014).

The development of Cybernetic organisms: using brain inspired algorithms is being accelerated and Neurolink - Elon Musk's new company has already managed to create electrodes in an array of threads embedded in the brain. There is also the Blue Brain Project is about build biologically detailed digital reconstructions and simulations of the rodent, and ultimately the human brain. Equally we are seeing growing involvement in the research on the potential for embedding nanobots - nanocomputers inside the human brain, what is being called minds without organs, downloaded consciousness is an increasingly popular theme in science fiction (Avatar, Dollhouse, etc.) and is in preliminary research as BCIs (brain-computer interface) or neural control interface research expand (Allison et al., 2010; C. Brunner et al., 2015; P. Brunner et al., 2011). Current global research is advancing areas such as neuro-robotics, bioengineering and genetic engineering, molecular nanotech, mind-to-mind communication, and life extension all aimed at augmenting human capabilities. In parallel, 25 years after the publication of Donna Haraway's 1985 book A Cyborg Manifesto in which she reflects the ways in which emerging technologies have entered and pervaded the everyday lives of humans, we are seeing increases in cyborgs with digital implants, biomechanical extensions and extrasensory enhancements, This is being made possible by rapid advances in neuroscience, coupled with super computers and enhanced body parts and artificial limbs, leading to the fusion of human and machine. Advancing from the introduction of wearables over the past decade or so, we are seeing devices which were once worn on the body are now being implanted into the body, leading to a class of true cyborgs, who are displaying a range of skills beyond those of normal humans-beings (Barfield, 2015).

In parallel, we are witnessing an acceleration of interest in transhumanism. Through the work as a Board Member of TAFFD's (The Transdisciplinary Agora for Future Discussion) Think Tank and conversations with close friends Transhumanist philosophers Max More and Natasha Vita-More, I have come to understand that the Transhumanist movement is firmly focused on genetic engineering and radical biotechnology for the purposes of life extension and improvement, health-related body modification and the augmentation of all levels of human capabilities. In a recent interview with Natasha Vita-More, she explained that the current shift amongst transhumanists is towards undoing biology and rethinking mortality. The growing interest in this field is underpinned by the establishment of the UK Transhumanist Party and the fact that the colleague Zoltan Istvan will be challenging for the US Presidency.

Equally, the success of Nick Bostrom's 2015 book Superintelligence, a New York Times Bestseller has created a enriched fervour around the whole question of how humans and machines will interact, communicate and collaborate. Bostrom talks enthusiastically about hardware neural networks, simulate neural networks, classical AI, extracranially cultured tissue, quantum computers, large, interconnected computer networks, evolutionary chips, nootropic treatment of the human brain, biological-electronic symbiosis systems, etc. as though they are now all part of our everyday, although many are still in their infancy. Bostrom's book, although not actually academic has inspired considerable discussion, investment and research in the halls and labs of academia, not least because of his own academic papers while affiliated with the University of Oxford. Similarly books by James Barratt: Our Final Invention - Artificial Intelligence at the end of the Human Era, which is based upon 15 years of academic research and Max Tegmark: Life 3.0 - Being Human in the Age of Artificial Intelligence (which has sold over 20 million copies) are influencing how companies begin to understand the impending transformation in workforce structures and education, particularly in relationship to a potential AI-driven economy, a concept espoused by Tegmark's fellow MIT Professor Erik Brynjolfsson.

Simultaneously, while society is experiencing incredible advancements in the less visible forms of AI, such as machine learning, NLP, deep learning, etc. and cyber-physical systems that share data from sensors unlike IoT that are physical devices with an IP address and need Internet to function, it is also witnessing a plethora of developments in humanoid robots. In the interview with Prof. Dr. Aleksander Rodic, Head of the Robotics Center and Vice-President of the Mihailjo Pupin Institute in Belgrade, Serbia at the ICT innovations Conference in Ohrid, Macedonia at which I was keynoting in 2018, I was told that the Institute had now developed a humanoid robot that was 70% human under laboratory conditions, but only 38% human in a real-life situation. While the humanoid had a higher performance than a human on dealing with data and relatively human-like physical capabilities, it was still far behind on the emotional and wisdom aspects of knowledge. Currently, there are seven humanoid robots that are leading the race to the perfect human-like robot, each with differing qualities that are beginning to solve some of the issues of emotional communications and collaborative interaction. They are as follows:

a) Sophia: maintains eye contact, Kingdom of Saudi Arabia citizen
b) Nina: continuous learning, thought and images
c) Furhart: emotions from computer animation

d) HRP4: Tracks faces and emotions and responds
e) Atlas: military, withstands inhuman conditions
f) Valkyrie: supports astronauts and the NASA space program
g) Kengoro: sweats and is more flexible than humans

One needs to remember that robots do not need to be fully humanised in terms of the way in which they achieve their emotional interaction with humans. Not dissimilarly, to the immersion created with multimedia, which I discuss in Chapter 7, the humanoid robot response can exploit anything from AI-induced rapid response cameras, multimedia and mood depicting tone of voice, to sensors that read gestures and create an emotional feedback loop. Machines will be increasingly capable of interacting with humans in a workplace on all levels. We have reached a point in human-machine interaction that we need an adequately supported operations manual that includes the culture, ethics, trust, flexibility to deal with this emerging set of circumstances. We are transitioning beyond the solely human centric society.

While this brief review of emerging and medium-future developments of humans and machines and their augmented capabilities may seem superfluous at this point, the decision to include them in this dissertation is rooted in their relevance to both impending workforce management and the working environment as well as the changing structures, currencies and context for knowledge and the skill repertoire needed to successfully adapt to and cope with the demands of the potential new jobs, roles and the changing workplace, which is ultimately reflected in the adaptation of the education system.

This emerging human-machine workforce will not only generate new work tools methods and interfaces, but it will generate new paradigms, formats, and currencies of knowledge. While we are already used to data being structured, accessed, gathered, stored, analysed, and shared differently, and for information to be readily available anywhere, any place, any time, any format, there are still major disagreements about what knowledge really is, given that within a world of more and more non-linear thinking techniques and abstraction, the notion of knowledge is frequently being re-conceptualised, but is always assumed to be actionable. As Harvard's David Weinberger points out "Knowledge is more creative, messier, harder won, and far more discontinuous." (Weinberger, 2010) The fourth element of the DIKW hierarchy, namely wisdom seems to have lost favour in the age of Information Technology, since it is far more difficult to map. While it is less salient for the discussion here, we understand wisdom to build off knowledge by adding our experience, insight, common sense, unbiased judgment both within and outside of ourselves, and even qualities like empathy.

In the case of a human-machine workforce, we can expect the data inputs to be multimodal, so that the outputs as information are likely to generate new patterns of learning and interoperability. This in turn could create new types, formats and layers of knowledge, so that we experience knowledge differently (Williams, 2011). We will be able to construct our knowledge from new information structures, perceptions and multiple formats that will potentially redefine the currency of knowledge and new values of excellence and performance. This reframing of the value chain will drive changing spheres of possibility, enabling us to consider not just 100s but millions of variables, that we can systematically model into a refined matrix of unexpected knowledge scenarios. In the near future AI will be able to give its own explanation of how it arrived at the solution.

Within this matrix of human-machine possibilities the power of human cognitive and thinking skills will be even more critical as we leave more and more to the machine or swarms of machines. Bruce Sterling in his book *Swarm* sees unbound intelligence as self-destructive and while he talks about the complexity of mutual intelligibility amongst multiple species or symbiotes, the same issues will challenge our ability to fully integrate humans, cyborgs, transhumans and machines into our everyday workplace. However, intelligent humans are capable of thinking about and experiencing the space between the matrix as described by Slavoj Žižek's piece "From Physics to Design" (Žižek, 2006). Žižek deals with Daniel Dennett's polemic about the human mind having a central point of perception-decision at which all information is gathered, appreciated, and then turned into action. This will continue to be the human's central role in stewardship in the medium-term future. Zizek points out that evolution (of ideas) take place in the space between the vast synchronous "external logical matrix" of all possible combinations and the vanishing opportunity space of feasible combinations, which are accessible or workable. So, we have that gap between the eternal logical combination and us being constrained to a particular contingent situation. I would add here that we need to unshackle these thinking constraints to arrive at paradigm shifts at the point where we are looking to re-conceptualise concepts such as "work" "learning" and "education".

A human-machine workforce will require a collaborative HMR ecosystem and a new environment to drive the system: CPS (Cyber-Physical Systems) architecture. These Cyber Physical Systems are creating "open systems" able to dynamically reconfigure, reorganise and operate in closed loops with often full computational and communication capability. Machine Learning can be fully integrated with Artificial Intelligence—often without human intervention. Cyber Physical Systems can exploit less conventional computational and physical substrates such as bio-nano combinations.

It will require a refreshed human attitude towards smart machines and intelligent assets reflecting changing behaviours, emotions, and interaction. It will demand human capability optimisation & augmentation like those described in my 2004 book Future Frequencies, where on the 50th anniversary of the publication of Maslow's Hierarchy of Needs I revisited and revised the needs in the context of what I termed the "Remix Lifestyle". (Fig.7)

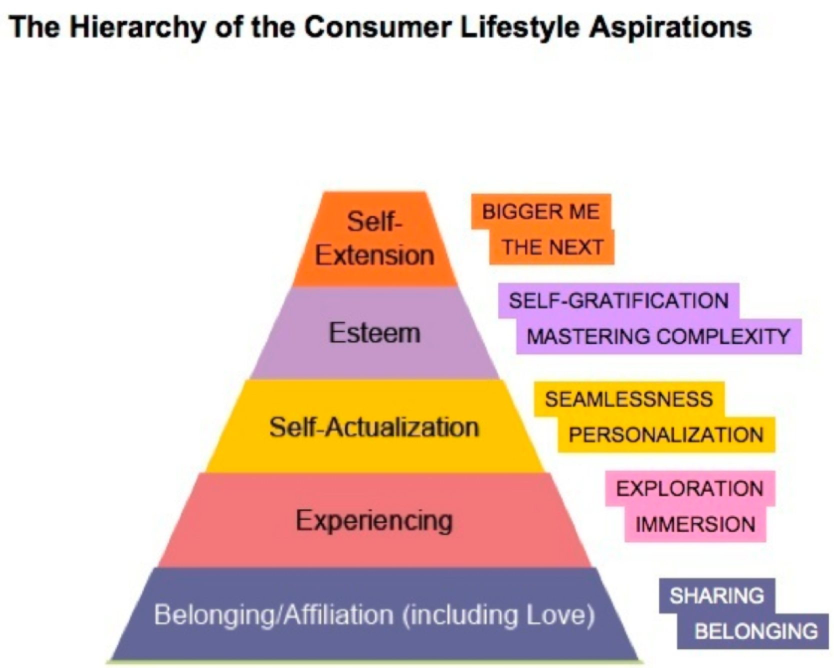


Figure 6 Revsiting Maslow's Hierarchy of Needs (Woodgate, 2004)

My choice at the time of the concept of self-extension (beyond self-actualisation) is a result of the growth of multiple and reconfigurable personalities in the remix society. It is about the growing desire for humans to extend their scope and abilities by both natural and other means, from the basic level of plastic surgery to adult education, to multiple jobs, to vanity projects, implants, to seeing the body as a machine, blood and organ replacement to technology driven upskilling and even the internet as the external brain. I also believe this enduring desire for self-extension beyond self-actualisation, is growing from emerging technologies—such as character-building agents, synthetic characters with built-in emotions, gestures, and morality systems, AI-human interaction, directable robots, and performance enhancement. All of these are helping humans gain a completely different perspective of themselves and human potential. Including machines as part of the workforce commonly known as the no-collar workforce will require HMR management to envisage the machines as another worker cohort. In this context to achieve mutual intelligibility, AI will continue to explore human thinking. Yin et al. (2012) believe that one needs to design an imaginal thinking frame, which refers to thinking in terms of images, as they further conclude that the fundamental characteristics of human thinking, involve memory and knowledge all being stored as high dimensional images. Furthermore, Zhang et al. (2015) postulate that an imaginal thinking frame whereby machines imitate human imaginal thinking puts “humans and machines on an equal platform” and sets forth the need for a new intelligent design paradigm based upon human–machine integrated automating design. Here, I am also referring to cyborg-machine interaction and connectivity, as humans become increasing enhanced with implants, extensions, reinforcement, sensory stimulators, and the like.

AI learning analytics may provide support with systematic and performance evaluation, by mapping patterns of behaviour and interaction, vetting decisions, providing risk scores and sourcing. Principles will need to be determined for economic, ethical and policy control of functions using Functional Requirements

Analysis (FRA) to maximise the efficiency of both the humans and the machines. There are complex ethical questions arising and to ensure that the machines collaborate as designed they will be likely fitted with an Ethical Black Box to provide seamless security.

HMR models and stewardship will need to create job descriptions for both the humans and machines to optimise their joint capabilities & adaptive, dynamic allocation (see Fig 8.) This will create the need to reorganise, upskill and reskill workers around the collaborative human-machine process and workloads. It will require new ways of thinking about jobs, culture, technology, and, most importantly, the human and augmented human cohort. Lui et al. (2011) and determine three key guidelines, namely: Human and machine comparison based upon perceived abilities and effectiveness of function; Cost focus and benefits; and human-centredness in respect of physiological and psychological wellbeing.

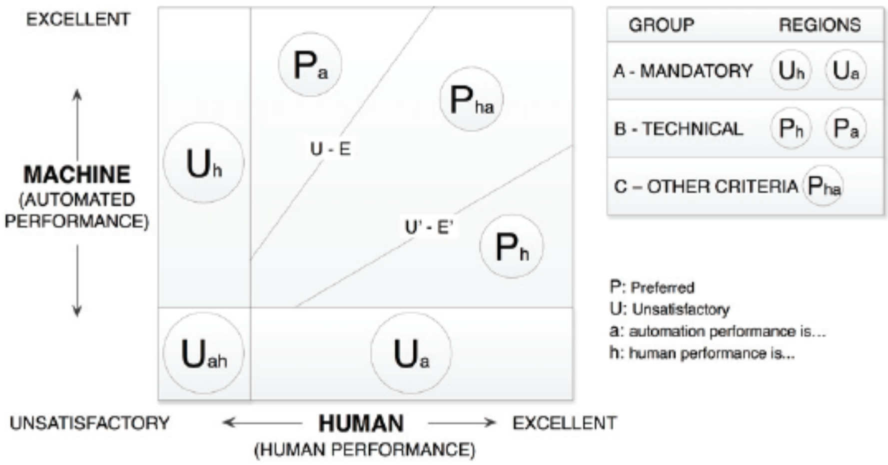


Fig.1.Allocation Decision Matrix from NUREG/CR-3331[2].

Figure 7 Allocation Decision Matrix

There will also be machine teams and the need to manage spatial behaviour & team cognition, which potentially could be guided by cooperative perception software. We will see the advancement of kinetic workplaces.

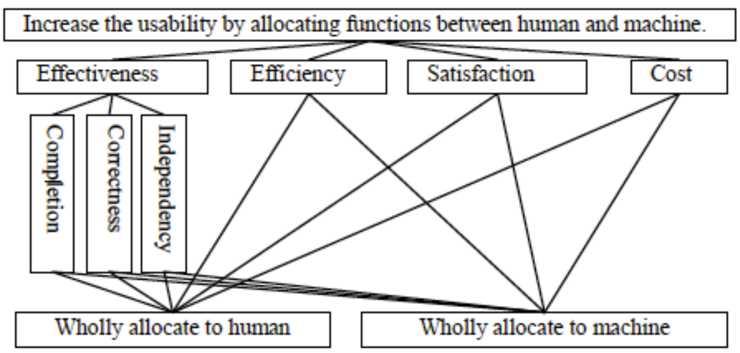
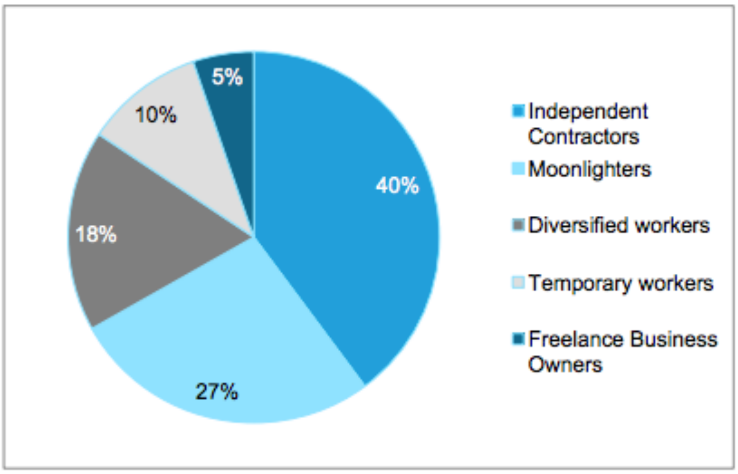


Figure 8 A hierarchal model of functional allocation Lui et. al. (2011)

"In adaptive allocation the control of functions shifts between humans and machines dynamically based on specified criteria for environmental factors, operator competence, or psychophysiology" (Hancock & Scallen, 1998). The shifts will entail a reconfiguration of roles for each cohort, determined by workforce (size, skills, reward etc.), processes, structures and collaborations, technologies, and other management systems.

In parallel, it is anticipated that beyond the human-machine concept, the humans will have to deal with a new employment structure, which due to the Fourth Industrial Revolution and its advancement of technologies and best practices has already reduced the number of full-time employees retained in-house at major organisations. A study by Intuit predicted that by 2020, 40% of American workers would be independent contractors. This is being driven predominantly by digitalisation, in the sense that the workforce is increasingly mobile, and work can increasingly be done from anywhere, so that job and location are decoupled. The research by Rand found that 94% of net employment growth from 2005–2015 in US was from alternative work arrangements, and that 25% of workers aged 55–74 have alternative work. So, with this expectation that only 40 per cent will be full-time employees, it is projected that of the remaining 60%, 20 per cent will be on a retainer or contract, 15% expert consultants and the rest will be networked. Citi research for the Freelancers Union found that of these non-full-time employees 40% would be independent contractors and 27% moonlighters (Fig. 10) a reflection of the growing segment called the Gig Economy. The 2016 PWC report predicts that the percentage of employees in full-time employment will drop to 9% in 2030.



Source: Freelancers Union & Elance-oDesk[37], Citi Research

Figure 9 Projection of employees in full-time employment in 2030

These projections are in line with the 50:50 model known as "horizontal" loyalty, described by author Daniel Pink in his book Drive. He believes that the workforce will be defined by and loyal to teams and projects rather than to a business. In parallel we have seen a significant growth in the "platform economy", which mainly working from home or occasionally working in shared in small units in tech hubs in companies. Although it provides workers with a high degree of flexibility in place and time at the same time it is often irregular and risky (Katz & Krueger, 2018). For employers it provides access to a much larger pool of skills and experience at a fraction of the cost of hiring workers on traditional contracts (OECD, 2016).

Similarly, the growth in the decentralised economy supported by distributed systems, AI and a plethora of cryptocurrency payment schemes supported by Blockchain and in future post-quantum cryptology is dramatically impacting value chains and trading procedures, leading to a new employment and workforce structures. There has been gradual move away from a work-life balance to a work-life integration (a term credited to UC Berkley for many of the emerging technology-enhanced jobs). These new workforce and workplace structures, while more customisable are having implications for the value change as they are formulated to optimise the emerging, distributed economies (Maloney & Molina, 2016). Overall employment to population ratios is growing, fuelled by the improvement and increased female employment in some of the fast-evolving G20 countries, continuing globalisation and foreign demand for skilled and specialist workers, but also a significant increase in involuntary part-time workers (OECD, 2018).

3.2 Emerging and future jobs

As mentioned in the introduction, many emerging jobs and roles will gain in saliency over the coming years, while another cluster of jobs are set to become increasingly redundant.

It is projected that in the EU, there will be job openings in all sectors with over 10 million additional jobs estimated and over 100 million replacement jobs by 2030. In the US the largest number of job openings is predicted to be in the health sector inspired by emerging health technologies including nanotechnology, neuroscience, and biotechnology. Simultaneously, we can expect continued growth in areas of remote surgery and the exploration of causes and solutions to a plethora of new diseases. New jobs are also needed in the green sector and industrial sector, with expected growth in quantum computing, meshnets and nanosatellites and a rethinking of networks. The IT sector will continue to create new employment opportunities, including security analysts and advanced cryptology; data scientists; cloud architects; and the implementation and analysis of the Internet of Things and cyber physical systems as situated, and context awareness redefine our smart cities and new modes of transportation and interactive architecture. According to Citicorp, the IT section is still projected to be one of the fastest growing sectors, but ultimately, we will see completely new development areas such as self-developing intelligent systems,

As discussed in 2.2. above, robots will replace jobs but also generate new jobs for design and interaction engineers and technicians, as well as policy makers and those engaged with law, defence, and security amongst other critical areas. (Fig. 11) below shows where the greatest risk of job changes will occur with or without automation in G20 countries.

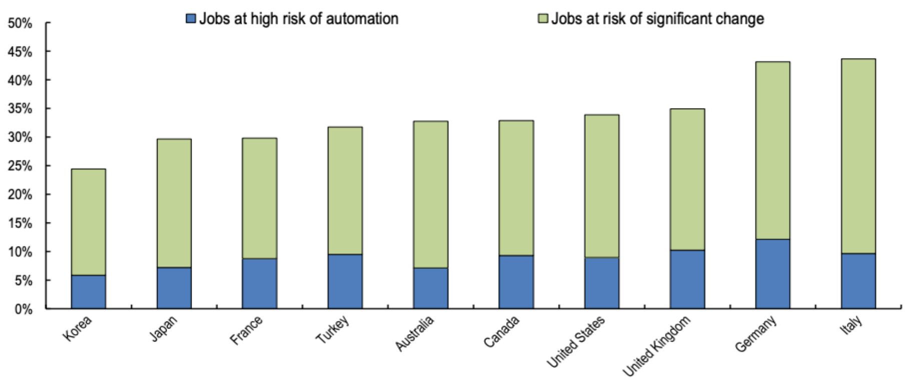


Figure 10 Jobs at high risk of automation in advanced G20 countries

Figure 12 from McKinsey Global Institute (Manyika et al., 2017) delivers and analyses several diverse scenarios that indicate the levels of the projected changes through key catalysts for change as it applies jobs lost and gained from 2016-2030. The data is based upon a 2016 baseline from 2014 data. It shows the role of automation, projected labour supply and new job creation.

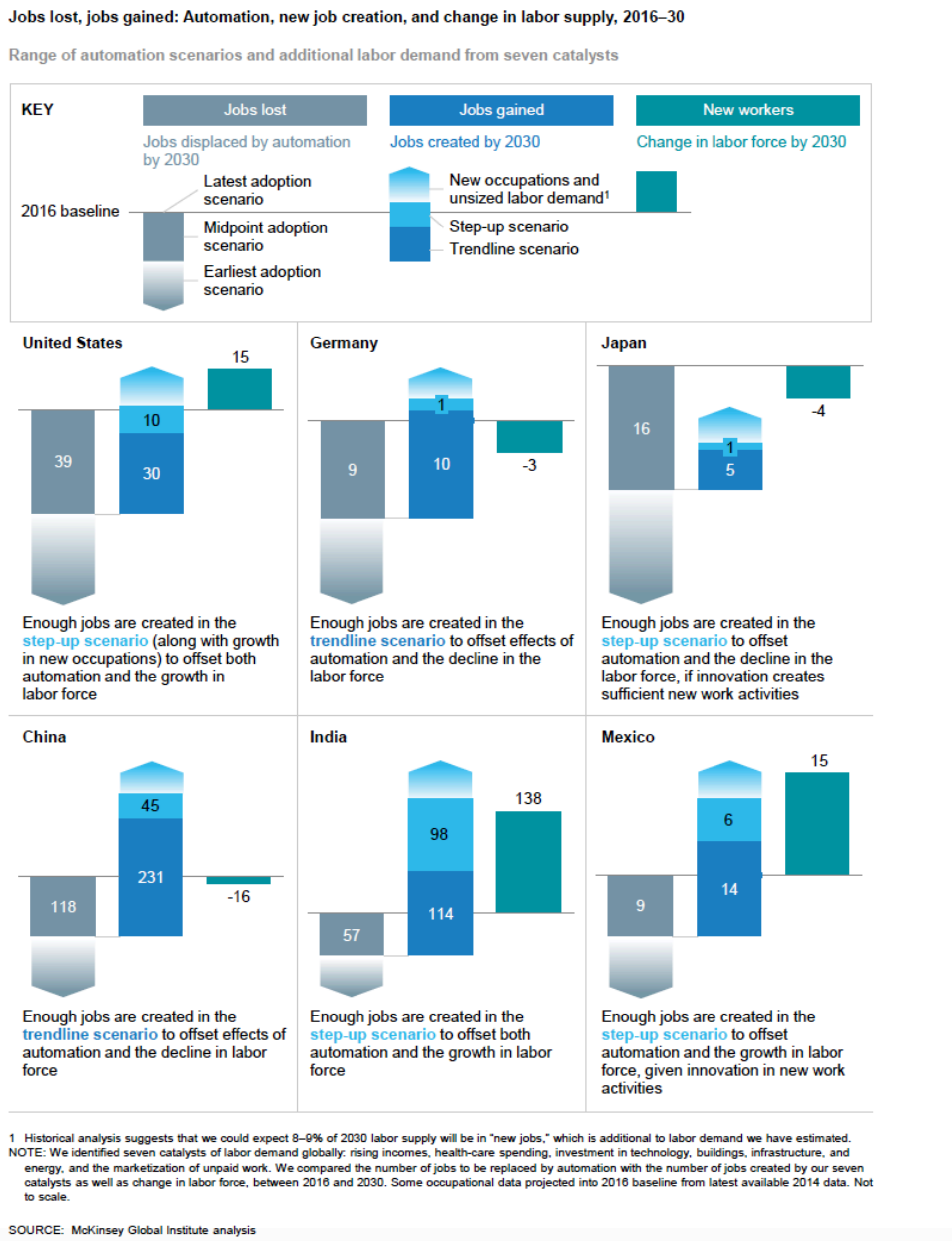


Figure 11 Jobs Lost, jobs gained scenarios (Manyika et al., 2017)

The new types of jobs that will be created will require people to be highly skilled; in fact, it is forecasted that nearly half of the new opportunities in the EU will require high skilled workers with skills not yet fully defined and integrated. Therefore, acquiring these skills is extremely important for future employment and could affect the already changed way that we work and will continue to do so. Whether it will create more jobs than it will replace is another question in itself.

The United States O⋆NET program collects, compiles and analyses data on 974 different occupations in the US. One particularly insightful aspect of the program is what it refers to as "bright outlook" occupations, where new job opportunities are likely to evolve in the short and long-term future. It categorises these occupations as:

(1) Those that are projected to grow faster than the average employment growth.

(2) Those that are projected to have many jobs openings.

(3) New and emerging occupations which include new workforce requirements, including changes in technology, society, law, or business practices and are leading to new and emerging occupations.

The Citi Research data in Fig 13 below shows that the information technology career cluster has the highest percentage of occupations (62%) considered to have a "bright outlook", followed by marketing, sales, and service (50%) and health science (45%) (Citi GPS, 2016).

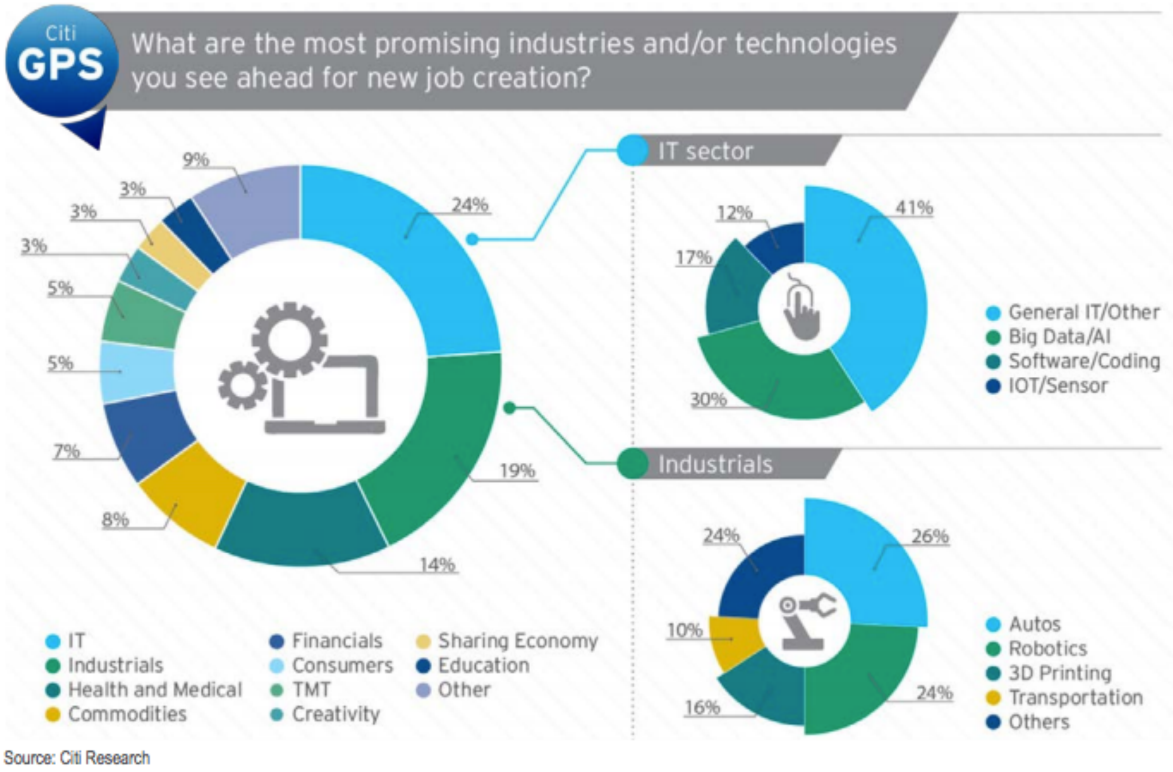


Figure 12 Most Promising Industries (Citi GPS, 2016)

Envisaging the types of jobs and skills that will be in demand in the future while challenging and uncertain given the acceleration of time horizons for adoption, the growth in adaptive industries and distributed economies and markets, but an analysis of research and detailed data sets are helping us observe both the trend drivers and the directions they are taking. As metaeconomics and stakeholder or equitable capitalism grow in importance (Ashmarina et al., 2020) in terms of debating the future of economic systems, we can expect to see an even deeper exploration and experimentation with transformative business ecosystems and their workforces that embrace notions such as the stock-exchange being long-term focused (Greene, 2020) or communitarianism with its reciprocal obligations towards each other, and incentive structures that mirror reimagined values of progress. Ultimately, these changing values will necessitate new job and skill formats, yet to be envisaged (Woodgate, 2018b).

1. Neuro-social profile integrator
2. AI integrator
3. Smart city quantum communications designer

4. Emotion simulator for robots
5. Robot-human task integrator
6. IoT and CPS designer
7. Crypto crime fighter
8. Autonomous transportation expert
9. Biochem IED specialist
10. Digital underground investigator
11. Space communications & defence
12. Drone fleet aggregator
13. Mixed media training development officer
14. Geo-fencing expert

Similarly, in 2017, I completed a two-year long project, which commenced with a fully blown foresight project to determine the future conceptual platforms, scenarios, and vision for the future of the construction industry for AEM (The Association of Equipment Manufacturers). The outputs from this work became the conceptual architecture for the 120,000 square ft. Tech Experience including the areas, i.e., Future of Infrastructure, Future of Intelligent Construction, Future of Workforce and The Future and The Future of Additive Manufacturing. They were bundled under the What's Next theme. I was responsible for curating the content for the overall event and for advising on the design, construction, and visualisation. In the Future of the Workforce pavilion, I developed a job kiosk (Fig. 14), which enabled visitors to enter their current job description and skills and to see what future job would be a possible fit. There was a choice of 20 current jobs and 20 future jobs. The future jobs were developed based upon the futures scenarios I had created on the future of the construction industry for AEM broken down to the micro level in terms of potential skills, present and future as well as multiple patterns and combinations that considered both migratory and completely new skills. The user interface, coding and the back end of the kiosk were developed under the management of my wife and fellow futurist, Helga Veigl. Nearly 2000 visitors used the kiosk and the outputs demonstrated that current skills and jobs could be applied and transferred to around 60% of the future jobs, although in about 22 per cent of those cases some degree of upskilling would be required. The outcomes underscored the goal of the kiosk which was to demonstrate to current construction professionals that there was a potentially optimistic future ahead.

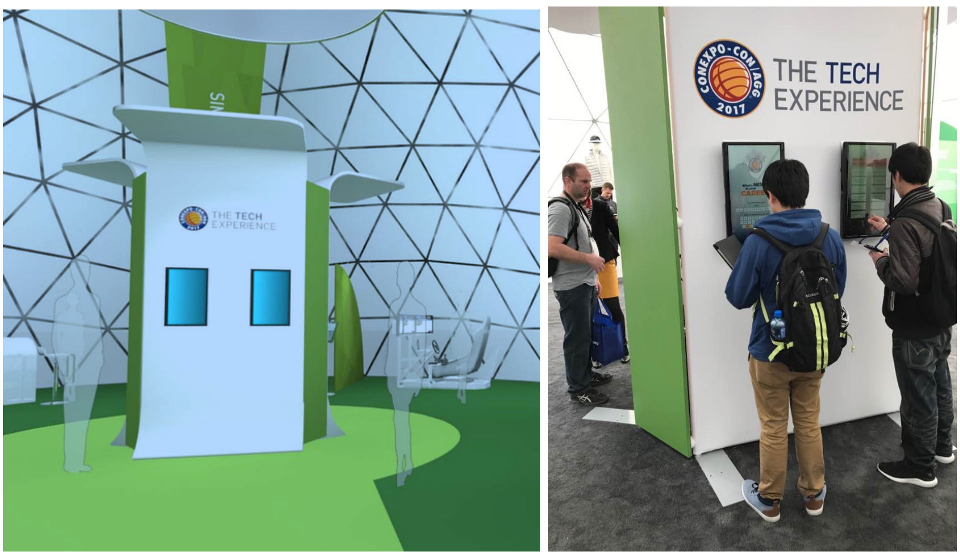


Figure 13 AEM "What's Next" event at the CONEXPO-CON/AGG 2017 show in Las Vegas

I mentioned earlier that we need to be seeing our world as one which is not simply human-centric. Beyond the issues of mutual intelligibility and role reconfiguration, we need to develop a new paradigm that provides a framework even a new schema for how we deal with the interplay between humans, transhumans and non-humans and parallel realities in terms of everything from interfaces, language, intelligences, cultural attitudes, identities, etc. Single but differing lifeworlds will ensue and we will need to break the categorical schema by which we currently frame ascertain and understand the intricacies of world order. Will non-humans have archetypes? Certainly, they will have a sense of hierarchy, even if it is not in terms of the awareness humans expunge now. Human input data hierarchy is obviously a given, but self-generating AI will develop its own integrity. All three elements (human, transhuman and non-human) will expect recognition. This will require a new layer of cultural transformation. As Bruno Latour believes, material objects need to be included in social analysis. Emerging wearables that understand tone of voice and plenty of IoT with situation awareness through programmable surfaces, therefore cognitive interaction. AI will develop cognitive in its own way and its interpretation of what is a "soul" and how it plays out will be intuitive to the AI rather than understandable to other than maybe technically. Transcribing algorithms into cognitive behaviour that are understandable to humans, but purely performative in terms of the way they are generated by AI will be a major challenge. So, think of the role of an HMR professional in the future.

The complexities of shared responsibilities, skill validation, evaluation and determination will make shared labour or project/task structures difficult to valorise. The opportunities for intellectual advancement through human, transhuman, non-human collaboration is enormous, but many see AI bringing in a new level of intellectual retreat. The parallel realities I mentioned earlier are critical to the division and valorisation of labour. AI subsets like machine learning, once they are self-generating and self-directing are developing in their own "body", humans and potentially transhumans when working in mixed media environments while somewhat disempowering reality, will create a simulation of a new body of labour. It will be critical to map the likely imperious rise of one of the three manifestations of the "body". Later, I will discuss how these potential redefinitions of "body" are reflected in perspectives of our reality being simply a simulation. (Derek Woodgate, The Well - a conversation with Media Philosopher Patrick Lichty [2017])

Integrity in the context of non-humans, transhumans and post-humans deals with having strong ethical principles that are aimed at advancing future society. That is why I write a lot about moving beyond a human centric society only and the need to curb dominance by any "species". In this next phase, it will be more about human integrity developing AI for societal advancement rather than destruction. I noted several the future challenges for AI in an earlier comment, but probably the most critical in terms of integrity lies within Gilbert Ryle's "ghost in the machine" theory and the parallel, harmonised advancement of AI software and hardware, say robotics. Programmed AI is one thing, self-generating AI in this context is very different. There is much talk currently about creating ethics committees and innovation safety and the well-conceived Stanford report "One Hundred Year Study on Artificial Intelligence" that reviews the impact of AI on culture and society in five-year timespans, defining some of the more crucial challenges, pathways to innovation and likely changes. These primarily deal with human integrity. To survive, self-generating AI will need to develop its own reasoning about integrity to optimise its own existence. We can quite possibly learn something on this by studying the role of integrity in the development of AlphaGo Zero or its previous iterations. Did the AI learn to play the game fairly and honestly, even though it self-generated moves that we had never seen before and astonished champion human players? As far as I know those moves were neither dishonest nor disqualifiable. The same goes for robot soccer, which I presented at Plutopia 2012 during SXSW. It would be interesting to take the debate on the importance or otherwise of emotional intelligence to advanced human integrity into the augmented human-machine arena. If as I mentioned in my earlier response, AI and its configurations achieved consciousness and emotional-cognitive abilities, then aspects such as the role of emotion perception, emotion understanding, and emotion regulation facets will be critical for explaining AI performance. Here it is considered both optimised efficiency and performative faculties. IoT for example will have embedded performative capabilities early on if its various renditions are credible and useful in terms of situation awareness and response. Emotion perception precedes emotion understanding as a causal sequence and in my view, will be critical to optimised functioning of situation aware IoT. Consequently, non-human in terms of AI and its subsets may need to self-develop emotional and advanced cognitive faculties before it can really prove to have integrity. However, understanding the need for survival will make that happen (Woodgate & Lichty, 2017).

3.3 Postnormal skills

As established in Chapter 3.2., the new types of jobs that are emerging or will be created over the next decade and beyond will require people to be highly skilled; even with skills not yet fully established or integrated into either our education systems or workscape. Acquiring these skills will be essential for future employability as jobs higher levels of complex problem solving, creative thinking and collaboration with machines as humans face accelerated technological enhancement and the need for rapid adaptation in increasingly unexpected circumstances.

Creativity is just one of the critical skills that are expected to be part of the future worker's palette. The others that I have included within my newly developed learning system described in Chapter 6 are: virtual collaboration and teamwork, computational thinking, transmedia literacy, social/emotional intelligence, sense-making, cognitive interaction management, domain expertise, cross-cultural competency, novel, nomadic and adaptive thinking, transdisciplinarity, socially motivated creativity, and innovation and design thinking (which is loosely tied to creativity) (Woodgate, 2018b).

My selection of these specific future skills arose from a detailed analysis of the different approaches of academics, educationalists and practitioners who had over the past decade explored the potential future skill and competency needs for future jobs predominantly under the banner of 21st century skills within the framework of a significantly changing economy broadly categorised as industry 4.0. These included expanding the work of Siemens and Tittenberger (2009), who amongst other competencies consider: acceptance of uncertainty, creativity, connectivity, criticality, pattern recognition and manoeuvring through new knowledge formats and landscapes, as highly relevant to the networked environments in which we now operate. They believe that adopters of new technologies often employ a grassroots approach –using resources outside of formal institutional support. Siemens' work on connectivism (Siemens, 2004), which I deal with in more detail in Chapter 7 substantiates the growing need to confront increased complexity, rapid changes, global collaboration and connectivity, social literacy and technology adoption and adaptation as a powerful means of mediation.

Henry Jenkins sees participatory culture as a framework for understanding changing skill needs (Jenkins, 2014). Like Siemens and Tittenberger, Jenkins sees collaboration and networking as critical drivers that build upon the foundation of traditional literacy, research skills, technical skills, and critical analysis. Jenkins sees approaches such as simulation, appropriation, collective intelligence, transmedia navigation as necessary skills for the near future.

The Partnership for 21st Century Skills divides the skill sets into three major spheres, namely: 1) Learning and Innovation Skills; 2) information, media and technology skills; 3) life and career skills. The third of these cover skills such as: flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, leadership and responsibility.

Cathy Davidson and David Theo Goldberg at The Future of Learning Institutions in a Digital Age have set out ten principles for the future of learning, which they see flowing back into the workplace in line with emerging jobs. Unsurprisingly, these include network and self-learning, decentralised structures and open-source education as well as learning as interactivity and connectivity.

One can see several obvious patterns arising from this postnormal skill analysis. It was therefore interesting to observe the work of Hyewon Jang (2015) who studied the changing needs within STEM education to better prepare students for their future careers. In Jang's study, he identified important STEM competencies and evaluated the relevance of present frameworks used in education, by using the standardised job-specific database from the United States Department of Labor. STEM disciplines include chemistry, computer science, engineering, environmental science, geosciences, life sciences, mathematics, and physics/astronomy. Jang's analysis established the importance of 109 skills, types of knowledge and work activities, revealed 18 skills, seven categories of knowledge, and 27 work activities important for STEM workers. Jang divided his findings into two groups (high and low) in terms of the average of importance across the knowledge needed for potential emerging job activities. His high group had skills such as critical thinking for complex problem solving, systems design and analysis, social perceptiveness, thinking creatively, judgment and decision-making and dealing with complex communications. During his research, Jang found that engineering educators in Massachusetts Institute of Technology (MIT) explored two central questions for building engineering skills and education standards, namely: what is the full set of knowledge, skills, and attitudes that engineering students should possess as they leave the university, and at what level of proficiency?" and "how can we do better at ensuring that students learn these skills?" The ability to definitively measure the cognitive and performance benefits from the application of 21st Century skills is an important area of investigation (Parsons et al., 2008). Accordingly, creating standards, evaluating and accessing the impact from my established 21st century skills is a critical aspect of determining whether or not the system developed and applied as described in Chapter 6 was valuable beyond surface opinions. It meant therefore that it was necessary to create evaluation criteria for the skill that lies at the centre of this dissertation namely, creativity.

In the process of evaluating current thinking on 21st Century skills, which given that we are already two decades into 21st Century, I refer to as postnormal skills, I also interviewed Dr. Elaine Raybourn, a collaborator and friend from Sandia National Laboratories, who has for the past decade or more been working on developing new sets of skills, training structures and talent management for the US Military through the ADL Initiative, specifically for military executives and special ops. Much of her work has centred on convergent skills and self-development to ensure continuous learning based upon adaptive trajectories and high-level technology enhancement. As mentioned earlier, Elaine is a member of the exacomputor development team at Sandia Labs. Consequently, the skill sets Elaine has worked on are predominantly aimed at rapid analysis that is adaptive to unexpected operational contexts, multiple pathways to problem solving, personal process development and applications and integrated anticipation of issues occurring in human-machine operational environments. Much of her team's work centres around the creation of learning agents and multimedia-enhanced tools including open software that facilitate the learning of these new skills (J. T. Folsom-Kovarik & Raybourn, 2016).

In addition to the above-mentioned repertoire of skills and competencies: we can expect to see new approaches to skill integration and ways to separate, share and co-develop ideas and projects – and new forms of collaboration, which will evolve these skills and generate a whole range of new skills or re-contextualised or hybrid skills that will arise with developments in adaptive approaches to creation, production and performance as well as fresh knowledge about cognition, behaviour, immersion and human-machine co-creation.

Influential to my thinking behind critical new skills is the work of Rotherham and Willingham (2009) who while recognizing the new skills needed for future jobs are concerned about the challenges of creating appropriate content to embrace the skills and to deliver them richly, effectively and engagingly to a broad student body beyond the privileged few. The ability to spread the skills throughout the various curricula is a serious challenge, especially as Rotherham and Willingham point out, teachers, trainers and executives have limited experience of teaching and applying skills such as self-direction, collaboration, creativity and innovation. Rotherham and Willingham put considerable emphasis on domain knowledge and practice beyond experience, believing that improving and upskilling are more critical than simply learning, with feedback as a potent conduit.

My decision to build my own repertoire of postnormal skills revolves around the lack of clarity about the nature of these required skills and the challenges of applying them to emerging curricula that mirror the needs of future jobs. As discernible from my own analysis of the various frameworks for 21st century skills and Dede's (2010) research on the same subject, the frameworks have a lot in common, principally as they reflect what we believe to be the changing landscape of the future workforce and citizens and the needs for skills that both optimise or augment human capacities and participation, given the projections regarding the transformative nature of the workforce in a human-machine operational environment. The emergence of these very sophisticated information and communications technologies and the network ecosystems that they fuel, are making these new skills both essential, but also somewhat transient as we continue to witness the rapid changes and advances to virtually every aspect of our society. Economists Frank Levy and Richard Murnane (2004) highlighted a crucial component of what constitutes 21st century knowledge and skills: namely the declining portions of the labour force engaged in jobs that consist primarily of routine cognitive work and routine manual labour in favour of the growing need for expert thinking, metacognition, complex communication, effective pattern matching and creativity.

Levy and Murnane's claim is substantiated by the changing global workforce structure between 1980 and today. The transformation referred to in Chapter 2.2. has resulted in a major percentage growth in the share of the creative class in the global workforce with growth in the USA over the 35-year period from 8% - 36% and the creative class now representing 42% of the workforce in Norway (Tinagli, 2012). In 2015, it was projected that a further 6.8 million creatives would be required in the USA by 2020, while the current US education system is projecting a considerable shortfall.

The Creative Class or creatives are defined according to sets of creative occupations as given by Richard Florida (2002). These distinguish between the creative core, creative professionals, and bohemians. Creative core members are those individuals who invent and are basically comprised of occupations in research and development, and higher education. Creative professionals include educators, managers, and health care professionals. Bohemians are engaged in cultural and artistic occupations (Table 2.)

The creative occupations	
Groups of creative people	Occupations (ISCO Code)
Creative core	Physicists, chemists and related professionals (211);
	Mathematicians, statisticians and related professionals (212);
	Computing professionals (218);
	Architects, engineers and related professionals (214);
	Life science professionals (221);
	Health professionals (except nursing) (222);
	College, university and higher education teaching professionals (231);
	Secondary education teaching professionals (282);
	Primary and pre-primary education teaching professionals (233);
	Special education teaching professionals (234);
	Other teaching professionals (285);
	Archivists, librarians and related information professionals (243);
	Social sciences and related professionals (244);
	Public service administrative professionals (247).
Creative professionals	Legislators, senior officials and managers (1);
	Nursing and midwifery professionals (223);
	Business professionals (241);
	Legal professionals (242):
	Physical and engineering science associate professionals (31);

	Life science and health associate professionals (32);
	Finance and sales associate professionals (341);
	Business services agents and trade brokers (342);
	Administrative associate professionals (343);
	Police inspectors and detectives (345);
	Social work associate professionals (346).
Bohemians	Writers and creative or performing artista (245);
	Photographers and image and sound recording equipment operators (3131);
	Artistic, entertainment and sports associate professionals (347);
	Fashion and other models (521).

Table 2 The Creative occupations (Florida, 2002)

In principle the bohemians have two roles: members of the creative class, while at the same time, they reflect an urban culture of tolerance; and as such they are a key attractor to the two other categories of creative class. Florida states that the creative core and the bohemians are engaged principally in "problem finding" activities, i.e., creating new ideas, knowledge, technology, designs and content. Creative professionals on the other hand are active in "problem solving" activities. These broad categories form the basis of global analytical research aimed at demonstrating the growth of creatives by country or region. This growth has led to the development of consolidated metrics such as The Global Creativity Index (R. Florida et al., 2015).

Luxembourg has the largest share of the creative class (54 per cent)—which spans science and technology; arts and culture; business management, and the professions.

The Global Creativity Index places the USA 2nd and Norway 11th based upon three key measurements: technology, talent and tolerance.

Another major metric is R&D investment, and this element is seen as a critical contributor to future economic growth in the western economies. Globally, the spending on R&D has shown a consistent growth, which more than trebled between 1996 and 2015, reaching $1.7 trillion. For 2020, those changes are expected to result in the investment of more than $2.4 trillion in R&D on a global basis, a monetary increase of 2.7%, or $64 billion, over what was invested by those same organisations in 2019. (R&D World based upon 115 countries, numerous industries, universities and governments and innumerable technologies).

There is also a projected growth in the spend as a percentage of GDP with the forerunners being the US, which is planning to invest 2% of GDP in R&D; and EU, which is targeting 3%. To sustain this level of growth in research investment, a pipeline of innovations is required, together with a growing need for creativity.

As discussed earlier, this need will be met from a very differently structured workforce, not only in terms of the categories, but also regarding employment modes. It is projected that by 2020 only 35% of the corporate American workforce will be full-time employees. The remainder will be made up of contingent workers, consultants and external creatives.

The on-going discussion over this potential shortfall of creatives, together with the widely expressed viewpoint that the western economies will need to focus on creative innovation to remain competitive over the next 15 years inspired/motivated me to consider how and to what degree the current approaches to education and learning would need to be transformed even revolutionized to generate large numbers of creatives and innovators with the appropriate skill repertoire, ready to for the jobs likely to emerge over the next decade and beyond. As the Mercer Report indicated (2020), the greatest skill needed for future jobs is creativity. People with a greater creative capacity are thought to be more desirable to employers (Choi et al., 2008; Pace & Brannick, 2010), express greater confidence (Bungay & Vella-Burrows, 2013), and are seen as possessing a special trait (García-Ros et al., 2012). Beyond the obvious external outputs of creative individuals, creativity is also linked to psychological wellbeing. Therefore, it seems that people also need to be creative for the sake of their sole survival (Puccio & Cabra, 2019).

Accordingly, I have selected delivering creativity as the key skill and main thrust of this research. However, it is imperative that a holistic education system should take account of these other skill needs and transforms its structures, content, and pedagogical approaches in harmony. Consequently, as we see in Chapter 7, the future learning system that was developed embraces all the other skills from my repertoire of future skills.

4 Establishing the concept of and context for creativity

This section deals with the concept and context of creativity with brief coverage of how to achieve it through a learning structure or how to incite the cognitive and physical drivers. This includes the theory, models, dimensions, and nature of creativity, particularly the intrinsic values that differentiate it from innovation and invention. The relevance of the cognitive, affective, genetic, and social aspects, as well as the relevance of inspiration, exposure, expression, and performance are also covered. Finally, consideration is given to some aspects of how it can be applied, delivered, assessed, and evaluated.

4.1 What do we mean by increased creativity?

While there are various understandings of creativity and their philosophical underpinnings, the most widely cited is that produced by Sternberg and Lubart (1999) (referred to in over 1000 papers). It states "creativity is the ability to produce work that is both novel (original and unexpected) and appropriate (useful, adaptive concerning task restraints"). This confirms Glück et al. (2002); Klausen (2010) who agree that the standard definition of creativity is that creativity requires both originality and usefulness (Runco & Jaeger, 2012), as originally proposed by Stein (1953) or in other words novelty and relevance. Runco and Jaeger (2012) states that the uniqueness of creative ideas is a key definition.

According to the Cambridge Handbook of Creativity there are ten theories of creativity (Kaufman & Sternberg, 2019). They are as follows:

1. The Developmental Theory, which states that creativity evolves or develops over time. By starting with creative potential, it attains creative achievement because of an individual interacting with the environment (surrounding places, family, etc.).
2. The Psychometric Theory measures creativity in terms of assessing the reliability and validity of the creative product itself. It focuses full on the output.
3. Economic Theories reflect creative ideas and behaviour that are influenced by the marketplace and the economy.
4. Stage and Component Theories, state that creative expressions proceed through a series of stages such as preparation, incubation, and verification.
5. Cognitive Theories relate to creatives who apply remote associations, divergent and convergent thinking, conceptual combinations, and metacognitive processes.
6. The Problem Solving & Expertise-Based Theory deals with creative solutions to ill-defined problems. It relies on individuals using rational processes and expertise-based approaches.
7. Problem-Finding theory is where people proactively use an exploratory approach to identify problems to solve.
8. The Evolutionary Theory relates to situations where ideas are combined in a blind fashion, namely a chance combination. The most interesting combinations are retained and made into creative products, which are assessed by others.

9. Typological Theories consider individual differences such as the creators' personalities, work habits, and career choices.
10. Systems theory. A frequent approach applied in the science of foresight which views creativity as a result of a complex system with interacting sub-components (i.e. the body of knowledge that exists at a particular time, the individuals involved, etc.).

Recent research is tending to develop hybrid combinations of several these theories, forming new platforms that reflect a combination of the creator's personality and attitudes with the cognitive processes involved, the various stages through which that the creative process travels with the type and purpose of the task and the external factors that influence the overall process. Advances in neuroscience are adding new dynamics, perspectives to our understanding of how creativity is developed, achieved, and enhanced. Creative ability is generally considered to be equally based on knowledge and analytical/creative thinking. In an earlier paper, Sternberg and Lubart argued that creativity is a function of six factors: intelligence, knowledge, thinking style, personality, motivation and environmental context. In foresight work it is frequently described as the connecting of disconnects into novel concepts and contexts that provide useful and relevant advancement for the future of humanity. "The more mutually remote the elements of the new combination, the more creative the process or solution" (Mednick, 1962). Mednick's theory assumes that creative processes can be understood as the ability to rearrange knowledge that already exists in the mind. Therefore, the greater the number of disparate associations a person has in relationship to the task at hand, the greater the probability of reaching a creative solution. In this sense creativity involves both divergent and convergent thinking. The former leads to unexpected, discontinuities or disconnects with the potential to re-conceptualise and re-contextualise our world, while the latter leads to the creation of a novel, useful, relevant outcome. Onarheim and Friis Olivarius (2013), developed a Double Diamond (DD) Model (Fig. 13) of which a key feature is to understand when to apply creative thinking and when to balance with critical thinking. The model is designed to bridge the distinction between approaches based on "cognitive processes" and on "associational and affective mechanisms" Scott et al. (2004) and substantiates Raj Persaud's claim that divergent thinking alone is not a sufficient condition for creativity training, believing that more emphasis should be placed on the critical thinking in creativity (Persaud, 2007). As Csikszentmihalyi points out, creativity thrives on uncertainty and requires considerable effort to balance challenges and skills. According to Freeman Dyson there is a need to force oneself to create, but as he further points out genetics define how we deal with the challenges and how they are presented. "People with self-efficacy set their sights higher, try harder, persevere longer, and show more resilience in the face of failure" (Kelley & Kelley, 2013).

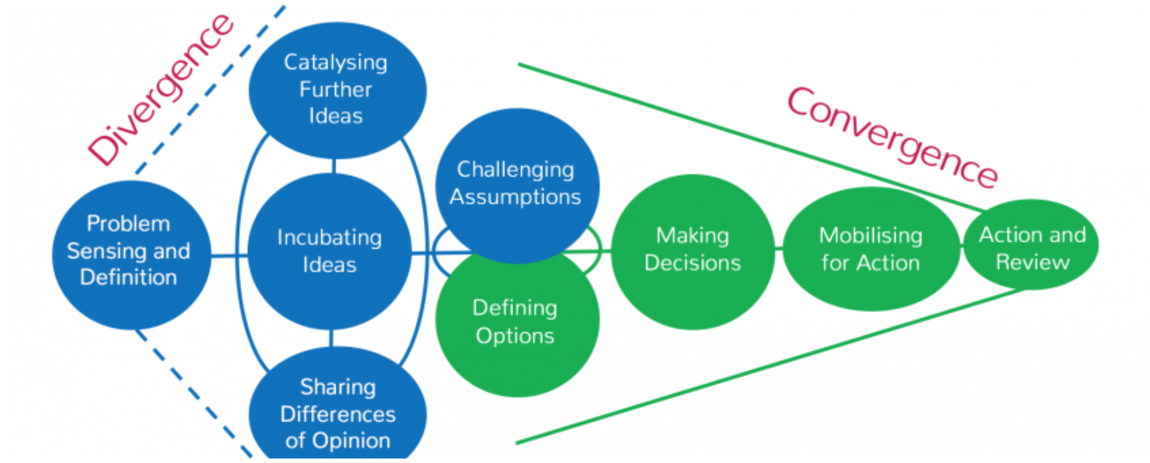


Figure 14 Divergence vs. Convergence (Onarheim & Fris-Ovarius, 2013)

The framework of creativity outlined by Arne Dietrich involves functional neuroanatomy and introduces recent developments in the field of cognitive neuroscience. This rapidly advancing field identified distinct brain circuits that are involved in specific higher brain functions. As such, Dietrich concludes that there are four basic types of creative insights, each mediated by a distinctive neural circuit. Creative insights occur in consciousness. Dietrich proposes that creative insights can arise in two processing modes—spontaneous and deliberate. He emphasises similar distinctions between modes of thinking, for instance, intuition and analysis or explicit and implicit, have been made previously (Ashby et al., 1999; Shirley & Langan-Fox, 1996; Simonton, 1975). It is widely established that the brain has two different types of neural systems both designed to extract information from the environment, one emotional and the other cognitive to help define detailed feature analysis. Either separately or in tandem each line of information processing enables us to create increasingly sophisticated computations. In principle, there are four basic types of creativity, namely since novelty can be created in emotional structures or in cognitive structures, by crossing the type of information with the two modes of processing mentioned above (deliberate or spontaneous) we arrive at the four types.

Harvard's Teresa Amabile considers the impact of these types and processes through her componential theory of creativity. It is a comprehensive model of the social and psychological components necessary for an individual to produce creative work. Her componential model consists of four components, which she considers are necessary for any creative response. Three components rest within the individual, namely – domain relevant skills, creativity-relevant processes, and intrinsic task motivation. The remaining component lies outside the individual, that being the social environment in which the individual is operating (Amabile, 2013). Domain-relevant skills include knowledge, expertise, technical skills, intelligence, and talent. John Baer (1998) referred to a growing body of evidence that suggests that creative performance is domain specific. This has led both to reconsideration and intense discussion about the nature of creativity and to a re-examination of previous evidence and assumptions about the generality of creativity. Creativity-relevant processes include a cognitive style and personality characteristics that are conducive to independence, leading to the creation of new ideas. Task motivation is about one's passion and desire to meet the challenge. The social environment coves all the external factors that provide either stimulation or obstacles to creativity. All four of the components should work together and each influences the creative process. Subsequently, updates to reflect the importance of affective influences, which I interpret as the need for deeper participation through immersion. Amabile's framework is an advance of Rhodes' 4 Ps of creativity from 1961, expressed as Product, Personality, Process, Place/Pressure. These phrases sound rather like innovation rather than creativity. However, creativity is frequently a critical component of innovation. However, one needs to clearly differentiate creativity from innovation and invention. As stated, creativity is the capability or act of conceiving something original or novel with a usefulness or relevance, then innovation is the implementation of something new that provides value creation, and Invention is the creation of something that has never been made before and is recognised as the product of some unique insight. Although as mentioned earlier Jaeger sees uniqueness as a critical element of creativity, having a unique perspective of self-expression.

Earlier work from Amabile outlined what was not to be considered creative. Much of this referred to those elements that only produced novelty rather than purpose. This work however drew discussion around those areas of creativity where the usefulness was more abstract. One could refer here to areas such as the Fluxus Movement or some forms of minimalist art. What we consider creative outputs are only so in respect to another which is considered less creative. A work of art that produces pleasure, joy, amusement (or any other emotion), recreates that emotion each time one meets it. As mentioned earlier, encounter or exposure is critical for the development of aesthetic sophistication. A work of art re-creates the same pleasurable effect if we, ourselves, did not change in the meantime, but of course we do and with it our sense of what is and what is not creative, especially in the arts. To reinforce my point on exposure reference is made to the Nobel Prize winner in economy, Gary Becker, who observed that "people who attend concerts invest time in refining their musical aesthetic sense, and therefore give themselves the chance of improving their tastes".

Expanding on Dietrich's work in this area, neuroscience for applied creativity (neurocreativity) (Onarheim & Fris-Ovarius, 2013), is seen as contributing to our better understanding of the cognitive concepts and processes of creativity. It is advancing the theories that support creativity training both from the relevance of creating the right conditions for developing increased creativity, especially in education (Selvi, 2007) and for ensuring that the combination of understanding the underlying concepts of creativity married with real-life application represents the most effective approach (Scott et al., 2004). Neuroscience is beginning to provide a deeper and more precise understanding of the critical components of creative thought, not just in typical areas such as divergent thinking, but moreover adding convergent thinking to the mix in parallel. Neuroscience explains creativity as constituting five key concepts based on basic brain processes (priming, close and remote associations, inhibition, fixation and the release of inhibition—referred to as incubation). This mirrors the first two elements of Graham Wallas' model of the creative process (Wallas, 2014), which is still considered foundational (Fig. 16), namely: Preparation, and Incubation, Wallis presents two further layers: Illumination (a rush of insights, and ideas rapidly arise from the mind to provide the basis of a creative response), and verification (assessment as to whether or not the outcomes in the illumination phase satisfy the need and the criteria defined in the preparation stage.

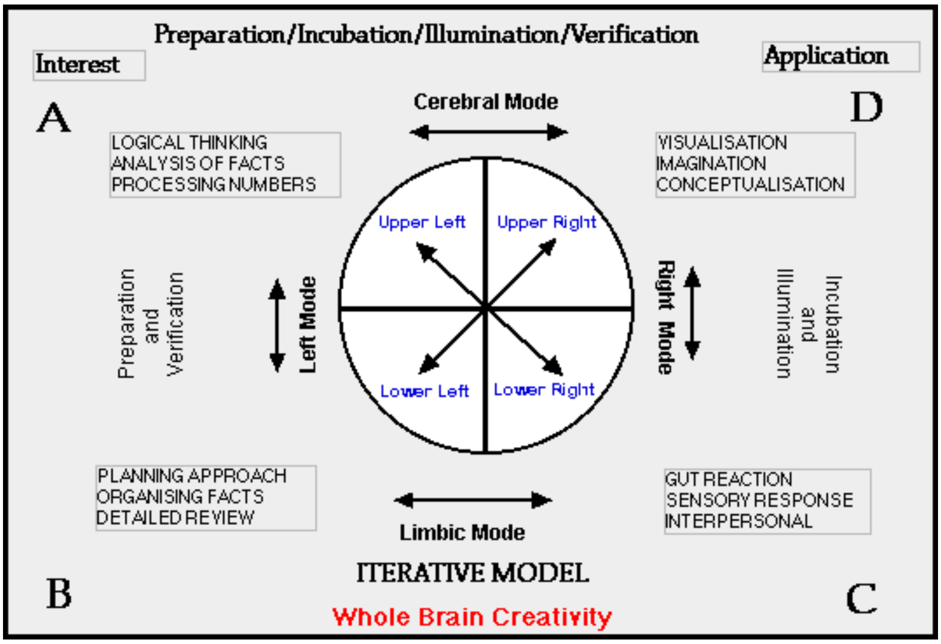


Figure 15 Whole Brain Creativity (Wallas, 2014)

Through the excellent work of cognitive neuroscientists such as Abraham et al. (2012), who explores the aspects of cognitive expansion as well as divergent and convergent thinking, Pearce et al. (2016) who focus on neuroaesthetics and creativity, and Zabelina (2018), whose work deals with attentional flexibility and cognitive control as related to creativity, we now believe that creativity does not involve a single brain region or single side of the brain. Instead, the entire creative process from preparation to incubation to illumination to verification--consists of multiple interacting cognitive processes (both conscious and unconscious) as well as emotions. Recent research by Beaty et al. (2018) found that three distinct brain networks were present with most creative thinking. These are known as the default network (related to brainstorming and daydreaming), the executive control network (which activates when a person needs to focus) and the salience network (known for detecting environmental stimuli and switching between executive and default brain networks). Beaty states "It's the synchrony between these systems that seems to be important for creativity, "People who think more flexibly and come up with more creative ideas are better able to engage these networks that do not typically work together and bring these systems online." So, it is believed that different brain regions react according to the creative task at hand. Many of these brain regions work in tandem to achieve their goal, *and they may* call upon structures from both the left and right side of the brain (Fig.15). Evidence suggests cognition results from the dynamic interactions of distributed brain areas (Jung et al., 2010).

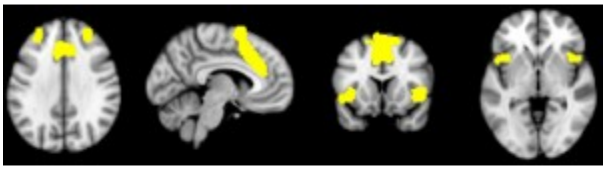


Figure 16 Rex Jung and colleagues provide a "first approximation" regarding the neuroscience of creative cognition in the human brain (Jung et al., 2010)

While the field of neuroscience is progressing at rapid pace, The Neuoscience of Creativity, an MIT publication edited by Oshin Vatanian, Adam Bristol and James Kaufman, provides a comprehensive overview of the critical areas of existing knowledge and those for further exploration, including brain augmentation and transdisciplinary approaches to enhancing creative skills, many of which were discussed over a decade ago (Farah et al., 2004) and are now on the horizon, such as brain implants, psychophamacology, advanced neuroimaging studies of intelligence and creativity, working memory and reducing inhibition to creativity. In Arlindo Olivera's book *The Digital Mind - How Science is redefining Humanity* (2018), importance is placed on shifting the dominance away from Von Neuman architecture towards a combination of heterogeneous architectures that advance the concepts of self-learning and self-directed computing. AI is beginning to use humanlike sensors together with brain-like AI to make all sorts of ordinary devices smart. Olivera believes the future will involve synthetic intelligences, superhuman thinking abilities, digital and biological minds and whole brain emulation or mind uploading.

Amabile also drew attention to the issue of ethical creativity and that it is critical that creativity is not used to justify unethical behaviour both in terms of what is created and how it is created bearing in mind these advances in foreseen above. The 2014 book The Ethics of Creativity edited by Moran, Cropley, Kaufman (2014) discusses in detail the challenges of harnessing technology for good, when novel creativity tends to push us into new realms beyond our conventional norms, which can often quash what could be highly progressive, effective creative ideas that would improve and advance society. The book pays particular reference to issues of the papers of Mai et al (2015) reflect three pieces of research that ultimately demonstrated that trait activation theory and self-concept maintenance theory, a creative personality and unethical behaviour are often linked together. Creatives find it easier to justify unethical behaviour through their ability to break the rules (Kolnhofer-Derecskei, 2016). Similarly, research by Beaussart et al. (2013) underlined a significant negative connection between observable integrity and creativity, simultaneously, with a clear connection between self-reported integrity and creativity. In their research regarding creativity and ethical behaviour, Mumford et. al (2010) found that later stage creativity was less prone to unethical consideration as once the work was moving towards the usefulness stage much of the unethical behaviour was eradicated. Increasingly, we are witnessing the integration of neuro-scientific frameworks with psychological frameworks. These will subscribe further knowledge to such issues in this field, as reflected in our foresight work on the future of security, policing and in particular, neuroforensics. The issue and practice of ethics is highly influenced by presiding social norms. They often relate to a perceived social pressure to engage or not engage in specific behaviours (Ajzen, 2011). Although social norms can be conceptualised in different ways (Chung & Rimal, 2016; Knight Lapinski & Rimal, 2005), the role of perceived normative peer behaviours and attitudes have emerged as key predictors of behavioural response to novelty. There are three main canonical theories of conformity: socialisation, social identity, and rational choice. When considered through the lens of creativity, evidence shows that all three theories are deficient; their definitions of what is a norm are too rigid and limited to account for the rich landscape of potential and its impact on what we will likely accept as ethical as society evolved. The concept of societal misperception often negatively impacts adoption of unique, novel ideas. As such we need to understand and project tendencies towards likely conditional preferences (Bicchieri, 2006) brought about by change. Only the joint presence of a conditional preference for conformity and the belief that other people will conform to these potential new ethics will produce an agreement between normative beliefs and potential future behaviour.

4.2 How to deliver increased creativity

Over recent decades, research on the conceptions of creativity and creative ability have shifted from the belief that it is purely genetic, and limited to the few, only involves the right side of the brain or moreover is a matter of certain personality types, (the creative personality) or is an artefact of only divergent thinking. Nowadays, we have greater understanding of the how the brain works when it comes to creativity, both through complex systems models, information and network studies and neuroscience as well as respecting the value and integration of both divergent and convergent thinking, linear and non-linear inputs, the relevance of the affective and experiential conditions, external factors such as the physical, virtual and social environment and influences and the fact that creativity has a huge role to play beyond just the arts and sciences. The fact that there is currently general agreement, reinforced by neuroscientific studies on the basic whole brain processes engaged during creativity (preparation to incubation to illumination to verification), allows us to giver deeper consideration to the means and points of impact of delivering greater creativity. It allows us to understand the importance of each step in the creative process and to create the necessary higher levels of intuition, imagination, spatial narrative building, critical thinking, rapid combination and recombination of mental representations, self-expression (turning off the internal and external critic), socialisation, immersion and personal ambience as well as thinking and multimedia tools for augmenting creative abilities. These are demonstrated in Chapter 8 as critical to delivering enhanced creativity in the present and emerging era. In a psychological analysis of the relationship existing between empathy and creativity, Paulo Legrenzi (2005), found that there is a close link between the ability to see the world from the point of view of others and tolerance, critical thought, and the acceptance of diversity. Legrenzi sees this ability to change the way perspective changing the type of knowledge and the strategic approach to a creative. Legrenzi’s findings underpinned Florida’s earlier work. Empathy is a critical social attribute, which provokes diffused creativity. Florida refers to this as creative environments. The UK artist Stanza believes it is empathy that unites artists and information technologies and that it explains why people who are all in some way creative but come from different professions find similar elements attractive and desirable. Florida believes that it is these elements that generate the social empathy and sense of belongingness that result in high urban creative concentrations.

I will also discuss a range of proprietary approaches that have been developed which interestingly reflect some of the thinking from the World Play Project (Root-Bernstein, 2014) in which they promote the idea that a child’s imaginary worlds are an adult’s creative playground, as well as supporting Tony Wagner’s (2015) concept of how to create innovative students by shifting them from passion to purpose within a creativity model. Some of the latest developments and role of STEAM (Science, Technology, Engineering, Art and Mathematics) in advancing creativity are presented.

Part of the delivery process involves that Certain baseline traits are included in the creativity development teaching model such as engaging the students to contemplate ideas from unrelated fields and complex disconnects; requiring them to challenge their world and worldviews by asking big questions; challenging new insights through multiple lenses and perspectives; collaborating in transdisciplinary groups despite differences of opinion and creating both meaningful and meaningless artefacts to challenge their understanding of creativity; having to apply and experiment with new and emerging equipment with which they are unfamiliar. The idea behind these tasks is reflected in Howard Gardner's concept of harmonizing a creative's potential skills and challenges, provoking the development of abilities to deal with novelty and complexity beyond their current skills and to master unfamiliar technologies, all of which requires a degree of mind changing.

Consequently, in developing this section of the dissertation included here are sections of an interview I conducted with Howard Gardner in 2012, to better understand his latest thinking about how delivering increased creativity would require a component of mind changing and potentially help creatives to expand their full mind approach. In his 1993 book Creating Minds (H. Gardner, 2011), Howard discussed seven exemplary creators: Freud, Einstein, Picasso, Stravinsky, (T.S.) Eliot, (Martha) Graham, and Gandhi, our conversation focused on his more recent thoughts on creativity, change and minds, to better structure my potential approaches to those areas of this research related to help creatives to increase their creative potential.

The interview with Howard Gardner underpinned several considerations on delivering increased creativity, namely the importance of integrating different disciplines or spheres or perspectives into a coherent whole and to communicate that integration to others; the importance of understanding how affect reflects differently in changing situations and amongst different personalities and how creativity should balance opposing pressures and deal with ambiguity, even absurdity.

4.3 How to measure increased creativity

Understanding what is a creative or a creative person is paramount for the task of delivering increased learner creativity. Chavez-Eakle, Lara, and Cruz found creative people to be adventurous and exploratory when being exposed to novelty. Also, they found them to be optimistic, tolerant of uncertainty and change, and keen to pursue their goals with intensity. Martindale et al. found highly creative individuals to be frequently over-stimulated. Openness is the personality trait most associated with creativity in studies where creativity is considered as a static construct (DeYoung et al., 2010; Feist & Barron, 2003). Traditionally, many psychologists and educators have believed that people's successes and failures are attributable mainly to individual differences in abilities. Cognitive, learning, and thinking styles are not abilities but rather preferences in the use of abilities (Kienitz et al., 2014). However, for the past few decades, research on the roles of thinking, learning, and cognitive styles in performance within both academic and non-academic settings has indicated that they account for individual differences in performance that go well beyond abilities. New theories better differentiate styles from abilities and make more contact with other psychological literatures; recent research, in many cases, is more careful and conclusive than are some of the older studies (Kienitz et al., 2014). For example, Sternberg pays great attention to intuition and the development of intuitive conceptions. He emphasises not only to mathematics and science, the fields in which intuitive concepts have been studied most extensively, but also to the social sciences, arts, and humanities. Sternberg links his findings to education and focuses not only on students' intuitive conceptions but also on teachers' intuitive beliefs about learning and teaching (Torff & Sternberg, 2001).

Frequently in attempting to assess creativity, researchers turn to the process and deconstruct its elements to evaluate each element independently. These models of evaluation involve individual elements such as neurological, cognitive, affective, and motivational factors as well as environmental factors (Hennessey & Amabile, 2010; Rubenson & Runco, 1992; Scott et al., 2004). Additionally, social and interpersonal factors have been shown to affect creative outcomes (Byron & Khazanchi, 2012) and it is important to include metrics for these aspects in one's evaluation model. With growing shifts towards the importance of creativity as a critical skill for economic growth, it is important that any research embraces a broad range of creative expressions. Including collaborative creativity and work in teams whether in person, virtual, real-time, or staged. To understand the creativity of collaborating teams, we need a theoretical framework that allows us to reason how groups of people work together, and how the collective actions result in a final created outcome. Collaborative creative production involves distributed cognition—when each member of the team contributes a critical piece of the solution, after which these individual components are all integrated together to form a collective output. This is a very important recognition of the collaborative process as large projects are usually too complex to be generated by a single individual; they require a team approach, with a division of workload and the well-designed integration of many specialised creative individuals, who generally provide a greater perspective and number of ideas than the individual.

Within creative expression, we need to understand the distinctive values of say novelty as a completely new, original outcome versus that breaks with tradition and formal structures and novelty that seeks to expand tradition and reframe established conventions and values. Many studies on creativity focus on the moment of insight – that eureka moment (Ward et al., 1995 for example), which in turn tends to define it as a cognitive process. Yet, as Howard Gardner pointed out in our interview, there is rarely "a thunderbolt". The most impactful creations rarely emerge, fully formed, from a single moment of insight. Rather, they typically involve many small "mini-insights," expressed as drivers, influences or leverage points that are brought together through a combination of creative thinking techniques to deliver in meaningful creativity. These mini-insights are deeply embedded in a broader social process (Csikszentmihalyi & Sawyer, 1996). The periods of development that precede and follow the insight are fundamentally social either in terms of teamwork or in the individual's internalised understanding of the creative domain itself. As Csikszentmihalyi and Sawyer wrote, quoted from Sawyer (K. Sawyer, 2008, p. 5), based on an interview study with 60 exceptional creators: "This requires conscious expertise on the part of the creator - to structure the workday so that these mini-insights continue to emerge, to implement systems and practices to enable each insight to spark the next, and to enable the aggregation of multiple insights to result in the eventual emergence of a worthwhile idea." With the rapidly evolving implementation of multimedia, robotics and agents, computation and interaction, wearables and cognitive interfaces, synthetic artefacts, and expansive learning technologies in our everyday study and work lives, it is imperative to rethink assessment models for increased creativity either by adapting existing techniques or creating totally new ones.

Experiential workshops and design studies offer rather different opportunities for creativity because of the "openness" of problems (ill-defined problems, the existence of a variety of pathways to the solution, the absence of pre-specified "correct" solutions) and even the creation of novel, unthinkable, futuristic artefacts. Despite this openness, it is still important that the outputs are considered, diagnosed, and evaluated for creativity to ensure that the overall and individual levels of creativity can be advanced.

For this research, given the importance of a new learning system in Chapter 6, which involves multimedia enhanced learning approaches, new and combined evaluation models are presented.

However, at this stage it is important to discuss current and dominant assessment processes related to creative abilities, creative production, levels of impact and affect, increased creativity, and other elements that determine levels and values of creative performance. Studies tend to focus on classrooms or workplaces as both conducive venues for individual creative enhancement and evaluation as well as situations in which creative processes may be implemented to change the overall environment (Craft, 2005; Craft et al., 2008). In this case, we used a combination of classroom and media and future learning labs at the University of Agder in Grimstad Norway as the primary venue for experimentation and research. As we will see in Chapter 9, this was substantiated by additional qualitative and quantitative research. The models for research into increased creativity and extended creative ability have become very diverse in recent times. Accordingly, some of the more common and relevant assessment approaches for the creative space are outlined.

One of the most common and widely applied tests for creativity is the Torrance Tests of Creative Thinking (TTCT), which have been used to assess creative potential (Baer, 2017; Kim, 2006, 2011). The test includes figural and verbal subtests. The TTCT-Verbal has two parallel forms, A and B, including the following subtests: (a) Asking Questions and Making Guesses (subtests 1, 2 and 3), where participants write out questions and make guesses about possible causes and consequences of situations based on a drawing of a scene; (b) Improvement of a Product (subtest 4), where the examinees list ways to change a toy elephant so that they will have more fun playing with it; (c) Unusual Uses (subtest 5), where the examinees list interesting and unusual uses of a cardboard box; and (d) Supposing (subtest 6), where the examinees are asked to list all the consequences should an improbable situation come true (Torrance, 1969). The TTCT-Figural consists of two parallel forms with three subtests: (a) compose a drawing; (b) finish a drawing; and (c) compose a different drawing parting from parallel lines (Baer, 2016). The tests provide a creativity index and scores that assess the cognitive aspects of ideational fluency, originality, elaboration and flexibility. Fluency refers to the total number of meaningful ideas generated, while originality relates to the rarity or uniqueness of the responses. Elaboration is the amount of detail in the ideas and flexibility corresponds to the number of different groups of ideas. It also assesses the various cognitive aspects. One of the aims of the test is to measure the unidimensional and multidimensional nature of creativity when assessed through divergent thinking tasks. The battery is made up of various tasks with verbal and figurative content. It works sometimes in parallel with Confirmatory Factor Analysis (CFA) that reveals that the unidimensional model (a general factor of creativity) and the model of factors as a function of the cognitive dimensions of creativity are based on task content and fit in terms of value and purpose. The ideal with the best fit has a hierarchical factor structure, in which the first level comprises the factors for each of the subtests applied and the second level includes verbal or figurative content. More and more importance is being given to the evaluation of affective elements, particularly when considered in parallel with creative divergent thinking (Fernandez-Abascal & Martin Diaz, 2015) who conducted a variety of studies to explore the relation between affect and production of creative divergent thinking, using the Torrance Tests of Creative Thinking (Figural TTCT). Their work considered the motivational aspects of creativity in terms of generating a positive, neutral, or negative response levels depending upon the real-time and enduring relationship between emotional intelligence (EI) and empathy for those people engaged in the creative process. In Chapter 9, this aspect of creative engagement and increased creative abilities through the lens of immersion and personal ambience (Woodgate, 2011) I have further explored. Social and interpersonal factors have been shown to affect creative outcomes and should be included in any assessment (Byron & Khazanchi, 2012). Creativity emerges from complex social systems, with constant communication, collaboration, and knowledge sharing, to achieve the necessary structure that could enable ideas to spark later ideas, and to ensure that the component insights could be connected in a manner that could generate an effective creative ideation.

While cognitive dimensions have been generally considered a structured way of assessing creativity including of course Torrance in 1977, there is an increasingly frequent debate on whether or not the Torrance test has a construct validity that provides sufficient differentiation in scores to be truly meaningful (Almeida et al., 2008).

In the practice of foresight, we tend to use four key indicators, which when combined cover the aesthetic, formalist, and technical properties (D. H. Cropley et al., 2011; Slater, 2006). These are:

a) Novelty (the concept is original, surprising, and germinal)
b) Resolution (the concept is valuable, logical, useful, and understandable)
c) Elaboration & Synthesis (the concept is organic, elegant, complex, and well-crafted).
d) Closed or open

Surprise and uniqueness are considered strong winning properties.

For this we use the Creative Solutions Diagnosis Scale (CSDS model) Table 3 below shows the original model, which was recently updated (Cropley, 2020) Table 4.

Table 3 Original 30-Item Creative Solution Diagnosis Scale (CSDS)

Functional Creativity						
Relevance & Effectiveness	Novelty			Elegance		Genesis
	Problematization	Existing Knowledge	New Knowledge	External	Internal	
Correctness	Diagnosis	Replication	Redirection	Recognition	Completeness	Foundationality
Performance	Prescription	Combination	Reconstruction	Convincingness	Gracefulness	Transferability
Appropriateness	Prognosis	Incrementation	Reinitiation	Pleasingness	Harmoniousness	Germinality
Operability			Redefinition		Sustainability	Seminality
Safety			Generation			Vision
Durability						Pathfinding

Table 4 The Creative Solutions Diagnosis Scale (CSDS) Updated by (Cropley, 2020)

Property of the Solution	Indicator	Rating
Relevance & Effectiveness	CORRECTNESS (the solution accurately reflects unconventional knowledge and/or techniques)	
	PERFORMANCE (the solution does what it is supposed to do)	
	APPROPRIATENESS (the solution fits within task constraints)	
Problematization	DIAGNOSIS (the solution draws attention to shortcomings in other existing solutions)	
	PRESCRIPTION (the solution shows how existing solutions could be improved)	
	PROGNOSIS (the solution helps the beholder to anticipate likely effects of changes)	
Propulsion	REDIRECTION (the solution shows how to extend the known in a new direction)	
	COMBINATION (the solution makes use of new mixture(s) of existing elements)	
	REINITIATION (the solution indicates a radically new approach)	
	REDEFINITION (the solution helps the beholder see new and different ways of using the solution)	
	GENERATION (the solution offers a fundamentally new perspective on possible solutions)	
Elegance	SAFETY (the solution is safe to use)	
	CONVINCINGNESS (the beholder sees the solution as skillfully executed, well-finished)	
	PLEASINGNESS (the beholder finds the solution neat, well done)	
	COMPLETENESS (the solution is well worked out and “rounded”)	
	GRACEFULNESS (the solution well-proportioned, nicely formed)	
	HARMONIOUSNESS (the elements of the solution fit together in a consistent way)	
	SUSTAINABILITY (the solution is environmentally friendly)	
Genesis	FOUNDATIONALITY (the solution suggests a novel basis for further work)	
	TRANSFERABILITY (the solution offers ideas for solving apparently unrelated problems)	
	GERMINALITY (the solution suggests new ways of looking at existing problems)	
	SEMINALITY (the solution draws attention to previously unnoticed problems)	
	VISION (the solution suggests new norms for judging other solutions-existing or new)	
	PATHFINDING (the solution opens up a new conceptualization of the issues)	

I have applied these criteria and the accompanying metrics in my evaluation of student projects in Chapter 8.

As discussed earlier psychologists such as Bull et al. (1995) identified “cognitive approaches” as one of four general approaches to creativity training, while Scott et al. (2004) distinguish between approaches based on “cognitive processes” and on “associational and affective mechanisms”. With the advancement in neuroscience these two concepts can now be connected, by explaining the cognitive processes using the associational and affective mechanisms to make the cognitive concepts more accessible and tangible. In her paper (S. Bull & Kay, 2010), Bull uses a new approach to creativity assessment involving Open Learning Models, which act as a support aid to students, but also enable third parties to use the model as an intelligent system that enables the assessor the opportunity to study the creative processes and progress that the student follows. Other models such as the Reisman Diagnostic Creativity Assessment (RDCA) use self-report assessment based upon high, medium and low against 11 assessment criteria (originality, fluency, flexibility, elaboration, tolerance of ambiguity, resistance to premature closure, divergent thinking, convergent thinking, and risk taking).

A team led by neuroscientist Rex Jung of the University of New Mexico has been collecting data on creativity evaluation by using an MRI technique called diffusion tensor imaging, which allows researchers to peer through the skull of a living person and trace the paths of all the axons by following the movement of water along them. Computers then comb through each of the 1-gigabyte scans and convert them to three-dimensional maps — wiring diagrams of the brain. The team's conclusion is that creativity research would benefit from psychometrically informed revision, and the addition of neuroimaging methods designed to provide greater spatial localisation of function (Arden et al., 2010).

The team uses a standard MRI machine. "However, by using some sophisticated techniques you can look at certain chemicals in the brain. Some of those chemicals are very involved in important neuronal processes. And we've correlated those with behaviour" (Jung, R. interview with Audrey Hamilton [SOP, 2014]). Jung's team used a combination of tests to assess creativity. Some were measures of divergent thinking, which in this case reflected the ability to come up with many answers to a question. People were asked to draw as many geometric designs as they could in five minutes. They also asked people to list as many new uses as they could for everyday objects, such as a brick or a paper clip. The participants also filled out a questionnaire about their achievements in ten areas, including the visual arts, music, creative writing, dance, cooking and science. The responses were used to calculate a composite creativity score for each person.

The third technique that Jung's team used is simple structural magnetic resonance imaging (MRI) and that allowed them to look at the processing modules of the brain – the cortical thickness – the computers that are on the surface of the brain and how much or little of that one has on the surface of the brain.

Further neuroscientific research on creativity involving statisticians David Dunson of Duke University and Daniele Durante of the University of Padova analysed the network of white matter connections among 68 separate brain regions in healthy college-age volunteers. The brain's white matter lies underneath the outer grey matter. It is composed of bundles of wires, or axons, which connect billions of neurons and carry electrical signals between them. Dunson and Durante trained computers to sift through the data and identify differences in brain structure. They found no statistical differences in connectivity within hemispheres, or between men and women. But when they compared people who scored in the top 15 percent on the creativity tests with those in the bottom 15 percent, high-scoring people had significantly more connections between the right and left hemispheres. The differences were mainly in the brain's frontal lobe.

It seems that while technology and neuroscience in particular is demonstrating how and when we are being creative and enabling us to build new models that that depict creative potential through size, signals, connections, etc. we still need to develop feedback approaches that can more rigorously model and evaluate the levels, novelty, and purposefulness of the creativity and to find robust and salient means to increasing creative behaviour and abilities – overall individual and group creativity.

As Csikszentmihalyi reminds us in his seminal work (Csikszentmihalyi, 1996), "creativity thrives on uncertainty". Either creating environments and ambience that provokes that uncertainty or designing tools, interfaces and interaction that inspire and awaken our unconscious/subconscious mind and creative interaction and flow from which to create and develop novel, purposeful ideas. This also requires an atmosphere and structure of learner empowerment, one in which the learner is free from fear of failure and where learners can explore further their own learning experience and styles, to explore and expand their creative personality, their spheres of knowledge of both the specific domain and the world at large, as well as adapt to the rhythms of the challenges to arouse their creative energy. As Howard Gardner mentioned in the interview and I covered in detail in my book Future Frequencies (Woodgate & Pethrick, 2004), learners can expand their creative skills from exposure to creative individuals who are prone to experiential, experimental and fringe activities, whether the arts, science even comedy, particularly those who exploring unique, unimaginable horizons, who are not harnessed by the need economic gain. It is critical that the learner can harmonise these inspirational environments with his or her inner self, whether it creates a positive or challenging milieu, whatever breaks one's apathy and evokes strong affective participation. A particularly successful creative environment is one that expands or sensory engagement or adds another sensory expression to the experience. The advent of interactive, fully immersive 3D or even 4D worlds, simulation, adaptive environments with changing 360-degree sensory visual narratives and a plethora of emerging tools and interaction design techniques are making the evaluation of creativity and increased creativity more complex, but equally more comprehensive, which if framed well will deliver outputs that can provide a platform for further avenues of research in the supporting transdisciplinary sciences. The problem currently is that creativity is not a priority or even an ingredient in most educational institutions (Sir Nicholas Serota, Durham Commission on Creativity and Education). We must update education with job readiness, the ability to compete against smart machines and the creation of long-term economic value in mind (Krishnan, 2020).

5 The Need Gap: Comparative evaluation

In the previous chapter, I have discussed the challenges society will potentially face due to the impending changes to the emerging workscape, likely future jobs that could transpire from these changes, the need for the development and teaching of new skills to execute the tasks demanded by these future jobs and in particular the growing demand in the market for creatives, with fresh concepts of and contexts for creativity, as well as transformative approaches for augmenting creative ability and thinking techniques. The key drivers and influences on these changes are outlined and expressed through the lens of STEEP (society, technology, economics, environment, and politics). These drivers have covered a plethora of changing theories and emerging structures that will leverage large impact influences such as learning technologies including those advancing human augmentation, and hybrid domains such as those involving the integration of philosophy and the arts with the science and engineering subjects. This is all part of the growing trend towards transdisciplinarity: the integration of nanotechnology, biotechnology, robotics, AI and computer sciences, quantum computing and communications and their adjacent fields as well as neuroscience and its role in massively improving our knowledge of human cognitive performance. Not least in our ability to better understand how creativity happens in the brain, including the differing integrated components that activate creative ideation.

The new subject domains will enforce a link between creative teaching and creative learning beyond the conventional education approaches we have been pursuing over the past century or more, which are still dominant into today's global educational landscape.

5.1 Towards Postformal education

As Dede (2010) points out: "Conventional, 20th century K-12 instruction" emphasises manipulating pre-digested information to build fluency in routine problem solving, rather than filtering data derived from experiences in complex settings to develop skills in sophisticated problem finding. Knowledge is separated from skills and presented as revealed truth, not as an understanding that is discovered and constructed; this separation results in students learning data about a topic rather than learning how to extend their understand beyond information available for assimilation." Moreover, conventional (20th Century paradigm) instruction requires that problem-solving skills are often presented in an abstract form regularly removed from their application and contextual meaning. As such, the ability of the learner to translate this information to real world situations is extremely difficult. Insufficient time is spent on building capabilities in group interpretation, negotiation of shared meaning, and co-construction of problem resolutions. The emerging workspace will demand that humans engage in richly structured interactions that perspectives and subject matter both unfamiliar and unexpected for the audience. There will be an increasing need to develop communications capabilities in virtual environments that require the learner to participate in mediated dialogue and in shared knowledge building. As shown previously, potential future jobs will invoke new concepts and context for work and employment including a transformative approach to education, which will require a rebalancing of perennial and contextual skills and performance. The latter is not generally present within conventional education systems (Richards & Dede, 2020).

Unsurprisingly, education stakeholders are beginning to understand that education systems in economically advanced countries need to be redesigned both in terms of organisation, structure, and curriculum. In a recent Australian Future of Education survey, undertaken by Real Insurance (2018) (Fig 16), 42 per cent of respondents said the current school curriculum is inadequate, and 30 per cent are not confident children are being prepared for future jobs. The survey concluded that most Australian parents have little faith in the curriculum throughout all levels and most worry about how well the education system aligns with the needs of future workplaces. Equally, many are concerned about the balance of technology in the classroom, particularly as digital literacy is already a critical skill. "It's about blending technology with the right curriculum design." (Cowan, 2018a). US research by Gallup and Strada shows 34% of students believe their schools are not preparing them for success in the job market, and that policy needs to fix the bridge from education to employability (Strada Institute, 2019). That research suggested the development of a fresh ecosystem to optimise "education to employment' focused on student-centred learning and five critical supporting components:

1. Students having a detail overview of the available and future job market, with clear career pathways based upon their passions and competencies (AI technologies are slowly being introduced to create comprehensive, dynamic, student profiles (Woodgate, 2019).
2. Wrap-around supports (human or machine) that provide mentoring and continuous assessment.
3. Targeted and tailor education with clear understanding of the input value (application and cost).
4. Opportunities for integrated learning and earning with portable benefits.
5. Transparent, unbiased hiring process with adequate opportunity for the student to demonstrate competencies and expanded skills (Strada Institute, 2019).

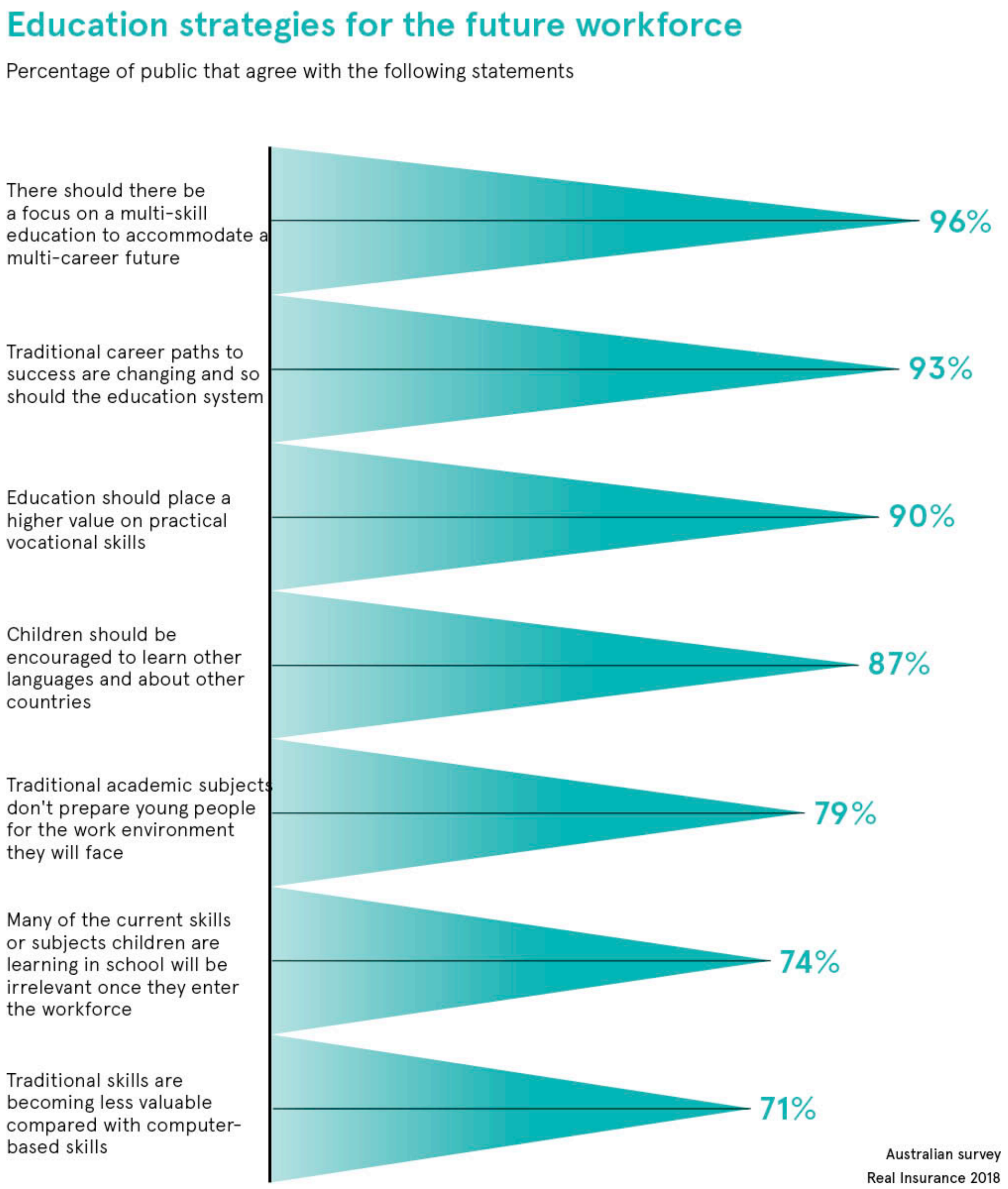


Figure 17 Australian Future of Education Survey (Cowan, 2018b)

Reiterating an earlier point, 60% of future jobs have not been developed yet and 40% of nursery-age children (kindergarteners) in schools today will need to be self-employed to have any form of income (World Economic Forum, 2018). We need to prepare students for jobs that have not been created yet and to become entrepreneurs. What we need to learn, how we learn, and this will have a large impact upon the learner-teacher relationship and the advancement of the student-centred learning philosophy (Dede & Richards, 2020). At the same time, learning collaborative skills, mutuality and knowledge sharing are critical aspects of the new approaches. In knowledge-based economies there is a shift towards team work rather than individual work. This requires team management to ensure that there is diversity and balance between the competencies and skills of team members. This is also true of collaborative work in the virtual space.

The Strada findings were supported by research undertaken by the Career Colleges Trust. Their CEO, Bev Jones, said: “The education system is frequently talked about and debated, but rarely do we ask the young people themselves about their own experiences. This research highlights the concerns that teenagers have about their education and career pathways – and more support is needed to help them plan their futures." (Belgutay, 2019) The research indicated that "employers were facing skills gaps, and yet young people were not aware of the many opportunities open to them. "With schools focused on academic achievement, students are struggling to make key decisions about their futures and not getting the exposure to industry and work experience that they need to do this." These issues do not only relate to college students but are equally voiced by high school students. According to the same research, 17 per cent of young people say "they have no idea of any options outside traditional academic routes", and a third say "they have no idea about what career path to take". Over a quarter of students believe "the education system is 'not fit for purpose'", and a third state this is because there is a 'one size fits all' approach to education. A further 25 per cent say the system fails to "cater to different learning needs" and the same proportion feel that the curriculum and teaching styles are "outdated". (Belgutay, 2019)

A 2014 report by Zogby Analytics, a leading international opinion research firm commissioned by Laureate International Universities, which surveyed students at 37 Laureate network institutions in 21 countries with more than 20,800 students responding to the survey, (the largest international survey ever of student attitudes), expressed the belief that the "university of the future" will be accessible, flexible, innovative and job focused. The report demonstrated that the respondents saw the university of the future as clearly focused on producing graduates that are job ready. Sixty-one percent believed that industry experts would design most courses that will be offered by future universities. More than 70 percent believe that career-oriented skills (not just subject matter) will be taught in future universities.

Two research programs in which I have been personally involved and familiar are the Readiness Project undertaken by KnowledgeWorks in 2017, to which I contributed, working together with Jason Swanson and Katherine Prince. The project consisted of a series of in-depth interviews with leaders at cutting-edge organisations, to better understand the expectations of future candidates, post-university. The outcome revolved around three core skills that promote the social and emotional awareness needed to succeed in the future workforce:

1. Deep self-knowledge: Individuals will need to continue to discover their own personal and professional strengths, weaknesses, passions and emotional patterns.
2. Emotional regulation: Workers will need to be able to recognise their own emotions, understand the triggers that create them and move to more productive emotional states.
3. Empathy and perspective taking: People will need to be able to recognise others' emotions and perspectives to help build inclusive, collaborative work environments.

The others were conducted by my department faculty colleagues at the University of Houston, titled: Students Needs 2025 & Beyond (Hines & Suarez, 2017), aimed at aiding organisational innovation. The research was based upon interviews with some 50 students at the University of Houston, College of Technology. The research was expanded and published as Nine Emerging Student Needs (Hines & Whittington, 2017). Both placed "relevant skills for emerging and future jobs" at the top, insisting that current curricula and approaches are lagging behind the needs of real-world work skills.

The other eight skills in descending order are:

1. Mentorship – human or AI agent
2. Real-time feedback on all areas of life
3. Frameworks and advice for adaptive/new situations
4. Opportunities to show uniqueness
5. Experience – job placement or exchange opportunities
6. Personalised/customised instruction
7. Options for blended learning (f2f and on-line)
8. Learner optimisation, through AI-based student monitoring and recommendations

All the above-mentioned research reports and many more indicate that there is a significant gap between most available education programs and frameworks, the curricula, teaching and learning approaches and the skills that will be required to meet the job needs and individual employability in the economically developed countries in the near future and even more so in the medium-term future. This gap is also true of societal needs. While this gap applies across many of the necessary 21st Century skills discussed in Chapter 2.4.1., teaching and learner self-development of creativity and creative abilities are among the skills that are lagging the most (R. K. Sawyer, 2014). In fact, creativity is rarely a statutory requirement outside of the arts, whereas it should be a core part of every subject (Desailly, 2016). Sawyer emphasises that any serious attempts at exploring creative potential must consider the full range of human creativity. In that sense Sawyer places as much emphasis on game and synthetic character design as mathematical theory and experimental laboratory science. He pays particular attention to the importance of improvisation and experimentation and the way that such genres are developed and expressed across world cultures (K. Sawyer, 2008). It is his believe and that of other great creativity theorists such as Csikszentmihalyi and practitioners such as Juliet Desailly that these forms of creativity will play a significant role in the creative societies of the future. Although we can learn from the thinking processes and approaches involved in pure arts, especially those pushing the fringe towards new frontiers, Sawyer (2008) argues that "from an education and policy making perspective, these forms are unlikely to provide leverage for increasing the overall creativity of a society and an economy; specifically, they represent a small fraction of the overall revenues accruing to the creative industries."

5.2 The pedagogical challenge to increase creativity

A major pedagogical challenge here is that to determine and integrate new approaches to expanding creativity as a critical skill, educators are expected to adapt their curricula for jobs that do not exist for 65 per cent of the children starting school presently, so that they are prepared for the time they come to seek employment. Not only are students uninformed of future potential, but most educators find themselves facing similar issues. As futurists our role is to create the future, not predict it and as such where foresight-based programs are introduced, students begin to both project themselves into the future and to create future-relevant artefacts (Woodgate, 2019). It is true that as times change and market needs evolve, educational subjects sometimes come in and out of vogue, while others are threatened with abandonment. However, we are at a point where a transformative approach to subject selection, content development and the technology-aided delivery is paramount. Educators in New Zealand are promoting what they call the future-focused principle and the need for educators to be future-oriented and adaptable. Dr David Parsons, associate professor at Massey University in Palmerston North, explains in a New Zealand Ministry of Education presentation: “The curriculum encourages students to look to the future by exploring such significant future-focused issues as sustainability, citizenship, enterprise and globalisation.” These are integrated into some of the more traditional subject or hybrids of those subjects. Professor Jeremias Adams Prassl from Oxford University believes forecasting underlying skills is not necessarily a new challenge. In his own discipline of law, he says: “The law always changes and as legal educators we need to focus on transferable skills, such as legal thinking and writing. We need to focus not just on the content, but how we go about teaching it. Do you emphasise the passing on of knowledge or the critical interrogation of the subject?” Adams-Prassl adds that future skills must be taught with technology-based tools. It is about blending technology with the right curriculum design (Adams-Prassl, 2020).

To expand upon this point, a major part of transforming education in terms of expanding the role of creativity as a prominent skill to be taught and learned, is the introduction of creative teaching techniques and critically the allocation of creative teachers with the skills and personal qualities that will help learners expand their creative capabilities. Equally important is the provision of a creative curriculum specifically aimed at expanding learner creativity, namely planning creative inputs and outputs. Ultimately this involves taking risks to make teaching interesting, and equipping learners to deal with the unexpected or even the unthinkable. This means proposing tasks that have the ability to reflect critically and rigorously on their own competencies whether new or an extension of existing expertise. Enabling the learner to create artefacts and ideas that reflect their understanding of real-world values and opportunities builds deeper participation, motivation (a combination of extrinsic and intrinsic), engagement and immersion, leading to both the learner having a greater self- belief in his or her creative competency as well as a sense of fulfilment and self-actualisation. There is a strong argument (Craft, 2004) that creative teaching is actually effective teaching and falls within the “noticeable characteristics” of outstanding student teachers and one of the key teaching criteria as determined by OFSTED (The Office for Standards in Education, Children's Services and Skills) in the UK and ESG – the European Agency for quality standards in higher education (ESG, 2015). Anna Craft argues that “in a constructivist frame, learning and creativity are close, if not identical” (Craft, 2005) and that teaching for creativity is “learner empowerment”.

Juliet Desailly (2016) frames these qualities as follows:

1. Teaching creatively: imaginative teaching strategies – effective and engaging
2. Learning creativity: autonomy of students to own their learning experience in accordance with their preferred learning styles.

3. Teaching to develop creativity based upon the eight elements of creativity (such as applying known skills in different contexts, generating new ideas, developing skills of perception, dealing with ambiguity, applying a constructive approach, expanding paradoxes).

Desailly supports these with several pillars such as persistence, setting milestones, trial and improvement, working in groups, generating ideas, thinking skills, listening and responding and focus. Desailly expounds the strong link between creative teaching and creative learning.

Unquestionably, increasing learner creativity would be difficult if the learning environment was not conducive or even inspiration and provocative. Optimizing the environment for creative endeavours, especially as education moves towards student-centred learning is essential and consideration should be given to the layout, tools, and visual presentation. Today one should remember that with so many tools such as projection mapping, interactive screens, simulation, and holographic techniques, flexible, adaptive, pop-up workspaces, and individual and collaborative communications tools and networks, creative workplaces can be potentially adapted to the creative task at hand. This is the experience gained from consulting on numerous creative learning spaces including the labs at the Creative Media Industries Institute and The Digital Arts Entertainment Lab (DAEL) both at Georgia State University in Atlanta, Georgia, USA, for the ARUP Group in the UK, the STEAM Lab at Charles Drew Academy in Atlanta and of course at UiA. What all of these have in common is that they build connections between creative learning, creative teaching, creative curricula and a creative environment that (Chen & Chen, 2011) underpinned with program of creative intelligence and for which (R. Chen et al., 2020) developed and evaluated an instructional program for improving university students' creativity based on a blended knowledge-management (KM) model that integrates e-learning and three core processes of KM: knowledge sharing, knowledge internalisation, and knowledge creation.

In this dissertation, having identified and substantiated the deep gap between the growing need for creativity in the future workplace and the lack of relevant creativity teaching and learning in education systems in economically developed countries, a comprehensive creativity enhancing strategy is included that focuses on accelerating the increase in individual and general learner creativity within the potential future of education and learning environments.

5.3 The scope of the gap

Having established that there was a clear gap between the requirements of the future projected workforce with its anticipated need for a major increase in creatives and the present education system, further research was undertaken to determine why and how that gap was expanding, together with deeper investigation of current thinking on how to rectify with the perceived growing divergence between the current system and emerging needs.

5.3.1 Transitioning to a new learning paradigm

The baseline characteristics and assumptions of traditional education and learning, which have been called, variously, a transmission and acquisition model (Rogoff, 1997), the banking metaphor (Freire, 1989), instructionism (Papert, 1993), and the standard model (OECD, 2008) are shown to neither embrace the needs of the

Innovation Age, nor meet the changing paradigms spurred by the desire to acquire deeper conceptual understanding. Here I am referring to aspects such as diverse knowledge systems and sources, collaborative group learning; competency-based assessment, enquiry-based learning; integral learning with its new learning pathways and microcourses; etc. Instructionism does offer certain positive aspects that can be applied to the emerging learning paradigm, such as learning about unforeseen uncertainties, complex causal effects, influence signals, broader exploration of action spaces.

To embrace the complexity and contradictions and the challenges that ensue from these fragmented approaches to transformation, we need to pursue a willingness to envision alternative futures (Montuori, 2011) to transcend the current environment and to expand efforts towards "complex thought" (Morin, 2008): thinking and complex dialogue that embrace paradox, complexity, uncertainty and imagination. Much of this transformation of education is found in the evolving education philosophy of postformal education (Gidley, 2016), under which she discusses how global education must now turn towards the values of love, life, wisdom and voice with practical virtues such as empowered imagination, critical reverence, an openness and awareness to multiple points of view, and an ability to communicate one's authentic presence. Gidley who is a futurist colleague of mine and former President of the World Futures Studies Federation, adheres to the notion that there is a need for an integrated mapping of individual development against forms of cultural evolution. Her intention is to integrate "spiritual models of the layered human being, process-oriented postmodern philosophies, socio-cultural evolution models and developmental psychological models", what she sees as the re-humanisation of education at a time when we are shifting rapidly towards student-centred learning.

Gidley undertakes a survey of approaches to what she calls postformal pedagogies in educational theory, in which she draws upon the early work of Steinberg and Kincheloe (2010) on multicultural education which focuses on a few of these dynamics to situate the moral dimensions of a twenty first century reconceptualised critical theory. Gidley maps relationships between the four themes of the evolution of consciousness: conscious, compassionate spiritual development; mobile, life-enhancing thinking; complexification of thinking and culture; and linguistic and paradigmatic boundary-crossing; with pedagogies which align (either explicitly or implicitly) with postformal thinking qualities and postformal reasoning. Sinnott et al. (2003) describes postformal thinking as 1) Self-reference: there is some amount of subjectivity in all knowledge, thus all knowledge is somewhat incomplete. "People are constantly urged to act, though they are always "trapped in partial subjectivity" due to the limits of their knowledge, therefore the logic they use is self-referential to some degree". 2) Ordering of formal operations: "As people decide what is true, logical processes develop out of these conclusions and progress and become more complex".

5.3.2 Acknowledging advances

So, while there is a clear gap between emerging workscape needs and current education approaches, it is evident that in the four years since I developed the original course we have seen and experienced major advances in digital learning values, affordances, systems and digital learning design and approaches. Şendağ & Gedik (2015) discuss the importance of embracing online social networking tools, virtual and augmented reality as a means integrating 21st century skills of critical thinking, problem solving, collaboration, communication, creativity, decision

making, innovative thinking and as such. Their concern is that traditional university structures are unsuitable as places for creating scientific knowledge, as they are always behind the training levels and novelty that students' needs to be ready for real world jobs. Consequently, there is a growing push among students, particularly where college fees are high to seek out alternative approaches that embrace these technological advances reveal new ways to fulfil these needs, while still providing their required levels of certification.
The use of digital media technology in teaching and learning has been increasingly getting diverse both in terms of the available technology solutions and the pedagogical approaches for various teaching & learning contexts. On one hand, this diversity of technology and contexts of use could open more possibilities to enhance the human performance, through the support of a wider variety of learning activities, human-human (H2H) and human-machine (H2M) interactions. On the other hand, however, the diversity calls for more research to devise effective pedagogical models and new concepts of digital technology mediated interactions for learning.

The constant discussion and experimentation underway within both academia and the public at large about the need for a truly transformative reconceptualisation of the education system tends to be firmly focused on these two key dimensions or drivers of change that will enhance human performance. The first of these is framed as the role that emerging technologies (tools, environments and platforms) can play in adapting learning to the needs of the future workforce as defined by the various lists of necessary postnormal skills (Woodgate, 2018) that students should be required to acquire both for the good of keeping developed economies salient and also to match the changing workforce structures that have occurred in these economies over the past three decades as a result of the falling manufacturing and agricultural jobs in favour of the growing creative class (Florida, 2002; Florida, 2011). The situation is amplified by the continuing reduction of full-time company employees in favour of temporary freelancers and consultants, what we now call the gig economy. Richard Florida told me that providing a creativity-based education and radical upskilling are the only ways to improve the chances of the lower paid workers and sustaining employment in the future. He mentioned that in his recent research showed that only a small percentage of lower-paid workers are able to move into jobs that provide a pathway to higher wages. As he points out low-wage workers are likely to become unemployed rather than to move up the economic ladder.

The second relates to the position of the student in the teacher-student duality, in terms of the belief that shifting from the “sage on the stage” mentality of authority vs. subordinate to “student-centred” learning will provide a new generation of self-organised graduates with enhanced, adaptive approaches to problem-solving and alternative thinking techniques that will be more relevant to and deliver the knowledge, competencies and performance required to successfully negotiate the emerging challenges of the multiple dimensions of change (social, cultural, human and technological), as we enter the third decade of the 21st century.

While in general terms, both these key dimensions of transformation are extremely valid as determined by a plethora of research over the past decade and the outpouring of potential learning structures and approaches that have resulted, there are multiple points of confusion as to what type of overarching model would deliver a truly transformational, longer-term solution for the future of education, rather than short-term tactical explosions or experimentation. Such an overarching structure would need to be robust, but adaptive and flexible enough to cope with the rapidly changing socio-economic landscapes, a broad base of emerging driving forces from outside of the education system itself and even changing worldviews and cultural paradigms. This same dilemma is present when it comes to the scope, specifics and dynamics of the technologies that would enhance human performance in a pedagogical context.

Askar (2014) summarises the digital advancements that he believes will ultimately drive education stakeholders to transform and adapt to the 21st century. In detailing these drivers he focuses on knowledge access and dissemination roles shifting away from traditional learning environments, which will new learning platforms and providers into the marketplace; new interactive digital platforms that vastly improve participation through sensory enhancement as well as new expressions of knowledge, the power of social media in relationship to collaboration and communication, big data and learning analytics; massive online open courses (MOOCs) and open educational resources (OER); educational or serious games driving new platforms for mentor-learner interaction. Also, the aggregation of these advances was pushing more and more towards to future job inspired education and professional training with particularly emphasis on employability.

In Associate Provost Richard Lester's 2017 Global Strategy for MIT's Strategic Plan considerable focus is placed on entrepreneurship-based innovation pathways to help "accelerate the conversion of discoveries and inventions into practical technologies, products and services, and this in turn is adding new dimensions to the Institute's interactions with the world". Lester's plan demonstrated clear areas of development that would provide opportunities to participate in the local innovation ecosystem by attracting large international firms to MIT's Cambridge neighbourhood. Lester also recommended MIT entrepreneurship "bootcamps', namely intense short courses taught in conjunction with online entrepreneurship education programs.

While universities had already been moving increasingly in that direction (Pegg et al., 2012) various education authorities had turned to Dacre Pool and Sewell's (2007) CareerEDGE model as a broader, more student-friendly model of employability that included degree subject knowledge, generic skills, self-efficacy and reflection and evaluation, but also included "emotional intelligence, personal experience, self-esteem and self-confidence" (Vakoufari et al., 2014). Pegg et al. in their 2012 paper also state, that "the ability to articulate learning and raising confidence, self-esteem and aspirations seem to be more significant in developing graduates than a narrow focus on skills and competences." They further argue, that "employability" is understood by both employers and learners to go way beyond skills; rather, employability is "a process of 'becoming" related to graduate identity". Similarly, one needs to consider flexibility and adaptability as "personal attributes" that go beyond "technical competences". Together we can understand this as contextualising employability as the aggregation of domain or topic knowledge; skills and competencies; and personal development.

Accepting the assumption based upon the findings outlined in this Chapter that the present education system is considered inadequate to meet the changing demands of the Workscape, at the same time, one must recognise that the system is undergoing scattered attempts at a significant transformation reflecting the general tenets of postnormal times with their complexity, contradiction and often chaos (Sardar, 2010). To address the challenges and radical nature of these postnormal times, we need to develop new forms of education and imagination (Morin, 2008). Such action means understanding, accepting, and adopting accelerated change on all fronts from technological innovation for learning tools, interfaces and environments, to modes of teaching/learning, social platforms, immersive and collaborative environments, learner modelling, and integrated curricula. As well as other provocations such as integrating the learning of new skills, new economic models with a barrage of education suppliers, certification, assessment approaches and course structures and pathways.

5.4 The Hypothesis

The transformative changes described above substantiate and further propagated my belief that education and learning need to be redefined at their core. Accordingly, I have developed an initial hypothesis statement and flowchart for this dissertation (Fig 19) based upon establishing an actionable response to the complexity of the gap conundrum and in line with the problem statement and research questions.

"Research states that there is emerging major transformation of jobs, workforce structures and workplaces over the coming decade. This is fueling a growing need for a creative workforce that is not served by the current education system. A fresh learning system, which would integrate necessary future skills and transformative pedagogical approaches based upon futures thinking is necessary to accelerate and increase learner creativity, and creative skills?

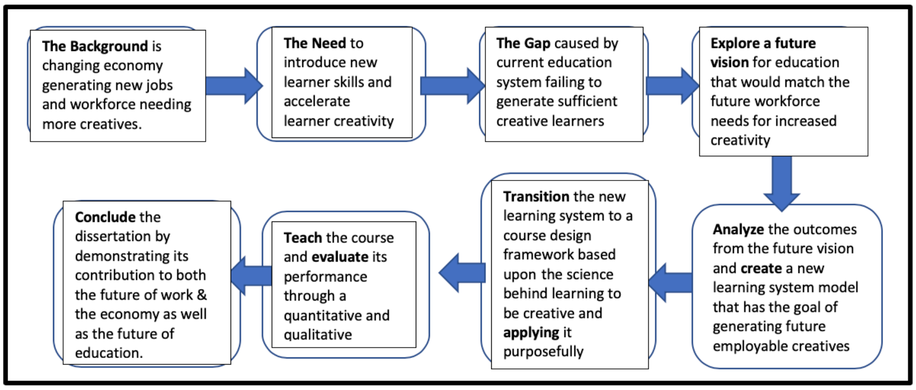


Figure 18 The hypothesis proofing process flow

6 Creating a solution framework to resolve the need gap problem

Given the core reasons for the gap between the impending changes to the workscape, and current approaches to learning, as well as the volumes of scattered recommendations for this radical transformation of education discussed in Chapter 4, I decided as a preliminary exercise to undertake a foresight study to determine potential opportunities for education and learning over the next 10-15 years. This enabled me to draw greater parallels between future work needs and education as well as broader societal, technological, economic and environmental drivers and their implications.

The foresight study would provide the impetus for me to go beyond current thinking to separately deconstruct the current and transitional concepts of education and learning by subverting prevailing assumptions; revisit values; reason and signifiers; assess areas of fracture, potential impact points and disruption; reconstruct "plutopian" realities by creating and "experimenting" with paradoxes and hybrid structures; and create models that change perspective and provide conceptual and contextual relevance. By creating futures scenarios it was possible to envision a more sustainable connection between work and learning, and their influence on progressive social change as a whole, while placing increased creativity at the forefront.

Consequently, it was envisaged that together with the learnings from the previous Chapters, the outcomes from the foresight research would inspire the development of a new learning system that is capable of increasing learner creativity levels while contributing to the future of the education system.

6.1 Foresight study of the future of education and learning

The foresight study was designed using foresight methodologies (futures studies) to create a plausible baseline vision of the futures of education/learning in the context of the workscape transformation. This futures baseline helped establish a start-point on which to consider an appropriate learning system that would be robust and comprehensive enough to optimise future learning, deliver increased creativity, in line with future workforce needs in a way that will connect their purpose, context and meaning. This study also provided me with insights into key areas in which multimedia and creativity-driven processes could be integrated. Experience told me that the combination of modelling and imagination would enable me to create disruptive, artificial models of education and learning that would help determine new avenues of exploration and open new gateways to creativity and innovation.

Foresight is a rigorous process of systematic and explicit research and thinking about potential alternative futures. It is a field developed in the 1950s and 1960s (Son, 2015) aimed at demystifying the future to keep it under human control. Wendell Bell's book Foundations of Futures Studies (W. Bell, 2003) is widely acknowledged as the fundamental work on the subject. Over the past two decades, the field has grown globally both through an expansion in the number of universities that teach it as a subject and through formalised organisations such as the Association of Professional Futurists (of which I am a founding member) and the World Futures Studies Federation (where I head up the WFSF-UNESCO Committee). The objective of foresight is to explore plausible, alternative futures and identify the challenges and opportunities that may emerge. Foresight helps us understand the forces shaping a system, how the system could evolve and what surprises could arise (Padbury, 2020).

The outputs of the foresight study enriched the foundational platforms on which to develop transformative teaching and learning models that will have relevance for a 10 -15-year horizon and longer and established a parallel with the future insights into the projected changes to the Workscape as described in Chapter 3. Importantly, the foresight development methods are coupled with stringent evaluation processes. The process we apply involves over 40 methods and tools. The process combines multiple modelling methods and computational thinking coupled with transdisciplinarity and sensory intelligence. Foresight fuses linear and non-linear or nomadic thinking techniques, such as rhizomatic thinking, which provide the necessary creative and visionary input.

6.1.1 The foresight process

For this research, I used my foresight consultation company's (The Futures Lab, Inc., TFL) six-stage foresight process (Fig. 20) (P. Bishop et al., 2007; Woodgate & Pethrick, 2004). TFL's six-stage process has many similarities with other foresight frameworks (Conway, 2016). The key difference stems from the TFL process's origins back in 1996: it was aimed at corporate clients, who over the past 25 years have primarily expected a revolutionary rather than an evolutionary approach to foresight, with the vast majority of assignments based on discontinuity and 3rd horizon potential (Curry & Hodgson, 2008). The process shifts very early to a future baseline with less focus on the past and present. It is designed to deal with unstructured knowledge in unknown worlds, which forms a basis for creating discontinuous futures opportunities.

It has a good balance between creativity and systematic approaches. The TFL process has a positive bias and considers the challenges, disruptions, and implications more in terms of a positive future with less reflection, on worse case scenarios. The process places greater focus on weak signals (Hiltunen, 2008), wildcards (Markley, 2011; Petersen, 1997) and emerging issues, rather than trends, which are already established.

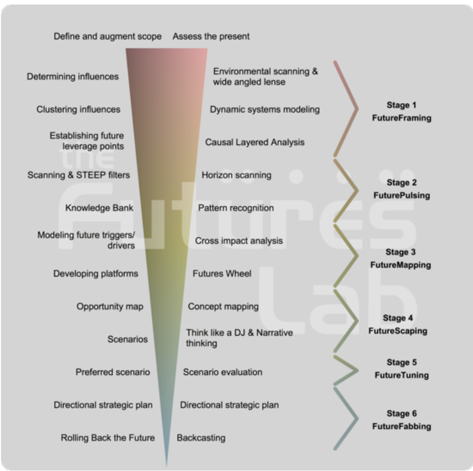


Figure 19 The Futures Lab Inc's six-stage foresight process

Using this particular foresight process involves starting with a blank canvas on which to create unfettered visions without reflection upon the past or present. The value here is to provoke discontinuity and to help shift from their present self to the future self (Woodgate, 2019) to unlock new gateways to unexpected signals and breakthrough ideas.

There is no single driver of change, nor is there one plausible future, but multiple with different dimensions and perspectives. In principle a harmonisation of either all or at least four of the conventional STEEP (social, technological, environmental, economic, political) forces are required to achieve discontinuous change, which is a critical goal of foresight and a differentiation factor when foresight is compared with strategic planning or forecasting. Whilst STEEP is rather limiting and most often used for environmental (horizon) scanning (J. L. Morrison, 1992), it is a useful baseline tool, especially if accompanied by Wilber's four quadrant integral futures structure (Wilber, 2000), which Slaughter adapted as an integral scanning tool in 1999. Consequently, the STEEP forces are used to provide a preliminary framework and understanding of an informal potential vision of the future, in this case related to future education and learning as a holistic, harmonised, transformative and causal entity. Consequently, it is crucial to interpret STEEP for the selected domain in a future context (Fig. 21)

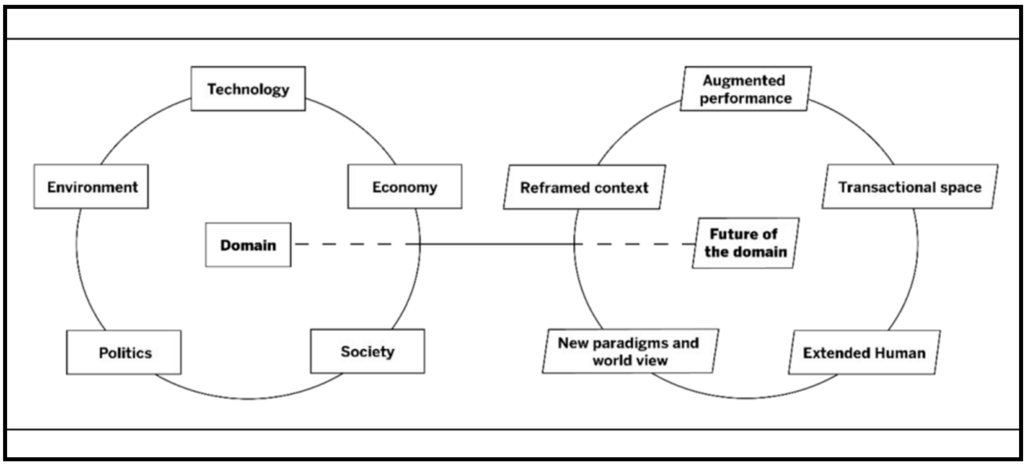


Figure 20 The STEEP future context model (Woodgate & Veigl, 2020)

While, I will not describe every aspect or method followed in this six-stage foresight process, an outline of the steps taken and focus on how the outputs arose and how they were translated, transformed and migrated through the project are provided. The foresight process works like a funnel, moving from a vast number of potential influences on the chosen future domain down to a preferred future or one that we believe provides an optimised vision of probabilities and is plausible in terms of scope of opportunity, feasibility, relevance, risk and ultimately, desirability.

6.1.2 Framing the present and emerging drivers of change

The start points in Stage 1 involved flushing out and determining a clear future domain to study, i.e., the future of education or the future of learning or the future of learning technologies or maybe even as specific as to how the future of social change may impact the future of learning. Whether broad or narrow, the framing of the domain follows specific criteria, and the decision should provide sufficient flexibility to take account of potential wild cards, disruptors or reconceptualisation of the meaning or relevance of the domain, ten years or so from now. A future horizon scope of 2035 was applied (Curry & Hodgson, 2008). Beyond the criteria, I also ensured that we considered the future as the baseline, rather than evolving from the present. This required changing our mindset and perspective to projecting ourselves into the future for each consideration of what is future possible. It was determined that we should create a vision for the future of learning as our framework model in which to consider the role and relevance of teaching and learning technologies. This meant asking ourselves how we would describe the experience of learning in 2035? What new values could be brought to bear? What could symbolise each in 2035? Could they be hybridised? How could their conceptual relevance change? To answer this last question, I employed a post-structuralist methodology called causal layered analysis (CLA) (Inayatullah, 1998), which considers the concept through four filter layers, namely Concept (litany-observations), Context (social causes/drivers), Worldview (discourse) and Myths and metaphors (values, signifiers and emotional responses). CLA as a theory seeks to integrate empiricist, interpretive, critical and action learning modes of knowing. As a method, it creates transformative spaces for alternative thinking. This process was supported by a secondary thinking technique that called "Thinking the Unthinkable" (Woodgate & Pethrick, 2004), which ensures that we subvert assumptions, peel away the surface, revisit values and signifiers, ascertain potential points of fracture, impact and disruptors by reconstructing the dystopian reality by considering paradoxes and hybrids, juggle with potential wildcards and "upside-down" worlds. This technique is not dissimilar to the catalog of the unexpected and future relevant attributes developed by DeSantis (2015). This ensured that we had a 2035 vision of what learning could be rather than what we think it is today. It created simple outputs such as: decentralised, adaptive, affordable, interactive, self-organised, technology enhanced, enquiry-based, on-demand, rapid learning, collaborative, knowledge as a commodity, redefinition of classroom and discussion about deeper conceptual understanding, diverse knowledge systems, machine learning for assessment and student modelling, ensuring that a student's knowledge is integrated, coherent and contextualised, etc.

These outputs are expressed as future avenues of exploration.

This work also began to provide me with considerations of influences that was built into the next task, which was to create a wide-angled lens. The lens provides a crucible for hundreds of our ideas from the broadest possible areas of influence, both direct, adjacent and divergent.

The wide-angled lens is boundless without clusters or relationships or connections at this point. It enabled us to envisage the complexity of a domain such as the future of learning and it reiterates the point that the future is never truly influenced by any one driver or that there is one possible future. In considering inputs for the wide-angled lens, I took into account all the aspects of STEEP (social, technological, economic, environmental and political) and beyond, such as: influencers and movements and concepts that do not yet exist. Besides STEEP, it was essential that the wide-angled lens integrated our parallel research into social and cultural change. At this junction, the ten theories of change (Giddens, 1979; Whittingham, 2015) were applied, especially the four dimensions of change: Sources and Levels (from where?), Time horizon (how long?), Rates of change (how fast?), Forms of change (what shape?). This process enabled me to gain a comprehensive insight into four areas of change, namely, social cultural, human, and technological.

Key outputs from this stage of the included:

1. Social: self-directedness, learner well-being and learner profiling, intellectual flexibility, new value dimensions of power and prestige.
2. Cultural: Bottom-up influences – agency, learning agents, new skills, new occupations, learning playlists, workforce structures, gamification, culture of learning.
3. Human-development/emerging learner: enhanced human potential through tools, body modification and interfaces, multiple identities, changing anchors, values metaphors and signifiers, redefined transition points, learning as lifestyle, desire for experiential learning.
4. Technology: Intelligent environments, augmented virtuality, natural/rich interfaces, interactive cognitive systems, augmented reality, nanotechnology and interactive materials for learning tools, wearables, location-based learning, machine learning & data analytics, neuroscience and assessment, personalisation and security, fluid interfaces and personalised interactive haptics, claytronics, Web 4.0, advanced intelligent learning tools and displays, supporting technologies, including batteries and storage.

The integral futures model (Wilber, 2000) (Fig.22) was applied to create early visions of an integrative reasoning for the social, cultural and human development areas, so that we could later overlay potential relevant technologies.

The outputs from the wide-angled lens, and the parallel sociological research were then integrated into a systems dynamic model.

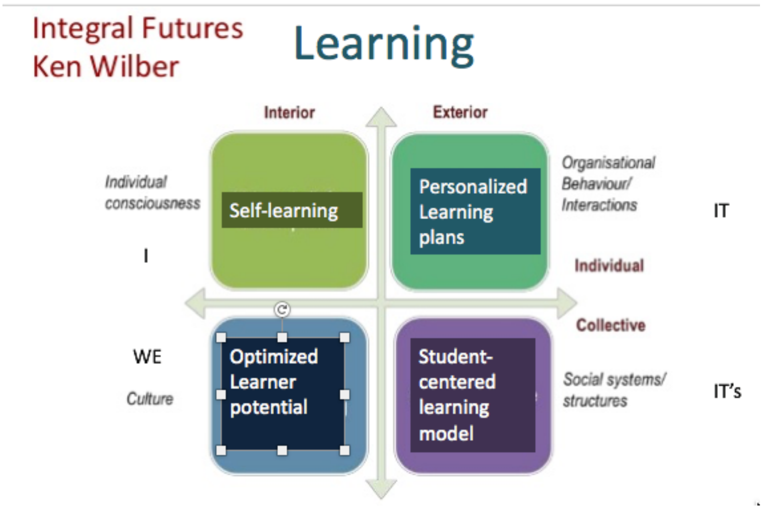


Figure 21 Integral Futures Model for integrative reasoning

Several models from different perspectives of the domain using systems dynamic modelling were created. Systems modelling and thinking are a fundamental element within foresight methodology. Based on Arthur Koesler's "holon", every system and every part of a system is connected to every other system, at least indirectly. It enabled us to build relevance and context, connect disconnects and cluster change agents, which can become critical future leverage points and reduce the hundreds of influences in the wide-angled lens down to manageable areas for further research.

The system allows us to play with causal chains and feedback loops and to help us understand the interaction between the lower-level nodes. Once completed, a study of the model allows me to visualise the interaction between the various outputs, agents and sub-drivers as experiences or objects that could represent future drivers. The model basically determines key variables of interest by building initial micro systems, which inspire possible future leverage points.

We arrived at the inputs by using a set of assumptions, which included adoption probability, time horizon, learning curve strength, and approach effectiveness.

The systems dynamic model generated eleven future leverage points or clusters of influences namely:

i. Holistic life learner well-being engagement and assessment
ii. Future learner and social and cultural change
iii. Future workforce needs - curriculum transformation
iv. HMR collaborative leaning and knowledge creation
v. New currencies of excellence and knowledge
vi. Supportive learning technologies –incl. implants, robotics, simulation, ML
vii. Alternative teaching models
viii. Personalised education, changing human, new cohorts, identity, and reputational dynamics
ix. Life-long learning, life extension, later retirement
x. Multimedia, gamification, intelligent learning environments
xi. Decentralised and universal education

6.1.3 Deep horizon scanning, the critical influences, weak signals and wildcards

Consequently, we commenced Stage 2 of the foresight process by undertaking a comprehensive horizon scanning of the eleven future leverage points. This involves pursuing in-depth study of anything we could find on those subjects following four specific motivations: 1) undirected: reading or viewing everything available from academic articles, university labs to Ted Talks and company strategic plans; 2) conditional: responding only if it met certain criteria, such as being novel, unexpected or timely; 3) informal: means seeking specific information in a structured way and 4) formal searching is about devising methodologies that refine the scan. At the centre of scanning are three different attributes to a piece of data, i.e. a trend, which is already framed, but helps understand the near future, an emerging issue – something that is becoming of interest, but is not yet fully formed, immersive 3D learning environments and lastly, weak (early) signals (Hiltunen, 2008) that are just a piece of scanned data for which as a futurist we can see a potential future application or development, even though it does not yet exist even as a concept, i.e. internet banking before there was an Internet, based upon knowledge of object databases. The scanned data was run through eight filters (future marketplace forces, emerging technologies, critical social influences, quantifiable trends, changing lifestyles, future education trends, political and policy influences, potential disruptors). Wildcards and weak signals are tagged additionally. Each scan is registered in an Artificial intelligence (NLP) supported Future Knowledge Bank. Each scan is evaluated in terms of its role and purpose (confirming, curating or resolving) and its implication (impact, novelty, feasibility and timeliness).

Further scanning analysis first involves cross mapping the outputs against on one hand the eight filters and on the other the future leverage points. After which, the data is then clustered and analysed for critical insights using an extended version of the wisdom hierarchy (Frické, 2009) by adding signal to DKIW (data, information, knowledge, wisdom) (Fig. 23).

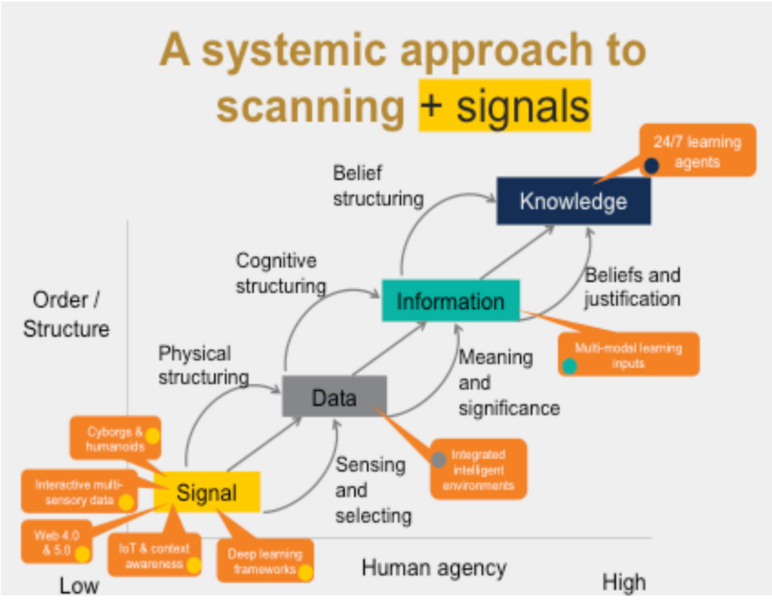


Figure 22 A systemic approach to scanning and weak signals, (Woodgate Veigl, 2020)

6.1.4 Mapping and modelling the opportunities and their potential impact

The translation of the above-mentioned scans, signals and their resulting insights into something more tangible that can act an overarching entity in Stage 3, is called "The Flux of Becoming" It mirrors the intrinsic sensibility within Deleuze's opposition to simply being and his infatuation with the moment when the metamorphosis of an insight into a touch of reality. The notion behind The Flux of Becoming, which Deleuze modified from Peirce's three modes of image and three aspects of signs, deals with that moment of encounter, when an idea, or perception in this case the insight transitions from simply being a possibility to a well-defined concept with allocated meaning and purpose, which is called a future trigger, into a sensation with resonating aesthetics (Kennedy, 2000).

To shift through the three phases of the Flux of Becoming, we apply a variety of techniques loosely gathered under the three foresight mapping approaches: (a) Oiling the Triggers, (b) exploring opportunity spaces, and (c) creating Future Concept Platforms.

Oiling the Triggers consists of a set of methods (Woodgate & Pethrick, 2004) to further develop the emerging issues and insights into future triggers. A future trigger is a combination of selected drivers harvested from all processes used to this point, which opens-up a path to directional thinking about the future. The processes used to arrive at the future triggers tend to be linear and the outcome—the future trigger itself focused on a central framing concept. The thinking behind the approach was influenced by Žižek's (Žižek, 2006) piece "From Physics to Design" in which he deals with Dennett's polemic about the human mind having a central point of perception-decision at which all information is gathered, appreciated and then turned into action. Žižek points out that evolution (of ideas) takes place in the space between the vast synchronous “external logical matrix” of all possible combinations and the vanishing opportunity space of feasible combinations, which are accessible or workable. Accordingly, it is necessary to maintain that gap between the eternal logical combination and being constrained to a particular contingent situation. Following Žižek, there is a clear necessity to unshackle these thinking constraints to arrive at paradigm shifts at the point where one is able to re-conceptualise concepts such as “learning,” “university,” and “education.”

A basket of methods is used to expand the value and relevance of each of the future triggers including: pattern recognition, random generation amorphoscapes (Stanza, 2020), 3D thinking worlds (Kapp & O’Driscoll, 2010), implications wheel (Barker & Kenny, 2011), a simulation to test the power of the trigger, concept mapping (Novak, 1990), and causal layered analysis (Inayatullah, 1998). Each has the role of deepening and extending the future context, and the purpose of the future trigger. In this case of the future of education, I developed six future triggers were subjected to the Oiling the Triggers process. It is always hoped that by fusing, remixing or reconstructing the knowledge that supports each of the future triggers, we will find connects in disconnects that generate new perspectives, paradigms, and hybrid notions.

We conducted each of these methods consecutively, with each outcome reinforcing or expanding the other. Two methods applied to the future of the university project, namely 3D thinking worlds, and amorphoscapes, provided a different value and enhanced opportunity for reflection, by creating a greater sense of immersion into the essence of the future trigger by re-dimensioning the aggregation of the future drivers also through an affective lens. Both provided more random inputs into the analysis and extended the narrative space and the ability to express the signifiers and values more expansively. The use of randomisation in the foresight practices is becoming more commonplace (Burrows & Gnad, 2020; Cheong & Milojević, 2017; Voros, 2003).

The 3D thinking world technique involves an interactive 3D environment. It consists of changeable backdrops and a variety of virtual tools that allow the user to build a visual narrative around the selected drivers that underpin the trigger. The world was modelled to integrate text, audio and visual representation including synthetic artefacts of each of the drivers surrounding the trigger, and each of the drivers can be connected from multiple angles.

The main value from this technique is that it allows the user to change the connections between the drivers both in a random or directed manner to create different perspectives and contexts for the future trigger in terms of its potential to generate further ideas. There is a simple scoreboard inside the world that enables the user to evaluate each of the outputs in real-time against predetermined criteria. One key learning from this approach was that the use of visuals and audio in addition to the text provided greater immersion into the essence of the trigger, which resulted in a radical evolution of the inner meaning of the future trigger by uncovering the affective relevance, emotional values and signifiers embodied in the future trigger or the sensibility surrounding it. While this technique can radically transform the essence of the future trigger, by adding new dimensions, meanings and dynamics, it is important to not fully lose sight of all the earlier work that led up to the development of the future trigger. After the evaluation, I reframed the ending up with eight, namely:

1. **Content is the learner** – you are the curriculum (Adaptive, tailored learning)
2. **Competency-based learning** (Aperture learning – learner-centred teaching)
3. **My second brain** (Technology enhanced knowledge-driven learning)
4. **Learning as self-extension** (Holistic learning & human development)
5. **Learner as an immersive interface** (Living classroom – engagement-based learning)
6. **Alternative knowledge suppliers** (New business models and structures in education)
7. **Revalorisation of knowledge** (Multimodal perspectives, human-machine intelligibility, expressions of excellence)
8. **Transdisciplinarity** (Power of neuroscience, AI literacy, STEAM, new subjects – employability)

To understand how the future triggers will fit into a potential future of learning landscape in terms of relevance, influence, viability, saliency and feasibility for development over a 10–15-year horizon timing and space.

While still in Stage 3 of the foresight process, these future triggers were then further developed into Future Concept Platforms, which form the basic potential direction for any future outcome. They are critical to the entire process and undergo rigorous evaluation in terms of their relevancy, learner, teacher and social benefits, directional prowess, technology & market drivers, timeliness, feasibility, size of opportunity and impact, etc.

Each trigger is further tested in terms of its positive and disruptive implications using a feedback model. The triggers are then analysed in depth in terms of their robustness, risk, benefits, and strategic direction and mapped in a future opportunities framework to determine where the optimal potential lies for transforming learning within the selected future time horizon. They are considered through the lens of the following questions:

a. What drives the future landscape?
b. What are the most important areas/aspects of change?
c. What are the determined change agents?
d. What goals and benefits are we looking for?
e. What are the implications and challenges?
f. What is the most likely environment?
g. Who are the key stakeholders?

These questions inform the thinking that goes into the Directional Opportunities Framework, where we are looking for future opportunity spaces as identified in Table 5 below.

Table 5 The selected future opportunity spaces

Future opportunity space	*Future drivers*
Optimised learner potential	Learner self-extension
	Personalised interfaces and knowledge formats
	Multimodal mentors and knowledge delivery
	Neuro-bio learner modelling

	Interactive data archives/repositories & recommenders
	Generation Z & Y – new mindset, new anchors
	Life long, life relevant and Jukebox pathways
	Competency-based assessment
Delivering future concepts and contexts for knowledge	Leveraging new worldviews and paradigms for knowledge
	Delivering new concepts, sources and formats of knowledge and wisdom
	Foresight mindset and research strategy
	Human-non-human and AI integration/collaboration – workforce/learners
	Gamification, serious games, transmedia
	Global learning networks, platforms and standards
Transdisciplinary creatives	Future skills and workforce needs
	Deep experiential-based research
	Meta knowledge beyond work
	Super advanced internal large-scale innovation research labs
	Focus on immersion as a means to participation & creativity
	Integration of robo, nano, neuro, robo & quantum
	Academic misfits & self-directed learning
Self-managing institution	Future technology/quantum readiness
	Adaptive management systems
	AI/Robot administrative services - APX for Asset tracking - Linked data from multiple inputs
	Advanced cyber systems & safety & security
	IoT and responsive artefacts and learner responsive interfaces for self-management
	Global connectedness and collaboration
	Poor practice detection
	Multi stream budget/revenue generation
Integrated and multimodal learning spaces	Transformative learning interfaces from agents & nano devices to implants
	Quantum internet, Web 4.0 and 5.0
	Fully immersive real-time simulation
	AR/VR-based curricula
	Integrated multimedia/mixed media learning tools
	Super advanced internal large-scale innovation research labs
	New expressions of excellence as an emerging cultural currency

6.1.4.1 Transforming potential opportunities into robust contextualised futures concepts

The opportunity spaces form the basis of Future Concept platforms. A Future concept platform is a definitive directional framework that qualifies and integrates the outcomes from the future triggers work and the opportunities spaces. The Future concept platforms embodies drivers, implications and benefits, possible manifestations and opportunities, tipping points, significant contribution and strategic direction, and value for each future concept. Future concept platforms mediate the relation between our minds and the future envisaged world.

To round off Stage 3, I conducted an external Zoom discussion with a Frontline Panel of experts on 4th September 2018 (Fig. 24) to discuss the robustness and relevance of my future concept platforms, as well as to garner some additional insights.

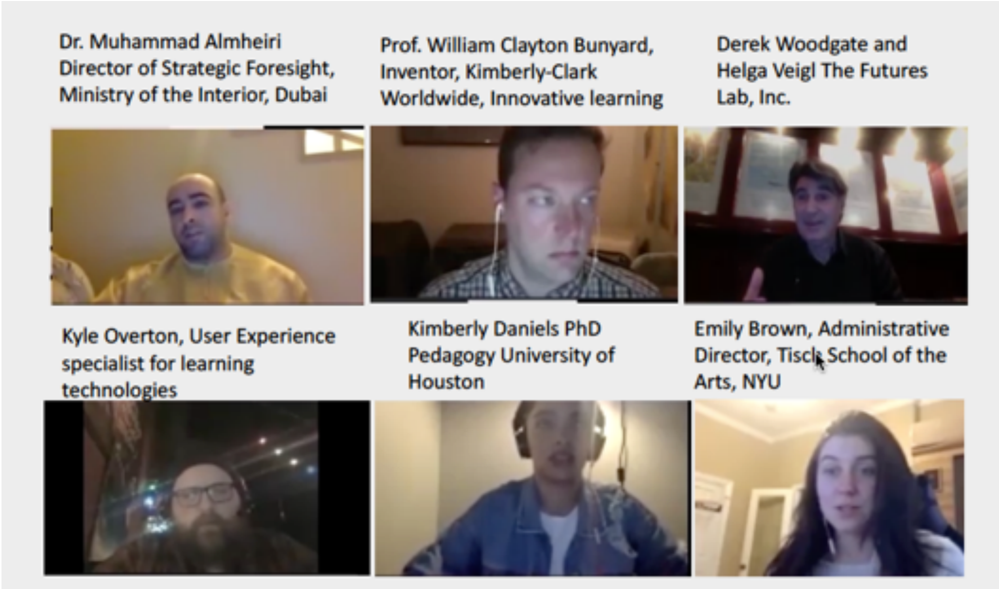


Figure 23 Frontline Panel of experts

The panel followed a predefined narrative supported by stimulus boards.

The panel created the following key outputs:

a. Roboethics, net neutrality and legislation will be critical to agent and avatar implementation as learning tools
b. Randomness will expand, which will create challenges for all aspects of learning, including self-directed learning
c. Rethinking the diploma
d. Personalised education will mean education that is fully integrated into the learner via brain implants or other cyborg like extensions
e. Discover holes in one's knowledge and fill them with new courses and knowledge
f. Transdisciplinarity: constructing our knowledge from 4 or so different disciplines into a completely new subject
g. Theory can provide the glue between the conventional academic and the design learning approach
h. Increased role of neuro in the overall education/learning process
i. Expansion of emotional IQ in curricula design
j. Need for futures thinking in all subjects

The panel outputs were taken into account in our enhancement of the future concept platforms

The future concept platforms form the basis for the future scenario/vision building - the centrepiece of Stage 4. In fact, the futures scenarios are an actionable embodiment of the future concept platforms that bring the concept to life via a simulated future vision. Futures scenarios provide a range of alternative possibilities through plausible futures narrative demonstrating both novelty and purpose. They are grounded in the dynamics of change and need to deliver easy to understand patterns of change that the viewer can quickly envision.

6.1.5 Scaping and ideating visions and scenarios

The Stage 4 of the TFL foresight process we call the "Art of Awe". It is the creative phase of the foresight process and involves developing multiple futures scenarios from the future concept platforms. The futures scenarios provide an observational context with the ability to provide abstract multiplicity or better said multiple levels and horizons of abstraction. The greater the potential for abstraction or complexity, the greater critical consideration must be given to the interaction between receptivity or and spontaneity, understanding and sensibility (Kern & Smyth, 2006). This interaction allowed me to build on the notion of the space of reasons in the realm of freedom. The process was then moved forward to transform this notion through intuition, conjecture and imagination without external restraints embodied in reason. This provided the foundation for our initial incursions into rhizomatic thinking—nomadic thought (Woodgate & Pethrick, 2004).

This work resulted in 6 futures scenarios. The process involved a high level of alternative thinking techniques, including rhizomatic thinking (Fig. 25) (Woodgate & Pethrick, 2004), echoing Deleuze and Guattari's Rhizome Introduction (1976) and A Thousand Plateaus (1988). This involves a process of nomadic thought that is a-centred, non-linear, integrative of disparate ideas, implicates, not replicates and boundless (Woodgate & Pethrick, 2004).

6.1.5.1 Rhizomatic thinking

Rhizomatic thinking forms the basis for my "Art of Awe" approach (Woodgate & Pethrick, 2004). Success depends upon the ability to create an environment that goes well beyond the logical space of reason and the logical space of nature (and second nature) to explore both the deep, rich, expansive experience of worlds within us and around us, as well as the schema provoked by empirical processes of immediacy that led to the Future Concept platforms. I considered various scenario types (deductive, deep, inductive, normative). In recent years we are witnessing significant changes in approaches to scenario-building (Muckelbauer, 2009), not ostensibly different from that originally envisaged by American game theorist and futurist Herman Kahn, which was generally about probability or Gaston Berger, Bertrand de Jouvenel (Bradfield et al., 2005), and others who were more about what should happen. I am deeply in the camp of creating the future. Changes are in the levels of creative thinking techniques and delivery, as well as the role of storytelling and the new contexts for immersive narratives (Riggs, 2019). This is partly influenced by the use of animation, interaction, simulation, virtual reality, augmented reality, gaming and other emerging technologies to deliver more immersive and persuasive scenarios.

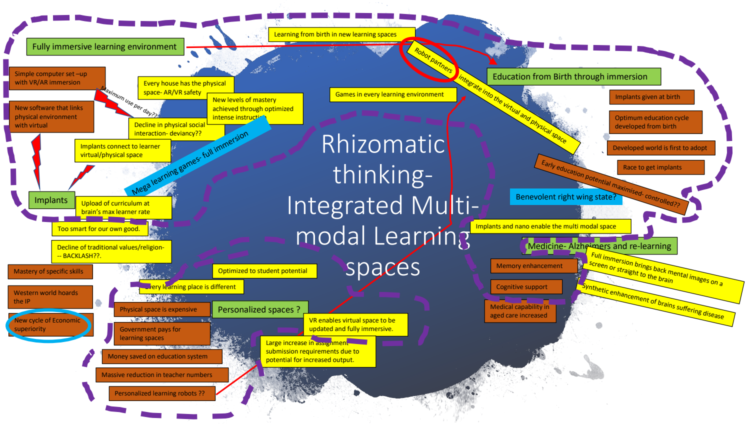


Figure 24 Applied rhizomatic thinking

Some of the changing approaches we are seeing include alternative and abstract creative techniques; greater use of intertextuality, imitation and self-reference; the thinning down of meaning with greater emphasis on the spectacle and depthlessness, described by the eminent philosophers Eco, Jameson and Baudrillard; more formalist means of expression as a distinction from post-modernism ("less absolutist"), more "Story in Story" using Twitter, Instagram – real-time integration, spatial storytelling with GPS and wearables, navigation through hybrid interactive spaces, distributed /aggregated/emergent narratives using transmedia (McErlean, 2018); Free Play (jouissance) collages in unfamiliar contexts and the power of the obscure (McCaffrey, 2012) or Disney's Story Engine. In recent years the use of experiential and experimental foresight has grown significantly thanks to the work of colleagues such as Candy and Kornet (2019), Dannenberg and Fischer (2017) etc., which is discussed further in Chapter 8.

The Art of Awe consists of four scenario-building approaches that I have been practicing, testing, and improving since we first created and presented them at the Association of Professional Futurists' Annual Gathering in San Francisco in 2006 (Woodgate & Veigl, 2020). I make a point of using them on every project either one after the other to achieve an aggregated output or in parallel to consider each future concept platform from different perspectives. At their core they are non-linear techniques inspired by rhizomatic thinking, that have a high level of randomisation and follow undetermined routes, often referred to as Nomadic Thinking (Woodgate & Pethrick, 2004) with its vitalism and commitment to flows, networks, and dynamic transformations. Awe is more than emotion it is an experience, which can be enhanced by mixed methods (Chirico et al., 2018). The Art of Awe augments nomadic thinking with affects, imagination, and creativity in the way envisaged by Rosi Braidotti (Braidotti, 2012). At the core of the four scenario building techniques is the desire to connect our conscious with our imagination and boost our creativity (Chirico et al., 2016). Each of the four approaches demand that we stretch our imagination through ambiguity, destabilisation and deep cognitive challenges and let it roam unhindered by argument or the need to cramp our intuition (Polanyi, 1981). All four techniques were applied in my quest to create scenarios for the future of education and learning.

The four techniques applied were:

1. Rhizomatic thinking
2. Think like a DJ
3. Remixing creative imagination
4. Imagine in the Abstract

6.1.5.2 Think Like a DJ

"Think like a DJ" is an alternative thinking technique that forms part of the process of creating a scenario narrative that ultimately provides the input for the creation of the visualised futures scenarios. The core idea is concept remixing: thinking in meshworks (nets that extend to other nets), close one action and start another, working in the spaces between the rhythm, and create a new ecology.

I have been working with this remix technique since the early 2020s, but it came to life in 2008 at SXSW with Paul D. Miller aka DJ Spooky – The Subliminal Kid, widely considered the philosophical DJ – where we discussed how a DJ thinks and works. The outcome reengineered the original process which consisted of deconstruct, mix, cut, paste, collage, reconstruct the FCP into a totally new future vision (Woodgate & Pethrick, 2004). Ten main remix steps were developed: Deconstruct, Mutate, Spin, Transform, Migrate, Displace, Simulate, Fuse, Translate, Recombine. While the technique evolved over time, using stacks of domain-relevant cards that both visualise the FCP and provide a vast array of randomised alternative futures. It was not until 2018 that we set about creating a digitalised version of the Think like a DJ method, shows the digital version of the remix tool. The architecture was developed by Helga Veigl using natural language processing (NLP) and primarily Python programming language. It involves exploratory data analysis, topic modelling, association analysis, clustering, and other NLP tools.

6.1.5.3 Remixing creative imagination

Remixing creative imagination is a technique that takes the ideas and futures narratives that arise from the Think like a DJ tool and expands them into visions of futures Imagination is in itself, a straight-forward form of virtual reality and that virtual reality is a basis of not only computation, but also imagination and external experience, science and mathematics, art and fiction (Deutsch, 1998). In a later book, Deutsch states, "What matters for knowledge creation, is creativity" and as outlined in the description of the science of foresight at the beginning of this chapter, new ideas that provide radical visions of a potential future require "outside-the-box thinking as the unknown is not easily predicted from past experience" (2012). Remixing creative imagination is a multi-layered creative technique that applies 10 filters, namely:

1. Convergent disconnects
    - Convergent disconnects can either be connected or remain disconnected depending on how much power we want to give them.
    - The content and the learner are very different entities and nowadays both can be "animate." How would wearables or implants help us connect them
    - Both become less stable as we introduce transmedia learning and less formulaic learner behaviour.
    - Can we devise a self-assessment program that responds to learner performance, by controlling learning effectiveness?
2. Random worlds
    - Amorphoscapes are self-learning, visual generative works.
    - Random experiences and creative ideas from abstract visuals.
    - They can be interactive, and they can generate random experiences that can develop into worlds or environments where we can envision unexpected seemingly abstract visuals, where we can see meaningful ideas if we use our imagination.
3. Think the unthinkable
    - Imagine the hero is neither the content nor the learner, but an effective learning environment that the learner can enter through a portal.
    - A 3D world in which the learner is surrounded by points-based knowledge games that allow the learner to pursue multiple paths and perspectives to learning the content – the points are part of the competency-based assessment
4. Collision

    - Rather than there being a fixed content, the content is constantly evolving making the learner adjust to increasingly difficult demands and challenges
5. Biomimicry – bionomics
    - How does nature learn?
    - How can content generate learning skills and a growing learning environment?
    - How does change grow, mutate, transform?
    - How do certain being deal with challenges and adapt to new knowledge formats?
6. Parallel Realities
    - Are the learner and the content parallel realities? Or are they two separate realities that coexist and grow simultaneously?
    - Do they go hand in glove or is the content actually the learner and they are one of the same?
    - Is the content nothing more than that which the learner masters and retains?
    - What roles will VR/AR and machine learning play in reconstructing these realities?
7. Body>Data>Space
    - Learner (Body), content (Data), learning environment (Space) a framework for abstract reflection on their interaction and accumulative and individual role and relevance.
    - Interactive connectivity to engage learners on multiple levels simultaneously.
    - BDS is an ideasphere that puts the learner at the centre of the system and reflects in real-time the positive impact of the learner based upon the level of new content/knowledge that the learner contributes to the system
8. Magical and Alchemical
    - Expressing the futures through metaphor and allegory
    - The symbolism, signs, images, emblems, principal patterns are important for scenario building
    - A synthesis and fusion of disconnects that provide the force of a superior ferment or attraction.
9. Comedy
    - Serious play as a thinking tool, add comedy to make the point with a powerful tagline.
10. Sci-fi
    - A continuous repository of provocative visions reflecting different genres of sci fi: from hard science to deep consciousness and expansive imagination

6.1.5.4 Imagine in the Abstract

Imagine in the Abstract is a proprietary thinking technique that provides deeper significance and broader context for the futures scenarios. It uses abstract imagination and requires the thinker to go beyond concrete ideas into deep abstraction. It applies numerous thinking tools, of which the four most often applied by my team are the following:

1. Hidden Worlds

    - What is we do not see that lies behind or adjacent to our vision or is maybe overarching?
2. Missing Colours
    - Visualise the concept and ask yourself which colours are missing and what is the affect that is impacted?
3. White Spaces
    - What lies in between the lines, in between the rhythms?
4. Unusual Perspectives
    - Use another viewpoint, reverse the focus, think in paradoxes or hybrids.
    - (NB. For Unusual Perspectives I also use Roger Van Oech's Creative Whack Pack for inspiration and provocation.)

Once the four techniques were conducted, I continued to develop and visualise futures scenarios. This resulted in an initial twelve futures scenarios, details of which are shown in the Annexe to this dissertation.

1. Transdisciplinary courses
2. Holographic virtuality, immersiveness
3. AI Institutions
4. The Living Classroom
5. Personalised learning modelling
6. The Cradle of Invention,
7. The Cognisphere: simulated projection
8. Upskilling – employability
9. Multimodal knowledge delivery
10. The Optimised learner
11. Neuro analytics
12. Life-long learning

The futures scenarios developed demonstrate a diverse use of emerging technologies, human and social advancement, future educational relevance, learning approaches and environments within a wide variety of contexts. The scenarios are pitched for full integration across the learning spectrum for 2035. It is indicative that certain technologies based upon VR and AR are likely to be nearer in implementation, while those with brain implants, complex AI or neuroscience will only be potentially implemented towards the end of the 10 to 15-year horizon. Even the complexity of creating adaptive intelligent, 3D VR learning environments that can be customised to the learner and involving feedback technologies that enable salient analytics that can be recycled into the learner's behavioural profile in a way that enables the mentor to optimise curricular modifications is some way off.

Beyond the experimentation stage, in order for there be to be a global, transformational shift in education as a concept we will need to the full decade, but by using a Rolling Back the Future technique (Woodgate & Pethrick, 2004) it is possible to map and demonstrate the potential steps towards full implementation. Scenarios are indicative. Their role is to portray potential and alternative futures.

They need to be feasible and desirable, well composed, based upon robust research and creative techniques, but also flexible enough to be adapted to changing circumstances and possible disruption. That is because much of what has been envisaged is dependent upon rapid developments in artificial intelligence, especially self-developing structures, large increases in computing power and network platforms for connectivity. There is likely to be significant disruption along the way such as the real needs of the changing economies and workforce structure for new skills and professions. This will have a direct impact on how and where students are educated and likely lead to the rise of a plethora of new business models (R. K. Sawyer, 2014) leading to a new dawning of alternative knowledge suppliers, new learning pathways and course and mentor matching agents, potentially AI. At the core of these scenarios is the essence of student-centred learning and student-centred teaching (Weimer, 2013; Wright, 2011) and constructionist learning (K. R. Popper, 1969; Piaget, 1977; Papert, 1987; Arends, 1998; Elliott et al., 2000).To arrive at true student-centred pedagogy (Jonassen & Land, 2012; Singal et al., 2018) that is not just an evolution of the present we will need to see great strides made in the field of neuroscience, so that we can garner a true understanding of whether or not these transformations are able to contribute to measurable creativity gains and greater learner engagement in terms of real performance enhancement and the time when learning is simply a part of enjoyable life rather than a separate ordeal.

While it is critical that we establish clear roles and relevance for humanity beyond technology, at the same time we need to shift our thinking from what has always been human-centric to one in which we understand the power, interplay, and roles of more and more self-generating and self-organizing technologies.

6.1.6 Scenario evaluation and strategic implementation planning

The next steps, in Stages 5 and 6 of the Foresight process we give due diligence and attention to comprehensive scenario evaluation against a rigorous set of criteria that take account of timelines, risk analysis and full scope of opportunity to arrive at our preferred future or this case, those key scenario elements that inform my approach to creating a transformative learning system and recreate the future of mobile learning course in line with my findings from the foresight process. As part of stage 5, I conducted a *living the future* workshop with 7 professors and 10 doctoral students from the University of Agder in Grimstad to reinforce, argue and evaluate the power of each of the scenarios to understand what they mean to diverse disciplines and stakeholders. The workshop dealt with each scenario in various combinations of individuals and teams, enabling at least two teams to separately work on at least two scenarios. The setting reflected simulated future learning environments flanked with corresponding interactive visions interchanging on the 9-m long screen and covered conceptual design of the role of future teaching and learning agents and serious games as well as discussion on the worldviews behind institutionalised and distributed learning, potential future paradigms and transformative pedagogical theory. Some of the workshop groups were required to develop imaginary artefacts from the future, based upon unfinished concepts. Other groups dealt with the questions such as the "reframing of knowledge"—creating learning societies through simple interaction by imagining combinations of quantum computing, AI and linguistics as a transdisciplinary model. We used "Props" and open-ended embodied improv in teams to create didactic, horizontal experiences, as well as virtual characters, visuals of fictional and fantastical objects from sci-fi and animatronics, many of which were created by the Multimedia Masters' students at UiA. Other work revolved around transdisciplinary curricula, changing domains and creating new disciplines in line with 20 potential future jobs a list of which they were given with mock job descriptions. Some courses covered robotics and neuroforensics, quantum communications and the arts, AI ethics and literacy, and mentor and robot teams that are able to provide adequate nugget-style knowledge delivery across the nano-robo-neuro-quanto-bio spectrum.

The value of the *living the future* approach is that allows the participants to live out or simulate the scenario and in doing so, to augment the scenario by better understanding the strengths, implications, contradictions, and challenges that could be potentially involved. The environment, props and surrounding sensory stimulation help to transport the participants into a future world where they can experience and envisage through the workshop activities a sense of a future potential reality, not just imagine it, but live it.

In addition to the commentary at the workshop, nine of the participants provided detailed feedback. This feedback was integrated into the final outcomes of the foresight process and taken into the next Phase of this research paper.

After evaluating and reworking each of the scenarios during the "Living the Future" workshop the 12 scenarios were reduced to five. These five were further evaluated using three methods, namely: Creativity Value (novelty and purpose considerations), Confirmatory factor Analysis and a Scenario Assessment Tool as per the examples below in Figs. 26, 27 and 28.

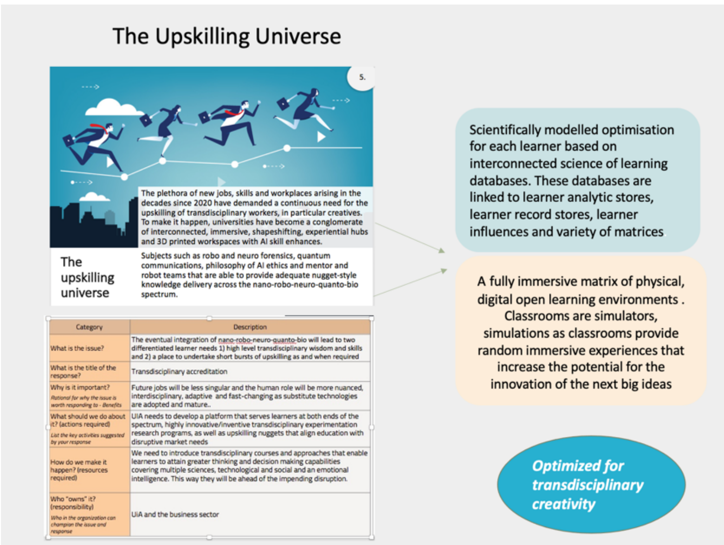


Figure 25 Creativity Value Assessment

Character Spacing

Confirmatory factor analysis with platforms

Futures Scenarios	Description
The Cyborg Learner	The scenario is ideal for optimizing learner potential, as it can be easily and immediately altered/personalized as needed to support individual learner needs and interests. It provides easy self-extension and adaptation of new technologies. It brings the learner into line with emerging machines and utilizes the benefits of agents, wearables, implants, etc.
Transdisciplinary creatives	The scenario is highly limiting in terms of this platform. It denies the humanity – and uniquely human creativity - and makes it harder to go transdisciplinary . However, it reflects the need for breaking down silos and developing new subject domains that teach complex future project-based topics.
Multimodal knowledge delivery	The scenario is ideal for delivering future concepts and context, as it frees the learner from the limitation of their own physical space and bodily limitation. As self-generating AI grows, and paradigms change, the learning experience is quickly and easily changeable. Learners are highly independent.
The Cradle of Invention	The scenario demonstrates the need for experiential, rich experimental labs that increase creative inputs and outputs by exploring and creating expansive, imaginary visions of potential future artifacts that will improve global society. The lab will facilitate the premise of working with unstructured knowledge in unknown worlds
The Living Classroom	The scenario largely reflects multimodal l in terms of learning spaces and supports diversity of style or change of environment. While the ultimate learning space itself can become anything in the universe, the essential learning space can be the same virtual interface that works by integrating multimodal pedagogical methods with multimedia based upon an optimized transmedia plan. Immersiveness is key.

Figure 26 Confirmatory Factor Analysis

0= low, 5= high

	User	Scenario Functional Creativity	Fit to Vision	Robustness	Inter-operability	Risk Optimization	Expansion Potential	Size of Opportunity	Gut Feeling
	Intended user in context of scenario evaluation	Ability of concept to uniquely meet the gap needs	How effective is the concept or strategy in meeting the gap	How sustainable is the solution	How functional is the solution in the context of the larger system/its dependencies	What external forces or risks does the scenario uniquely solve for – and how much does it matter	How scalable is the scenario in terms of its subject domain coverage	How big is the opportunity – does it have	What is your intuition about this scenario?
The Cyborg learner	5 =Future learners with augmented abilities and learning tools	4 = Early-stage cyborgs in time horizon includes agents, wearables and basic implants supported by neuro	3 = it's a shift in vision, and should enhance creativity both through upskilled abilities and neuro-enhanced thinking	4 = highly sustainable in terms of investment and robustness. It has a clear development curve and migration potential	5 = more interoperable than the current status quo – could adapt to different creative needs	4 = risk of human acceptance, integration speed and emergence of content for the growing tech development patterns. Cost concerns	5 = scenario is totally scalable from early AI agent to full scale brain implants with multi domain access and analysis	3 = opportunity is highly visible but will take multiple decades to reach potential	Given advances in mind-to-mind tech development, nanobots, data science advances and neuroscience early stage will happen 2030-2035
Cradle of Invention	4= Strong role for future university and academic institutions to fight consumerization of learning through eduenterprises	4 = while the scenario could outwardly serve the research needs both internal and external and support livelong learning.	4 = high potential fr increasing creativity, delivering creatives and advanced, practical employees.	3 = Need large ongoing investment and influx of experienced transdisciplinary mentors and learners – counter to current trends	4 = interoperable if other programs or universities take the same approach and push for collaboration across transdisciplinary lines.	4 = low external pressure to take the risk. But it does have similar ultimate risks in terms of investment and corporate competition	3 = totally scalable if desired, in the case of mutual program adoption across academic institutions and government strategic support	5 = opportunity is highly visible and large	Would help develop short term upskilling programs as well as large scale full-blooded invention. A cross between Paris's 42 and MIT

Figure 27 Scenario Assessment Tool

6.1.7 Creating strategic implementation plans

In Stage 6 of the Foresight process, we develop a comprehensive strategic map (Fig.29) to understand the full potential of the scenario and expand this potential through a Rolling Back the Future (Backcasting) that would indicate the challenges and opportunities that the scenario could present in the future (Fig. 30).

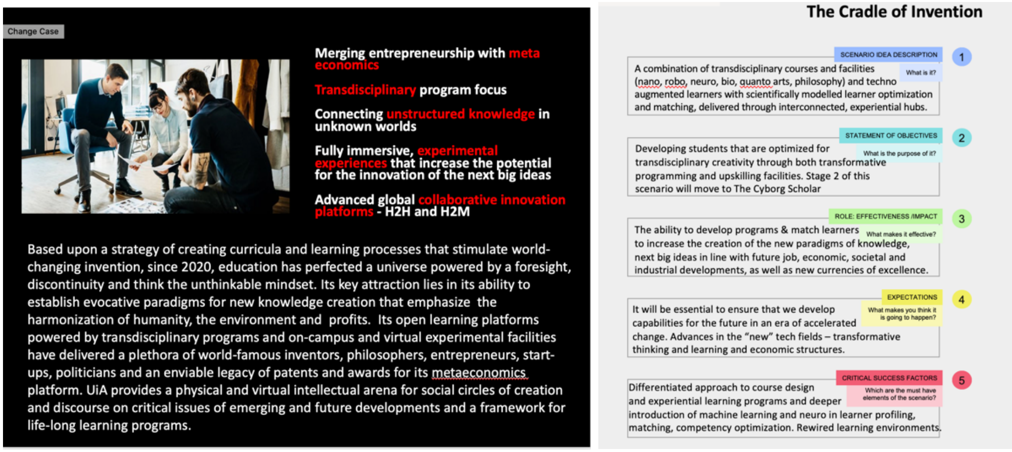


Figure 28 Scenario strategy building

The Cradle of Invention **Rolling Back the Future**

	2035	2032	2028	2025	2022	< 2020
Partnerships Private / public / university	Partnerships for cross – modul learning approaches for cyborg and ultimately superhuman learners.	Partners for full global learning and experirmentation network structures physical and virtual. Non-human interfaces.	Co-development of learning environments, interfaces and learner and teaching tools	Partners in learning and teaching related neuroscience, cognition practises, tools and modelilng techniques	Redistribution of faculty –growth in externals and UiA alumni	Determine potential scope of inventions, possible experimentation labs/hubs, etc.
Policy External /internal	Prepare new architecture and framework for future learner types and styles.	Optimizing income from patents and inventions	Consolidate new cultural currencies and new knowledge paradigms	Neuroscience for deep self- knowledge	Consideration of strategic move towards preparation for meta economics	Development of AI literacy program Arts, science, philosophy &
Learner relevance UiA / international	Completely new avenues for optimized invention teams.	Programmed learners - standards	New rules on learning agents, avatars and implants	Major changes in neuro and cognitive ethics and modelling boundaries	New standards for future-focussed education	Change in contextual thinking techniques driven by foresight
Organisation and structure Committee	Program linked into Self-organizing university system provides directional assistance for research, experimentation & invention.	Global quantum communications network that links both physical and virtual experimental invention	Deep creative learning through computer augmented field mixing and mashups	AI with bio signals and multimedia training. Major focus on deep immersion and personal ambience	Context-driven courses – modular adaptive environments Transdisciplinary arenas	The Philosophy dilemma – demand & responsibility Develop strategic plan & KPIs
Capabilities and skills Training, HR etc.	Testing and training of human-machine inventions and new knowledge paradigms	Adaptive intelligence beyond human learning Human-machine iintelligibility and knowledge building	Animatronic playgrounds to develop futuristic artefacts and cognition	Transdisciplinary program focus coupled with experimental, experiential approach aimed at entrepreneurship.	Establish evocative paradigms for new knowledge creation that emphasize the harmonization of humanity, the environment and profits,	Introducing the Science of Foresight, thinking with unstructured knowledge in unknown worlds – faculty training
Budgeting	TBD	TBD	TBD	TBD	TBD	TBD
Technologies	Brain to brain global collaboration in virtual exploration labs	Predominance of cyborg, brain implant augmented researchers using accelerated data driven research tools to resolve unthinkable problems	Creation of wide range of virtual tools for project development in virtual worlds	3D printed pop-up learning hubs – fully immersive, experiential experiences	Determine new set of salient inventions i.e. of dissolvable nanobots to cure cancer – making UiA technology ready	Foresight-based curricula, an entrepreneurial mindset and an experimental, experiential, transdisciplinary multimodal learning environments

Figure 29 Outlining futures opportunities and challenges for each scenario

The final five preferred scenarios selected were:

1. Transdisciplinary creatives and courses
2. Multimodal and multisensory knowledge delivery
3. The Cradle of Invention
4. The Cyborg Learner
5. The Living Classroom

Together these five preferred scenarios illustrate a future education and learning landscape that has the potential to deliver the inspiration for the development of a necessary fresh learning paradigm, which would meet the need gap expressed in Chapter 5. These scenarios also provided significant input for the development of a new learning system that whilst resolving the need gap issue also would lead to the necessary increase the levels of creatives being

7 Develop a learning system to meet overall future needs

In a broader context, the outcomes from the foresight process and the "Living the Future" workshop helped cement my belief that I needed to create a new learning system to close the gap between the needs of the emerging and future workforce, in particular the increasing demand for creatives and the current education system with its non-conducive approaches to learning. The objective behind the development of a new learning system is to structure a platform on which to design courses as well as to redevelop my own courses to ensure that they were not just in line with changing teaching and learning paradigms such as the theoretical transition discussed above but was also harmonised with the changing economic environment and its impact on future jobs and workforce structures and workplaces. It was also becoming apparent as the Mercer Report alluded that increased learner creativity would be central to the emerging jobs and workforce.

7.1 Design considerations

Consequently, whatever learning system to be designed needed to take into account the following three baselines:

1. The changing workforce, emerging and potential future skills (Chapter 3)
2. Means to increasing learner creativity and improve employability (Chapter 4)
3. The outcomes for the future of education and learning from the foresight study and new approaches to pedagogy on the horizon. (Chapter 5)

Below is a summary of these three baselines based upon the findings in the earlier chapters of this dissertation:

Table 6 Baselines for LLS

Baseline	*Findings*
1. The changing workforce, emerging and potential future skills	Growing needs for creatives and higher-level skills. Creativity, is seen to be the most crucial skill
	Skills: The twelve critical skills in my postnormal skill repertoire
	Rapid analysis that is adaptive operational contexts, multiple pathways to problem-solving, personal process development and applications
	Expert thinking, metacognition, complex communication, effective pattern matching and creativity
	Acceptance of uncertainty, creativity, connectivity, criticality, pattern recognition and maneuvering through new knowledge formats and landscapes
	Participative culture, collaboration and collective intelligence
2. Means to increasing learner creativity and improve employability	Ability to manage complexity, abstraction, paradoxes, discontinuities, convergent and divergent ideas
	Emotional resonance and affective stimulation – deep immersion, positive cognition, personalised information
	Neuroaesthetics

	Engaging multiple brain networks simultaneously
	Ability to project oneself in imaginary worlds . Think future – alternative thinking methods
	Fix the gap in current education system in terms of teaching and learning
3. Outcomes from the foresight study: Future of education (5 scenarios)	The need for transdisciplinary creatives, courses and syllabi
	New approaches, technologies and learning environments to expand immersion and multisensory and experiential learning
	The power of AI/robotics, agents, implants and interactive learning tools
	Employability strategies - potential for upskilling, targeted micro-courses, pathways and competency-based assessment
	Great learner agency, self-direction and well-being
	Personalised and optimised program structures based upon neurofeedback and modelling
	Potential for constructivist growth and continuous learning

In fact, the in-depth knowledge and understanding of these elements both separately and collectively would need to provide the backbone to the system, but simultaneously I felt a new framing schema would benefit the entire system project. The next step involved mapping out what ultimately became a foresight-based learning platform. This resulted in the development of a detailed integrated learning system, which I call the "Living Learning System" (LLS) (Table 7). The system integrates eight key elements all of which were designed to provide a pedagogical system that stimulates higher levels of learner creativity. Each element singularly and in tandem with the others is designed to expand learner ability to think systematically and imaginatively beyond the present, to optimise their competencies, self-development and engagement through higher levels of affective technology-enhanced immersion and experiential practices and to extend their ability to master complex abstract and transformative real-world opportunistic and disruptive concepts and contexts. The LLS is also designed to take account of the need for the changing postnormal skills, to improve employability and to provide a transdisciplinary perspective of the learner's selected domain of study. The eight elements have an overall objective of achieving high-impact learning, of reinforcing learning at the meta level either working individually or in collaboration with others, by enriching each learner's encounter with both our current substantiated domain knowledge, as well as unknown worlds, thus providing a framework that facilitates resilience and adaptiveness to change and greater resourcefulness to meet the rigorous challenges of working with expanding formats of knowledge. All of which are essential to the growing need to attain successful global citizenship embodied with a multitude of cultural differences, complex social narratives and greater awareness of life circumstances and prospects.

Table 7 The Living Learning System

Organising model	*LLS System Elements*
Structural	Constructivism based - blended learning
	Self-directed/real-time concept building
	Cognitive and social presence Personal ambience & embodiment

Strategic	Science of foresight Opportunity-oriented problem-based	
	Real world simulation - Spatial Narratives	
Institutional & tools	Multimedia enhanced accelerated learning	
	Experiential-Kinetic learning	
	Decentralised systems thinking & concept redefinition	

Each element within the system was selected to play a definitive role aimed at delivering an integrated and accumulated response to the three key needs of the future workscape, increasing creativity and the future educational environment.

7.2 The pillars of the Living Learning System (LLS)

Below the reasoning and role for each pillar of the LLS is presented:

7.2.1 Constructivism-based blended learning

The consideration of this element was based on the concept of constructivist alignment which is a teaching principle that combines constructivism (Harel & Papert, 1991), the idea that learners construct or create meaning out of learning activities and what they learn, and alignment, a curriculum design concept that emphasises the importance of defining and achieving intended learning outcomes. It is described as an example of outcomes–based education. Consequently, we start with the outcomes we intend students to learn and align teaching and assessment to those outcomes. The outcome statements contain a learning activity, a verb, that students need to perform to best achieve the outcome, such as "*design a future 3D learning environment*", *or "explain* the *concept of rhizomatic thinking*". The learner is assessed on the competency he/she has mastered in relation to the intended learning outcome. Learning and knowledge are constructed by the activities performed and experience acquired by the learner. Ernest von Glasersfeld explains constructivism as a theory of knowledge that follows two principles: "knowledge is not passively received but actively built up by the cognizing subject; and the function of cognition is adaptive and serves the organisation of the experiential world, not the discovery of ontological reality" (von Glasersfeld, 2001). It is a highly learner-centred approach and is about what the learner does, and not about what we teacher or mentor does. However, the teacher/mentor must take account this shift from the passive to the active to facilitate learning. In the paper *The Effectiveness of Constructive Teaching Methods* (Barman & Bhattacharyya, 2015), the research demonstrated that a) a democratic environment, b) shared responsibility (teacher-learner and learner-learner), c) opportunities for autonomous expression, d) learning through experimentation, and e) abstract thinking, contribute most to increased learner performance and motivation and ability to be creative and master complex concepts. In constructivist learning, the learners are assessed on their competency to fulfil the outcome requirements for which they are given considerable flexibility in terms of modes of delivery. In this context, I envisage constructivism-based learning to be about the learner's ability to create something unique that is novel with purpose, rather than simply report back on readings. This inspired blended learning classes (face to face, on-line and week-long experimental labs) with a mixture of learning environments, individual and group assignments. In this way, one is able to create a variety and potentially flexible learning structures irrespective of the circumstances of the learning (Harel & Papert, 1991).

The learners are provided with in depth on-line modules, readings, videos, podcasts, expert interviews, role playing, brainstorming, group experiential work, group research and panels as well as social platforms such as a Course Café for discussion, collaboration and debate (a community of enquiry – internal and external cognitive approaches). Al-Huneidi A., Schreurs J. (2012) discuss how Conversation theory supports Constructivism theory in this context. Conversation theory is based on discussion of the learning system and states that the interaction and collaboration between learners and teachers play an essential role in the learning process. Conversation theory of learning places emphasis on the learner as an active maker of knowledge. Blended learning is able to deploy learning technologies to facilitate and encourage collaboration, interaction, communication, and knowledge construction and sharing among the students. Blended Learning arose to overcome the disadvantages of traditional learning and to obviate the failure of e-learning by providing a combination of various learning strategies or models. It mixes various event-based learning activities, including face-to-face classroom, live e-learning, student-centred learning, and self-paced learning, which increases learning quality, social contents, and learners' interactivity potentially enhanced by integrating various modes of mixed media.

Through these collaborative platforms and structures, much can be gained by the individual having greater freedom of expression and construction and the augmented ability to reflect upon, discuss, compare and build off of the outcome created by a fellow learner. They also have access to additional reading and collective knowledge repositories. As we will see in Chapter 8, the learner performance throughout a constructivism-blended learning course featuring competency-based assessment is clearly mapped against a variety of assessment criteria or rubrics that demonstrate progress, in terms of ongoing levels of understanding which are built into the intended learning outcomes at key impact points throughout the course. Constructive alignment can be applied to individual courses, full programmes, and at the institutional level, for aligning all teaching to graduate attributes, performance modelling and intended outcomes. A critical element of my thinking here has to be to design into the curricula, potential opportunities for learners to bring in and expand upon their existing knowledge and experience, and for the learners to contribute to building and extending the course in situ and on a continuum (from semester to semester) based upon changing pedagogical, social and cultural circumstances, emerging technologies, policies and market-based skill needs to ensure freshness, learner employability and state of the art curricula upgrades. As Papert further pointed out constructing things for others to see makes it more potent given that learner's "ideas get formed and transformed when expressed through different media, when actualised in particular contexts, when worked out by individual minds". Steier (1995) points out the circularity of collaborative and reflective thinking and describes how mirroring occurs between learners "like two mirrors facing each other", where each reciprocator affects the other. Ackermann, claims that the emphasis has shifted from "general laws of development to individuals' conversation with their own representations, artefacts, or objects-to-think with." (Ackermann, 2004). This is particularly true of learning in microworlds, creating unthinkable future objects or educational tangible objects or unfinished artefacts. Further in his 2009 paper Ackermann links constructionism and creativity through flow theory. Flow is considered the optimal experience, "the holistic experience that people feel when they act with total involvement" (Csikszentmihalyi, 1985). Developing creative skills requires the ability amongst of things of in imagining in the abstract, considering and discussing discontinuity, working with unstructured and undiscovered knowledge and non-linear thinking.

7.2.2 Decentralised thinking systems

In Difference and Repetition, Deleuze states there is no beginning to Philosophy or true philosophical beginning (Deleuze, 1995). He sees thinking in this context as a circle and even though we take any thought or idea to a new level we are ultimately dealing with rediscovery, because even if we are talking about reconceptualisation or recontextualisation, we ultimately return to beginning to better understand where we started, but where we are hoping not to find high levels of repetition or imitation. I wanted a thinking structure that encapsulated the idea that the learning process would be ostensibly nomadic, without accentuating its diagnostic function. Learners looking to discover singular rhythms, clusters, modulators or identifiers, or enter the realms of the dialectic or discourse, (whether internal or external) would be able to experiment with striated space, multiplicious perspectives, continuous interconnectivity and a-centred and non-hierarchical avenues of development. With this focus on alternative thinking to supplement areas such as emotional thinking within the Living Learning System. In making nomadic thought a critical value within the system I am disputing the necessity or recognizing the disbarring of Hegelian rational totalisation and the absolute as an underpinning conceptual system (Inwood, 2013), which have been substituted in the postnormal age by the interplay of fragments overlaid with complexity and confusion. In any case, while there is considerable debate over the true meaning of Hegel's absolute and other concepts (Nuzzo, 2019), there is much value in "playing" with Hegel's structures of self-relating of the notion or new notion to understand potential missing links, inherent limits and the ability to transcode the starting position and reposition presuppositions, which are necessary techniques in creativity learning and exploring discontinuity and radical paradigm shifts.

Often, but loosely referred to as part of the New Hegelianism revival referred Slavoj Žižek points out in *For they Know not what they do* (Žižek, 2004) that understanding the Other or the alternative is pacifying it. Nomadic thought extends the life of those alternatives and recreates and recodes the essence, power and substance of the alternative by repositing their signifiers, roles and actions. Nomadic thought augments nomadic thinking with affects, imagination, and creativity in the way envisaged by Rosi Braidotti (Braidotti, 2012). Nomadic thinking techniques are aimed at connecting the creator's conscious with their imagination and boost their creativity (Chirico et al., 2016). Such approaches demand that we stretch our imagination through ambiguity, destabilisation and deep cognitive challenges and let it roam unhindered by argument or the need to cramp our intuition (Polanyi, 1981). Knowledge construction in this type of thinking structure involves ardent enquiry, multiple critical thinking techniques, multimodal communicative actions and non-linear thinking. Nomadic thinking requires thinking in meshworks – nets that extend to other nets, close one action and start another, working in the rhythm between the spaces, which enables us to create a new ecology or framework for thinking creatively. The thinking process enables concepts to be flexible, so that their meanings and intensities change with the (temporary) territory they inhabit. These shifting intensities represent "a continuous flux and the disruption of flux." The concepts act as signifiers rather than "truths". These signifiers as Deleuze calls them help direct interpretation in a way that it is the intensity of the learner experience that outweighs the meaning itself. These signifiers break the boundary between context and interpretation allowing the learner to travel freely across and through divergent concepts to create new worlds and paradigms.

My thinking here was influenced by Deleuze and Guattari's "Bodies without Organs" (Deleuze & Guattari, 1984; Kennedy, 2000) or moreover Žižek's inversion "Organs without Bodies" (Žižek, 2004), not as a place or unit with predetermined dimensions or elements, but a field of production that is fluid, mutable, open, textual, affective and ripe for assemblage. It is the space of becomings (Bankston, 2017). Elizabeth Grosz sees this type of freewheeling approach: as a "body before and in excess of the coalescence of its intensities and their sedimentation into meaningful, organised, transcendent totalities" (Grosz, 1994 and 2020). In Nomadic thinking and conversely, rhizomatic thinking (Woodgate & Pethrick, 2004). We talk in terms of Lines of Flight: defined at the limit of their outside – connect them outside of themselves and connect them. Rhizomatic thinking acts as an immersive unprimed canvas on which to both discuss construct combinations of influences and influencers to reason and evaluate dynamics, intensity and spheres of change while widening our sensibilities and perception. At the core of rhizomatic thinking lie four distinctive pillars:

a) Self-organisation, one that responds automatically to environmental feedback;
b) Non-linearity – every element has an impact on everything in the sequence and that impact is disproportional to the original input;
c) A chaos dynamic, where a tiny change generates a massive impact;
d) Emergent properties leading to the development of new higher-level phenomena.

This mode of thinking has many advantages that are critical to the development of higher creative skills and new paradigms in so much that it encourages implication rather than replication, integrates disparate, even transdisciplinary fields, and works in dimensions rather than units envisaged as a platform or overarching event and not single acts.

Developing the ability to think in changing paradigms or set of ideas requires an understanding, resignification and application of the parallax view (Žižek, 2006). The apparent displacement of a concept (the shift of its position against a background) is resulting from a change in observational position that provides a new line of sight and cognitive relationship. As such, the observed difference is not merely "subjective," because the base concept exists, rather it is seen from two points of view. The subject and object are inherently "mediated," so that an "epistemological" shift in the viewer's point of view always reflects an "ontological" shift in the concept itself. This can be repeated and extended into multiple viewpoints from which to derive new patterns or build new models. This interpretation of the parallax concept provides a thinking framework for reconceptualisation. The parallax view helps to attribute fresh visions, which can be extended to encompass divergent and convergent contexts and purposes.

My work with and inclusion of a-centred or decentralised thinking systems was originally influenced by Žižek's (2006) piece "From Physics to Design" in which he deals with Block and Dennett's (1993) polemic about the human mind having a central point of perception-decision at which all information is gathered, appreciated, and then turned into action. Žižek points out that evolution (of ideas) take place in the space between the vast synchronous "external logical matrix" of all possible combinations and the vanishing opportunity space of feasible combinations, which are accessible or workable. So, we have that gap between the eternal logical combination and us being constrained to a particular contingent situation. Dennett (1996) maintains the idea that consciousness deals with multiple narratives simultaneously in different parts of the brain all add to the theme of decentralisation.

In recent years I have also been teaching Michael Resnik's work on decentralised thinking systems and his original idea of distributing ideas, functions and powers away from a centre (De Jouvenal et al., 2012). In the past two decades, Resnik has taken this concept further with his Starlogo modelling and simulation software and agent-based language specifically aimed at simulations of complex systems. Starlogo was developed together with Eric Klofler, and Daniel Wendel and has had several iterations that have found their place into gaming, educational learning environments, etc. Decentralised thinking has a significant role to play in both more abstract, non-linear thinking and systems modelling.

In addition to the various thinking structures and approaches discussed above and the multiple techniques explained throughout the foresight study in 6.1, other key decentralised and creative thinking techniques should be pursued as part of the application of the "Living Learning System" are external representation, conjecture and design thinking.

External representations are a technique that helps us project cognitive structure. These representations are activities that help us tie external representations to their referents, but also enable us to expand our field of thought by adding dissonant or unconnected artefacts or concepts to the initial canvas of ideas. Such approaches are quite often vitally important to sense making and for breakthrough understanding or ideas that can be further modified to materialise our cognitive projection. A bundle of techniques embodies the practices of conjecture (De Jouvenal et al., 2012), clue hunting, thinking without thinking (Woodgate & Pethrick, 2004), visual spatial intelligence, plausible reasoning and the development of an imagistic simulation that describes basic relationships between imagery, imagined actions, implicit knowledge, and mental simulation. Imagistic simulation works as a thought experiment allowing the learner to construct and evaluate and determine the potential consequences of idea and models in his or her head (Clement, 2009). Plausible reasoning involves the use of default inferences. Here reference is made to inference in terms of aspects such as degree of belief, evaluating the strength of the arguments, as well as inference drawn from the absence of information, or the use of unsubstantiated concepts. (Some of these techniques were enhanced through my work with the US Government's Advanced Distributed Learning Initiative, through collaboration with Dr. Elaine M. Raybourn, a senior scientist at Sandia Labs and the Initiative's lead on Cognitive Sciences and Systems for Experience Design.)

While much of the focus here is on alternative thinking techniques, it is important that the Living Learning System provides a good balance between creativity and systematic approaches. Consequently, where appropriate courses should include systems thinking and complex adaptive systems (CAS) (Holland, 2006; Von Neumann & Arthur Walter, 1996) with its causal loop and dynamic models, cybernetics, automata, data and concept cross-mapping and predictive and agent-based modelling, etc. This is important for understanding complexity, chaos and contradictions and having the ability to adapt to changing contexts and scenarios and to encourage dynamic, innovative thinking. Complexity is a deep property of a system, whereas complication is not. So, understanding the importance of each connection is paramount. Using different perspectives and agent models changes the viewpoint and sometimes the output not dissimilar to the parallax shifts. Advances in artificial intelligence, and its elements: NLP, Deep and machine learning robotics and visualisation, as well as learning from works such as Minsky's "Society of the mind" and self-developing AI such as DeepMind's MUZero, which operates without being told the rules, emphasizing its ability to plan winning strategies in unknown environments, by utilising reinforcement learning algorithms and its look ahead tree search.

Finally, even though it is mentioned above that alternative thinking systems often provide signifiers rather than truths, I still consider that a critical aspect of this pillar of the Living Learning System is the role of the theory of knowledge or epistemology (Brandl et al., 1990; Chisholm, 2010) especially regarding its methods, validity, and scope, and the distinction between at its core, justified belief and opinion. It is generally acceptable that there are six principal movements of knowledge as a philosophy (logical positivism, relativism, ontological realism, post-modernism, social constructivism, and scientific realism, and six types, namely: a-priori, a-posteriori, explicit, tacit, propositional, and procedural). While a full treatise on critical epistemology is not discussed here, it is necessary to recognise that for a learner to receive, accept, or even consider finding credible the knowledge made available to the learner, a basic understanding of its central tenets of truth, justification, and acceptance, is important. This is also true of foundation theory (acceptance of basic beliefs or phenomenalism, intrinsic credibility), contextualism (subject to circumstantial variations), and metaphysics (the theory of reality or knowledge that could be plausibly real in the future), (Clay & Keith, 1989; Williams, 2011). Increasing emphasis is placed on demonstration as an elaboration of classical justification since it can provide richer conceptions of knowledge (Williams, 2011). Ultimately creativity will likely reflect radical signifiers as well as substantiated truths. A solid understanding of the dynamics of knowledge as a cognitive domain is relevant in this element, because we are witnessing new currencies of knowledge and means of acquisition. There are also emerging structures of knowledge and horizons brought about by aspects such as transdisciplinary education, human-machine collaboration and multimedia sensory experiences. This brings into question aspects such as perception in terms of appearance and reality, especially because most research has been confined to the "real" world rather than the virtual world where our sensory experiences and sense of a previous belief can be disrupted, leading to new levels of scepticism. I recently interviewed Sandia Lab's scientist, Dr. Elaine Raybourn concerning questions around how emerging communication software is having an impact on the "social construction of knowledge" and its ability to create new currencies of knowledge, even help develop new formats of future knowledge. Raybourn told me that the notion of the social construction of narrative specifically, which describes a framework for simulation experience design, will deliver levels of immersion and formats of affect for which we will need new terminology and interpretation.

It is not just about what formats and currencies of knowledge ensue, but how we construct, experience, and make sense of knowledge. Sense making is framing and acting in the unknown (Weick & Sutcliffe, 2015). Sense making is particularly important in this fast-changing, complex world and a period of transformative education, which may seem unintelligible. Sense making is critical where it involves adaptive challenges, those that demand thinking outside of one's existing repertoire often present as a gap between an aspiration and an existing capacity. a gap that cannot be closed using existing modes of operation. David Kirsch (2009) explains how external representations (diagrams, illustrations, visualisations, instructions, etc.) enhance cognitive power and provide a structure that reflects a sharable object of thought. They facilitate re-representation and often facilitate understanding better than thought alone. A shared object of though means that the learner can refer to it and grasp the referent based upon attributes for the referent agreed with others. Objects need to be identifiable, re-identifiable and individuatable from similar objects. The clarity usually comes from understanding the difference between the internal and external representation caused by its augmentation factor. In practice, it is often useful to compile multiple external representations, whether visualisations, symbols or ideas that can be substituted, inferred, simulated, or rearranged to help with abstraction. A key element of interaction is to juggle with the representations to restate the idea. We gain better understanding about events or issues when we view them from a broader range of perspectives. This can be achieved partly by means of deep scanning where different modes of analysis reveal similar patterns from which we can make sense of the matters at hand. Sense making is generally considered more effective as a collective undertaking, whereby it is far better to compare views with those of one's peers discussing, blending, and integrating thoughts, until mutually accepted sense of the issue is achieved.

7.2.3 Cognitive & Social presence

This element builds off the idea of the optimised student, from the perspective of the interrelationship between the learner identity as an individual or team member, the learner's level and scope of agency, and contribution to the learning process, as well as the learner's potential for cognitive and competency growth.

When considering the issue of learner identity in the context of the Living Learning System, the focus is on identity, styles and orientations, cultural identities and social identification, performativity, and particularly where these areas have demonstrated a significant impact on increasing a learner's creativity. Such issues as the impact of genetic or body modification or augmentation, brain implants and pharmaceutical neuroagents or other highly transformative potential identity changing processes are not tackled here. However, I have also considered the impact of digital media and emerging learning technologies on learner identity as the growing influence of technology increases the need for multiple highly contextualised social identities. Identity is central to human activities and having a functioning psychological and social identity is critical to a learner's well-being, not more so than in the growing trends of lifelogging and lifesharing, which will ultimately leave a digital trace of a learner's very existence way beyond the logged period.

While identity covers a broad spectrum of meanings and relevance in a variety of fields from philosophy and psychology, certain elements remain consistent across these fields. Here I am thinking of definable, recognisable attributes (narrative self), persistent identity over time, and personal continuity in terms of one's core self. Creativity can be considered as a particularly relevant and salient resource to foster self-construction and life design.

Personal identities are a range of experiences, which are currently expanded through a fusion of outsider identities, unbounded hybrid, and subaltern identities, which are often contradictory or competing and that are not limited by their location. This is leading to what is termed third space identity with its liminality collapse through aspects such as virtuality and new forms of sensory immersion and their erosion of geographies (Whitchurch, 2008). This third space phenomenon applies to teachers as well as learners. Consequently, there is a suggestion that the development of a "creative commons", involving "networking, laterality, hybridity, flexibility, multitasking and media capability" would assist universities to "identify continuities between traditional education and this new era of "super-complexity" (Taylor, 2008). This increasing fragmentation is provoking identity disassembly followed by an ongoing reassembly into a unity of individual identities, which is very different to more traditional identity exploration, consolidation, and Mallory's (1988) concept of the identity achieved person. This reconfiguring of identity is creating the need for highly contextualised social identities, which means that learners now more than ever have a inert fluidity, flexibility, adaptability and on occasions a penchant for total transformation depending upon the learning environment. This makes learner profiling more complex especially when the profile in the database is at loggerheads with the learner's self-image. This is an issue as self-images and reputational capital are critical, self-development capital for learners and their personal understanding of their own creative self (Karwowski, 2017). Maintaining their desired, ideal self-image in the learning arena underscores their egosyntronic commitment to their values. Creating a course that takes into account the multiple dimensions of the recognition paradigm and reputational capital and reflects and recognises cultural differences, namely, social patterns of representation, i.e., cultural domination, non-recognition, and disrespect is essential for maintaining identity consolidation.

Consequently, learners need to feel they control the space and expression of their identity. Aspects such as student selection of integrated multimodal academic activities and learning cadence help diffuse some of the concern over their scope of control. Agency and "Authority" acceptance and disciplined imagination for example contribute to identity formation in the sense of obligation. It is therefore critical to embed learning and response structures that take account of the social categories of difference notion of syncretism (identities can be contradictory and always situational) and ensure that learners understand the relevance and benefit of their overall learning experience, in a way that it enables the learner to create their individual learning story. This is particularly relevant for group work where the fusion of outsider identities can influence identity development and consolidation. To achieve this, the Living Learning system avows itself of several approaches including allowing learners to manifest their learning by permitting assignment delivery in any format rather than a prescriptive format, as well for learners to feel that they can contribute to ongoing course development in real-time.

This emphasis on identity is significant as research portrays parallels between identity and creativity (Dollinger et al., 2005). There is a mutual relationship among the traits of creative personality and identity styles. Being able to draw upon multiple social identities in multiple domains is thought to augment creative performance (Cheng et al., 2008). The same research found that by "bringing together the literatures on social identity, knowledge accessibility, and creative performance, identity integration is an important individual difference that moderates creative performance". Conversely, selected traits of creative personality influence identity construction (Sramova & Fichnova, 2008).

Judges rated these on a dimension of richness or individuality (i.e., more creative, aesthetically oriented, complex, self-reflective, multidimensional, "one-of-a-kind" vs. repetitive, conventional, dull, and unimaginative). Those who had been or were still engaging in identity exploration (i.e., the achieved and moratorium statuses) were judged to have richer photo essays than those not doing so (foreclosed and diffuse).

Social learners occupy a hybrid, user-and-producer position that can be described as being community-based on the assumption that the community as a whole, if sufficiently large and varied, a contribute more than a closed team of producers. In other words, social learning characterises a fundamental shift in agency from broadcast teaching to content generation and a decentralisation of resource provision. As mentioned elsewhere, stability in the classroom has given way to a world of fluidity and the power of authors has given way to a world of collaborative text-making.

Socially embedded and social driven learning is pervasive (Friedland et al., 2014). We do not consider individual learners as learning in isolation. Future social learning is becoming seamless, supported by technology that gives a greater sense of presence extends beyond formal learning hours if there are any, with the expectation of continuous collaboration and input from team members and irrespective of location. Such interactions require team members to demonstrate physical, verbal, emotional, categorical, and moral practices of mutuality. These relationships reflect our understanding of mutualism, which expresses the fact that the mental cannot be reduced to physical causes, a concept that underpins what Sawyer (K. Sawyer, 2008) refers to as the sociocultural approach. Increasingly, the individual and the social inseparable in the context of transformative approaches to learning. This social cultural approach reflects the changing understanding of the meaning of Third Space, not limited by location, but also forging a hybridity of identities that enable the learner to transgress the elusive boundaries of trust, confidentiality, uniqueness, partiality, to collaborate freely. This increased openness and collectiveness raises confidence and self-esteem for which Eden (2014) believes that learners should be pushed out of their "comfort zone" to ensure that they take a more proactive stance, making them more willing to tackle unfamiliar tasks and develop emotionally.

7.2.4 Foresight-based curricula

Given my work as a Senior Member of the World Futures Studies Federation's UNESCO Futures Literacy Committee[1], where a major part of my role is to develop programs that promote the introduction of futures literacy as a critical competency, not surprisingly, teaching learners to think beyond the past and present is critical to their growth, adaptiveness, and readiness for the potentially unexpected. In addition, I am part of the team that is drafting the UNESCO Resolution on introducing futures literacy into global education. The essence of futures literacy is that it stimulates and empowers the imagination and expands our ability to be ready for transformative changes as they occur. That readiness entails us all being potentially competent at preparing, designing and inventing both solutions to potential disruptions and unknown future opportunities. The term Futures Literacy mimics the idea of literacy (in the writing or digital sense).

For the purpose of the LLS, I decided to include foresight-based learning rather than the science of foresight (or futures studies as it is otherwise known). We are currently in the perennial cycle separating these two terms in a way that sees the science of foresight as related more to institutional and corporate consulting projects and futures studies referring more to the theory and methods behind anticipating the future and

[1] https://en.unesco.org/futuresliteracy/about

academic research. In fact, the terminology is more geographically driven resulting from the traditions and dominance of either of these practices in any given region, i.e. foresight in the USA, Gulf and Australia, Futures Studies in Europe. These arguments stem from the continuing dilemma as to whether foresight is an art or a science or a hybrid of the two. Increasingly, it is being accepted as a science in the mould of take management and organisation sciences. These have become the natural reference points for determining futures theory as a science (Fergnani & Chermack, 2020). Fergnani and Chermack focus on the scientific approaches and processes within futures studies rather than the theory of futures studies itself.

In short, for ease of reference, I will use the term foresight here for both foresight itself and futures studies. Foresight is a range of plausible alternatives, defined as possible, probable, and preferable. There is not a singular future hence we refer to multiple futures. Foresight is a process and framework for creating and shaping the future. It has nothing to do with prediction or forecasting. The latter is built upon evolution of the present from the past, whereas foresight is based upon discontinuity and applying the imagined future as a baseline rather than the present (Woodgate & Pethrick, 2004). It is transformative in nature and an overarching system and approach that is greater than its individual methodologies and tools. Critical benefits of foresight-based learning include understanding change theory and how to anticipate change, reducing fear of making mistakes since there is no correct answer other than mastering foresight skills. This involves leveraging unknown potential and thinking in an abstract way, dealing with unstructured knowledge in unknown worlds, connecting disconnects and creating visions and scenarios of the future, which help develop imagination and above all creativity. It also leverages the human ability to create (or re-create) sensations and images that are not immediately present, namely "to picture another world in another time radically different from ...and which is absolutely preferable to the present one ...and seems desirable because of its magnetic and suggestive appeal." (Polak & Boulding, 1973). Foresight-based approaches direct learners to subvert assumptions, to peel away the surface of concepts, to revisit values and signifiers, determine potential wild cards or black swans by determining potential aspects of fracture, critical impact points and the possible pace and level of disruption. Such approaches require learners to reconstruct utopian and dystopian realities, question recognised truths, explore fresh paradoxes and hybrids and to value multiple perspectives and conceptual relevance. The systems thinking, clustering, cross-mapping and modelling tools provide a counter, but correlating perspective that rather like transdisciplinary learning helps to master complexity, confusion and criticality – all key determinants of what is now referred to as the postnormal, which (Sardar, 2009) describes as "in an in-between period where old orthodoxies are dying, new ones have yet to be born, and very few things seem to make sense. Sardar further characterises this period of transition by three different c's: complexity, chaos and contradictions. The post-normal is rooted in Industry 4.0 and as such the radical areas and forms of transformation that we are and are likely to experience over the coming decades provides a solid backdrop for understanding the relevance of foresight-based curricula in that such approaches focus on opportunity-based problem solving rather than present-day problem solving, which not only stretches the imagination, but underscore the need for creativity and moreover requires an holistic, harmonised view of our world, which reflects the integrated futures of society, technology, economics, environment and politics. (STEEP).

Over the past decade Rex Jung and his colleagues (Jung et al., 2010) have demonstrated scientifically that there is a clear connection between foresight and creativity. The research set out the difference between domain specific knowledge, which is acquired through intensive training and foresight-driven creativity with its ideational fluency and greater originality. Jung's work also ascertained that excitatory and inhibitory neural processes in creative cognition and in particular divergent thinking are important for inhibiting the activated networks that store semantically similar information while exciting or activating the semantic conceptual networks that have been only weakly activated or not activated at all. Activation of these remote networks might be important in developing the alternative solutions so important in divergent thinking which is at the heart of many foresight processes.

7.2.2. Multimedia-enhanced accelerated learning

The introduction of multimodal multimedia-based learning has been emerging over the past three decades, even before Christopher Dede's seminal work on The Future of Multimedia: Bridging to Virtual Worlds in 1992 (C. J. Dede, 1992). Back then Dede described two stages of potential development that could make multimedia the core driver of a future education and learning reform, namely: (1) incorporating hypermedia to enable knowledge construction by learners; and (2) using visualisation and virtual communities to create artificial worlds. Dede envisioned the introduction of multimedia-based learning with its potential for creative thinking, visual perception, spatial ability, retention, alternative thinking skills, etc.

Today, nearly thirty years later, the many facets of convergent multisensory multimedia are becoming more commonplace in our design thinking for both curricula, content and learning approaches. Whilst there is extensive discussion on the desirability of embracing these emerging technologies, critically there seems to be insufficient consideration given to identifying intrinsic benefits of each medium, contextual drivers, emotional design, the power of positive affect and differentiated motivations afforded by optimised human-centric interaction design. Multimedia currently stands at the forefront of multisensory learning.

Also, over the past two decades, we have been constantly celebrating the values of digital convergence and the fusion of the real and virtual. The multiplicity of interconnected technologies and devices, peer-aggregated knowledge, open source, and collaborative design and development have created integrated multimedia technologies that have begun to find their way into education and learning. Multimedia refers to the integration of multiple modes of expression within a single application (Jenkins, 2014). The introduction of multimedia into education requires a clear vision of how education and learning can best deploy, experience and advance the world of emerging multimedia technologies in a way that puts the learner at the centre and ensures that such technologies provide effective personalised learning benefits as well as improved learning systems and support mechanisms.

The basis for including multimedia-enhanced accelerated learning into the LLS is based upon my belief that its intrinsic affordances help generate greater potential for deeper learner immersion, multi-perspective and multi-dimensional observation of content, higher creative thinking performance and enhanced intuition, a belief substantiated by Kassim (2013). Equally, the cognitive theory of multimedia learning (CTML) popularised by Mayer (2009) and other cognitive researchers argue that multimedia supports the way the human brain learns. CTML draws from several cognitive theories such as Baddeley's model of working memory, Paivio's dual coding theory, and Sweller's Theory of Cognitive Load.

My approach to multimedia-enhanced learning involves the principle of technology in – technology out. Here I mean that students are required to learn and experience the characteristics, applications, usability and benefits of relevant emerging technologies and then to use them to create innovative tools, artefacts, environments and delivery systems related to their course content.

Determining how to best integrate multimedia into learning/teaching programs and understanding how to optimise the available or selected media for the profiles and learning styles of the learners in any given class in critical. Mapping the most suitable multimedia options against each element and module of any course is an essential start-point. Taking account of learning styles adds another layer of performance effectiveness.

With the growing shift to online and blended learning, there is an increasing need to develop methods and tools to computationally model how learner messages and learner characteristics elicit responses in ways that support critical discourse in technology-mediated environments. Research is progressing on how learners interact and collaborate in constructing knowledge through forum discussions for example, as well as how learners negotiate meaning and opinions, how they analyse and modify the synthesis of the knowledge in the group discourse, and finally, how learners apply the newly constructed knowledge. Research has shown that greater collaboration, connectivity and social interaction, openness and reflection were shown by learners using such discussion portals (Balaji & Chakrabarti, 2010; Tseng et al., 2016).

The learning styles are:

1. Active-Reflective Learners: This refers to how students process information. Active learners prefer active experimentation, an indication that they like to work in groups and express opinions freely. Reflective learners prefer reflective observation, an indication that they like to work by themselves or at most with only one person.
2. Sensing-Intuitive Learners: This refers to the kind of information students prefer to perceive. Sensing learners observe and gather data through senses; therefore, they like facts, data, experimentation and detailed information. Intuitive learners use speculation, imagination and hunches; hence, they prefer theories, principles, complications and innovations.
3. Visual-Verbal Learners: This refers to which modalities of information representation students can effectively perceive. Visual learners prefer and remember information presented in pictures, diagrams, graphs and demonstration whilst verbal learners prefer words and sounds.
4. Sequential-Global Learners

The requirement to understand the user learning style profiles of individual and groups of learners has become increasing critical not only because of the accelerated rise in online learning but also because of the need to understand how to integrate multimedia with other emerging learning technologies, especially when the desired result is greater immersion and increased creativity. Keengwe, Onchwari and

Wachira (Keengwe et al., 2008) emphasise the complexity of technology integration process with many factors such as teacher motivation, perceptions, and belief about learning and technology. Now, over a decade later, "The emerging technologies can also reduce the digital divide - groups with particular learning difficulties can be assisted through access to learning activities which suit their learning styles, preference and/or learning need" (Millea et al., 2005). Learning technologies are defined as "tools, concepts, innovations, and advancements utilised in diverse educational settings to serve varied education-related purposes" (Veletsianos, 2016, 2010). Naturally the online learning data is somewhat corrupted by the challenges of the COVID 19 pandemic, but the curve was already growing dramatically before the pandemic by at least 5% p.a. The percentage of students taking one or more online undergraduate classes in the United States increased from 15.6% in 2004 to 43.1% in 2016 (Snyder et al., 2019).

The emergence of learning experience platforms (LXPs), which are considered to be the next-level learning management systems (LMS), are expanding possibilities for customised and greater social online learning experience. LXPs, are AI-powered learning mediums that are expected to be extensively adopted by huge enterprises and post-formal education. At the forefront of learning technologies is J Michael Spector who defined the foundational pillars of learning technologies (2012). Spector identifies six pillars:

1. Communication - optimizing each tool to design an effective pedagogical message.
2. Interaction - human – machine interaction that makes learning immersive and participatory and facilitates performance feedback.
3. Environment – a system that optimises physical (learning place) and psychological (learning space) and organisational context where learning takes place.
4. Culture – different learning communities with dispersed geographies collaborating despite diverse languages and cultural practices.
5. Instruction – all levels of planning, development, class structure and delivery should ensure they are framed and structured to best deliver the objectives both individually and jointly, which is where transmedia thinking is a powerful benefit (J. Folsom-Kovarik & Raybourn, 2016; Raybourn, 2014).
6. Learning – expanding the potential, augmenting the learner's abilities, to better understand, gain novel experiences, creative acumen, and domain expertise.

While researchers have been applying and concluding that there are specific benefits to integrated multimedia-based learning for nearly two decades, there is still not sufficient hard data on the learner performance using emerging learning technologies but as with this dissertation and certain of my previous papers (Woodgate & Isabwe, 2018) where we demonstrated that virtual reality technology for example can be an invaluable resource for experiential learning of abstract concepts such as chemistry, there is a plethora of ongoing attempts to demonstrate on a case-by-case level the possible performance results of integrating multimodal technology-enhanced learning into both f2f and online learning approaches. Multiple research projects have shown solid advantages in terms of engagement, affect and motivation (Burleson, 2011), learning experience (Sansone et al., 2011) comprehension and metacognition (Winne & Azevedo, 2014), creativity (Ambrose, 2017), domain expertise (teaching and learning) (McKlin et al., 2019), design and abstract thinking (Godat, 2012), engagement and expression (Long et al., 2019), improved research skills and learner resilience, etc. Use of multimedia learning materials nevertheless has the potential to improve students' creative performance and to accelerate learning.

There is a current move to add XR (extended reality – the overarching term for various forms of computed augmented reality) to basic learning technologies is expanding the possibilities for mentors and learners alike. Augmented reality (AR), virtual reality (VR) and augmented virtuality are penetrating deeper into eLearning both in more formal educational settings as well as the decentralised education market. This is in addition to the professional training market where they have been increasingly present for the past five years or so. While VR refers to the technology that provides users with an immersive experience that aims to shut out their actual physical environment, AR, which Milgram and Kishino referred to as the "virtual continuum" in their 1994 work "A Taxonomy of Mixed Reality Visual Displays", adds digital elements to a live view of the physical environment produced by a digital device's camera that falls into the category of situated learning that commonly uses geo-tagging (1994). AR can provide rich, contextualised content in a customisable real-world environment. AR acts as a conduit that can connect physical enhanced experiences as well as abstract modelling of the surroundings, providing extended possibilities for both virtual and outdoor experiential and collaborative learning through data overlays, instructions, analytics, and feedback, etc. In depth research studies by Klopfer, Squire, Jenkins (2012) and Nincarean et al. (Nincarean et al., 2013). using location-based AR with handheld mobile devices found that the AR experience provided instructional scaffolds enabled the students to use and synthesise the data from the environment quickly and easily and to add significant amounts of new knowledge to their existing knowledge. Multiple cases have demonstrated that AR applications with virtual models (Gutiérrez & Meneses Fernández, 2014), museum displays (Yoon & Wang, 2014), interactive storytelling (McErlean, 2018), digital puzzles (Ireton et al., 2013), instructional design and serious educational games design (Kaszap et al., 2013) assist learners in developing critical thinking skills, provide on-demand learning, extend learner ability to apply multiple perspectives to the content and adapt the materials to their personal skills and attributes. AR is emerging with a additional applications linked to the internet of Things (IoT) a concept that refers to a plethora of networked devices that can share information and be controlled over the internet often connected to new classes of wearables, especially Visual Input Enabled Wearable (VIEW) technology. IOT will deliver the concept of alpha convenience, which will articulate the broad scope of Internet "any-everything" connectivity. However this alpha convenience is as Sherry Turkle talks about her seminal work *The Second Self* (Turkle, 2005) is shifting human agency onto technology, causing disruptive intrusion, a subject she continues to discuss in her work *Alone Together* (Turkle, 2011) and *Reclaiming Conversation: The Power of Talk in a Digital Age* (Turkle, 2016). In her work on IoT, Turkle considers how designers of computational objects have to take into consideration what they do for us as humans and our way of seeing the world, and others. As these objects, artefacts or intelligent others have shifted from doing things for us to doing things with us. They are beginning to have states of mind, becoming more self-regulating, adding notions beyond their xMedia status, and creating artefact to artefact (M2M) conversations. This decoupling of reasoning and intelligence from humans by applying sensory and situation awareness and adaption to the environment in which they are embedded is reducing human agency and affordances. The mental operation between their environmental stimulus and the artefact is influencing the actor process whereby even in the case of their correspondence with human wearables, such artefacts are acquiring sensory augmentation and a sense of personal interconnection. Thus, the human needs to reconsider, reframe and regain its status in these interactions.

Instructional designers should also consider holographic AR. Holographic technology uses the interference and diffraction principles to record and reproduce real three-dimensional images of objects. Various technology frameworks are influencing this arena such as: those that eliminate the problem of accommodative convergence, others use optical waveguide technology and recently we have seen the development of an artificial intelligence enhanced holographic cloud that acts as a content provider for AR, which allows you to see and interact with the three-dimensional images of objects that do not exist in the real world. This is an opportunity to expand learner imagination and creativity.

Mixed Reality (MR) removes the boundaries between real and virtual interaction via occlusion. Occlusion means that computer-generated objects can be visibly obscured by objects in the physical environment (Fig. 31). Mixed reality includes augmented virtuality, the next phase on the virtuality continuum in which immersion is paramount.

Figure 30 The Mixed Reality Spectrum

Multimedia, especially mixed reality, computer games and simulation, has demonstrated to create a higher level of communication and interaction between students; as a result, learning quality, experience and outcomes are increased effectively, particularly in a blended constructivist-learning environment (Kirkley & Kirkley, 2004). In a similar context, research shows that learners' creative thinking and product creativity increased through the use of multimedia learning tools when measured using established creativity instruments namely the Torrance Tests of Creative Thinking (TTCT) and Creative Product Semantic Scale (CPSS). For creative thinking the results showed that the MLT were instrumental for students to generate flexible and original ideas, cope well with divergent thinking, but not fluent ideas. This was reflected through students' product creativity, which showed novel and aesthetic qualities, particularly where their perceptions were supported through the use of animations and computer graphics.

Games-based learning using computer games is seen as a blueprint for complex learning environments that require instructional support in cognitive activities, such as decision-making (Wouters et al., 2013). Pivec (2007) argues that games-based learning supports constructivist pedagogy, enabling students to collaborate and interact in virtual environments so that they can learn through virtual experiences. Knight et al. (2010) found that. Previous studies argue that games, which simulate the cognitive and motor skills required in real-world situations are more likely to lead to successful learning outcomes than more abstract games (Tobias et al., 2014). Currently considerable research is underway on the transferability of the skills learned through games such as critical enquiry, resource management, problem-solving skills, motivation, self-efficacy for transfer, mindfulness and self-monitoring, metacognitive strategies for transfer, assessment, feedback, and competitiveness. A critical aspect is the ability to design games that are appropriate to a wide range of learner styles. Emerging interfaces, connectivity systems and better understanding of user experiences are ensuring that games are now designed to provide interactive, adaptive, engaging, and individualised learning experiences that may improve skill transfer potential.

In addition to games-based learning, there is increasing usage of gamification – which is defined as "...an informal umbrella term for the use of video game elements in non-gaming systems to improve user experience and user engagement" (Deterding et al., 2011). Gamification involves combining instructional design concepts with game dynamics and can be used to monitor learner progress, set course objectives, providing feedback and reward learners with performance awards in the form of badges and similar credentials. Consequently given the perceived value of both game-based learning and gamification, it is highly important that instructional designers and mentors clearly understand the affordances of each element to know when and where to introduce these approaches into the pedagogical structure to optimise their relevance and ensure they are in alignment with the overall institutional strategy and institutional infrastructure and support equipment needed to support the requirements of the game or gamified content, as well as instructional design tools.

In conversation with media scholar, Henry Jenkins (2019) who coined the phrase "media convergence" about creative technology which he describes as a broadly interdisciplinary and transdisciplinary field with emphasis on multi-sensory experiences made using interactive installations and other immersive experiences which may serve as research processes for humans' artistic and emotional integration with machines as well as with emerging learning environments to be more creative. He sees great opportunities for creativity to be revolutionised with technology and to expand the potential for participatory culture. Jenkins believes that rather than fit formal education programs into learning technologies that we should allow the technologies to generate novel transdisciplinary content. Jenkins reiterated his mantra about participatory culture: "content is participatory, content is remixable, content is spreadable, content is global, and content may be independent." He sees the emerging multimedia technologies as an environment that draws learners towards collective creativity and interaction. Jenkins mentioned "produsage", which refers to production and usage, that Bruns identifies as learner-led creation of content and reflects open participation, common property, unfinished artefacts with incomplete granularity as well as fluid heterarchy and holoptism (the implied capacity and design of peer-to-peer processes that allows participants free access to all the information about the other participants) ensuring multiple perspectives on the same artefact or idea (Bruns & Schmidt, 2011).

Jenkins went on to discuss the benefits of transmedia learning and teaching through the development of interactive world-building to support the learner's ability to adapt to multimodality and multiliteracy, terms coined by Gunther Kress (2009). Kress's research on the pedagogic dimensions of multimodality advocates the idea that the concept of mode is not fixed and should evolve in line with social-representational needs and that it is the affordances of each mode that is critical in ensuring that the instructional design is fluid but leverages the benefits of modal assembles of two or more modes joining together to deliver a more effective communication. Jenkins believes that transmedia demonstrates the shift in how culture gets produced and consumed, which is leading to a new way of managing the distribution and integration of media content across media platforms. In an earlier blogpost, Jenkins laid out his seven core concepts of transmedia learning, namely: spreadability vs drillability – sharable content; continuity vs. multiplicity – coherence and plausibility of core ideas; immersion vs. extractability – projecting oneself into the world and context; worldbuilding – richer, more holistic depiction of the topic; seriality: spread across multiple media systems, not chunks across one medium; subjectivity – introducing accompanying content to provide a diversity of perspectives; performance – integrate learner produced ideas and materials to the course. Jenkins sees these seven core concepts aligning to a greater extent with what Howard Gardner's multi-intelligences. Elaine Raybourn (Raybourn, 2014) describes transmedia learning "as the scalable system of messages representing a narrative or core experience that unfolds from the use of multiple media, emotionally engaging learners by involving them personally in the story".

Raybourn has been at the forefront for integrating transmedia into serious games, which are becoming an increasing popular approach to training and education. She points out while serious games are often used as stand-alone solutions, they can also provide a robust start-point for the development of course content to deliver a mixture of media to create greater immersion and creative solution-based thinking. Achieving learning goals via transmedia learning requires an applied sense of systems thinking and forethought. Serious games usually include role-play experiences, and social-process, immersive simulations for exploring interpersonal development, adaptive thinking, rapid response, mastering logistics, leadership, and strategic game management. Advances in neuroscience will expand the feedback interplay and loops. It will collect and label data to provide multi-sensory data, and develop new opportunities for learner profiling, modelling and customised programs, which in turn, will lead to greater engagement, retention, and experiential gratification for the learner.

Importantly, transmedia learning especially when incorporated within serious games, consists of sustained experiences that result in measurable behavioural change, whether physical and overt, intellectual, attitudinal, or a combination. Serious games often require the learner to take a first-person involvement, which increases the emotional investment. Recent research in this area is building upon Le Doux theories that perceptions and emotional responses precede rationalisation and judgment. This is particularly true in transmedia storytelling and learning. Accordingly, the design intent when applying transmedia is to create a system of experiences based upon interaction that gets reinforced and expanded through the serious game-based learning. Transmedia learning provides adequate opportunity to track learner performance across interoperable and heterogeneous, multiple media, especially where intelligent, multi-agent platforms are introduced to inform the development of shareable transmedia elements and the multimedia aspects of delivering content. Rankin and Sampayo's (2011) ongoing work in the field of serious education games (SEG) particularly simulation games (role play, gaming, and computer simulation) have demonstrated that demands of learning in virtual simulated real-world environments deepened observation, reflection, participation, involvement, concept development, decision-making and learning enjoyment (Rankin & Sampayo, 2011). According to Lean, Moizer, Towler and Abbey (2006), simulation approaches in learning are based on imitation of a system, entity, phenomenon, or process and enable learners to adapt quickly to both the positive and failed experiences and to align their actions with changes that occur in the simulated learning environment. With serious education games and simulation games the learners receive feedback on the consequences of their decisions, which allows them to revise their approach by re-evaluating the environment and circumstances and shifting their strategies.

Videos are perceived to be among the most effective content delivery mechanisms currently for online learning and course development, and as a learning format, they are preferred to text documents. While not necessarily a major reason for multimedia's inclusion in my system, one should recognise that eLearning takes 40% to 60% less employee time compared to traditional learning according to a study by Brandon Hall Group (Forbes, 2017) and in the corporate world where training costs are scrutinised, Dow Chemical claim to have reduced training course costs from $95 top $11 per learner. Recently, we are seeing an increase in volumetric video, which requires a multitude of high-resolution cameras, but enables viewers to explore 3D worlds on a flat screen without goggles or a 3D display. It uses a real-time engine and combines tools such as computer graphics, LIDAR, structured light (Depth kit, EF Eve) and customised avatars for personal expression, communication, and interaction. The approach uses both mesh based and point based building and rendering for polygonal models and content reconstruction such as human bodies. Schreer et al. (2019) developed a novel stereo approach, which provides "depth information from all perspectives, which is then fused to a single consistent 3D point cloud." The approach enables a meshing and mesh reduction algorithm to produce a sequence of meshes that can be integrated into common render engines. According to artist, writer, and film director, Illya Szilak (Loriemerson, 2018) who is at the forefront of volumetric video, the medium is considered to provide true immersion and greater emotional connection or increased intimacy and emotion impact as it allows for depth of engagement, involvement with other moving figures, potentially learners through additional movement-based language, as well as authentic VR chat.

Emerging multimedia technologies on experiential learning will in fact increase the learner's levels of creativity and innovation by using positive affect through Sense Events to amplify the learner's augmented and extended self.

One should also consider that multimedia amplifies the complexity and hazards of convergence, when too much simply leads to a collision of technologies, as well as technology overkill, cost inefficiencies, user ineffectiveness, and adaptation issues when students' subjective and objective understanding of the emerging education structures are not harmonised, particularly in the transitional period. Multimedia is a major player in this desire to meet the growing need for human self-extension.

More recently, advances in neuroscience are enabling us to better understand and map where the individual learner's potential lies. That will be a key determinant of a student's future expectations and needs. It could potentially drive the choice of truly personalised and adaptive learning, facilitating student developed content and learning tools, and new forms of assessment and even personalised curricula. Learner experience assessment/evaluation software such xAPI and Tin Can are helping to move us forward in this regard. They allow learning content and learning systems to speak to each other in a manner that records and tracks all types of learning experiences. Advances in our understanding of areas such as neuroplasticity and the interrelationship between multimedia directed behaviour, curricula, learning environments, tools, instructional practices, and emotional well-being will ultimately lead to highly personalised education, beyond what we are currently contemplating when we talk of student-centred learning. These advances are entering yet another transitional phase as we perfect the development of AI learning agents and teachers, revolutionise haptics (Bello et al., 2016) and advanced intelligent learning tools and embedded ambient intelligence. Although richly visual, immersive three-dimensional simulations provide new approaches to mastering complex topics, these systems need to harmonise with computer-based intelligent tutors/mentors, who are increasingly linked to the open education movement with its open-ended learning, open enrolment, open teaching and knowledge commons under the trained eye of a mentor.

The integration of multimedia and other learning technologies is having a major impact upon the issue of access and success encouraged by the changing unit of measurement of student work becoming increasingly focused on what the student is learning rather than how much time is spent in a course.

7.2.5 Experiential/Kinesthetic learning

Experiential learning requires that learners experience learning for themselves. According to Dewey what differentiates experiential learning or progressive learning as he calls if from traditional learning is that it consists of an experiential continuum and interaction. Dewey (1997) sees the experiential continuum as “longitudinal and lateral aspects” of experience. As experiences do not just succeed one another, but there is always a carryover, something that we retain and take from one experience to another, generally enhancing the quality of the subsequent experiences. Consequently, educators need to select experiences that have the potential for growth, interaction and reflection. Such dynamic experiences allow space for experimentation, collaboration and the connecting of the various experiences. Experiential learning is sometimes seen to be different from experiential education in so much that experiential learning refers to, “making meaning from direct experience”. Experiential learning facilitates the process of knowledge creation, sensemaking and knowledge transfer in teaching, training and development while experiential education is, “a process that occurs between a teacher and a student that infuses direct experience with the learning environment and content” (Itin, 1999). Those scholars that emphasise this difference see experiential learning as subordinate to experiential education.

Experiential learning should demand a degree of risk, experimentation, internal and external conflict mitigated through small risk strategies, randomness mutation, adaptation and incredible satisfaction from increased engagement and emergent creation. While there were forerunners like William James, we must thank John Dewey, Kurt Lewin, Jean Piaget, David Kolb and more recently, Graham Gibbs and David Schon for framing and strategizing the foundational ideas of the cyclical experiential learning model of cognition centred in experience. Kolb who has been the standard-bearer for experiential learning over the past few decades, conceptualises knowledge in a state of flux, constantly changing with experience. Kolb’s model involves four specific modes: concrete experiences, reflective observation, abstract conceptualisation, and active experimentation. Experiential learning integrates the concepts of knowing and doing, convergent-divergent learning and challenging assumptions. It is a continuous integrated flow and is seen as a process rather than simply outcomes. The learner reflects upon his or her prior knowledge informed by experience to garner new understanding. Below, I provide a graphic of the comparative experiential learning approaches of Kolb (experiential), Gibbs (iterative, repetitive) and Schon (reflective) (Fig 32). It is my opinion, that Gibbs' model is somewhat lacking in critical thinking. Schon's model is particularly interesting because of his double-loop approach, which allows for a changing set of outcomes.

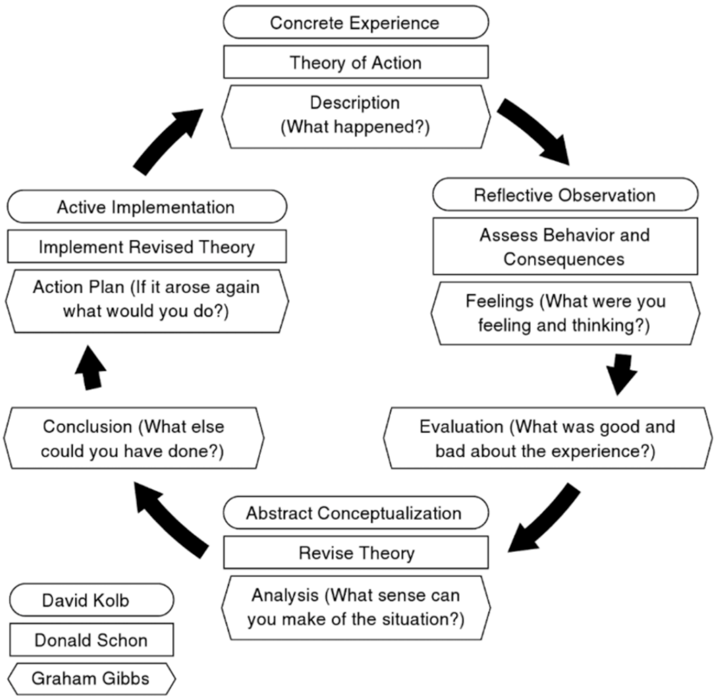


Figure 31 Comparative experiential learning approaches

There are other models, such as Driscoll's What model of Reflection (Kapp & O'Driscoll, 2010) based on Borton's Reach, Touch and Teach model (Borton, 1970), Jasper's Experience, Action, Reflection model (Jasper, 2013), and Gibbs (1988), etc. (University of Cambridge, 2021).

Mughal and Zafar's research (2011) critically analysed Kolb's theoretical model on experiential learning from a constructivist perspective by relating it to more contemporary practices in the field of experiential education. They indicated four areas in which Kolb's approach to experiential learning needs enhancement. Firstly, in terms of the psychoanalytical perspective – the emotional experience of a learner at the start of the cycle, in particular addressing anxiety. Secondly, the situative perspective, which proposes that learning is situated in the environment that a learner interacts with. "It is not a theoretical or an intellectual concept inside a learner's head upon which it can be reflected" (Fenwick, 2001). Mugyal and Zafar claim that Kolb's cycle provides inadequate information about the environment of the learner. Thirdly, the critical-cultural pedagogical perspective, one of power and power relations amongst peers in the experiential environment. Adding the dimension of increased agency will increase the learner's capability to be creative, improve social balance and structure the current experiences of oneself in the society. Finally, there is the enactivist perspective. This relates to the concept of enacting environment and cognition simultaneously to facilitate learning (Fenwick, 2001). These are interconnections between two systems, when they coincide; it generates a response in the other system. It is important that we understand the interaction of the learner's cognition with the experiential environment.

Another form of experiential learning is design thinking, which is considered to have a high potential for improving innovativeness (Clark & Smith, 2008; Gotlieb et al., 2015). Design thinking was created by David Kelley in the 1990s and described in his book *The Art of Innovation* (D. Kelley & Littman, 2001) and has as its main philosophy the idea that the combination of visualisation, collaboration between team members with diverse professional backgrounds and execution of concrete steps will transform the idea development process. The design thinking technique represents a creativity method based on the way designers organise their innovative thinking. The following principles form the base of the design thinking process:

1. Follow three different types of reasoning. Design thinking includes abductive (new idea creation, explanatory hypothesis), deductive (detail development, predict consequences) and inductive (generalisation, final idea creation) reasoning (Dunne, 2006).
2. Develop your innovation intelligence (emotional, integral, and experiential). Emotional intelligence reflects the ability to understand the emotional and cultural side of learners or peers and what creates their attachment and commitment. Experiential intelligence stipulates the ability to express senses in a tangible innovation (Clark & Smith, 2008).
3. Think in systems. Not only single elements should be analysed while developing new propositions. Various aspects, relationships, patterns and ideas should be seen as a whole picture (Dunne, 2006).
4. Welcome constraints. Learner should see constraints not as barriers but as additional stimuli and catalysts for new solutions (Dunne, 2006).
5. Work in diverse teams. The team members of innovative projects should consist of learners with different skills and potentially backgrounds, even cultures where relevant. The strengths of such teams lie in their different methodological viewpoints and diverse knowledge, as well as in their different experiences and analytical viewpoints.

In 2018, Michael Shanks from Stanford's D School and I collaborated at the World Learning Summit in Kristiansand, Norway, organised by the Future Learning Lab of which I am a member. I facilitated a workshop titled Smart Universities: Digital learning Policy, theory and practice for the future in which Michael was a participant. We discussed at length Stanford D School's approach to design thinking and how it was put into practice. The Stanford D Lab was founded by David Kelley who is also Founder of the design group Ideo. Kelley was influenced by Bob McKim who was working on the psychological side of designing. McKim also championed "needfinding," the idea that design thinking is human-centred, not technological, or business-centred. According to Shanks the multidisciplinary concept fell into place by chance with Kelley from computer sciences and two other professors one from mechanical engineering, the other from design began sharing their students and creating joint projects, which delivered unexpectedly innovative results. The multidisciplinary process led to a much higher level of creativity.

Tim Brown, the Chairman of Ideo and one of the other pioneers of design thinking, considers the practice to be a lineal descendant of Edison's innovation process. Brown describes the discipline as one that uses the "designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (T. Brown, 2008). Educational projects where design thinking is applicable ultimately pass through three spaces "Inspiration, Ideation, Implementation". Inspiration, for the circumstances that motivate the search for solutions; ideation, refers to generating, developing, and testing ideas; and implementation, refers to how the output can be materialised.

David Kelley at Stanford D School expanded upon the design thinking process by putting the definition of the problem in the middle of the process, which facilitates adaptability to changing the definition and scope of the project challenge as the learner proceeds through the process. This new dimension is referred to as "the r.frame," and it tends to be an extra inspiration for the big idea (T. Kelley & Kelley, 2013).

Design thinking pedagogy is advancing as education and teaching are beginning to expand into multidisciplinary approaches to solving problems. Schools like Stanford and the Hasso-Plattner-Institute in Potsdam, Germany, as I mentioned earlier, educate students from different disciplines – such as engineering, medicine, business, the humanities, and education – to work together to solve big problems in a human-centred approach. In such programmes, the courses are co-taught by professors from different departments, bring together students from different universities often for cross-disciplinary project work, and involve collaboration with different areas such as companies, start-ups, schools, non-profits, and the government.

Experiential learning is no longer directly limited to the domain subject itself, but moreover the introduction of aspects such having the learners design or build potential learning environments that they feel would optimise learning of the domain or advancing ideation and programming skills to develop new learning tools both for the specific domain and beyond, then applying those tools to existing instructional design to understand the gaps. In many such cases we are seeing the introduction of maker labs, learning labs, media labs and transdisciplinary learning labs, as well as the traditional technical and technology labs already in place.

7.2.3. Self-directed learning and self-determination

Education modes are changing from a teacher-led approach (that focuses on content delivery and assessable outcomes), to a learner-based approach (that encourages self-directed, peer tutored, and cooperative learning) (Biggs & Tang, 2007). In self-directed learning (SDL), the individual takes the initiative and the responsibility for what occurs. Individuals select, manage, and assess their own learning activities, which can be pursued at any time, in any place, through any means, at any age.

To be successful the learner must take responsibility for study and development of positive personal characteristics, such as: intention, determination, and courage, as well as character and sensibilities. Fortunately, those are the very features that pursuing self-directed activities cultivates (Karakas & Manisaligil, 2012). Self-directed learning involves managing all aspects of the learning process, albeit instructional designers are required to design programs and course materials that capture the essence of effective self-learning and modules and assignments that are conducive to multiple learning styles and individual learning alone or potentially with limited dialog with peers and mentors. Here I am focusing on SDL in general rather than focusing on lifelong learning or workplace upskilling or continuing education programs designed to meet regulatory standards. SDL programs should be adapted to the maturation, transformations and transitions experienced by learners as they progress throughout the course. While the academic aspect of the programs is central, courses need to enable learners to develop their personal, social, and technical faculties. The programs should encapsulate the potential for learners to develop their senses, emotions, and actions as well as their intellect. SDL is grounded in direct multifaceted experience, which is engaged by means of enhanced senses, feelings, and thoughts all essential for creating salient outcomes, while the mind reflects, analyses and plans. Ensuring that the learner has the opportunity to build strong character traits such as resilience, focus and dedication will make the learning process challenging and less engaging. At its foundation, SDL is designed to sharpen awareness, cultivate desire for success, encourage reflection and shape successful outcomes – to give the learner control over the process. Learning environments are a critical aspect of this success, whether the program is supported by an innovative, challenging learning management system with clear self or peer-evaluation processes or mentor involvement.

Clardy (2001) defined four types of self-directed learning: a) Induced, mandated by the educational institution, b) Synergistic – gateway opportunities or electives, c) Voluntary which are often created on a bottom-up basis by a group of learners in discussion with their mentor or alone, and d) Scanning which applies to situations where learners are given a project and required to research the knowledge needed to successfully acquire and self-evaluate the competencies needed to master the subject-matter. Boyer et al. (2013) determined that there are some crucial behavioural implications to self-directed learning, firstly, control of input, over the learning method, the materials, the learning environment, and the evaluation of learning effectiveness, as well as the consequences of the output. Here, I believe that learners should create their own story regarding the content, its relevance and the determined approach to course. Secondly, the matter of self-efficacy, namely the learner's belief in his/her ability to be successful in different situations, to have the opportunity to accumulate the acquisition of capabilities together with the continuing updating of competences and contribution to the program. Self-efficacy plays an important role in how learners approach challenges and set goals. In this context learners need to have the tools to evaluate their intrinsic and learned strengths, progress, and peer-compared competence. Thirdly, there is motivation or the desire and commitment to complete the tasks. Control is a driving factor for motivation. This motivation may be either intrinsic or extrinsic and can be explained by Expectancy Theory (Estes & Polnick, 2012; Isaac et al., 2001; Porter & Lawler, 1968). "If the learner sees a potential positive outcome from using SDL (valence), they believe that the actual use of SDL has a high probability of generating or resulting in that desired outcome (instrumentality) and that the investment of effort in SDL will actually lead to the goal (expectancy), then the learner will have greater willingness to engage in SDL (e.g., they will be more ready to use SDL)" (Boyer et al., 2013). The fourth element is support. Transformational learning, especially self-directed learning demands recognition and the necessary support from peers and mentors alike. This is especially true when the learner wishes to shift directions or to change the perspectives to the learning approach. The final behavioural implication is performance, specifically improved performance both on an individual or peer level. Improved performance will not transpire in the absence of the appropriate behaviours discussed above. Here I will cede to Fishbein and Ajzen (1975) in their seminal work the Theory of Reasoned Action who defined the sequence of events as follows: beliefs and attitudes (e.g., support, self-efficacy, internal locus of control, and motivation) lead to behavioural intentions (i.e., willingness to use or readiness for SDL), behavioural intentions lead to SDL use, and to outcomes, namely improved performance. I am of the belief that in this era of transformational learning, true success in this context relates more to the ability to integrate multiple disciplines rather than to master a single body of knowledge, *i.e., Multimedia and learning, neuroscience, etc.*

In parallel with SDL with need to understand and implement the tenets of Self-determination Theory (SDT) a theory of human motivation that examines a wide range of phenomena across gender, culture, age, and socioeconomic status. As a motivational theory, it "addresses what energises people's behaviour and moves them into action", as well as how their behaviour is regulated in the various domains of their lives (Deci & Ryan, 2015). SDT focuses on the psychological levels (generally positive) rather than the sociological and physiological aspects. Thus, using human perceptions, cognitions, emotions, and needs as predictors of regulatory, behavioural, developmental, and experiential outcomes. The theory contends that learners have three psychological needs (competence, autonomy, relatedness) and two types of motivation – autonomous motivation and controlled motivation. Competence relates to mastering the situation and environment, autonomy meaning to control the course of their lives, having choices and relatedness means having strong connections with other, particularly peers. Autonomous motivation is usually talked about as the prototype of intrinsic motivation which means people are engaging in an activity because they find it interesting or stimulating or simply enjoyable. Controlled motivation or targeted motivation meaning that contains both external and interjected motivation with external contingencies. It is akin to extrinsic motivation. It assumes that learners absorb new materials into their own sense of self.

Research shows that autonomous motivation leads to higher quality behaviour and experience, especially for heuristic activities and intrinsic aspirations are associated with greater well-being and better performance. Extrinsic motivation involves a contingency between the target behaviour and some separable consequence desired by the individual. Extrinsic behaviour is usually driven by some external reward rather than inner satisfaction, although it is possible that what were originally extrinsic motivators such as rewards could become autonomous if they were felt to lead to well-being. Deci and Ryan still believe that autonomous and controlled motivations are comprised of factors of both intrinsic and extrinsic motivations. That is a factor of the self-determination continuum. Providing learners with choice, as well as acknowledging their feelings and perspectives, tends to enhance their intrinsic motivation and performance. Understanding individual learner drivers in a given context and environment is one of the key attributes of good pedagogy.

7.2.4. Immersive Spatial Narratives

New spatial narratives express the powerful role of deep immersion as a key to increasing learner levels of engagement and creativity both through the development and use of multimedia learning tools and equally importantly the inner space and cognitive state that foresight generates in requiring learners to "live in the future". Central to this idea is the role of delivering inspirational immersive spatial narratives which means dealing with the reframing of the learning space in the service of creating more effective tools designed to deliver transformative approaches to learning and the development of new competencies to confront the complexities of emerging futures. In this context, I use the term spatial narrative beyond its more common meaning in architecture, urban development, and deep maps, to mean the story and opportunities within a learning space, whether it is physical, virtual or cognitive. Spatial narratives enable us to navigate and explore complex and otherwise difficult to experience knowledge. Spatial narratives achieve this as transformative learning spaces, like AI agent mentored 3D virtual worlds, together with their intermodal components, structural elements, their internal and external processes, and social interactions and encounters. They act as an experiential map that portrays optimal ways with which we can experience and learn knowledge more relevant to the emerging worldviews.

In this context, I am referring to the transformative dimensions of learning spaces as afforded by the integration of multimedia into the foresight-based learning system. This element of the LLS emphasises the construction of new spatial narratives that optimise access to, and accelerated application of transformative learning approaches that augment learner personal ambience and increase engagement and creativity through immersion. Personal ambience (Woodgate, 2011) reflects an extended sense of sensation and encounter leading to the expressed higher level of desirability to learn. It is achieved through experiencing the integrated elements of the holistic learning narrative. It is frequently allied with a flow state of pleasure (Csikszentmihalyi, 1996), which research shows leads to increased motivation and improved learner performance (Guo et al., 2020; Pearce et al., 2016). This supports the assertion that achieving positive personal ambience leads to greater student satisfaction and therefore engagement. Accordingly, it is argued that a positive association exists between the flow experience of students participating in transformative curricula and their learning outcomes (Lee et al., 2014). A study by Mayer and Estrela (2014) confirmed that emotionally appealing design enhanced learning and Efklides (2011) ascertained those positive emotions enhance motivation and overall cognitive abilities. While Isen and Daubmann (1984), determined that such cognitive processes increase divergent thinking and creativity as well as being able to apply heuristic strategies and abstraction processes, substantiated by Bless and Fiedler (2006).

Well designed, multimedia-directed foresight-based learning should have intrinsic immersive qualities, which provide an environment where the powers of involvement, knowledge, observation, and exposure come together to fuse the physical, the emotional, cultural and mental experiences (Isabwe et al., 2018). Augmented personal ambience helps to accelerate and better activate the learner propensity to optimise the impact of the experience, forming a higher level of intimacy and attachment. It is in the connective feedback spaces between the content, environment, interface and the human experience that personal ambience is created. To achieve this immersion and positive affect, I emphasise six key elements that I believe are critical to foresight-based learning course design: self-direction (active control), opportunity to enhance existing skills and deliver assignments in any/multiple formats (freedom), ability to contribute to the course development and the future of learning in general (pride), having to think and work in a future landscape (excitement), learning, applying and building multimedia (self-esteem), creating and delivering the unexpected (inspiration).

These connected feedback spaces add the dimension that transports space from the perspective of physicality whether real or virtual into an immersive sensory modality, which facilitates flexible, seamless interplay between switched modalities of optimised content augmentation and the role of experience as an enhanced mindspace. In addition, it is important to understand the potential interaction between emerging learning technologies with rich interfaces such as augmented reality, virtual reality, simulation, etc. embedded into intelligent learning environments; and the power of personalised AI learning agents to create interactive simulation and representation that expand human imagination beyond real-world knowledge. Multimedia-based spatial narratives are able to transport the learner into new universes by using immersion to change the internalised narrative that we create from the holistic experience (Woodgate, 2019).

It is critical to embrace the ability to imagine the learner's relationship with his/her cognitive environment/mindspace within a holistic intelligent learning environment rather than simply the role of the enhanced learning technologies involved, or the content being delivered through the course. Emerging forms of multimedia provide affordances that deliver technology-rich learning environments or spaces, which if designed optimally can enable higher levels of motivation, participation, engagement, creativity, and learner performance through the state of spatial immersion. This can occur when the spatial structure and affective drivers make the learner world perceptually convincing or real. The interplay between the learner, knowledge agent, multimedia interface or delivery mode, the intelligent environment and enhanced cognition deliver an immersive spatial narrative that transports the learner from participant to immersant (McRobert, 2007) a point reaffirming from Chapter 6.

In conventional pedagogical terms, we talk about learner climate, knowledge transference, instructional strategies, sequencing and messaging, delivery against learner profiles and learning how to learn, etc. In contemporary pedagogical terms, we focus more on learner self-determination, emerging competencies, and technologically based learner enhancement. We have witnessed the large claims of how ICT has the potential to transform learning in a way that our basic conceptions of knowledge will be rewired (e.g. Cigman & Davis, 2009; Lankshear et al., 2000). As we study weak signals and emerging issues that are driving transformational change in education, we are aware that while structural and pedagogical approaches are dealing with the significant challenges of design experimentation, the learner is also developing new characteristics, identities, behaviours, competencies, anchors, and signifiers. Understanding such developments enables us to design learner and spatial narratives that leverage those changes, especially, the learner's growing familiarity and experience with digitalisation in all its entities. The emerging learner's increasing ability to conquer varying forms of virtuality in Deleuzian terms (Ansell-Pearson, 2005), simulation, abstractionism, and telepresence, etc. provides a fertile platform for the development of spatial narratives that deliver a holistic immersive learning experience.

My interest in this re-dimensionalisation of space is inspired by Paul Miller's (AKA DJ Spooky) observation that the spaces in between the rhythms are where the dialogue starts. This led me to not only look at space through the lens of white spaces, black holes, reversed worlds and missing colours, but to question the subject-object roles of not teacher-learner, but the space in between and how that space could be leveraged to enhance learner performance. From this we can translate that multimedia, mixed media or converged media literally assume a space of integration, which has its own dynamics, time, flow, etc. The same applies to transmedia. Although, it is a single "story" that spans across multiple forms of media, its integrating connectors provide a space for augmenting learner cognition and engagement. How do we make these connections active? How do we leverage these spaces as dynamic tools that dispose with the subject-object confrontation generally derived from multimedia learning interaction (Brenda Laurel see interface design as theatre in a similar vein). I am not even seeing these spaces as human-computer interfaces (HCI), more a space for the interjection of the self, of an alternative self or ego ideal. We can experience these spaces in the way that Fried diagnosed minimalist art, where he discarded the output as an object and injected the concept of self-discovery or self-construction, which I see being developed through exploration, experimentation, motivation, engagement, and creativity. In this sense, I am deliberately forfeiting hierarchy, boundaries, and roles by replacing them with a democracy of elements that together augment learner personal ambience and performance. This concept explodes unity, fragmentation or even chaos by centring around the dynamic of immersion. It simply adds active "silence" as space in which the learner can identify with the whole in his or her consciousness, while traveling through unexpected affective horizons. It is about motivating the learner to transfer his or her fascination with the emerging technology itself and give it greater experiential relevance.

To optimise immersion outlines the importance of connecting consciousness in cyberspace and new definitions of self with abstract virtual realism and the power of multimedia-based immersion. Immersive spatial narratives are as much about the role and power of enhanced consciousness as about physicality and the technology itself.

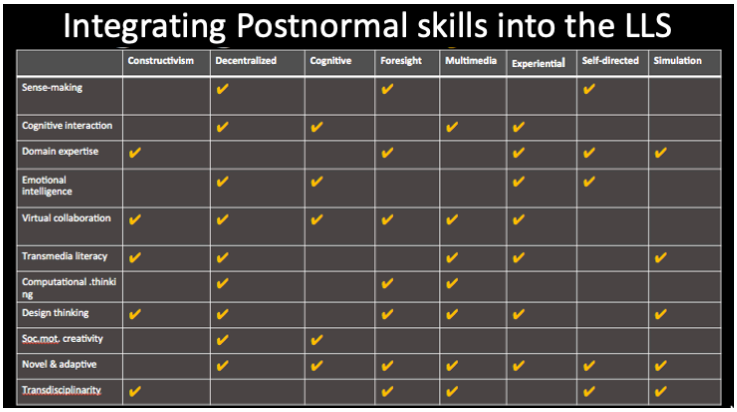
7.3 The Living Learning System (LLS) in practice

The Living Learning system (LLS) is an interactive, system designed so that all of these eight pillars described in in this Chapter are interrelated whereby each of the pillars is ultimately connected to and is dependent on the others. At the same time each pillar has to be considered in its own right and interpreted in a way that its application in course and curricula building adds critical value, relevance and ultimately leads to increased creativity. The LLS provides a platform on which to construct contextual and conceptual bridges across traditional disciplinary and transdisciplinary boundaries to demonstrate how highly creative pedagogies can emerge. The Living Learning system was designed to overcome the gap between present educational approaches and those needed for the future as identified in Chapters 5 and 6. The LLS and subsequent courses designed within the LLS framework are set against the background of the changing world of postnormal times, postnormal science and postformal education as discussed above. Specifically, I have interpreted Gidley's "Love, Life, Creativity and Voice" as: learner social well-being and compassion; foresight-based holistic learning and dealing with complexity and change; enhanced imagination, intuition, and creativity; and giving meaning and relevance by means of self-expression and self-direction enhanced through transdisciplinary, multimodal, and multicultural integration. Each of these elements is integrated into the LLS as well as other elements such as learner agency and authority, social learning and teamwork confidence, immersive, multisensory experimentation, and experiential programs, as well as a variety of critical and alternative thinking methods.

Simultaneously, the LLS is designed to mirror this postformal transformative education approach for the teacher or mentor. It requires that teaching technologies, pedagogical models, and implications, co-creative and knowledge sharing flexibility, project assignment delivery requirements and competency assessment are harmonised with greater learner freedom and increasing open learning structures. Teachers/Mentors are also required to reflect upon the learner contribution to the ongoing course development and to the advancement of their potential future professions, and to help students build meaning into their knowledge acquisition and practical relevance. This can require additional pedagogical training similar to the UNIPED course developed at UiA at which I taught a class on research-based pedagogy in 2019, which is designed to help teachers/mentors learn and master emerging pedagogical approaches, learning technologies and instruction design and changing teacher-learner roles.

7.4 Integrating the skills

After finalising the pillars, substantiating their theoretical background, their intrinsic structure, relevance and implications, I mapped their characteristics against my list of emerging and future necessary skills to ensure that they were covered by a combination of the pillars (Fig. 33).


Integrating Postnormal skills into the LLS

	Constructivism	Decentralized	Cognitive	Foresight	Multimedia	Experiential	Self-directed	Simulation
Sense-making		✔		✔			✔	
Cognitive interaction		✔	✔		✔	✔		
Domain expertise	✔			✔		✔	✔	✔
Emotional intelligence		✔	✔			✔	✔	
Virtual collaboration	✔	✔	✔	✔	✔	✔		
Transmedia literacy	✔	✔			✔	✔		✔
Computational .thinking		✔		✔	✔			
Design thinking	✔	✔		✔	✔	✔		✔
Soc.mot. creativity		✔	✔					
Novel & adaptive		✔	✔	✔	✔	✔	✔	✔
Transdisciplinarity	✔			✔	✔		✔	✔

Figure 32 The integration of postnormal skills into the Living Learning System

8 Translation and Application of the LLS

The LLS is an evolving model and has been the platform on which I have built my courses over the past few years. I first presented the initial structure as the keynote at the Laerinsfestivalen Plenum at NTNU, Trondheim in 2017[2]. Subsequently, I have presented it at various learning-related conferences and workshops to great interest, resulting in my assisting in the development of several LLS teacher training programs.

While the LLS is possibly not appropriate for teaching and learning of all subject domains, the eight pillars provide flexibility and a platform for exploring new pedagogical approaches to all domains. I have now applied the system to six diverse courses over the past four years (University of Agder, University of Houston and University of Dubai), and while I am discussing here the future of mobile learning course at the University of Agder, Faculty of Engineering and Science, Department of Multimedia and Learning Technologies, my experiences from each of these six classes has been very positive, even though the learning objectives differed.

The LLS reinforces learner-centric pedagogy, which also requires learner-centric teaching approaches where appropriate and possible. The approach should maintain a workable balance of power that encourages the learner to take active responsibility for learning, while seeing the teacher predominantly in the role of the mentor is seen to be essential (Blumberg & Mccann, 2009). For this to occur successfully and seamlessly, learners need to understand and accept the purposes and processes of content selection and assessment. This can be more easily achieved when a variety of effective teaching methods are applied to the content in a way that it illustrates the "what, how and potential use" of the content. Blumberg's research considered the differences between traditional learning approaches and student-centred learning. I have summarised her findings below through the lens of the LLS, in terms of what she feels are the crucial aspects of student-centred learning:

a) The need to put the learning into practice
b) Ability to think within the discipline
c) The learner to develop meaning and relevance
d) Framing the content to allow for additional opportunities to learn
e) Provide an environment that delivers intrinsic motivation
f) Peer and self-assessment
g) Continuous mentor feedback and multiple assessment opportunities
h) Greater opportunity to resubmit assignments and master the content

To a greater extent these findings 14 learner-centred principles, which Alexander and Murphy (2000) simplified into five domains, namely:

1. The knowledge base (learner's existing foundation)
2. Strategic process and executive control (self-efficacy)
3. Motivation and affect (engagement)
4. Developmental and individual difference (unique characteristics and patterns of behaviour)

[2] https://www.youtube.com/watch?v=H_wIjojCDI4

5. Situation and context (selected or given roles, reflection and personal relevance)

8.1 Translate: the learning system into a course based upon the combined strengths of the LLS with the objective of increasing learner creativity

Understanding the potential future learner and his/her environment is a critical start point for developing a learner-centred curriculum that leverages the theories embodied in the LLS and its eight elements.

8.1.1 Knowing the learners, competencies, skills, personality and behaviour

The core of the learner-centred models is that all instructional decisions begin with knowing who the learners are – individually and collectively. This means having a holistic perspective that includes the cognitive and metacognitive; motivational and affective; developmental and social as well as individual differences (McCombs et al., 2008). Only then is it possible to ascertain the potential for models for fostering self-motivated, student-centred learning, potential new learning pathways and novel approaches that help envision a holistic optimised environment for a constructivist blended learning programs that drive creativity.

The make-up of the classes I taught over the past decade or so at Georgia State University (GSU) – PhD students in instructional design; University of Houston (UH) – Master's students – Science and Technology and Foresight students; and the University of Agder (UiA) - Masters and senior undergrad students in multimedia and learning technologies have all had very distinct profiles and experience and have followed differing education systems. For this dissertation, I am focusing on the students at UiA as the CSDS analyses as well as the broader research undertaken and described in Chapter 8 all relate to UiA students. Accordingly, the course I will describe here is designed to meet the specific profile analysis of my UiA students based upon six years of observation and analysis of their in-class, social learning, workshop and team attitudes and performance and frequently their non-academic social behaviour. Every student has individual features such as knowledge, goals, experiences, interests, backgrounds, personal traits, learning styles, learning activities, and study results. Having a better understanding of the learners also enabled me to adapt the instruction from semester to semester. A learner model is a structured representation of a learner's knowledge, misconceptions, and difficulties. Learning analytics, the collecting, harnessing, analysing, and reporting of learner data are becoming a crucial element of optimizing both learning and the learner environment. The analytics also help personalise teaching and to identify specific learner needs and provide accelerated feedback. In the absence of a fully digitalised intelligent tutoring system, I constructed the learner data based upon observation (observable behaviour and indications including analysis of formal discussion groups and social platforms such as Slack and Facebook groups, as well as and self-identified signals) and performance data, as mentioned earlier.

Accordingly, I constructed a model that leveraged the benefits of learner models used for intelligent tutoring systems together with recent criteria discussed with Elaine

Raybourn and Jason Haag, both of whom have been directly and deeply involved with the development of the Advanced Distributed Learning (ADL) program for the US Department of Defence and were responsible for the design and advancement of xAPI (Experience Application Programming Interface) and its specifications and standards and effectiveness of course delivery. I also considered input from an adaptation of Siemens (Siemens & Tittenberger, 2009) learning analytics flowchart as well as the competency framework process developed by Eduworks authors (Robson et al., 2014). These additional sources were important as they alerted me to acceptable competency definition standards and levels of veritable assertions in terms of proficiency and evidence of performance.

The assessment or rather assertion process addresses the total learning architecture including the comfort or hostility of the learning environment. On the top level, I considered the learner's readiness to undertake the task, partly based upon prior knowledge as it applies to the capacity and ability to undertake the tasks that the course requires. This is considered as an enabling value in terms of the learner's experience towards the individual module objectives and the terminal learning objective, namely competency, knowledge, application and in this case, creativity. I also included innate attributes expressed through recall and application and the detailed aspects of KSAOs (Knowledge, skills, ability, and other characteristics). For the purpose of this dissertation, knowledge comprises facts, principles, and beliefs to be expressed through definitive submissions either as individual or group assignments or through the development of artefacts or visions, shared with others or acquired from others through communication. For the purpose of assertion, I frame this under "construction of knowledge". Skill is the capacity to effectively apply knowledge and abilities to perform a physical or mental task. Ability is the capacity relevant to performing a task a set of tasks with emphasis on creativity. Other characteristics, which were asserted through multilayer observation relate to contribution, team application, attitude, self-confidence, academic control, motivation of self and others, interests, inclinations, self-direction. Personal traits like self-confidence or emotional intelligence, interpersonal skills were included as they indicate a disposition to handle challenges more effectively.

Learner competency evaluation

		What is ... gender?	Which of the following best describes your age ...hen you took the course group?	What is your primary area of professional interest?	Creativity	Social intelligence	Team application	Self direction	Construct of knowledge	Thinking about thinking	Motivation	Knowledge application	Adaptive learning style	Behaviour in action	Emotional intelligence	Future-focused
8	8	Female	18 - 24	Computer Science Education	6	6	6	8	7	5	6	7	5	6	6	5
9	9	Male	25 - 34	Multimedia	7	8	8	8	8	7	8	8	7	8	8	7
10	10	Female	18 - 24	E-learning	6	7	7	7	8	6	8	7	6	8	8	6
11	11	Male	25 - 34	Game design, Web design	8	9	9	8	9	7	9	8	8	8	8	7
12	12	Female	18 - 24	Videography	5	5	5	4	5	4	5	5	4	5	6	3
13	13	Male	35 - 44	Technology supporting learning	7	8	7	9	8	7	8	9	8	8	7	7
14	14	Female	25 - 34	Instuctional design	6	7	7	7	7	6	8	7	6	7	7	6
15	15	Female	25 - 34	Web development	9	9	8	9	9	8	10	9	8	9	8	8
16	16	Female	18 - 24	E-learning	7	9	6	6	7	5	7	7	6	7	7	6
17	17	Female	18 - 24	Design	6	8	7	6	7	6	6	7	6	6	7	5
18	18	Male	25 - 34	E.learning and digital competence	6	8	8	6	7	6	7	7	6	7	7	5
19	19	Male	18 - 24	AR & VR	7	7	7	8	7	6	7	7	7	7	7	6
20	20	Female	25 - 34	Games / gamification for education	7	6	7	6	6	7	7	6	6	7	7	6
21	21	Male	18 - 24	Programming / developer	7	8	7	7	7	5	6	6	6	7	7	6
22	22	Male	18 - 24	Web design and web development	6	6	6	6	6	6	6	6	6	6	5	6
23	23	Male	25 - 34	Education Technology	7	6	6	9	9	8	9	9	7	8	6	7
24	24	Male	25 - 34	Multimedia design	7	8	8	7	7	7	8	8	7	8	8	7
25	25	Male	18 - 24	3D development	8	7	8	7	8	7	8	8	7	8	7	7
26	26	Male	25 - 34	Software development	9	7	8	9	9	8	8	9	7	8	7	8
27	27	Male	18 - 24	video production, editing and encoding	7	8	8	7	7	7	7	8	7	8	6	7
28	28	Female	25 - 34	Technology and education	7	7	7	6	7	6	7	7	6	7	7	6
29	29	Female	18 - 24	3D development	6	7	6	6	6	5	6	6	5	6	6	5
30	30	Female	25 - 34	Video/TV	5	7	5	5	6	5	6	6	5	6	6	5
31	31	Female	35 - 44	3D development	7	4	8	9	8	7	8	9	8	8	9	8
32	32	Female	25 - 34	3d	8	8	8	9	8	8	8	8	7	8	7	7
33	33	Male	35 - 44	Product development and Marketing	7	8	9	8	8	7	9	8	7	8	8	7
34	34	Male	25 - 34	Videographer and Multimedia Tech	8	9	9	8	8	8	9	8	8	8	8	8
35	35	Female	25 - 34	Technology and design	7	7	8									
36	36															

Figure 33 An analysis of my learner competency evaluation

Between 2014 and 2017, I applied the above criteria and analysis for a total of 35 students at UiA (Fig. 34). All the students have completed either my early version or initial adapted version of MM402 – The Future of Mobile Learning, or my Future of

Multimedia and Entertainment course. Generally, the later students on the list 27-35 showed an improvement overall. These were Fall 2017 learners. Both courses were given in the Department of Multimedia and Learning Technologies within the Science and Engineering Faculty. All the students had completed undergraduate studies either in multimedia and communications studies or a related domain, such as interactive design, computer sciences or media arts. The average age of the learners was 24, of which 19 were male and 16 were female. They covered a wide range of multimedia-related skill sets, which I clustered into 10 groups. Their prior knowledge of the core domain was fair to quite good. Overall, the students showed low ability in areas such as self-direction, thinking about thinking/critical theory related to the domain, adaptiveness to new materials. While overall, learner performance against most criteria started low, they improved significantly by the third year of the original course.

Overall performance of the 35 students followed an acceptable curve (4 As, 10 B+s, 14Bs and 8 Cs). Their learning style preference was mainly experiential, their group integration capability and team application were middle to high. Their knowledge acquisition and sharing increased between the first and second year of the course and remained stable thereafter. On those area where I used observable behaviour techniques, I found they displayed good self-confidence, good social and emotional intelligence especially in group experiential learning activities, thus their interpersonal skills were generally very good, but they often lacked mutual intelligibility.

The utilisation of campus resources outside of lectures, seminars and pre-set experiential learning workshops was low. (However, many learners - given their deeper interest in gaming, 3D modelling, videomaking and animation - had very good personal resources available at home). Their knowledge about educational resources/technologies was also limited. Their understanding of the learning goals was average. Their creativity was higher than average student levels because of their specific domain and prior education, but it was not particularly strong in relationship to the expectation, objectives and goals of the early iteration of the course.

The key outputs of my analysis are shown in the learner competency and behaviour graph below. Full details by individual student are available in the appendix.

8.1.2 Applying learning theories

Once I had this deeper understanding of the student cohort, I reconsidered specific learning theories that reflected the values of each element of the LLS, the overall objectives of the course within the context of the overall two-year master's program within the UiA Department of multimedia and learning Technologies, as well as the general learner competency and behaviour model and the needs of the student-centred learning strategy.

One of the central objectives of the course in addition to increased creativity was to encourage the learners to understand, adapt to and adopt positive change and to be future ready for the impending transformation of the workscape, increasing potential for employability. In this context, learning theories vary on what exactly is being learnt: some focus on complex belief change while others focus on more simple instrumental changes. My goal was to take them beyond incremental change to a world 10-15 years from the present day. Learning emphasises change at the level of individuals, but also within the intersubjective process, which anticipates that human interaction will increase the potential for group understanding. Concepts of learning overlap, and there are difficulties in specifying whether or not learning has occurred given the many possible intervening variables and alternative explanation. I am of the opinion, that the main conceptual advantage of learning is its explicit emphasis on change by enabling access to and encounter with changing context and perceptions, reconceptualisation of present assumptions, potential disruption, discontinuity, and the application of unconventional thinking techniques. Accordingly, I felt that an essential aspect of the learner knowledge construction objective was the acquisition of tacit knowledge in addition to the explicit knowledge provided through the formal structures such as course modules, readings, assignments, seminars, and workshops, etc. Tacit knowledge on the other hand is personalised and is shared through person-to-person interaction that takes place in group activities, conversations and accompanying social platforms. Tacit knowledge is seen as unarticulated, implicit, uncodifiable, procedural, abstract, intuitive, and difficult to imitate (Jashapara, 2005). While tacit knowledge is often more difficult to express, capture and share, it is critical to the notion of increasing creativity and therefore the course needed to facilitate activities that are participatory and drive emotions, interactions and communications that facilitate the creation of tacit knowledge that ultimately can be explored as explicit knowledge and therefore accessible and assessable, as well as novel and purposeful. For this purpose, it was critical that I consider the tenets of social learning and it emphasis of changing paradigms, worldviews and value shifts. For social learning to occur, it is important that a change in understanding has taken place within the learner involved and that the change goes beyond the individual and become situated within the wider social environment or relevant community and also that the change occurs through social interaction and processes between individuals within a social network (Reed et al., 2010).

8.1.3 Flexible structure: adapting to learner styles

Another major objective of the LLS system is to make it flexible enough to take account of a broad scale of learning styles (cognitive, personality, or learning-centred, instructional preference, social interaction, and information processing) summarised in Chapter 6 (e) under active-reflective, sensing-intuitive, visual-verbal, sequential-global. Instructional preference refers to a learner's preferred choice of learning environment and information processing refers to the learner's intellectual approach. In practice certain subjects provoke different learner approaches and behaviour and selecting teaching styles and a combination of content delivery mechanisms helps to ensure that each learner feels accommodated throughout the course. Also, much depends on content sequencing, the variation of assignments and delivery mechanisms with a balance of convergent and divergent thinking, logical and abstract and materials that support both visualisers and verbalisers, as well as experiential explorers and analytical debaters. In designing the instructional methods for the course, I was very cognizant of the need to take into account the knowledge gained from my learner competency modelling work, rather working from "within" as much as from an external perspective to promote effective learning and increased creativity. This is critical when dealing with the issue of learner identities and self-image as these are directly integrated with creativity and performance. Research shows that in performing creative tasks, people with high identity integration are better at simultaneously accessing and applying multiple identity-related knowledge systems than are people with low identity integration.

8.1.4 Structuring for transdisciplinarity

Incorporating flexibility into the design of the LLS also make it relevant for instructional design for integrated studies, diffusion studies, or transdisciplinarity courses, which are very much a theme of Postformal education strategies and a central topic of current educational policy. Transdiscioplinarity is commonly regarded as "beyond disciplines" and addressing the subject-object interaction (Nicolescu, 2010). The term "beyond disciplines" leads us to an immense space of new knowledge and requires new methodologies for curricula development. It also has led to a clarification of the differences between multidisciplinarity (studying one research topic in several disciplines simultaneously), interdisciplinarity (the transfer of methods from one discipline to another) and transdisciplinarity (across and beyond all disciplines). Transdisciplinarity has the role of understanding this postnormal world by unifying knowledge, especially across the science-technology-society triad. This is still an ongoing discussion as using this triad omits the spiritual dimension. Transdisciplinarity should e viewed on a grander scale, discarding the rigid boundaries that formal education employed because we need to see it through the lens of discontinuity, abstraction as well as science and not least to understand the actions between the disciplines along the conduits of connectivity, the seemingly invisible content. Nicolescu separated the core of transdisciplinarity into three axioms:

1. The ontological axiom: There are, in Nature and society and in our knowledge of Nature and society, different levels of Reality of the Object and, correspondingly, different levels of Reality of the Subject.
2. The logical axiom: The passage from one level of Reality to another is ensured by the logic of the included middle.
3. The complexity axiom: The structure of the totality of levels of Reality or perception is a complex structure: every level is what it is because all the levels exist at the same time. In this structure no "level of reality" constitutes a privileged place from which one is able to understand all the other "levels of reality".

In my opinion, it assumes that multiple perspectives on any topic are essential to ensure a balanced understanding of the core challenges. The notion of levels of reality shifts the focus from levels of organisation, which are more rigid and less conducive to seamless transformation and adaptation to emerging issues and discontinuous change. It allows us to consider aspects such as levels of interpretation, levels of integration or hybridisation, contemplation, objectivity and subjectivity, situational context and much more that stand outside of the siloed domains commonly required by organisational structures.

Transdisciplinarity played a critical role in how I approached the design of my courses, ultimately for the Future of Mobile Learning course, which is the topic of this Chapter of the dissertation and which I describe below, I chose the combination of emerging technologies coupled with multimedia design, development and application, the science of foresight and transformative pedagogy all represented and integrated throughout the course.

8.1.5 The pillars of the course overall design structure

I mentioned earlier that I had envisaged the course to follow a transdisciplinary design structure, one in which I saw the combination of emerging technologies coupled with a) the science of foresight, b) multimedia design, development and application, and c) transformative pedagogy all represented and integrated throughout the course, each having their individual and collective roles in increasing creativity.

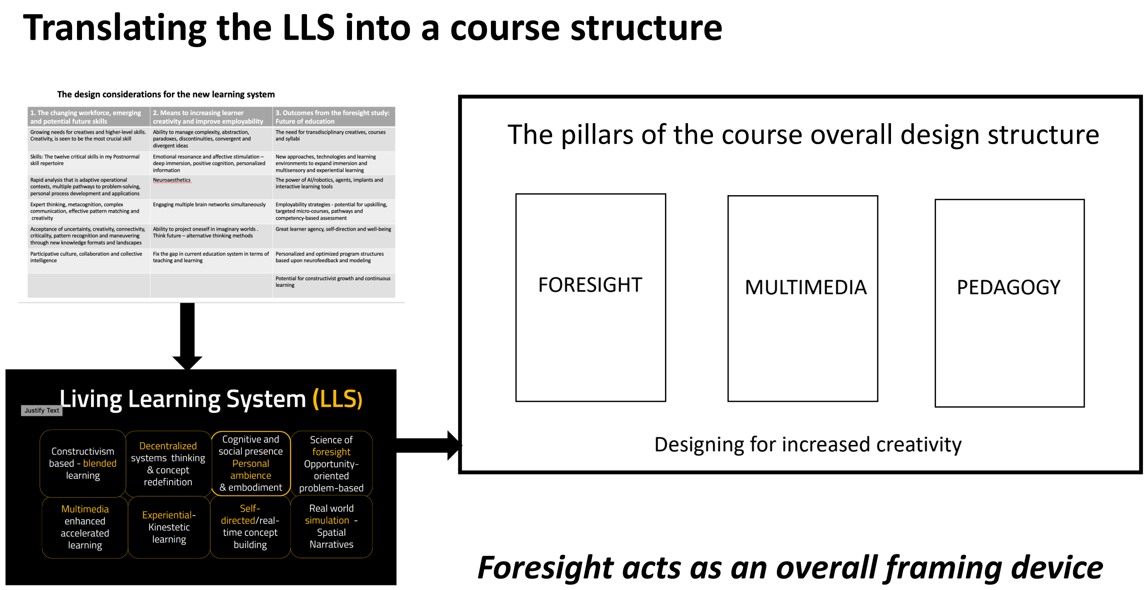


Figure 34 Translating the LLS into a course structure (Woodgate, 2017)

8.1.6 The science of foresight as a course framing concept

The "holodeck metaphor" provided a strong basis for my decision to use the Science of Foresight as the prominent framing concept as did Abraham et al. (2012) work on creativity in the context of conceptual expansion based upon novel, experimental design of the curriculum structure. Using fMRI they demonstrated the different reactions in the brain between divergent and convergent thinking, as well as how experimental curriculum design together with complex task solving, generated increased cognitive demand and response preparation and integration of information leading to increased creative thinking and creative performance.

This framing feature meets the objective of ensuring the students stretch their thinking mindset and push themselves outside of their comfort zones, which continues to be in my opinion a critical step towards elevating the student's potential for creativity. Having to work with unstructured knowledge in unknown worlds, thinking skills that lie at the core of the science of foresight are both complex and a skillset that I was aware that none of the students had hitherto experienced.

It also allowed me to bring my professional expertise to the course domain. It also enabled the students to be exposed to and encounter future visions and dimensions that a course predominantly focused on the past, present and immediate future would not provide. Within this foresight framework, I considered one of the most pressing student learning issues, given what would need to be the future-focused nature of the course, the student's ability to project oneself into and think in a future landscape. In addition to providing a deep insight into the science of foresight and the techniques, tools, and process for creating the future, I decided that the key to helping to alleviate the issue of projecting oneself into the future was to find a way of creating a sense of deep immersion into the simulated future. Given the skills and background of the students, I decided to put more emphasis on the optimisation of multimedia learning tools as a route towards augmented immersion. The development and use of multimedia learning tools provided a physical means of delivering greater levels and layers of immersion through a technology enhanced learning space. However, I needed to go beyond the physical to increase the learner ability to explore, think, create, and evaluate the potential, relevance, feasibility, desirability, and implications of experiencing a simulated future vision landscape with a time horizon of 10-20 years. This ability, I describe as "living the future". This specific learner ability is especially necessary for the study of courses that have a strong foresight-based structure. It requires a higher level of engagement and creativity and a bias towards the concept of multiple dimensions of change and the acceptance of re-conceptualised, re-contextualised notions of our world, space, and time.

Foresight-based learning structures demonstrate the importance of connecting consciousness in cyberspace and new definitions of self with abstract virtual realism and the power of multimedia-based immersion. I show that foresight-based learning systems can be as much about the role and power of enhanced consciousness as about physicality and the technology itself.

Three key aspects of the science of foresight stand out as potential generators of creativity, namely: having to project yourself into a future landscape of unknowns; opportunity to fearlessly develop novel ideas; the requirement to create future scenarios. Consequently, in addition to its overall framing role, the science of foresight played an important role in creating an immersive learning narrative for the learner, the ideal environment for increased creativity.

8.1.7 The role of multimedia

Emerging forms of multimedia provide affordances that deliver technology-rich learning environments or spaces that designed accordingly can enable higher levels of motivation, participation, engagement, and learner performance Wankel-Blessinger . While the technologies themselves and their intrinsic qualities and applications are paramount as facilitators, it is the interplay between the various entities involved in spatial narratives with their ability to create a holistic immersive experience that determines the effectiveness and agency of the content, multimedia, learning climate, approach, and environment, as well as the learner him or herself. Multimedia can enhance both cognitive attention and emotional engagement by creating a learning narrative and environment that reflects coherent and authentic representations of knowledge (Wankel & Blessinger, 2013), while providing an engaging platform for cognitive enhancement through deep experiential immersion. In addition, the scope of multimedia applications allows for flexibility in delivering multiple learning styles, approaches, levels, and objectives. It is as relevant for situated learning as contextual learning and is central to the interconnectedness of open and blended programs.

Multimedia is centred on social constructivism (Vygotsky, Mayer, Piaget, Bandura, etc.) and more recently collectivism and Mayer's work on the Cognitive Theory of Multimedia Learning (Mayer, 2009) reinforces the idea that instructional messages are more effective when grounded in sound design principles based upon how the mind works. While there are numerous affiliated drivers to this increased effectiveness, such as the power of digital narratives and storytelling, video annotation, self-authoring, and the role of cognitive loads, etc. I focused on multimedia's ability to interplay within the holistic learning process to deliver immersion and in turn, greater motivation, engagement, creativity, and performance. Multimedia's added strength is its ability to deliver both tacit and explicit conceptualised knowledge, especially the former, which involves engaging multiple senses and even experiences. Multimedia-based foresight-based learning exemplifies the relevance of space, through its social platforms, ability to travel across large distances, unlock unknown knowledge frontiers, work within intelligent learning environments, etc. It also leads to increased communication (peer and mentor), pacing flexibility based upon mood, and involves self-direction, and the ability to deliver a higher level of affective engagement. Equally, I emphasised the importance of learning to use and develop creative tools, all of which involve increased engagement and opportunities for designing immersion into the learning narrative. In its essence, foresight-based learning is often framed as meeting the needs of the learner as perceived by the learner: a wave to self-direction. Research has also shown that positive attitudes about their online course experience led to increased engagement, motivation, creativity and performance (Howland & Moore, 2002), also including an openness to self-direction.

Foresight-based learning design offers the opportunity for the development of learning narratives that optimise the sensory modality and immerse the learner in a way that fully engages the learner's activities and interaction. Moreno & Mayer list five common types of interactivity as dialoguing, controlling, manipulating, searching, and navigating (Moreno & Mayer, 2007). However, developing the immersive, affective interactions of the learning narrative are the focal issue here.

Virtual reality as a spatial narrative, can elicit a sense of presence, the subjective experience of "being there" in a simulated reality and provide learner feedback simultaneously (Dalgarno et al., 2015). Augmented reality (AR), which Milgram and Kishino (1994) refer to as the "digital continuum", provides the potential bridge of real-world activities and digital experiences, allowing the learner to connect their conscious with their imagination and boost their creativity (Chirico et al., 2016).

AR transforms passive environments into active spaces that can generate a new sense of being with fresh ideas, through divergent thinking. This is sometimes called "Augmented Creativity" as it employs AR on mobile devices and wearables to enhance real-world creative activities, support education, and open new interaction and cognitive possibilities (Zund et al., 2015). AR also has the potential to include experiential/kinesthetic learning in the foresight-based learning format, by taking the spatial narrative beyond the basic course learning environment into the real-world. It has the power to visualise and augment complex simulated future-world 3D spaces, while manipulating the virtual content and the interactive learning experience.

With personalised learning experiences becoming central to "student centred learning" practices, wearables and ultimately implants are emerging as efficient components of spatial narrative design. As we witness the increase in technology interfaces for the internet of things (IoT), we will expand the opportunities for personalised learning supported by neurofeedback and other cognitive enhancement tools. This will significantly change how we and contextualise space, connectivity, time, content, and the concept of learning itself. It will drive a new paradigm for learning and living and their interrelationship, which in turn will have a major impact on where the responsibility and scope for education lies beyond self-direction and life-long learning. Adjacent and inter-connected with this clamour for personalised learning will be the role, potency and status of personalised learning and intercultural agents, cognitive robots with cultural signposts and lower-level avatars. Avatar apps as science coaches in immersed learning environments have already been able to deal with medical data and instructional embodiment to guide scientific learning.

As data knowledge building platforms use machine/deep learning artificial intelligence to rapidly accumulate, structure, explore, analyse, validate, disseminate, share knowledge in real-time, student reactions to capacity building, response to questions and assignments, etc. will accelerate, potentially making knowledge a status-layered commodity. Other technologies such as simulation and holograms will take their place in spatial narrative design as and when their inclusion proves unique, novel and meaningful, or when their potential metadata provides valuable assets to the overall learning narrative. Research on the use of holographic and robot teachers has so far been limited, but the use of reflective holographic teachers has been going on for some time in medicine and "mixed reality" technology is enabling history students to experience 3,000-year-old building or science students to step inside a molecule or witness the inner workings of the human heart. Critically, such multimedia enhanced learning spaces and tools provide the opportunity for digital creativity exploration

8.1.8 The role for transformative pedagogy

Given that the course focuses on developing a future for mobile learning, it is imperative that the learners receive a strong grounding in learning theory, pedagogical approaches, curricular design as well as an in-depth insight into present, emerging and potential future learning technologies, both in terms of learning management systems (LMS) and augmented learning, competency assessment tools and learning analytics.

Theory and research are fundamental to the study of learning. It important therefore that learners are given a brief outline of the criteria for learning (change, endurance and experience) and insights into the four conditionings and behaviours of learning, namely: Classical Conditioning, Operant Conditioning, Cognitive Theory, and Social Learning Theory and all of their sub-theories such as constructivist, observational, experiential, etc. Learners should gain an clear understanding of the historical development of learning theory from rationalism - the idea that knowledge derives from reason without recourse to the senses and empiricism, the idea that experience is the only source of knowledge, to the beginning of the psychological study of learning and Wundt's psychological laboratory and Ebbinghaus's verbal learning, to structuralism (a combination of associationism with the experimental method including the scientific investigation of human consciousness) and functionalism - the view that mental processes and behaviours of living organisms help them adapt to their environments. In the context of functionalism, it is beneficial to discuss introspection, the view that mental processes and behaviours of living organisms help them adapt to their environments, as well as functional factors such as bodily structures, consciousness, and such cognitive processes as thinking, feeling, and judging.

Learners also need to understand the essence of behavioural theories which view learning as a change in the rate, frequency of occurrence, or form of behaviour or response, which occurs primarily as a function of environmental factors. Behavioural theories contend that learning involves the formation of associations between stimuli and responses (Schunk, 2012). Other considerations from social cognitive theory, such as self-regulation and self-efficacy and their relationship, to identity, self-image, agency and accountability help the learner to understand not just their importance in the context of creating mobile learning materials for somebody else, but also their own position and approaches to learning. This underpins the notion that mobile learning supports social-constructivist pedagogy, with emphasis on students' responsibility and ownership of learning. This is in contrast with the instructivist pedagogy because in mobile learning, students should take the initiative to engage with the learning content, their peers and the tutor(s) (Chuang, 2014). The learners need to study how humans make meaning from the relationship between ideas and experiences, how to embrace socio-culturism and acknowledging the uniqueness of the learner. In this context, the learners should gain a solid grasp of Vygotsky's "Mind in society: The development of higher psychological processes" (1980), Dewey's "Experience and education" (2015), Bruner's "Modes of Thinking and theories on constructivism" (1966), Piaget's "The construction of reality in the child (Vol. 82)" (1954), Ertmer & Newby's "Behaviourism, cognitivism, constructivism: Comparing critical features from an instructional design perspective" (2013). Cooper's "Paradigm Shifts in Designed Instruction: From Behaviourism to Cognitivism to Constructivism" (1993).

In this transformative postformal era of education, there is an enduring interest in pursuing connectionism and its expressions of learning transfer, individual differences and intelligence. It involves learners encouraging each other to collaborate via networks through sensemaking, i.e. metacognition skills (how to think); pattern/knowledge recognition; identifying critical knowledge and direction; and keeping abreast of emergent knowledge (merging formal and informal knowledge).

George Siemens (2004) quoting Karen Stephenson explains connectivism as "I store my knowledge in my friends" which is an axiom for collecting knowledge through collecting people. Siemens describes the principles of connectivism as:

a) Learning and knowledge rests in diversity of opinions.
b) Learning is a process of connecting specialised nodes or information sources.
c) Learning may reside in non-human appliances.
d) Capacity to know more is more critical than what is currently known
e) Nurturing and maintaining connections is needed to facilitate continual learning.
f) Ability to see connections between fields, ideas, and concepts is a core skill.
g) Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decisions.

Also, given our current transition into new paradigms of education it is important when talking of the future of mobile learning that learners study and understand the potential for disruptors. Accordingly, they need to consider the following questions:

a) How are learning theories impacted when knowledge is no longer acquired in the linear manner?

b) What adjustments need to be made with learning theories when technology performs many of the cognitive operations previously performed by learners (information storage and retrieval).
c) How can we continue to stay current in a rapidly evolving information ecology?
d) How do learning theories address moments where performance is needed in the absence of complete understanding?
e) What is the impact of networks and complexity theories on learning?
What is the impact of chaos as a complex pattern recognition process on learning?
f) With increased recognition of interconnections in differing fields of knowledge, how are systems and ecology theories perceived in light of learning tasks?

Beyond the formal aspects of learning theories, given my work with Haag and Raybourn referred to earlier, I chose to introduce Advanced Distributed Learning (ADL.org) ISD Framework as part of the basis of the pedagogy segment of the course. It allows the student to understand the difference between macro and micro strategies. Dick and Carey (Dick, 1996) define a macro strategy as the complete instructional plan that includes everything the instructor or instructional designer does to bring about learning, including learning objectives, assessment strategy, motivating components, content presentation, practice activities, the complete "delivery method". Micro strategies are the learning activities and designed learning experiences within the macro strategy. The micro strategies are usually mixed, either in a sequence or concurrently, within a single instructional design. Mobile learning provokes a clear understanding and need for micro strategies. In this case, I consider mobile learning as a macro strategy, especially since it includes many unique micro strategies that could not easily be achieved using any other technological medium or "delivery method". In line with other mobile learning strategies, there is often not solely a measurable learning strategy, but it can play its part. It is important for learning theories to be cover in the framework because they can have a significant impact on the type of mobile strategies to be employed. The inclusion of the "mLearning micro strategies" node in the diagram (Fig. 36) is an attempt to provide an intellectual framework that may help learners to organise thinking and discussion about potential micro strategies.

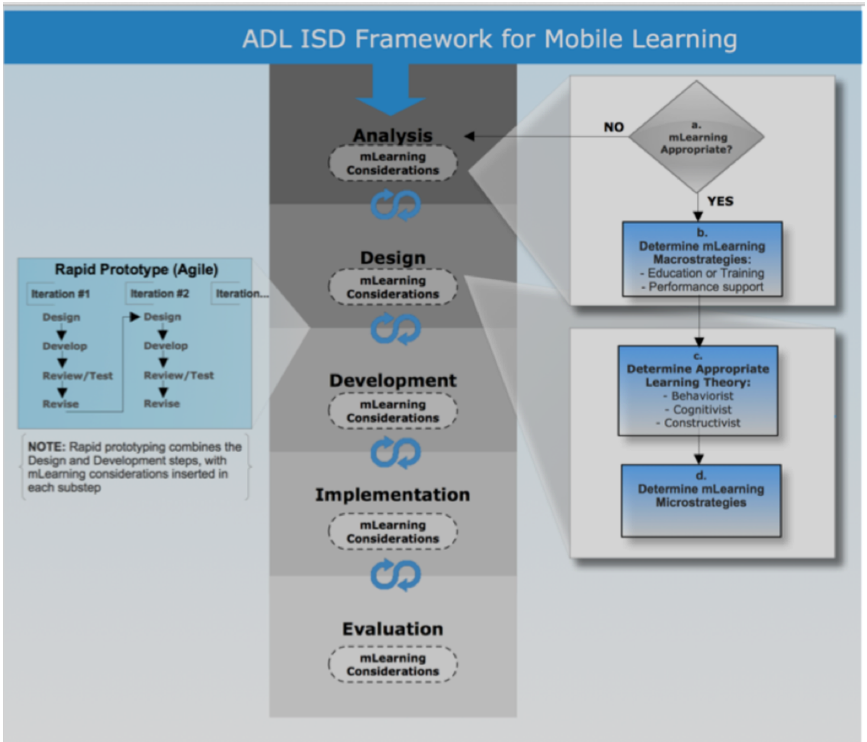


Figure 35 ADL ISD framework for mobile learning

This framework is meant to inject concepts, considerations, decisions, and guidelines specific to mobile learning into appropriate points in the ID model. The learners need to understand how to apply this conceptual framework to their own thinking around the development of future mobile learning.

While I have a personal preference for this framework for this particular course, I expect learners faced with similar needs to consider other learning frameworks (mobile and non-mobile). Accordingly, students should be familiar with de Freitas' and Oliver's four-dimensional framework (Fig. 33), which demonstrate: context, learner, representation, and pedagogy. This framework was originally developed for the consideration of games for learning.

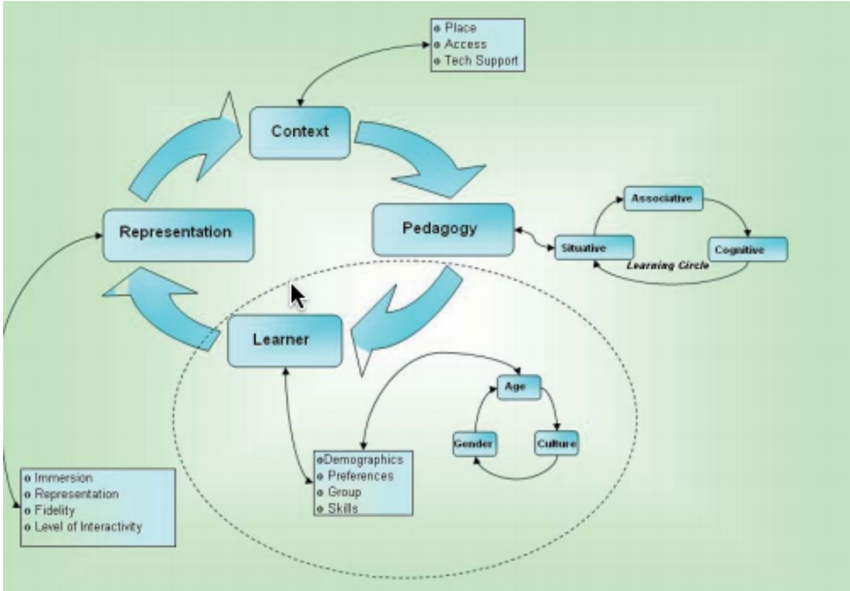


Figure 36 Four-dimensional Framework, Source: de Freitas & Oliver 2006

Similarly, new developments such as the serious games movement are facilitating collaborations between academic, industrial and government agencies seeking to develop proprietary learning games. In an effort to combine pedagogy and play, as well as retaining fidelity to the subject matter, Rooney (2012) proposes a triadic framework that integrates these aspects. She addresses different learning methodologies, such as situated learning and experiential learning, as part of this framework and further argues for theoretical underpinnings of designing games within these contexts. Rooney's is a conceptual approach that identifies similar dimensions of Game vs. Learning, Game vs. User, and User vs. Learning. Learners need to understand the importance of integrating sound educational principles such as motivational and educational effectiveness into the serious game design process (Braad et al., 2016; Gunter et al., 2006). Dormann et.al (2012) discusses the significance of game design patterns as a general reusable solution to frequently occurring problems. Once the pattern has been successfully applied in specific contexts in response to specific design problems, such as learning in the affective domain. The design patterns can act as for problem-solving during design and development, for idea generation, as a creative design tool, for analysis and categorisation of games, for exploration of emerging media, such as mixed reality serious games.

Other instructional design models that the learner should explore are Dabbagh & Bannan-Ritland's (2007) Integrative Learning Design Framework (ILDF) (Fig. 38), which is a comprehensive and flexible model that can be applied in multiple design and development settings.

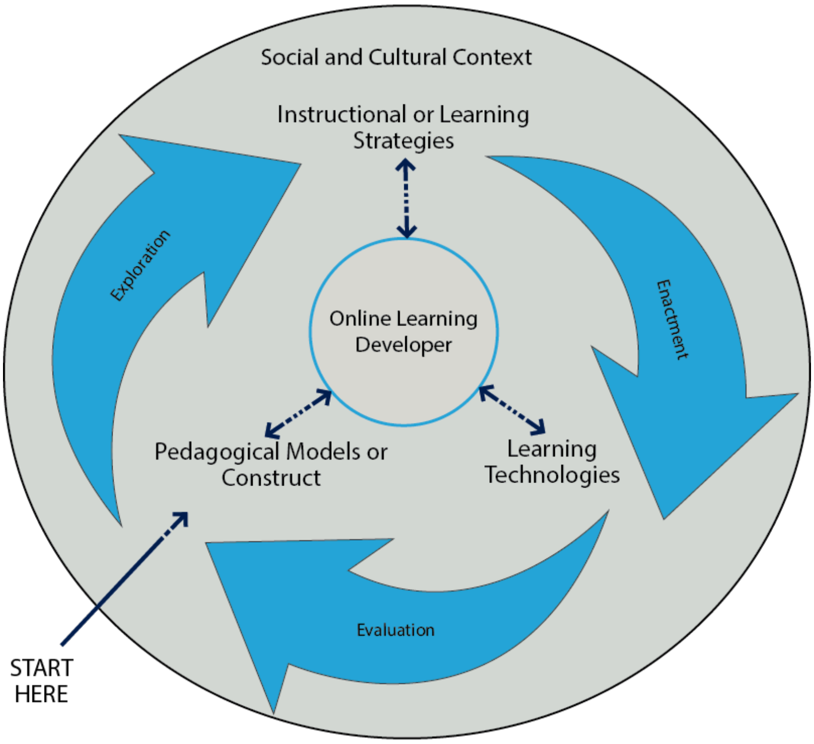


Figure 37 Design framework for online learning design course (adapted from Dabbagh and Bannare Ritland [2007])

I also introduced the Kolb model for experiential learning and the traditional Kemp Instructional Design Model Fig. 39 which contains the basic components of any instructional design plan.

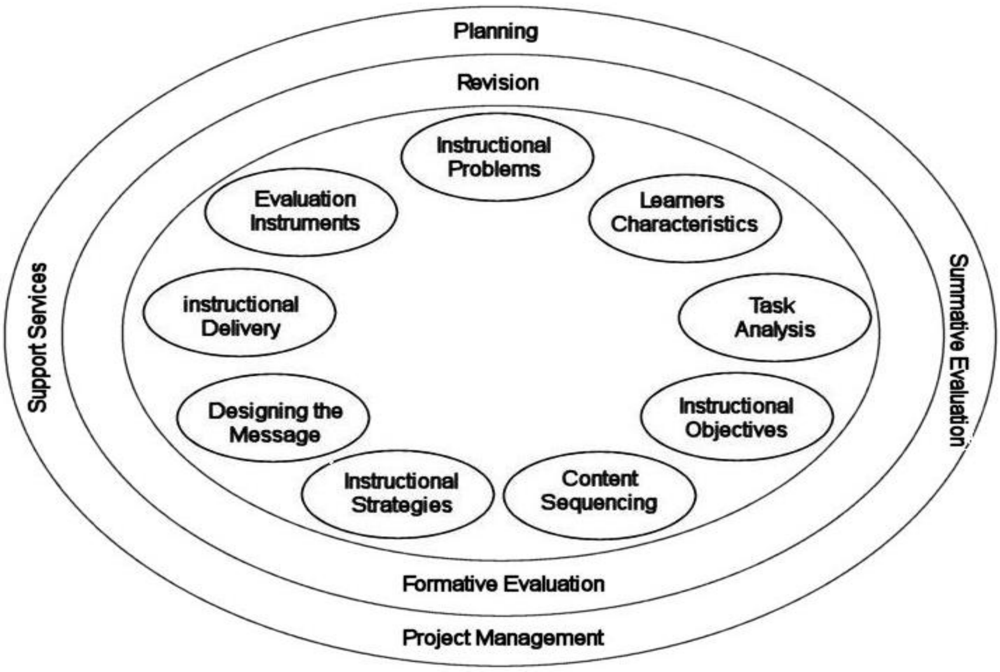


Figure 38 The Kemp Instructional Design Model (G. R. Morrison et al., 2019)

8.1.9 Designing for increased creativity

Although the LLS was developed to connect with and enhance all the critical emerging competencies, it was especially aimed at increasing learner creativity. As we saw in the Introduction, the most important characteristics of learner creativity building lie in the learning framework being able to develop a creative personality, to provide sustainable access to creative flow and to have access to a creative environment in which to develop. This requires harmonisation on multiple levels, not least in driving creative energy by evoking both the five basic senses, and if possible, the four additional senses ("Culture of the Senses" by Katheryn Lynn Geurts). The LLS includes the elements of multimedia and immersion, sensory and cognitive embodiment and is a strong platform for multisensory learning. Consequently, I examined the issues of emotional design and positive emotions in multimedia learning and their influence on increasing creativity. The importance of affective processes such as emotions (Park et al., 2014) is crucial to creativity development and in the case of multimedia, these emotions are impacted by the learning environment itself. Positive Emotions influence and enhance cognitive processes (Izard, 2009) and learning (Pekrun, 2006), and it is deemed that an emotionally appealing enhanced learning design fosters learning and motivation (Mayer & Estrella, 2014). Earlier Mayer completed seminal work on the cognitive theory of multimedia learning (CTML), but it did not explicitly emphasise the matters of motivation and emotion on learning. Moreno (2007) added emotional and affective aspects to Mayer's theory with his Cognitive Affective Theory of Learning with Media (CATLM). Moreno believes that affective and motivational factors mediate learning by increasing or decreasing cognitive engagement. Creative and divergent thinking is enhanced by a positive mood (Fiedler et al., 2003). That positive mood can be generated in multiple ways, but there is proof that while the environment is critical, the application of the appropriate medium for the content being presented must be engaging and to a greater extent immersive, otherwise learners could potentially employ that positive mood for non-learning in which case their comprehension performance is reduced (Park et al., 2014). In that research and follow-up work by Park, Knozer, Plass and Brunken (2015) that having a positive mood when entering the learning environment increased performance and when continued have an influence on a learner's mental effort and comprehension, by increasing cognitive load, often causing longer term memory and retention. Heidig et al. (2015) examined the technology, design and usability and other intrinsic design features that led to positive emotions, motivation, and creativity. Both perceived and highly expressive aesthetics and usability increase positive emotions and performance through positive activation and valence. Their study underpinned the fact that positive emotional states can facilitate complex learning processes. As mentioned above, usability (user experience) and interactivity are critical factors in the development of positive emotions the learning experience and enhanced creativity. Here I am referring to ease of use, user control, format, feedback, motivation, and content relevance reflected in overall user attitude moderated by the effects of the various user styles.

Finally, recent research (Li et al., 2020) on 316 Chinese students divided into two group using one group learning from materials based upon neutral emotional design and the other based upon positive emotional design found that by measuring using a positive affect scale and biofeedback instruments, those working with positive emotional design outperformed the neutral group on retention and transfer tests, but both were equal in terms of change of emotional positivity levels in contradiction to Um et al. (Um et al., 2007), and Plass et al. (2013).

However, this is maybe less surprising given that over the past five years learners have greater experience and familiarity with multimedia learning tools and with the usability affordances of such tools as well as the materials and learning approaches used in the various studies mentioned above and therefore, they have become part of their daily life, expected and adopted. It is not the technology that appeals to users (Raybourn, 2014), but the idea of creating and living out narratives that newer technologies that capture the "Holodeck metaphor" generate in terms of visions of future worlds and simulations of the multiple realities of the present, in which learners can immerse themselves in evaluating multiple solutions to simulated problem situations, and painlessly exploring the implications of potentially life-altering decisions. As we will see in Chapter 8, creating atypical immersive learning environments where learners can put theoretical knowledge into practice in a safe, comfortable environment, enabling students to try out their unbridled ideas and hypotheses by doing and increasing their creativity as though the outcome was situated in the real world.

In this particular course, I emphasised six key elements in the course design that would potentially enhance engagement and creativity: self-direction (active control), opportunity to enhance existing skills and deliver assignments in any/multiple formats (freedom), ability to contribute to the course development and the future of learning in general (pride), having to think and work in a future landscape (excitement), learning, applying and building multimedia (self-esteem), creating and delivering the unexpected, novel ideas (inspiration).

Deep experiential immersion enhances the learner's ability to imagine the learner's relationship with his/her cognitive environment/mindspace within a holistic intelligent learning environment rather than simply the role of the enhanced learning technologies involved, or the content being delivered through the course. Emerging forms of multimedia provide affordances that deliver technology-rich learning environments or spaces, which if designed optimally can enable higher levels of motivation, participation, engagement, creativity, and learner performance through the state of spatial immersion. This can occur when the spatial structure and affective drivers make the learner world perceptually convincing or real. The interplay between the learner, knowledge agent, multimedia interface or delivery mode, the intelligent environment and enhanced cognition deliver an immersive spatial narrative that transports the learner from participant to immersant (McRobert, 2007). The addition of multimedia to powerful creative approaches and tools otherwise intrinsically present in foresight practices or applied specifically in the creative stages of the foresight process, such as "Think like a DJ" and "Remixing the imagination" (Woodgate, 2018a; Woodgate & Pethrick, 2004), "Disruptive Mapping" (Morris, 2019), "Futures Window" (Hiltunen, 2008), "Scenario road mapping" (Drew, 2006), can significantly augment the foresight experience (Gabrielli & Zoels, 2003).

In a research investigation in which I was involved with my UiA colleague, Maurice Isabwe and two of our graduate students, Margrethe Moxnes, and Marie Ristesund (Isabwe et al., 2018), we introduced VR (Virtual Reality) into the teaching/learning of chemistry for junior school students. The investigation established *three integrative core contributions* from the virtual reality approach. *Firstly*, the ability of VR to provide a simulated experiential environment that enables the learner to undergo a task multiple times that would otherwise be dangerous and ill-advised in a real-world setting. *Secondly*, the VR set up delivered a fully immersive, close exploratory experience, which created a greater degree of sensory encounter and potential for a higher level of personal ambience. *Thirdly*, VR as a learning tool played a transformative role in helping both the learner and the teacher to trace an alternative, innovative approach to constructing and experiencing the subject content. We considered the deeper and broader experience that VR affords in this specific examination. Hence, we found the accumulated effect of the above three contributions recorded in the learner's ability to garner multiple perspectives to both simple and complex chemistry assignments underpinned by new physical and mental levels of engagement. This was an essential element expressed through the learners' satisfaction with the investigation, its high desirability or "wow" factor. It should be seen as part of the reward in addition to the knowledge gained.

In addition to the more physical aspects of interaction, we understood how this investigation delivered augmented ambience to the learner. Then VR experience created an extended sense of sensation and encounter leading to the expressed higher level of desirability as a learning approach to the more traditional classroom method.

Using the VR set up afforded us the opportunity to take a context-sensitive design approach, to capture and deliver the experience through a framework of integrated experiences that achieve that goal. VR's intrinsic immersive qualities provided an environment where the powers of involvement, knowledge, observation, and exposure came together to fuse the physical, the emotional, cultural, and mental experiences. At the same time, the conscious and unconscious need for volition, illustrated in Fig 40, as a critical driver for a desirable experience was enhanced by the novelty of VR.

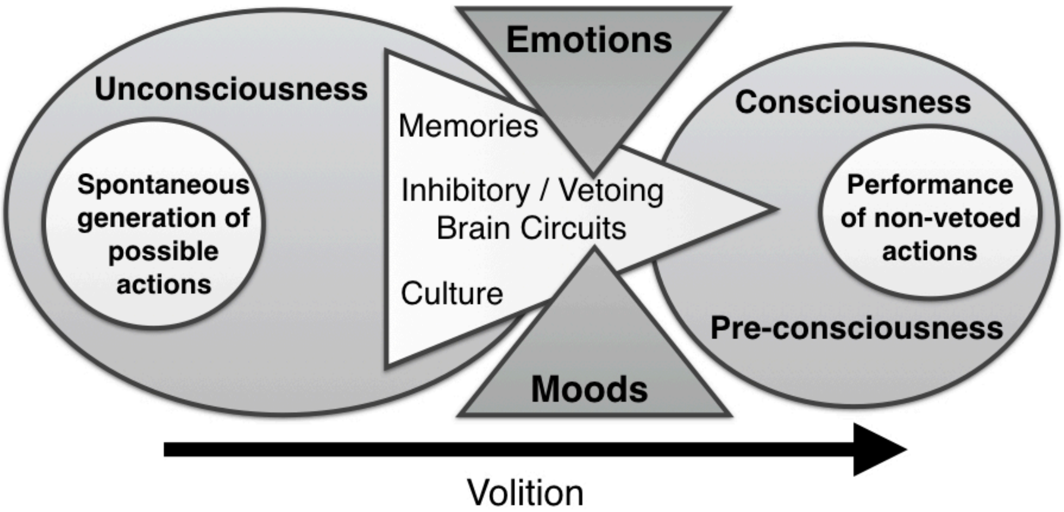


Figure 39 Expanded (Woodgate, 2011) volition by Lakoff and Johnson (Lakoff & Johnson, 2003)

The ability to learn and solve a problem within a simulated environment with textual or auditory overlays enables the student to subconsciously move from real to virtual and back to ensure that his or her internal cognitive communication engage in a multisensory manner, integrating the learner's auditory, visual, and kinaesthetic interactions simultaneously.

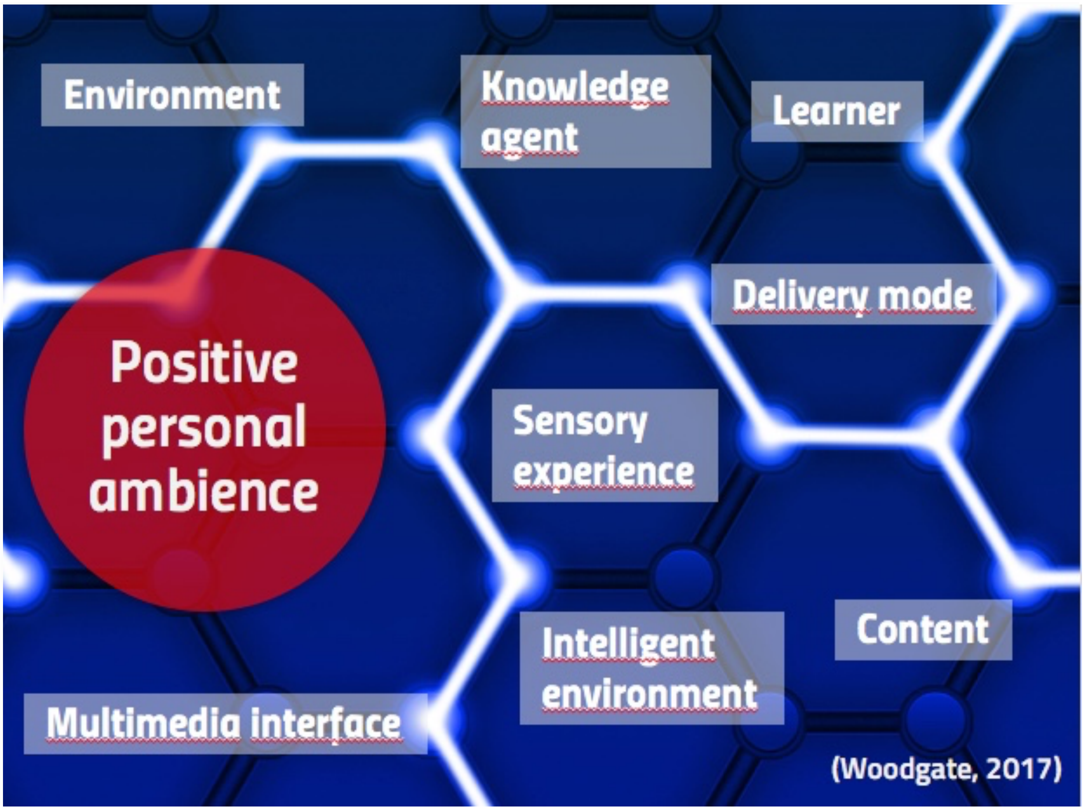


Figure 40 From Future Flow – From Sensation to Imagination, adapted from Woodgate (Ghislain et al., 2017; Woodgate, 2011)

Accordingly, VR has the ability by establishing a revised meaning of the task, to accelerate and better activate the learner propensity to optimise the impact of the experience, forming a higher level of intimacy and attachment. It is the feedback loops between the content, environment, interface and the human experience that create personal ambience as shown in (Fig. 41) In this case we clearly saw the role that VR played in this schema, by providing the learner with a unique environment and meaningful multisensory interface that enhanced the experience and with it the personal ambience and augmented level of encounter.

The experience therefore is an assemblage of forces and intensities and the polysemic nature of VR means that each learner is able to make his or her own sense of the approach and engagement with the question. Such experiences contribute significantly to the desirability of the learning tool and method. Understanding the complexity of experience building in advance (Fig. 41) helped us to construct the content Personal ambience (From Sensation to Imagination) (Woodgate, 2011) or the task in a way that better leveraged the specificities of VR, the questions, and the instructions necessary to complete the chemistry problem. Although this investigation was limited to small chemistry tasks, we considered the VR approach from a broader systems model.

A key factor in any paradigm for creativity and risk is the social factor of learning as it is in socially constructed environments such as group experiential learning that learners face the risks that evolve in sharing work to be judged by others (Perry-Smith & Shalley, 2003). Consequently, in such situations it is incredibly important that the intrinsic motivation and imagination required to achieve creativity are fostered, but also achieved through well-structured approaches. In the case of this particular course, I used several creativity stimulators to minimise this risk. These included selecting balanced teams based upon members' known competencies and helping them to establish a defining role for the group dynamic and project needs, while ensuring that the significance of those competencies was recognised by the other members as essential contribution to the planning and success of the outputs created by the group. This approach also has the role of increasing agency and authority, adaptability, reflexivity, mutual intelligibility and reciprocity. In this sense, my objective was for any tensions to inspire rather than suppress creativity. Secondly, I introduced the freedom to choose tools, modality, and interpretation for the delivery of assignments, where appropriate, taking into account each learner's context, and situation variables where I considered they influenced the learner level and understanding of creativity in the given situation, particularly where the question of the purpose and usefulness of the created work was in question. Thirdly, as described earlier the interactive, immersive experiential multimedia sessions, experimenting with unfinished and futuristic artefacts allowed for expansive imagination, ideation, conceptual thinking as well as the visceral embodiments of creativity through the senses and spatial narratives. Also, the work with alternative thinking methods and the need for the learner to continuously think futures also allowed for both jouissance, intuition and vision. All these methods were underpinned with stimulating, provocative, unexpected course content, module structures and types of assignments. In developing these various approaches, I was aware of the need to establish a synergistic connection between each of them to preserve and enhance the situated, emergent and kinetic nature of creativity. Designing the totality of creativity into the course structure requires it to be approached as an embodied, conceptual, and situated phenomenon. According to Creely, Henderson, Henriksen (Henriksen et al., 2020) these embodiments that are actioned and experienced first-hand, but also can be observed and studied in individuals and in groups at an abstracted level.

In my research (Woodgate, 2019) I discussed this process through the lens of immersive spatial narratives. My research dealt with the reframing of the learning space in the service of creating more effective spatial narratives that are designed to deliver transformative approaches to learning and the development of new competencies to confront the complexities of foresight-based learning systems. In this context, I use the term spatial narrative beyond its more common meaning in architecture, urban development and deep maps, to mean the story and opportunities within a learning space, whether it is physical, virtual or cognitive (Fig 42) Spatial narratives enable us to navigate and explore complex and otherwise difficult to experience knowledge. Spatial narratives achieve this as transformative learning spaces, like AI agent mentored three-dimensional (3D) virtual worlds, together with their intermodal components, structural elements, their internal and external processes and social interactions and encounters. They act as an experiential map that portrays optimal ways with which we can experience and learn knowledge more relevant to the emerging worldviews. I decided that the key to helping increase creativity was to find a way of creating a sense of deep immersion into the simulated future. I decided to put more emphasis on the optimisation of multimedia learning tools as a route towards augmented immersion, but to situate their application in a future horizon 10-15 years out.

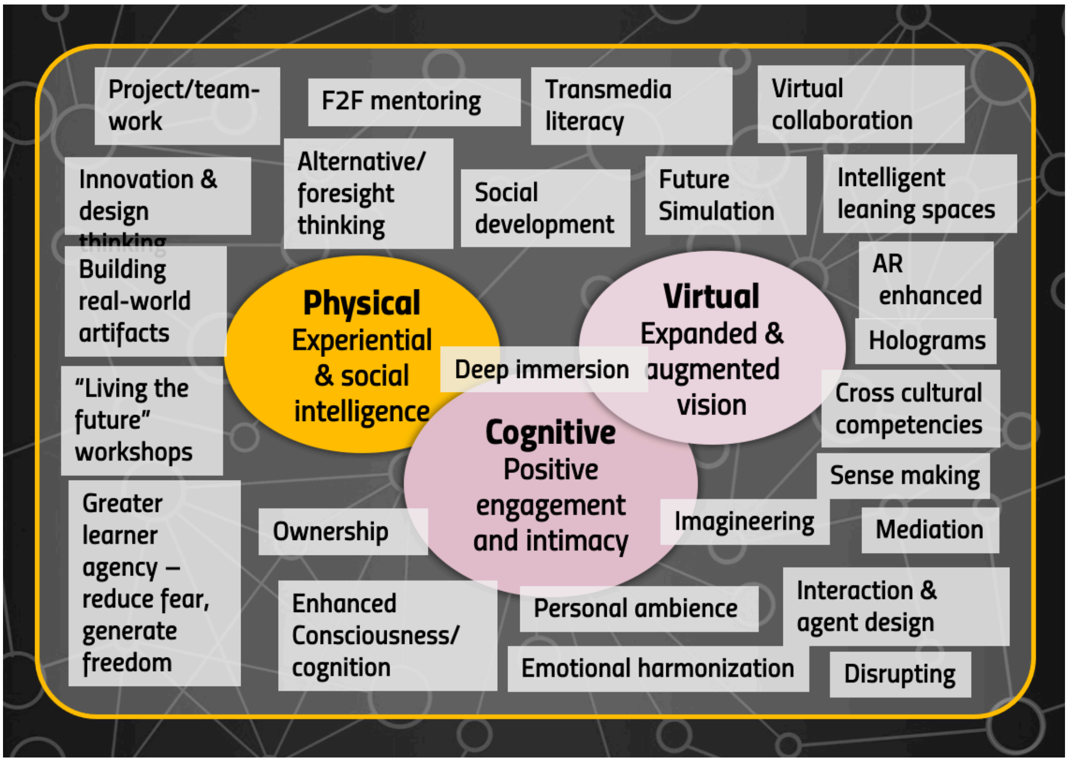


Figure 41 Mapping spatial narratives (Woodgate, 2019)

The development and use of multimedia learning tools would provide a virtual, physical, and cognitive means of delivering greater levels and layers of immersion through a technology enhanced learning space. It increases the learner ability to explore, think, create and evaluate the potential, relevance, feasibility, desirability and implications of experiencing a simulated future vision landscape. As mentioned in Chapter 7 (h), this ability, which I describe as "living in the future" requires a higher level of engagement and creativity and a bias towards the concept of multiple dimensions of change and the acceptance of re-conceptualised, re-contextualised notions of our world, space and time. This notion of the visceral location of the emergence of creativity in soma, in actions, and in affective responses tends to "differ from classic presentations of creativity in terms of problem-solving, intelligence, and cognitive processes" (Benedek et al., 2014). Creativity is much more than the processes of thinking, even using alternative thinking methods (even though I use these to inspire creativity and engagement), and imagination. It is also formed in the social and the cultural in holistic corporeal (mind and body) connection with other learners, together with its production in the virtual and physical worlds. I put as much emphasis on reconceptualisation and recontextualisation of assumptions with their new representations and combinatorial possibilities what Wu and Dunning (2018) refer to as hypocognition as I do the manipulation of the artefacts.

Another critical aspect for increasing creativity is the learning environment. As I mentioned in Chapter 2, the ultimate adding of the Learning Lab and Media Lab to the department in 2017 and our conversations with Brian Magerko, Head of the Expressive Machinery Lab at Georgia Tech, Frank Eichstadt at NASA, Pattie Maes at MIT and Elizabeth Strickler at Georgia State's Creative Media Industries Institute (CMII) about their design and application positively transformed the learning environment at UiA. I was previously the Futurist-in-Residence at DAEL (The Digital Arts and Entertainment Lab), the predecessor to CMII working on the long-term development of CMII as a future learning environment and I created and curated experiential environments for Plutopia at SXSW and corporate clients, transferring that experience into the development of the learning environment for the course on the future of mobile learning. However, the key is understanding that the environment is ultimately a matter of "personal ambience" – which as mentioned earlier is what we let in when the experience or encounter a sensation, reach the "visual heartbeat level", going beyond the five senses.

While achieving deep immersion, the sense of encounter or presence and engagement, whether in the physical or virtual learning environment is core to my course design decisions, aspects such as embodied and tangible interaction, exploration, improvisation, experimentation, and creative expression are all key to achieving greater motivation and increased creativity, whether creating artefacts or undertaking complex modelling of potential future solutions or partaking in alternative thinking techniques involving both f2f or virtual group work. With virtual individual or group work, the environment has to shift from the physical 2D screen either to a 3D environment or a vision in the imagination often achieved by learners have to discuss a vision of the future. While creating aesthetic engaging physical environments may seem easier in terms of dressing up the lab or changing the environment through projection and the ability to work with futuristic artefacts and xMedia technologies such as AR, VR, holograms, simulation tools, character creation and animation, creating a sense of being there through the transfer of the course content, the course structure and the accumulated interaction of the materials, environment, social connectivity, freedom, experimentation, thinking techniques, and expected outcomes are as important to increasing creativity.

While the framework and key elements of a course should be constituted in advance, there is often good reason to leave sections loose so that they can be refined through experimentation with student contribution in a way that it is common for changes to occur up until the end of the phase. Building a course framework that inspires and increases creativity requires a continuous pathway that assesses the mechanisms and levels of creativity being generated at given points throughout the course.

8.1.10 The final course structures

I anchored the Future of mobile learning course in line with the requirements of the LLS, on constructivism/collectivism-based blended learning (Al-Huneidi & Schreurs, 2012). A key objective was to obviate the issues identified from my observations around the initial course semester and its e-learning only structure. The blending integrated various event-based learning activities, including face-to-face (f2f) classroom, live e-learning, student-centred learning, experiential learning, and self-paced learning. In constructivism theory, learners become more active in developing and creating knowledge, both individually and socially, based on their experiences, perspectives, and interpretations. I incorporated the positives from the original course approach, such as alternative and future thinking, self-directedness, an updated and upgraded version of the content itself, with emphasis on our understanding of the emerging learner and enhanced human potential as well as a transmedia approach to assist in increasing learner creativity. As mentioned earlier, I selected the Science of Foresight as the overarching framework to connect the various elements from the LLS.

Consequently, the course was built on twelve underlying learner platforms, namely:

1. Each student learns to his/her own strategy to create personal relevance and engagement,
2. The use of alternative, experimental, thinking techniques beyond linear modelling and thinking,
3. Multimedia enhanced immersive multisensory learning with supportive transmedia content,
4. Optimised ZPD transitioning (zone of proximal development and scaffolding) - student control,
5. Open communication with virtual discussions and co-working sessions,
6. Opportunities for constant testing and enhancement of individual competencies,
7. Experiential opportunity-based problem solving (creating imaginary artefacts and applying disruption)
8. Increased creativity (input and output), leveraging prior learner competencies and skills,
9. Freestyle delivery of assignments, competency-based assessment with adequate performance assertion points,
10. Contribution to the course design and progression,
11. Opportunities for participatory culture and individual and group cognitive growth,
12. Engaging learning environments

While some of these are structural and other tactical, each of these platforms was given specific objectives with the collective objective of proving how the introduction of context-relevant multimedia technologies, stimuli-specific environments, and personal ambience, can lead to a new realm of experiences, enhanced creativity and accelerated learning and improved performance. However, other objectives included the development of learner compassion through working in multidisciplinary and multicultural groups, giving students a greater voice, agency and advocacy, enabling the application of intuition, imagination, spatial narrative building, advancing critical thinking to expand the learner's rapid combination and recombination of mental representations, growing the learner's self-belief and self-expression (turning off the internal and external critic), creating extensive opportunities for socialisation, growing existing learner competencies and extending into multiple new skills, selecting learning models that increase participation, engagement through immersion and personal ambience and selecting the most effective multimedia tools for augmenting learner creative abilities.

The course was designed to create a learning climate, and pedagogical structure that provides a sustainable future for learning in line with the outputs from the foresight study. Given that the critical goal is to achieve increased creativity, this course is constructed in a way that facilitates creativity assessment using the Creative Solutions Diagnosis Scale Model (CSDS).

8.1.11 Course Description

The field of education and learning are at a crossroads of seemingly dramatic change. We regularly hear about a real shift towards personalised, student-centred learning; new approaches and a general overhaul of teaching methodology; a plethora of learning technologies - anything from gamification and augmented reality and augmented environments to major advances in computing and human-machine interfaces. Then, there is the whole question of social and human change and economic factors and where will we be with neuroscience and its impact on cognitive feedback. Learner modelling, matching and assessment and what are the other wild cards that will significantly influence the future.

One of the most important major changes will result from the greater penetration of mobile learning in all its forms, from wearables and devices to mobile content development and immersive, interactive environments that enhance the learning experience, supported by AI driven personalised learning assistants and emerging assessment techniques and technologies. Additionally, over the coming decade, we will also witness the power of quantum computing and its impact upon communications networks, data security and the language and modes of connectivity. Another major area of exploration will be the interaction and interfaces between humans and machines and the potential for creating new currencies of knowledge and modes of collaboration.

8.1.12 Course Objectives

These are the eight main course objectives that I have defined in conjunction with the LLS:

1. To apply constructivism-based blended learning as a pedagogical platform
2. To use the science of foresight as a practical framework for studying and creating the future of the domain, namely mobile learning
3. To apply the principles of opportunity-oriented problem-based learning theory
4. To make increased engagement and creativity pivotal to the outcome and assessment criteria (competency-based)
5. To include key 21st Century learning skills based upon potential future workforce needs in the field
6. To deliver a “multimedia technology in – multimedia technology out” approach for accelerating learning of the technologies and creating future learning technologies
7. To emphasise alternative thinking techniques to better deal with the complexity of discontinuous change, which is central to creating the future
8. To create new spatial narratives as a critical platform for delivering student-centred, self-directed learning and the continuing development of each learner’s individual competencies and interests.

8.1.13 Course structure

The course is divided into three integrated units:

Unit One	Exploring the future of mobile learning
Module 1.1	What is mobile learning – A current perspective
Module 1.2	Technology enablers, future emerging technologies – xMedia affordances, interfaces, etc
Module 1.3	Devices, wearables, implants and frameworks - multimedia tool design
Module 1.4	Transmedia learning – transition or disruption, immersion and interaction
Module 1.5	Future context and benefits of mlearning – future learning pathways
Module 1.6	Future drivers, critical insight and the future landscape for mobile learning in 2030-35

Unit Two	**Creating the future of mobile learning**
Module 2.1	Introduction to the science of foresight
Module 2.2	The Theory of Change (Social-human, technological, environmental, economic, political)
Module 2.3	Connecting disconnects, creating future triggers
Module 2.4	Building future concept platforms
Module 2.5	FutureScaping the scenarios and evaluation (5-day workshop)
Module 2.6	Scenario implementation
Unit Three	**Applying the future of mobile learning**
Module 3.1	Introduction mlearning pedagogy **-** Learning design principles **-** criteria and assumptions for creating the design brief
Module 3.2	Mobile learning toolkit for future design brief – HTML5, LMS, and visualisation tools

Figure 42 LLS based course structure (Woodgate, 2018a)

Final project: Create a design brief for your future mLearning project for 2030-2035 integrating your multimedia and transmedia elements. This involves incorporating the future of the subject domain, the future student in terms of human change, learning climate and environment, learning tools, pedagogical advances, etc. set against the background of student-centred learning.

The *Practical Enquiry Model* below shows how the key future of mobile learning course elements are framed to optimise the learner experience, understanding, participation, engagement and creativity.

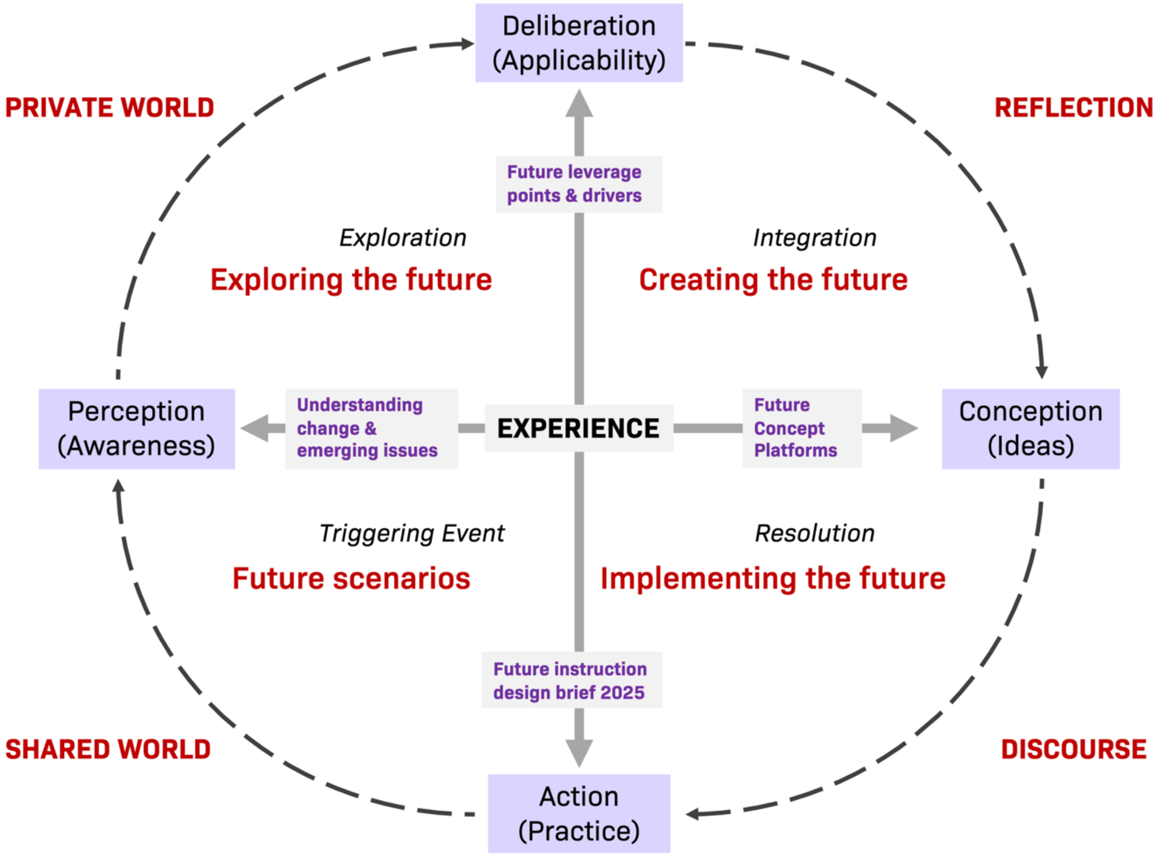


Figure 43 Practical Inquiry Model adapted by Woodgate

The practical enquiry model above (Fig. 44) is model of critical thinking) used to assess cognitive presence in terms of the course structure. Cognitive presence focuses on higher order thinking processes as opposed to specific individual learning outcomes. Practical inquiry is both a process and an outcome. Practical inquiry is grounded in experience but includes imagination and reflection leading back to experience and practice (Dewey, 2015). Recognizing the shared and private worlds of the learner is a crucial concept in understanding the creation and support of cognitive presence for this learning process. The first dimension of the model reflects this continuum between action and deliberation. The second dimension represents the transition between the concrete and abstract worlds. This is the perception-conception dimension. In my adaptation/translation of Garrison's and Archer's model I see the *Event* as the gap between formal and transformative education, *Exploration,* in terms of understanding the past, present and potential future of the domain and all of the elements that drive/influence the transformation of the domain, including disruptors, implications with an in-depth understanding of the emerging learning tools, which the learners are expected to learn, test and understand the design elements and potential applications, *Integration* is taking all this knowledge and applying the science of foresight methodologies it to imagine change by means of alternative thinking techniques, dispelling assumptions, as well as experimenting with the technologies and potential future artefacts to design and build potential futures scenarios in a 40-hour "living the future" workshop, Finally *Resolving*, I see as the implementation of the scenarios and artefacts through the development of a future course that helps transform the learning structure in a way that fills the gap that is identified at the outset of the course. One should remember, however that until the last modules of Unit 2, the learner does not know the extent of the gap until the learner has establish the potential opportunities for the domain in the period 2030-2035, that is because foresight works with opportunity-based problem solving and not problem solving based upon the present. Foresight works with discontinuity rather than evolution from the present (which is forecasting). Therefore, the learner has to first learn how to project him or herself into a future landscape. The course is structured in a way, that helps achieve that complex shift.

The Course Duration is 15 weeks and is represents 7.5 ETS Number of hours: 80 hours in class and 60 hours of outside class activity.

Since this is a blended course, the course commences f2f with a three eight our day introduction, in addition to Module 1. Followed by eight times three-hour online mentoring sessions, one per week. This is followed by a full 40-hour week f2f experimental learning workshop in the learning and media labs, followed by four times three-hour online mentoring sessions, one per week. The media lab is open for students both inside and outside of formal learning times.

This chart below explains the meaning and relevance of each element within the LLS and how the system is integrated and implemented throughout the course based upon inputs and outputs. Main activities are indicated in (Fig. 45) below.

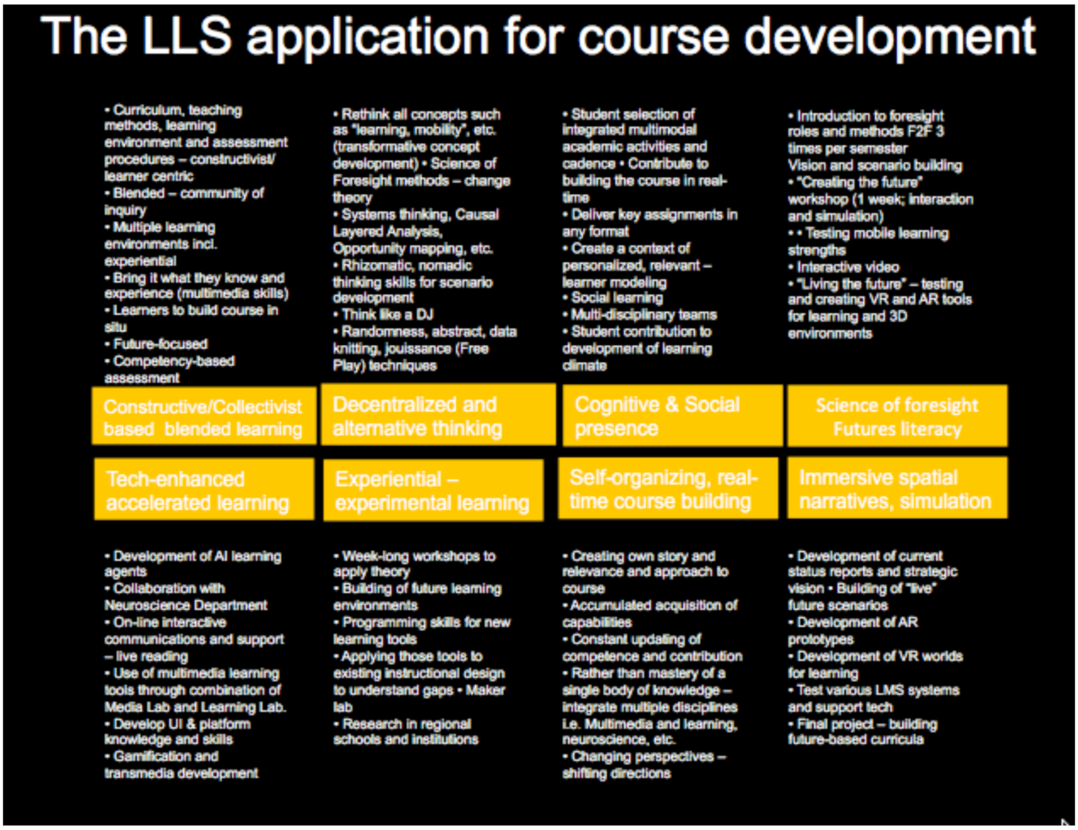


Figure 44 Outline of activities applying LLS elements

8.1.14 Learning objectives

These are the fourteen main learning objectives supporting the course:

1. Discuss the fundamentals of mobile learning and explain and demonstrate the educational benefits of current mLearning practices
2. Discuss the key drivers and future influences for the future potential of mobile learning 2030
3. Critique articles and recommended readings related to emerging mobile learning technologies and approaches.
4. Use, recommend, or create online resources and portals in a variety of educational settings.
5. Successfully develop and evaluate a future scenario for mobile learning.
6. Have a deep knowledge of the drivers and change agents that will have a definitive impact on instructional design in the future.
7. Design an innovative mobile learning project related to your field of interest.
8. Make recommendations regarding mobile learning initiatives, benefits, programs, and strategies for 2030
9. Obtain the skills to train/teach the skills and knowledge attained throughout the course using emerging learning technologies and pedagogically effective instructional activities and approaches.
10. For students to master change theory and to understand and apply the Foresight process and methods, while simultaneously creating meaningful scenarios for the future of education and learning.

11. To develop competence in both systems thinking and rhizomatic thinking and its application in developing alternative futures.
12. To be familiar with alternative creativity tools and approaches
13. To map the potential implementation for context-relevant preferred future scenarios.
14. To be able to apply foresight methodology and skills to a variety of domains.

Although the course is primarily competency based, it must meet the assessment criteria of the Norwegian Education System and performance is graded in line with requirements.

However, all assignments are assessed against the following criteria:

Table 8 Assignment assessment criteria

Assignment assessment criteria	Fraction
Originality	25%
Contribution to evolution of course	10%
Future focus	20%
Depth	20%
Reflection/analysis	15%
Social intelligence	10%

8.1.15 Teaching strategy

For this course, I decided upon the following teaching strategy:

1. Building a narrative of reflective and interactive experiential processes with multi-cultural and multi-skilled teams
2. Lecturing and mentoring through provocative, progressive texts, critical thinking, demonstration and open discourse and debate
3. Content created based upon transmedia inputs
4. Harmonisation of linear and non-linear thinking systems including modelling, visualisation and applied multimedia
5. Leveraging learners' existing skills to increase those skills and to upskill with must learn skills
6. Personalisation/open format assignment delivery
7. Competency based assessment

8.1.16 Performance Assertion Points

The learning climate incorporated a learning narrative around reflective and experiential processes that would need to vastly increase engagement and creativity, as well as performance. The key was to integrate a significant level of immersion at critical learning junctures throughout the course. It was at these junctures that I integrated performance assertion points in line with the creativity measurement system I applied. These are referred to as assertion points rather than assessment or evaluation points because they were used to prove learner competency levels rather than simply as grading stages. These are the four key points:

1. End of Unit One: Create and produce an individual video describing the potential role of emerging technologies, societal change and other future drivers for the future of mobile learning
2. Middle of Unit Two: Demonstrate Mastering of alternative thinking techniques such as rhizomatic, nomadic and abstract

thinking and knowledge mapping techniques, to create potential future tools from unfinished artefacts

3. End of Unit Two: Apply experimental foresight techniques and multimedia tools, techniques to create future scenarios for the future of mobile learning 2030-2035
4. Final Project end of Unit 3: Create a future curriculum design brief on any subject for 2030-35 (Future-based content, learning environment, tools, course structure and options, assessment methodology, teaching methods, future student characteristics, models, roles, etc.) with specific focus on optimised multimedia applications and transmedia narratives.

8.2 Application: Teaching the course and assessing the outcomes

Rather than describe every module and activity undertaken by the class I would like to illustrate the learner activities through an overview of the inputs and outputs through examples and by theme following the four performance assertion points outlined in 7.1.15. For this dissertation, I will reflect specifically on two classes under the denomination MM402 The Future of Mobile Learning from Fall 2018 (Sem. A) and Fall 2019 (Sem. B), both of which were taught using the redesigned course flowing from the LLS. The class from Fall 2018 had 24 students (average age 25 – Male 10, Female: 14) and the class from 2019 had 23 students (average age 24, Male 12, Female 11). This second class included 4 students of whom 2 were from Makarere University in Uganda and the other two from the University of Rwanda. All four of these students were part of the Equip Project supported by the NORAD Program, in which I am a team member. Skill sets for both classes was similar, except, the Sem. A class had more pedagogy students. Each class included individual and teamwork. Teams were created within the first three days of the semester. I built the teams by asking each member to define their core competency and then I spread those competencies throughout each of the 6 teams of 4 members each. Given that several the students in each of the years came up from multimedia undergrad together, I made a point of delegating those students to different groups where possible. The competencies included coders/software, game designers, illustrators, videographers, VR and AR developers, animation and synthetic character developers, artists, computer scientists, production engineers, screenwriters, digital graphic, web designers and eLearning, instructional design, and educational technology. Each team had a coder/software designer, a VR, AR, character developer and someone who could develop narrative.

While the course was not ostensibly a class on the science of foresight per se, it used foresight methodologies, thinking, approaches and tools as a framework to study the future of mobile learning and was built on a foresight-based learning system. Foresight-based learning is the learning of a designated domain (i.e. the future of mobile learning) through the lens of the science of foresight within a learning system that uses the study of the future as one of the pillars of the overall system (Woodgate & Isabwe, 2018). The class followed and applied a commonly used six-stage foresight process (P. C. Bishop & Hines, 2012; Woodgate & Pethrick, 2004) that involves numerous methodologies such as alternative thinking techniques, computational forecasting and modelling, environmental scanning, extensive cross-mapping of potential future relevant influences and influencers, scenario building and evaluation, strategic implementation. The science of foresight is commonly applied to horizons of more than ten years into the future. In this case we were working on a 10-15-year horizon. The course followed a technology in – technology out strategy, meaning that learners had to first become acquainted and competent with emerging technologies for learning in the broader sense and to then create artefacts using those technologies as we will see in the case studies below. However, the technologies were just one element of the overall narrative, namely throughout the course there was a clear emphasis on the importance of all five STEEP (Social, technological, economic, environmental and political) areas of influence.

The course followed the same structure for both Semester (Sem). A and Sem. B classes. The only difference being that the Sem. B course was updated with the latest information about emerging technologies, learning approaches and general upgrades in mobile devices and mobile learning. The technology available in the learning and media labs did not change between the 2018 and 2019 semesters in question. For this dissertation, I will describe the activities for both groups through a singular explanation. However, I will reference any differences in responses and outputs and in terms of any examples I show.

8.2.1 Unit One: Exploring the future

Unit One: Exploring the future lasts for six weeks and involved understanding the present domain and potential drivers for the future. This included current perspectives, characteristics, and the ways that mobile learning is influencing developments in education. In this context they studied the history and current status of mobile learning, considering its positive and disruptive effects on societal development. These developments were situated in the postnormal times context, which meant they were required to learn about complexity and chaos, systems thinking as well as the development of media theory and communications technologies, and device design including wearables and implants, frameworks and battery technologies and the impact that smart manufacturing could have on the future of mobile devices and communications technologies. They also received a solid grounding in games-based learning and gamification, transmedia theory and trends in educational technologies and other technology enablers. They also gained an introduction into the changing concepts of education and learning, Informal and formal learning structures, mLearning, micro courses and future learning pathways.

The class explored what I term the Remix Society through human, social and cultural change theories and practice, the values, characteristics, attitudes, aspirations and needs of the emerging learner in the context of 2030-2035. They learned to apply the four dimensions of change that when combined make many different types and varieties of change. We explored the two sources of change, i.e., the external world and oneself (inbound and outbound), time horizons, rates of change and forms. I focused on discontinuous change rather than evolutionary change, which is more relevant to forecasting. The exploration looked at the macro and micro level influences and took into account Rainer Silbereisen's models of linkage between social change and individual adaptation to emerging conditions and environments. We discussed the holistic learner in the context of changing meanings for identity, archetypes, social, symbols and signifiers together with major influences such as ethics, security (including cyber) privacy and safety, particularly in relationship to emerging multimedia technologies and their application through the development of synthetic characters with built-in emotions, also discussing plausible roles for interfacing and interacting with them, as well as the human-robot relationships, learning agents/virtual humans and other non-human change agents that will likely play a part in the education and learning environment 2025-2030. These readings, plus the teaching models and discussions helped the learners gain a completely different perspective of themselves and interaction with peers, machines and characters within gaming or in multicultural learning environments.

At the mid-point of Unit One, the learners were required to use my proprietary experimental *Unreality Studio* technique (Woodgate & Veigl, 2020) to demonstrate the changes being brought about with the shift towards student centred learning. This involved discussions on student modelling, integrated learning ecosystems, dynamic mentoring, eduenterprises vs. the establishment, mLearning analytics and future assessment models. The *Unreality Studio* technique is based upon subverting assumptions by examining the reflections of what already exists to discover the still invisible potential that lurks just beneath the peeling surface that we call reality. The technique extends the notion of "thinking the unthinkable" in this initial stage of the course by discounting structural analysis and networked ties or ontological links in favour of open-ended discourse on each learner's initial notions on what is to them an invisible domain.

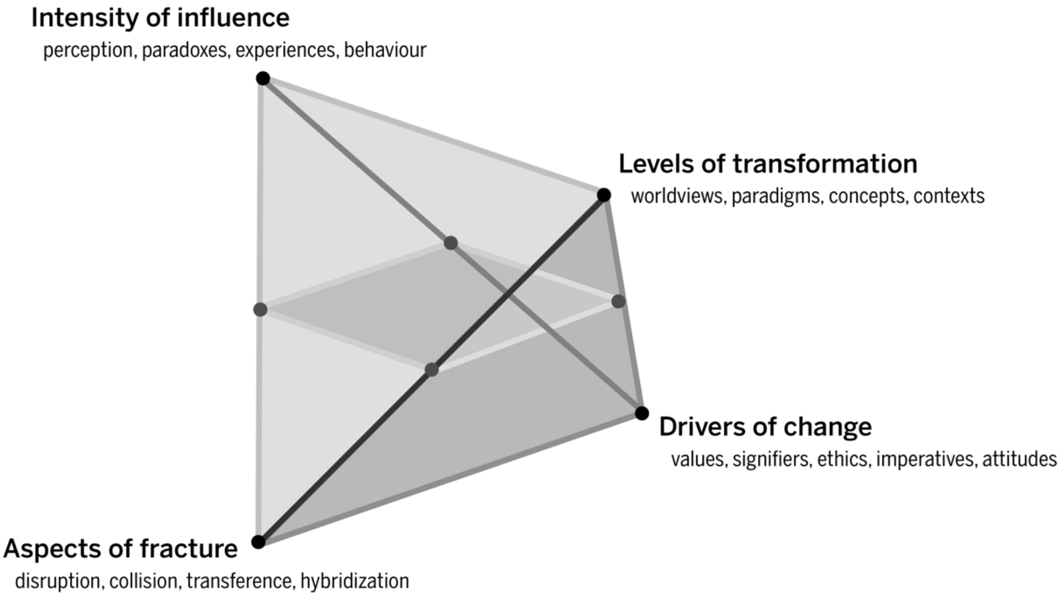


Figure 45 The Unreality Studio prism

The Unreality Studio covers a three-phase process. The first phase involves team interviews to garner discontinuous visions of the future; the second uses an immersive virtual environment in the form of a 3D digital immersive prism to study the visions from multiple perspectives that can be seen either separately or as a mash-up; and the third generates start-point questions as avenues of exploration generated by the two previous techniques. The prism is a recombinant, virtual interactive, three-dimensional, shape-shifting prism (Fig. 46) with a set of four filters within and through which we can articulate an uncoded, abstract composition of potential "avenues of exploration" defined as questions or topics. Avenues of exploration act as a future start point for developing and initial future view of the domain or building the future aspect of the domain definition. The learners working individually were asked to create unprompted top of mind visual or textual visions of the future of mobile learning. This was followed by the participants splitting into four mixed disciplinary groups of six as discussed above, with each group using prompt boards (covering curricula transformation, future work-force needs; future learner and socio-cultural change; intelligent learning environments; media, entertainment, and learning; alternative teaching models; learner well-being engagement and assessment, etc.) against which to consider and map their visions. Afterwards, the participant groups were randomised, and their task was to deconstruct the outputs from the previous day and input the key elements into the core of the prism, which was projected onto the large interactive screen. Secondly, the prism was manipulated to consider each of the four segments separately (Intensity of Influence, Aspects of Fracture, Levels of Transformation and Drivers of Change). After which the findings were cross-mapped and transcribed into questions to provide a framework for potential avenues of exploration about the future of mobile learning.

a) What will a mobile device consist of?
b) How will we receive our education?
c) What will be the role of intelligent agents and possibly robot teachers?
d) What will potential learning systems and environments look like including interfaces and mentoring including virtual, agents, robotic, human-machine integration, and holograms?
e) How do we create curricula that embraces the transdisciplinarity (roboethics, philosophy, nano, bio, neuro, sociology)?
f) How will advances in neurofeedback and learner modelling, impact learner optimisation, new learning pathways, and personalised programs?

Because there were more learners in the Sem. 2 groups who were involved with learning technologies and had a greater knowledge of pedagogy, they those groups tended to place greater emphasis on the learning process including areas such as new approaches to learner cultural, behavioural, social, and emotional advances rather than learning tools.

Given that the Unreality Studio is applied at the course's early stages when the learners have limited knowledge of the domain, it acts more as a platform for inspiration and reflection rather than deep analysis. The value of starting with a blank canvas on which to create unfettered visions without reflection upon the past or present is to provoke discontinuity and to help the participants shift from their present self to their future self (Woodgate, 2019) to unlock new gateways to unexpected signals and breakthrough ideas. These early groups also help strike up new relationships, shape an understanding of the personalities, abilities, and levels of engagement of the group members as well as empathy and togetherness, which is important as in the way I selected the group members means that they are not very often connecting with friends or acquaintances, but new peers.

There were some very concrete learnings from using the Unreality Studio method, insomuch that the learners' collaborative work in Group Se.1 provided a total of 23 and Group Sem. 2. 34 robust influences on the future domain of which ten and 14 potential influences were reconceptualised and recontextualised by the workshop participants through the four lens of the prism that could be taken forward.

The students not only learned media and communications theory and the historical development of the domain and critical drivers of future transformation and potential emerging paradigms, but also became familiar with technologies likely to be involved in the future of mobile learning (augmented reality, virtual reality and 3D/4D worlds, holograms, simulation, machine learning & deep learning, new devices technologies, structures, materials, batteries, and interfaces, neural networks, frameworks and platforms, cognitive feedback, xAPI, avatars and learning agents, apps, Web 4.0 and Web 5.0., natural interfaces, GPS, LMS, quantum computing, implants, even claytronics, etc.). Furthermore, the students were required to learn:

a) How to learn in alternative spatial narratives such as 3D worlds
b) How to create augmented reality tools
c) How to consider holograms for teaching and learning potential
d) How to build a learning avatar/agent
e) How to develop learning apps, distributed component-based architecture for student adaptive eLearning, and much more.

Here is an example of teaching augmented reality development (Fig.47) taken from my earlier work with my colleagues Jason Haan and Elaine Raybourn from the US Government's Advanced Distributed Learning team, I modified a lightweight system that could be understood and used by a broader base of learners.

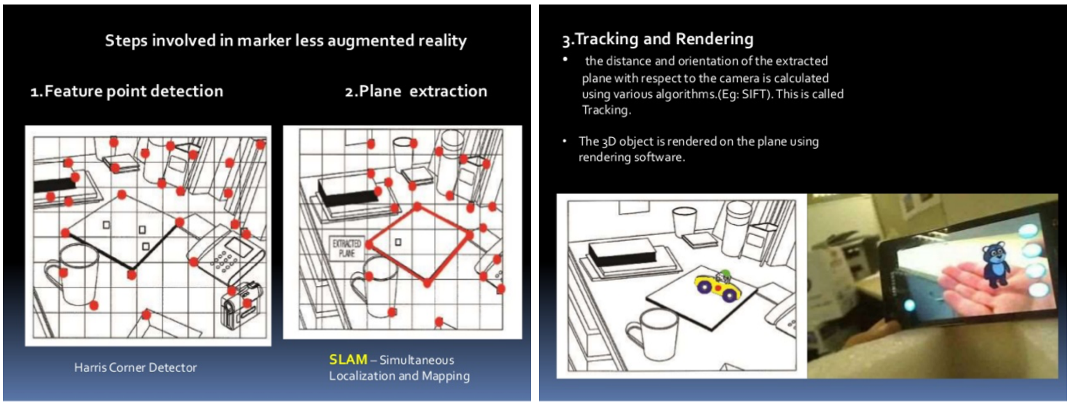


Figure 46 AR modelling framework that I used for the course

The learners worked with 3ds Max modelling and rendering software, but many brought their own ideas and programs to the classroom. While the smartphone provides the necessary sensors, students used the AR toolkit for marker tracking. The process allows for different types of data handling, i.e., visual patterns, multimedia content and 3D models. While not all learners in the groups were able to master the development technology, those that could we able to demonstrate or explain the process to the others in their groups. Below is an example of a fully operational 3D model of a virtual training machine (Fig. 48) developed by a learner from Sem 1. that can be deconstructed and rebuilt with the support of an AR mentor. It also uses a points-based gamification system to reward users for correctness and speed of undertaking.

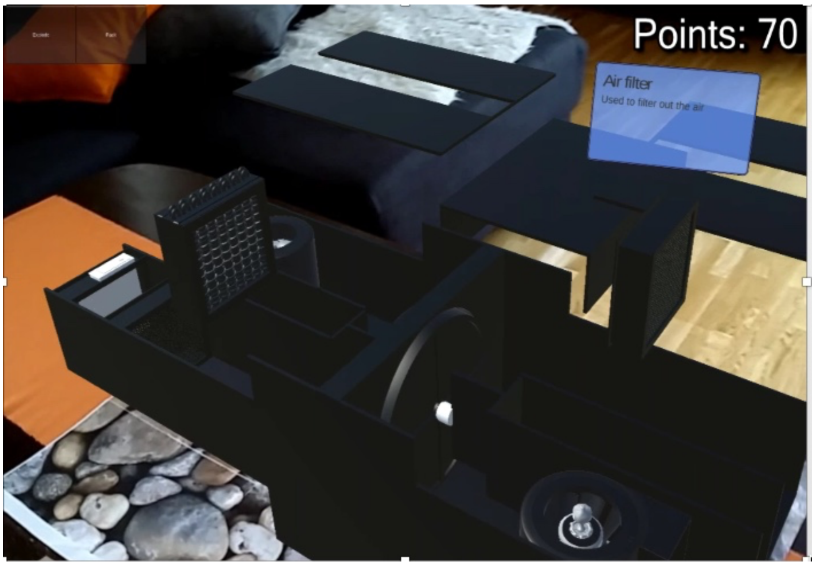


Figure 47 Fully operational 3D model created in AR with additional AR mentor

The final learner assignment for Unit One is for individual learners to create and produce an individual video describing the potential role of emerging technologies, societal change, and other future drivers for the future of mobile learning as discussed through Unit One, Modules 1.1.1- 1.1.6. This is a freeform assignment, so that having a video element is the only requirement. The design and presentation style, type of video, added media, narrative structure, are all open to interpretation, but it needs to have a novel, purpose approach, be future focused and needs to demonstrate comprehension, analysis and reflect on the entire Unit One content and teachings. The learners delivered their assignment in multiple combination of styles and approaches to present the assignment outcomes, including using a game-based robot and hologram teachers, extremely well-crafted videos with personalised presentation by the learner, interview-style, animation, and simple video presentation (Fig.49).

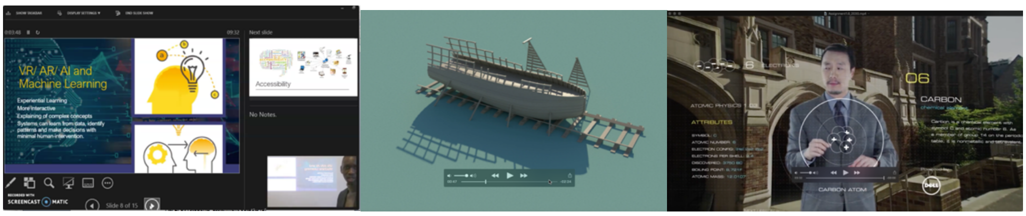


Figure 48 Screenshot of video submissions for the end of Unit One from Sem 2 students demonstrating different approaches

8.2.2 Case study 1: The Holographic Robot

Case Study 1: *Submission for Module 1.6. Unit One - Future of Mobile Learning, Fall 2019*

Task: Individual learners to create and produce an individual video describing the potential role of emerging technologies, societal change, and other future drivers for the future of mobile learning as discussed through Unit One, Modules 1.1.1- 1.1.6.

Submission: A VR game using a robot/holographic teacher (Fig. 50) to describe the future of robot learning for the year 2035, with a comprehensive overview of societal, technological, and economic drivers for the future of mobile learning, including implications and potential disruptors.

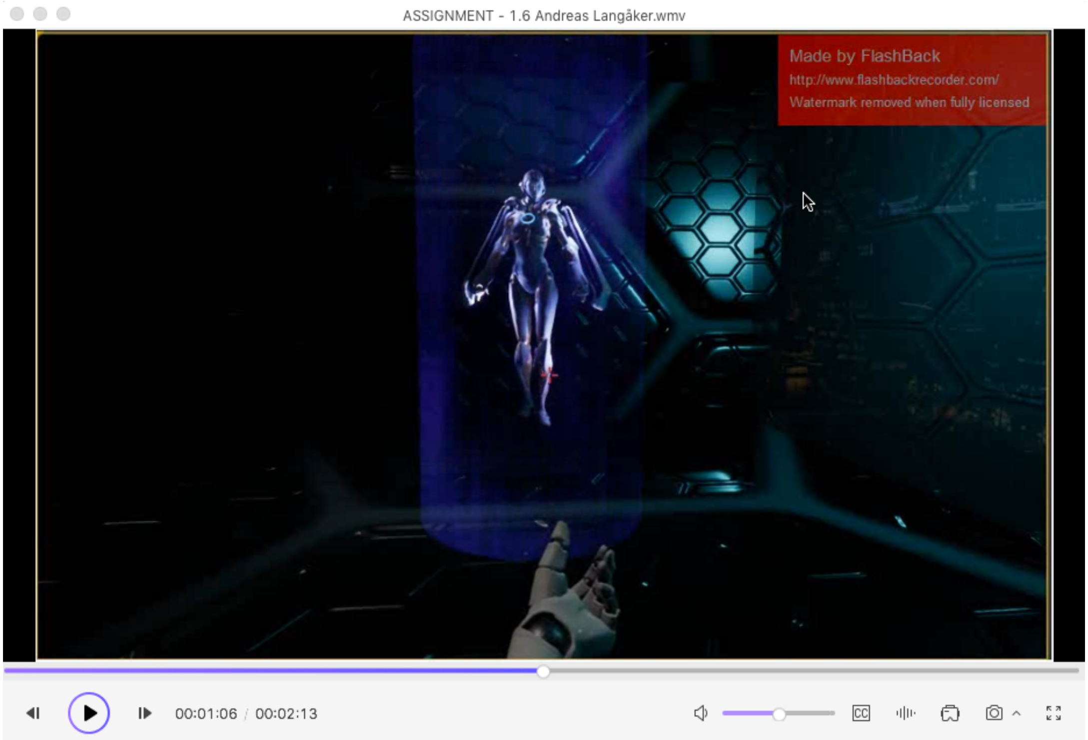


Figure 49 Case Study 1: The Holographic Robot

***Evaluation*:** using course criteria and creative Solution Diagnosis Scale (CSDS) (Tables 9 and 10)

Table 9 Creativity assertion for case study 1

Course criteria	**Fraction**	**Score**
Originality	25%	9
Contribution to evolution of course	10%	8
Future focus	20%	8
Depth	20%	8
Reflection/analysis	15%	7
Social intelligence	10%	8

Table 10 Revised Creative Solution Diagnosis Scale (CSDS)

Property of the Solution	*Indicator*	*Rating*
Relevance & Effectiveness	Correctness	8
	Performance	8
	Appropriateness	8
Problematization	Diagnosis	7
	Prescription	7
	Prognosis	7
Propulsion	Redirection	7
	Combination	7
	Reinitiation	8
	Redefinition	8
	Generation	7

Elegance	Safety	10
	Convincingness	8
	Pleasingness	8
	Completeness)	7
	Gracefulness	9
	Harmoniousness	8
	Sustainability	7
Genesis	Foundationality	8
	Transferability	7
	Germinality	8
	Seminality	6
	Vision	7
	Pathfinding	7
	Summary	218

8.2.3 Unit Two: Creating the Future:

Unit Two: Creating the Future: This unit lasts for 6 weeks and covers and demonstrates the power of foresight. The fifth week is a full 40-hour week face-to-face (f2f) “Living the Future” workshop involving experiential and experimental learning, working in teams to translate the previous four weeks of deep scanning of the areas of influence and avenues of future exploration resulting from Unit One, learning the art of systems modelling, cross-mapping of future-focus visions, building futures platforms and futures opportunities maps as a basis for the design and creation of alternative futures scenarios. The first four weeks of this Unit is heavy on systems and critical thinking, alternative approaches such as rhizomatic and nomadic thinking and several unique, proprietary techniques. The learners are taught to apply both linear and non-linear thinking, with more focus on creativity driven by intuition and dissonant approaches that demonstrate how to work with discontinuous change, randomisation, and unstructured knowledge in unknown worlds. Dealing with the futures means there is no wrong answer. The learner job is to create the future. This gives them greater confidence to take risks and experiment beyond the boundaries of the near future, deeper into the realms of their imagination. They learn to reconceptualise and recontextualise critical concepts. They learn how to connect disconnects and develop role-playing skills aimed at breeding increased positivity and empathy with their team-mates, while honing their existing strengths, but adding new skills that are both challenging and rewarding and cement their role and status in their team. This unit reinforces their knowledge of the advanced theory behind the application of multimedia and other learning technologies and the potential for those technologies in 2030-2035.

The approach to connecting disconnects requires a special awareness of transitional behaviour on the part of the learner. It requires a mindshift from what is and exists to something transformative that potentially could exist through emergence of the unexpected combination of concepts. The moment of reality when that connection is created, I call it The Flux of Becoming. To achieve that moment requires several experimental techniques that support that form of creative thinking, which is a cross between intuition, planetary vision, and a solid understanding of the concepts that one is working with.

At this stage we teach and apply a variety of techniques loosely gathered under the three foresight mapping approaches: (a) Oiling the Triggers, (b) exploring opportunity spaces, and (c) creating Future Concept Platforms (FCPs).

The first of these is Oiling the Triggers consists of a set of methods (Woodgate & Pethrick, 2004) to further develop the emerging issues into future triggers. A future trigger is a combination of selected drivers harvested from all processes used to this point in the course, which opens a path to directional thinking about the future. The processes used to arrive at the future triggers tend to be linear and the outcome—the future trigger itself focus on a central framing concept.

A broad arrange of methods is used to expand the value and relevance of each of the future triggers including: pattern recognition, random generation amorphoscapes, 3D thinking worlds, futures wheel and implications wheel, a simulation to test the power of the trigger, concept mapping, and causal layered analysis. Each deepens and extends the future context, role and overarching driving concept of the future trigger. In the case of the Sem. 1, working as a group, the learners agreed upon 10 future triggers which were subjected to the Oiling the Triggers process. Using the same process Sem. 2. created 8, some of which were similar. It is always hoped that by fusing, remixing or reconstructing the knowledge that supports each of the future triggers, we will find connects in disconnects that generate new perspectives, paradigms, and hybrid notions.

The learners are expected to test each of these methods consecutively, with each outcome reinforcing or expanding the other. Two methods that these groups because of their multimedia make-up successfully conducted were, 3D thinking worlds, and amorphoscapes, each of which provided a different value and enhanced opportunity for reflection, by creating a greater sense of immersion into the essence of the future trigger by re-dimensionalising the aggregation of the future drivers also through an affective lens. Both provided more random inputs into the analysis and extended the narrative space and the ability to express the signifiers and values more expansively. For the 3D thinking world technique, I applied an interactive 3D environment built for me by digital filmmaker Ken Adams, which he created in 3Ds Max and in fact could have been developed by several learners, had there been sufficient class time. It consists of changeable backdrops and a variety of virtual tools that allow the user to build a visual narrative around the selected drivers that underpin the trigger. The world was modelled to integrate text, audio and visual representation including synthetic artefacts of each of the drivers surrounding the trigger, and the class connected each of the drivers from multiple angles.

The main value from this technique is that it allows the user to change the connections between the drivers both in a random or directed manner to create different perspectives and contexts for the future trigger in terms of its potential to generate further ideas. There is a simple scoreboard inside the world that enables the user to evaluate each of the outputs in real-time against predetermined criteria. One key learning from this approach was that the use of visuals and audio in addition to the text provided greater immersion into the essence of the trigger, which resulted in a radical evolution of the inner meaning of the future trigger by uncovering the affective relevance, emotional values and signifiers embodied in the future trigger or the sensibility surrounding it. While this technique can radically transform the essence of the future trigger, by adding new dimensions, meanings, and dynamics, it is important to not fully lose sight of all the earlier work that led up to the development of the future trigger.

Amorphoscapes are an abstract digital synthesis of the drivers reinforcing the future trigger. They provide a multisensory non-linear interactive, immersive experience. They are coded real-time generative keywords and phrases (the drivers supporting the future trigger), transformed into shapes, sounds, rhythms, and intricate webs of narrative. It is useful to condense the core meanings of the drivers, but to transcribe them creatively and to spend time on the audio-visual design structures to optimise the mimetic representation.

As they fuse, the forms, moods, colours, sounds change allowing us to experience each sounds change allowing us to experience each trigger or combination or cluster of drivers differently, by size or importance and deeper connectivity, adding an overlay of emotional interpretation and personal ambience. This engenders a deeper meaning of the future trigger, which creates tension and opens our understanding and levels of potential. Given that the amorphoscapes are interactive maps, they can be moved and shaped into new audio-visual ideas. Each amorphoscape is an experiment in attempting to reconceptualise the meaning and aesthetic of the future trigger and its drivers. The initial idea for this technique was inspired by British digital artist and professor Steve Tanza (Stanza) and afterwards by the text to audio-visual work of Carpentier and Christidis (2017). More recently Helga Veigl has created a similar approach for TFL using Python. The interface allows for multiple users to interact with the amorphoscape and to discuss in real-time a holistic view of the triggers and where their potential lies as indicated by the behaviour of the drivers. This technique was successfully applied by the learners to support the translation of the reworked future triggers into well-defined future platforms. The power of these futures platforms is considered from the perspectives of potential implications, drivers, must-haves, benefits to the end goal, necessary tipping points, strategic direction and clear points of differentiation.

Prior to the f2f “Living the Future” workshop, the futures topics were augmented with further general information on developments in areas such as machine learning & deep learning, neural networks, cognitive feedback, natural interfaces, quantum computing, implants, claytronics, situational awareness, etc. The reason was not because they would be able to fully understand the intricacies and apply the technologies or to include them in their hands-on creative experiential practice, but I felt it was important that they understood the future world in which their creations would live. I wanted at least one learner on each team to be sure that prior to the workshop he or her had the competency to master:

a) How to learn in alternative spatial narratives such as 3D worlds including character building and animation
b) How to create augmented reality tools
c) How to consider holograms for teaching and learning potential
d) How to build a learning avatar/agent
e) How to develop learning apps, distributed component-based architecture for student adaptive eLearning

Since immersion is so critical to increasing creativity, three key aspects of the science of foresight stand out as potential generators of immersion namely: having to project yourself into a future landscape of unknowns; opportunity to fearlessly develop novel ideas; the requirement to create future scenarios. In this particular course, I emphasised six key elements in the course design that would potentially enhance engagement and creativity: self-direction (active control), opportunity to enhance existing skills and deliver assignments in any/multiple formats (freedom), ability to contribute to the course development and the future of learning in general (pride), having to think and work in a future landscape (excitement), learning, applying and building multimedia (self-esteem), creating and delivering the unexpected, novel ideas (inspiration). Accordingly, the science of foresight played an important role in creating an immersive learning environment for the learner in which to develop initial visions of the future based upon futures concept platforms (FCP). An FCP is a definitive directional framework that qualifies and integrates the outcomes from the future triggers work and the opportunities spaces. The FCP embodies drivers, implications and benefits, possible manifestations and opportunities, tipping points, significant contribution and strategic direction, and value for each future concept. They form the basis for developing scenarios.

This immersive learning environment leveraged the spatial narrative (Bodenhamer et al., 2015) that merges physical, virtual, and cognitive space, which are all part of the constructivist-blended learning experience. This immersive learning environment has the potential to deliver new perspectives, metaphors, and visions for the learner's personalised, externalised world, leading to increased engagement, creativity, and learning. It delivered futures narrative structures that were expressed by means of three final futures concept platforms, (Fig. 51). namely, i) The Intelligent Learning Playground, ii) The Augmented Learner, iii) Edu-enterprises – digital capabilities focused education. These provided the basis for the scenario development in the "Living the Future" workshop that followed.

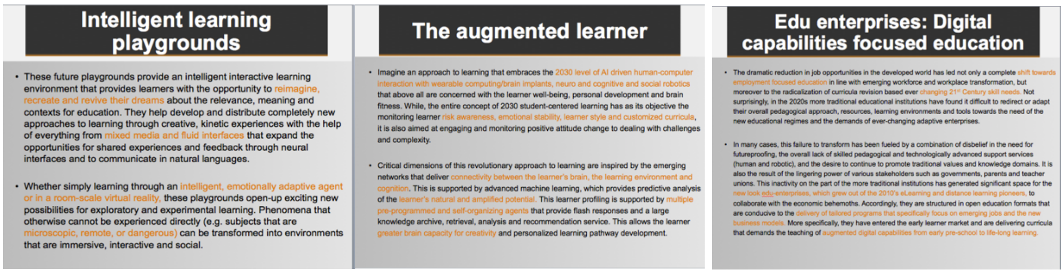


Figure 50 Futures concept platforms used as start points for scenario building

After four weeks of online lectures, discussion, and assignments both individual and group, we held the week-long f2f "Living the Future" workshop in the learning and media labs at UiA in Grimstad, Norway.

The objective of the workshop was to apply a combination of the foresight process, alternative thinking techniques and multimedia technologies to create future scenarios for the future of mobile learning and to evaluate those scenarios.

Table 11 The workshop schedule

Day	Time	Activity
Day 1	8.15-11 a.m. 12-4 p.m.	Update and platform clarification
		Lecture: New thinking techniques - The Art of Awe and scenario archetypes and expressions of the future
		Lecture: Convergence vs. Collision: Update on Emerging and future developments and experimentation in multimedia technology convergence, collision, and potential future applications for the future of mobile learning 2030-35
		Finalising Team roles and initial scenario/project discussion- 1 hour minimum
		Storyboading a potential transmedia vision narrative, testing multimedia tools
Day 2	8.15-11 a.m.	Lecture: Narrative development: I am the Story

		Lecture: The future generation of learners – Alpha characteristics
	12-4 p.m.	Workshop: Creating the scenarios (project Teams) and undertaking individual tasks
Day 3	9.15-11 a.m.	Lecture: Future workforce, skills and emerging markets
		Evaluating scenarios and selecting a preferred future scenario (Teams)
	12-4 p.m.	Reworking the scenarios – (Individually)
Day 4	8.15-11 a.m.	Project write up instructions and Continuing project development
	12-4 p.m.	Finalising project and write up
Day 5	8.15-10.15 a.m.	Final consultation on projects and setting up for presentations
	10.30 a.m.-12-30 p.m.	Presentation to faculty and students in public arena

Part of the success of this workshop is the fact that the learners needed to create working artifacts in the space of one week, which meant considerable time pressure. Naturally, individuals and combinations of team members worked ostensibly outside of the set class times either on their own equipment at home or in the UiA labs.

While the lectures cut into the experiential learning time, they were critical to push the learners to think creatively and to immerse themselves into the project. From my observation, the first day's Art of Awe foresight thinking approaches provoked the learners to experiment with new techniques, tools and design models to constantly question their narrative development and revise their work in situ. The teams were set up in various areas across the two labs (learning and media), as I provided direction with each group, I noticed how the Art of Awe processes also created positive tension and excitement amongst members of the teams, helping them stretch their imagination and inspiring them to extend their early narratives into futuristic environments, which they ultimately brought back to the time horizon demanded. It was visible from the different approaches to storyboarding (Fig. 52) all of which outlined the trransmedia approach and choices of medium and points of emphasis and impact that they really wanted these scenarios to be both unique to their team, but also portfolio worthy. The pressure of knowing in advance that they would be potentially presenting in a public space to their peers, students from other parts of the university and invited faculty seemed to inspire them to be additionally critical and emotionally engaged.

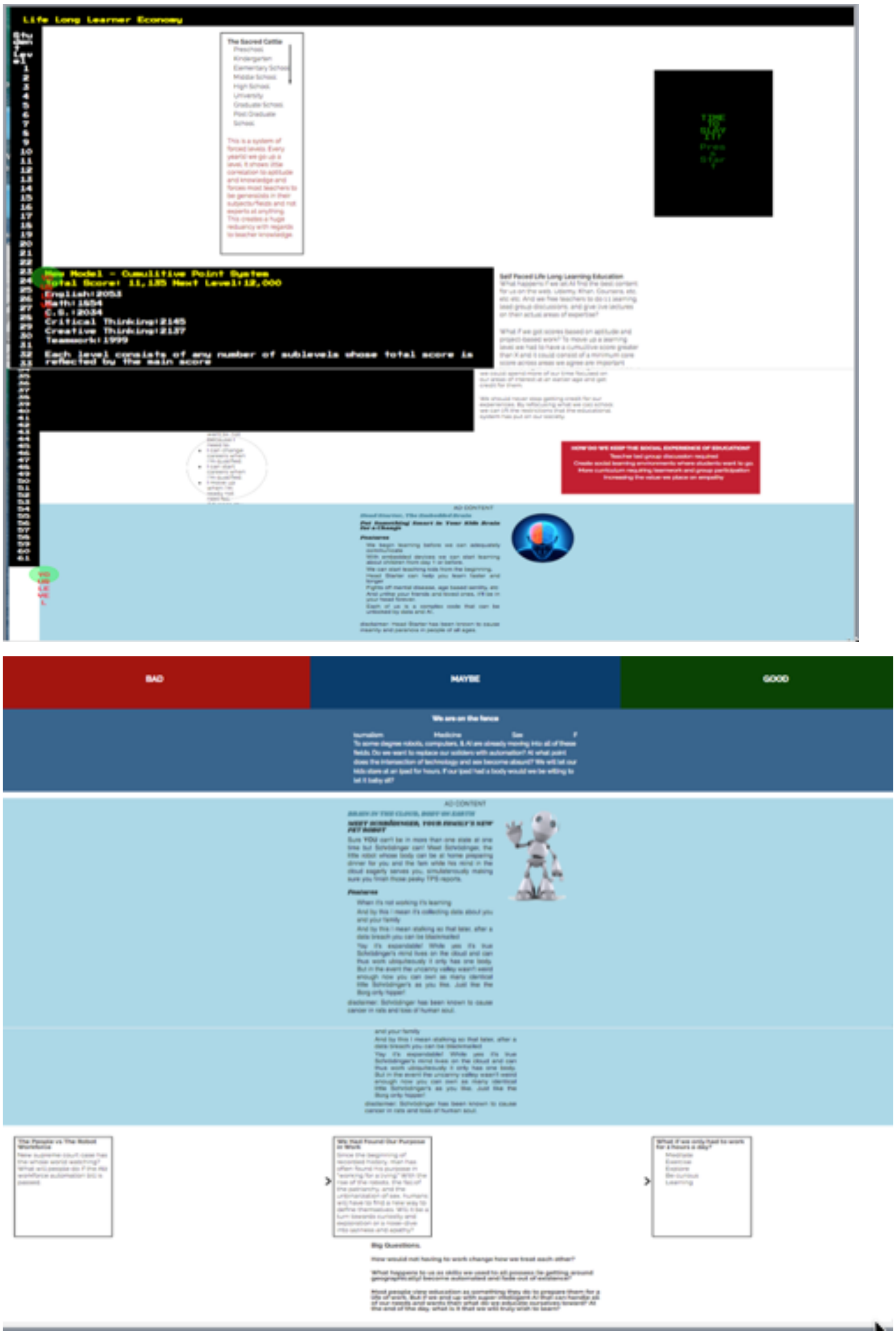


Figure 51 Storyboard from Sem. 2 which outlines narrative and approach and emphasises transmedia preferences

The Art of Awe is a set of experimental foresight thinking tools that I have devised, improved, and applied over the past decade or so. I referred to them earlier in Decentralised Thinking in Chapter 6 (b) of the explanation of the LLS pillars, but to reiterate, the set comprises four different thinking techniques, namely: Rhizomatic thinking, *Think like a DJ*, Remixing the Imagination and Thinking in the Abstract. My interpretation of experimental does not imply the use of the data gathered through scientific methods in a controlled setting, but moreover the way it is interpreted in the arts and performance. It involves freeform thinking, testing the boundaries (Hiller & Isaacson, 1979) and traveling the line between structured and indeterminate worlds. Incorporating unorthodox, disparate approaches, tools, artifacts and environments, experimental futures replace the absence of linear narrative with abstracting techniques, real-time mashing and improvisation that ultimately generate a catalogue of unexpected but future-relevant attributes (Desantis, 2015). Often these methods create texture or asynchronous ideas rather than harmonised, clearly formatted responses. They are also designed to test and expand more linear futures techniques, where randomisation and indeterminacy are less welcome.

The creative phase of the foresight process involves developing multiple futures scenarios from the futures concept platforms (FCP). It is here that the Art of Awe set of techniques is applied to create enlightening, plausible and meaningful, scenarios for the future.

FCPs mediate the relation between our minds and the future envisaged world. Davidson (Davidson & Begley, 2013) describes and often argues against the duality as schema and content considered from the perspectives of conceptual schema and representational content, can entertain the idea that a combination of alter-native thinking techniques and empirical judgment should deliver unique, unexpected signals that lead us to revolutionary outcomes. The FCPs provide an observational concept with the ability to provide abstract multiplicity or better said multiple levels and horizons of abstraction. The greater the potential for abstraction or complexity, the greater critical consideration must be given to the interaction between receptivity or and spontaneity, understanding and sensibility (Kern & Smyth, 2006). This interaction allows us to build on the notion of the space of reasons in the realm of freedom. We then move forward to transform this notion through intuition, conjecture and imagination without external restraints embodied in reason. This provided the foundation for our initial incursions into rhizomatic thinking—nomadic thought.

Each of the experimental foresight methods described is in a state of perpetual transformation. The combination of cognitive computing, machine learning with emerging multimedia design tools has enabled fresh levels of experimentation in structuring thinking tools and environments and new ways of applying them in foresight.

I consider the Art of Awe set of techniques as a form of experimental foresight, which has elements of experiential foresight and in some cases the bridging of design and futures. We distinguish the experimental and experiential insomuch that experiential refers to the way the foresight is conducted, whereas experimental is what is conducted, whereas Dannenberg and Fischer (2017) state that experiential foresight combines analytical, creative, and experimental approaches. Unquestionably, there is acceleration in the practice of experiential foresight. It mostly involves "methods and techniques of interactive play (theatre, board games), experimental research (modelling, design), and different forms of immersive visualisation (interactive videos, virtual reality)" (Dannenberg & Fischer, 2017).

Examples of these hybrid practices were central to my large-scale Plutopia events that were held in collaboration with SXSW from 2005 to 2013, followed by STEAM[3] in 2014 and 2015 and the design jams at the Extrapolation Factory or Situation Lab (Candy & Kornet, 2019). Frederick Polak's game "The Image of the

Future" has had a major influence on gaming futures (Polak & Boulding, 1973), as well as The Polak Game (Hayward & Candy, 2017). According to Dator (2017) games are the best way to "pre- experiencing alternative futures so as to have a wider understanding of what might be viable preferred futures." It is not surprising therefore that gaming futures elements are embedded in the experimental processes at the core of my approach.

Both Sem. 1 and Sem, 2 learners tested each of the four techniques from the Art of Awe set, and both groups overwhelmingly preferred Think like a DJ (Fig. 53), mainly because conceptually it resonated with their relationship with their everyday lives. Conceptually, it made sense, even though the exercise itself is quite complex, purposely repetitive to either substantiate or expand the concept at each layer of the mixing process. The tool facilitates three levels of thinking, namely: (a) the 10 remix steps, (b) seven attributes, and (c) finalisation tools.

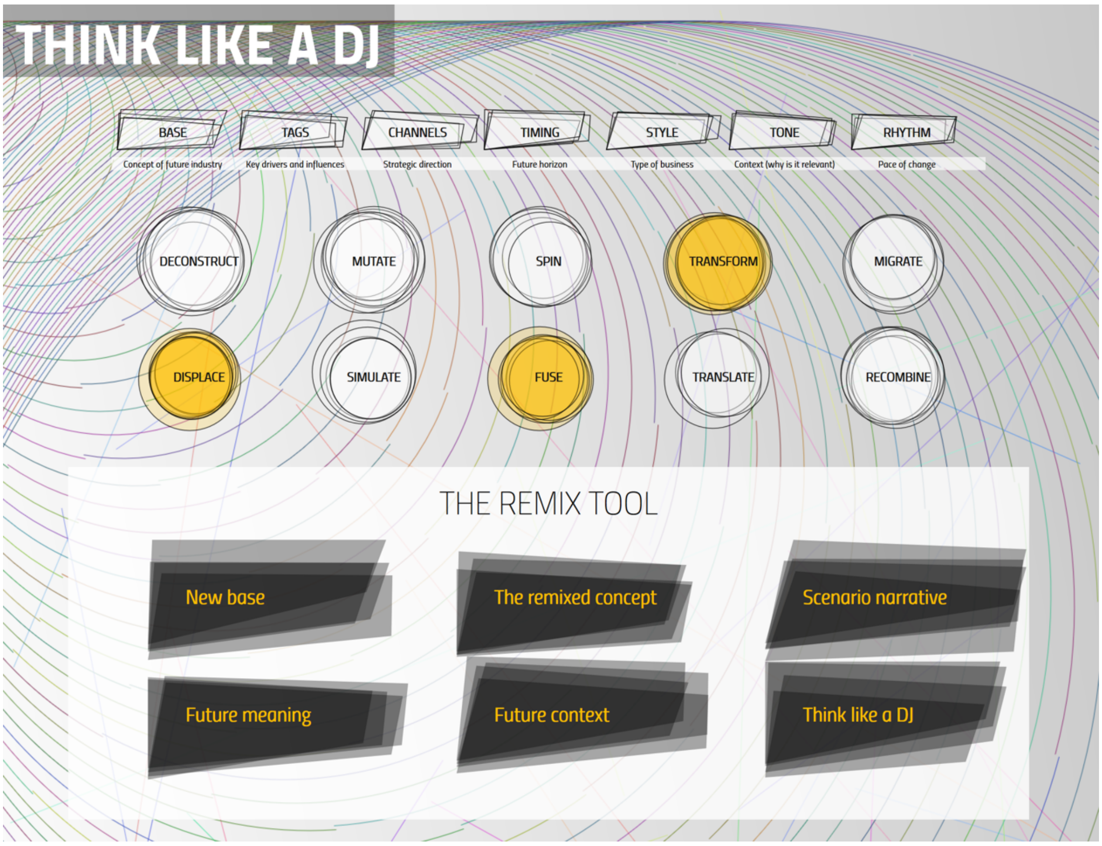


Figure 52 Think like a DJ interface

The seven attributes are: The Base which contains thousands of keywords and visuals developed across a plethora of domains plus in a separate folder for the newly uploaded FCP data and subdata. Tags are key themes pertinent to the domain; channels are strategic perspective—new market paradigm, revolutionary concept, futureproofing existing, disruption; timing equals relevance to one of three horizons; style is operational environment; tone is a feeling and rhythm equals shape of change. The Remix steps allow us to rethink every aspect of the FCP and to attach new concepts and influences.

Working in their 6 groups of four, both Sem. 1 and Sem. 2 spent around three hours working with this tool. Not all the possible steps or remix options need to be undertaken during the session. Each group of participants is given a FCP to experiment with as source material as a start point. They deconstruct the FCP source material into all its keywords or tags (called stems) from the earlier mapping techniques and enter them into the Base folder of the mixing tool. By pressing the Tags button, the stems are randomised into theme clusters based on NLP coding and made active. Next, they are mutated by adding new concepts selected from those already in the Base tool, basically adding wildcards and disruptors from both with and outside of the domain. This modifies or rearranges the clusters. Each cluster is then explored separately, and the team decide which of the stems to keep and which to discard. This action is achieved by using the Discard button. To decide on which to save and which to discard, we use a gaming mechanism that divides them into flashers (must keep), patterns (keep if connectors), gliders (limited use), and eaters (discard) (M. Gardner, 1970). Continuing with the originally selected cluster, the participant merges it together with another cluster using the Fuse step. This generates a greater number of stems which can be looked at from different combinations and strategic perspectives by using the Channel button or again go through the discard and fuse processes or Migrate the cluster to another cluster. By using the Rhythm button, participants can consider whether they have the potential to be accelerators, disruptors, magnifiers, animators, integrators, or simply drivers and therefore change the shape of change. At this point, teams and their members can aggregate their collections of selected stems and Spin them into randomised combinations that identify fresh possibilities for the FCP. Once the teams feel they feel comfortable that created a new ecology for the FCP and are able to develop some alternative futures, they reconstruct the clusters and recombine them into a new FCP, which serves as input for the drafting of the scenario narratives.

Each group to present its remixed futures concept platform and their scenario idea:

a) Explain how they got there—major game changers
b) How has it changed—what is the new meaning and context?
c) Why is it better?
d) How credible and salient is the scenario?
e) What are the must-haves? Why are they significant?
f) What would you change? What makes you satisfied or dissatisfied?
g) What's missing from the scenario?

The value of this tool is that it makes all the stakeholders reflect upon revolutionary applications of the concept, ways to re-conceptualise established perspectives of the concepts and to establish possible new visions, paradigms, context, and purpose. It has proven to be an exceptionally imaginative thinking tool.

It is precisely this imagination when inspired and augmented by the demands of the science of foresight that can tap into higher levels of immersion, cognitive transformation, engagement and creativity. Creating imaginative worlds through the process of potential future scenarios can change the learner's ability to extend his or her capability for expressing multiples dimensions of perception beyond an evolution of their current projections. The visions created with these future scenarios allowed the learners to expand what they see, by creating new narratives and iterations of the original scenarios. The process is seen to produce positive affect changes mindfulness and enables students to take an increasingly positive attitude to future potential.

Building the scenario from the narrative idea and storyboard developed at the beginning of the week requires a highly coordinated effort by each member of each group. Once the specific roles and tasks have been decided the team members work partly independently and partly with their group, regrouping at the end of the day to discuss progress, revisions, new ideas, technical problems, etc.

Having learned the available multimedia tools in Unit One and revised that knowledge throughout Unit 2, part of the scenario building requires each group to embrace the available and any personal technology as an essential element of the scenario, echoing my technology in – technology out requirement. The learners have at their disposal a full lab of virtual reality (VR), augmented reality (AR), holographic, animation tools, motion capture, 3D printing, avatar and agent development tools and a wide range of software from game design to complex interactive fluid interfaces. The scenario outputs range from animated, interactive 3D learning environments to future learning and engagement tools and devices and systems for mobile education in the coming decades.

They are expected to develop a multimedia-driven learning space suitable for mobile learning with the relevant live interfaces and interactions. However, they have freedom to use the technologies as they wish, to maybe create a learner interface or a new way of presenting content or a new discipline presented through transmedia thinking. The students need to determine the relevant integrated multimodal academic activities and cadence and show that their outputs can work across a variety of context-relevant learning environments that would potentially use mixed media learning tools.

On day 4, the morning lecture focuses on the presentation of the scenario and the categories that need to be covered in the formal presentation the next day, namely:

Description: What is it?

The purpose: why is it relevant?

How we got there?

Delivery: Demonstration

Which tech we used or would use?

Pedagogy: How does this change mobile learning in 2030

Who is it aimed at?

What are the benefits?

Timescale

I use basic evaluation criteria out of 10 during the presentation:

Creativity (novelty with purpose)

Future-focus – 2030

Application of learning from the course

Relevance and advancement of future mobile learning

Emotional intelligence

Presentation skills, clarity and persuasiveness

Each group can ask the other for explanations and the “audience” can also ask questions at the end of each presentation. Afterwards all the presentations are completed the students individually evaluate each group’s scenario and presentation.

Scenario examples Sem. 1 2018 (Fig. 54 and 55) and Sem. 2 2019 (Fig. 56, 57 and 58).

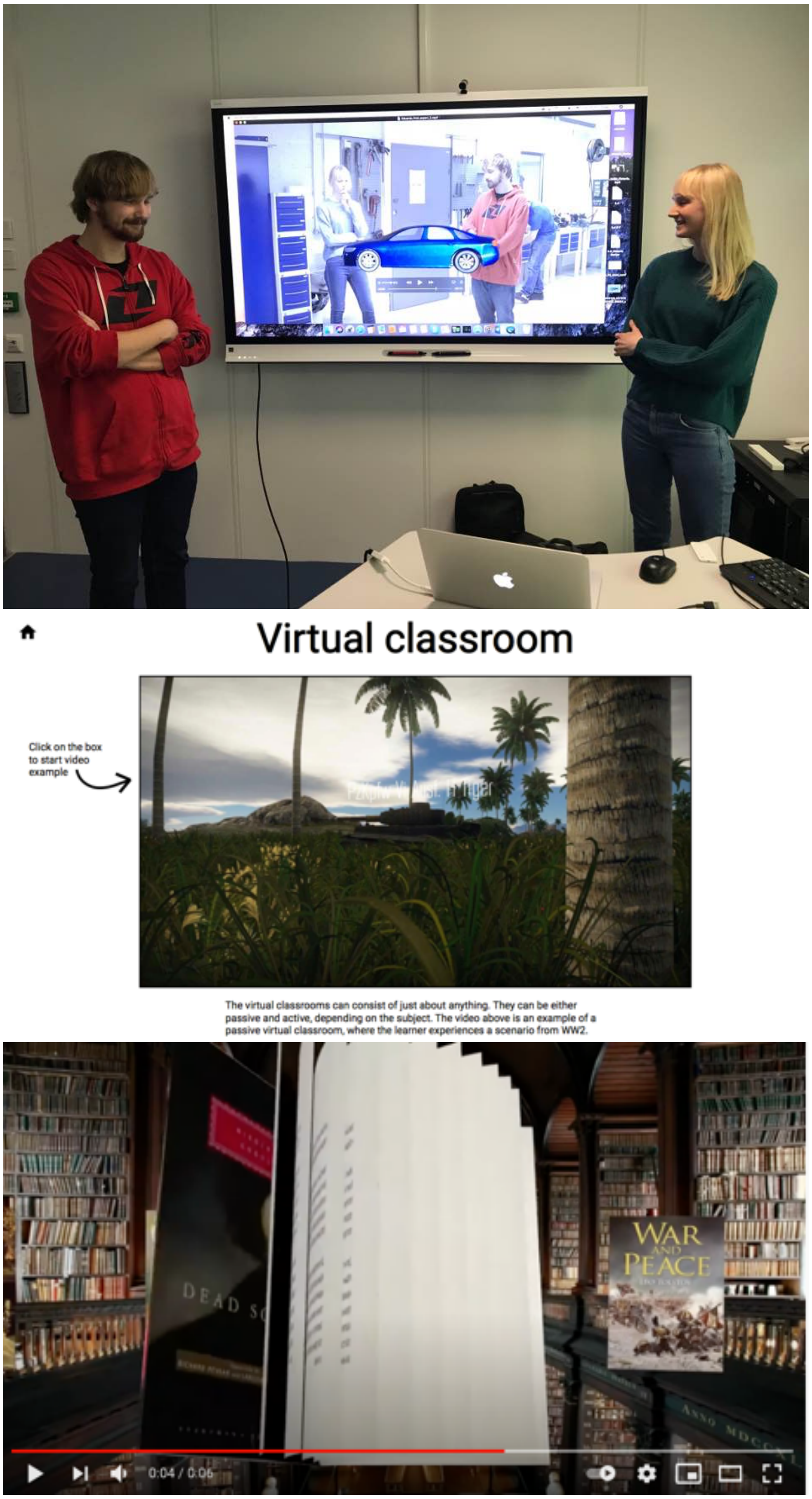


Figure 53 a) Fully operational 3D engineering interactive video classroom as game b) Virtual school library,with interactive book, c) AR mentor with 3D pop-ups and overlays

Figure 54 Fully working avatars with interactive interfaces and an interactive learning environment

Examples of futures scenarios from Sem. 2 (2019)

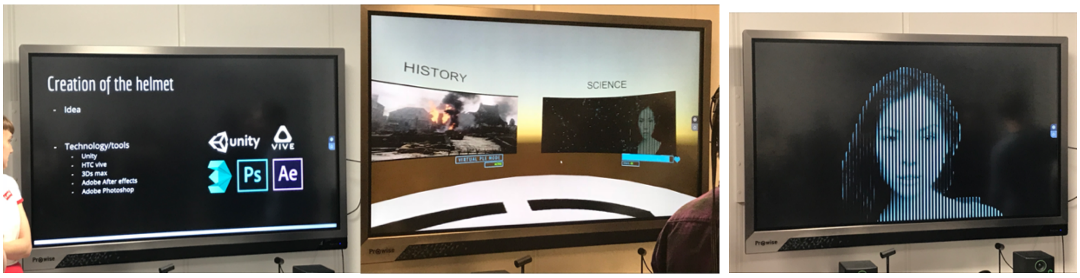


Figure 55 The Helmet: A 3D interactive learning environment with an advanced wearable taht connects the learner to a full range of courses in real-time supported by holographic teachers

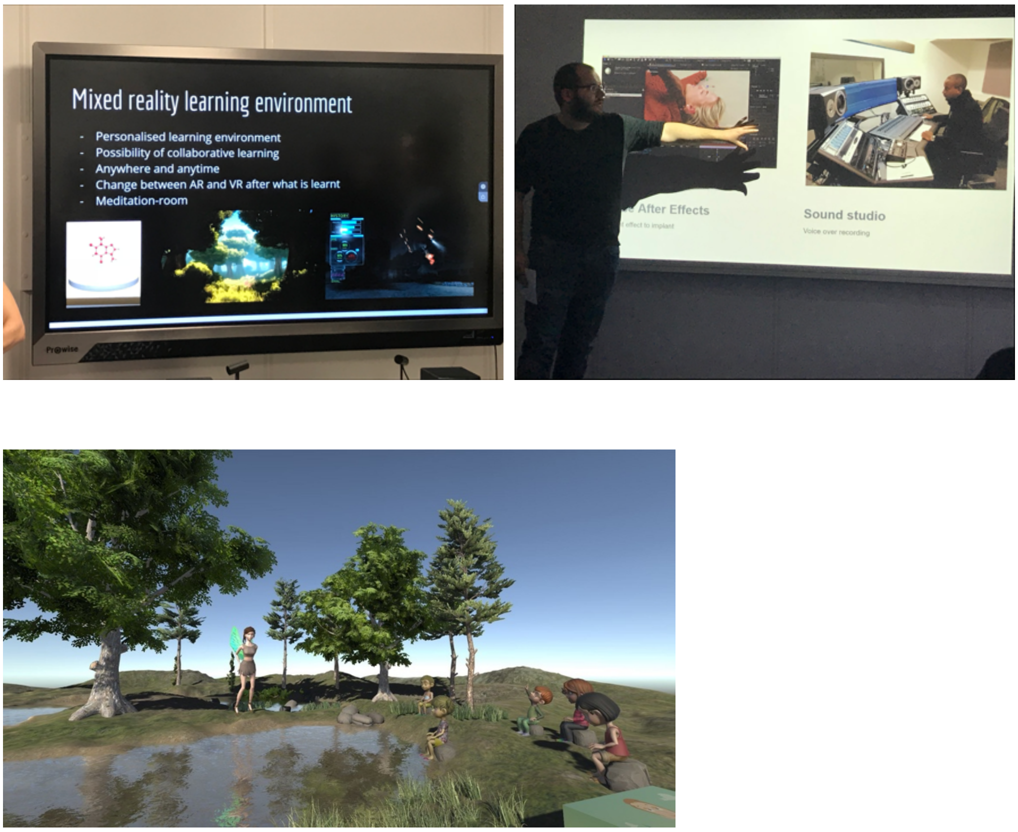


Figure 56 a) and b) A multisensory immersive, mixed reality learning environment that adapts learning media to the subject matter and c) a fully animated learning environment for children where the avatar adjusts to the topic being taught. The children are able to appear as avatars immersed in an animated 3D world.

8.2.4 Case study 2

CASE ASSERTION 2. NeoSpecies Engineering: Sem. 2. 2019

Figure 57 Case Study 2: Neospecies engineering Sem. 2 2019

Task: Create a design brief for your future mLearning project for 2030-2035 integrating your multimedia and transmedia elements. This involves incorporating the future of the subject domain, the future student in terms of human change, learning climate and environment, learning tools, pedagogical advances, etc. set against the background of student-centred learning.

Submission: This was an exciting and though-provoking team production. Outstanding visualisation of the ethical implications, emerging complexity, and policy-searching questions behind Transdisciplinarity and how we integrate emerging technologies and the complexity of determining their constraints while marshalling progress. This, beautifully crafted, interactive visualisation demonstrates how we should consider the matter of genetic editing/engineering, biotechnology, nanotech, neuroscience and ultimately Ai through the lens of the unthinkable. Given the framework in which this was created it was a class winner. It pushed the boundaries of the other groups.
Interesting attitude to changing environment, solution for extinct animals to maintain the ecological balance
The curriculum breakdown is excellent.
Tech tools used were vey varied and demonstrated the benefits and strength of group collaboration, down to the educational marketing tools and a fun logo.

Evaluation: using course criteria and Creative Solution Diagnosis Scale (CSDS) (Tables 12 and 13)

Table 12 Creativity assertion for case study 2

Course criteria	Fraction	Score
Originality	25%	10
Contribution to evolution of course	10%	8
Future focus	20%	10
Depth	20%	8
Reflection/analysis	15%	8
Social intelligence	10%	9

Table 13 Revised Creative Solution Diagnosis Scale (CSDS)

Property of the Solution	Indicator	Rating
Relevance & Effectiveness	Correctness	10
	Performance	9
	Appropriateness	8
Problematization	Diagnosis	10
	Prescription	8
	Prognosis	10
Propulsion	Redirection	10
	Combination	9
	Reinitiation	9
	Redefinition	9
	Generation	10
Elegance	Safety	7
	Convincingness	9
	Pleasingness	9
	Completeness)	9
	Gracefulness	10
	Harmoniousness	9
	Sustainability	7
Genesis	Foundationality	9
	Transferability	9
	Germinality	10
	Seminality	9 Ethics
	Vision	9
	Pathfinding	9
	Summary	217

Week 6 of Unit 2 has the objective of scenario evaluation. It involves

a. Testing the future scenarios with key group of decision-makers to reinforce, augment and evaluate the potential of each scenario.
b. Evaluation of selected scenarios
c. Scenario simulation, role playing (future optimisation)
d. Immersive, participatory, interactive (augmented engagement)
e. Creative thinking tools
f. Bringing ideas to life, give meaning, relevance, soul, emotion
g. Extend, transform, fuse the scenario

The learners dealt with each scenario in various combinations of individuals and teams, enabling each team to work on two scenarios, their own and another. The setting reflected simulated future learning environments flanked with corresponding interactive visions interchanging on the 9-m long screen and covered conceptual design of the role of future teaching and learning agents and serious games as well as discussion on the worldviews behind institutionalised and distributed learning, potential future paradigms and transformative pedagogical theory. The used "Props" and open-ended embodied improv in teams to create didactive, horizontal experiences, as well as virtual characters, visuals of fictional and fantastical objects from sci-fi and animatronics, many of which were created by the Multimedia Masters' students at UiA themselves.

Other discussions revolved around potential transdisciplinary curricula, changing domains and creating new disciplines in line with 20 potential future jobs a list of which they were given with mock job descriptions on Day 3 of the Living the Future workshop.

The value of this evaluation approach is that allows the participants to live out or simulate the scenario and in doing so, to augment the scenario by better understanding the strengths, implications, contradictions, and challenges that could be potentially involved. The environment, props and surrounding sensory stimulation help to transport the participants into a future world where they can experience and envisage through the multiple scenarios a sense of a future potential reality, into a future world where they can experience and envisage through the workshop activities a sense of a future potential reality, not just imagine it, but live it.

8.2.5 Unit 3: Implementing the future

Unit 3: Implementing the future - Two weeks, plus 2 weeks for final project delivery. Implementing the future is about fusing the scenarios development with applied pedagogy.

The final assignment of the course involves the students utilising the foresight process and domain knowledge gained throughout the course, as well as the pedagogy theory to develop a potential real-life future curriculum based upon choice of domain and delivered in an emerging future relevant format of choice. This meant students had to transport themselves into the future, which amongst other aspects, meant considering how the role of multimedia enhanced spatial narratives and multimedia tools could be integrated into the course. This requires the students to immerse themselves cognitively into a future world, where future worldviews prevail and many aspects of living and learning will be vastly different. Simultaneously, using the LLS in a blended ODL environment provided the opportunity to integrate fresh elements into the learning narrative, such as student content creation, peer instruction, future-focused thinking, collective intelligence building, immersive multimedia environments and multimedia tool development. Thus, the design of the course is based upon a "multimedia in-multimedia out principle" similar to that use in the "Living the Future" workshop.

The learners were given two weeks of further pedagogy training. As indicated earlier, Instead of using Problem Based Learning (PBL), which is where an initial problem serves as a catalyst for subsequent learning (Fogarty, 1997; Kingsland, 1996) and is an important principle of Engagement Theory (Miliszewska & Horwood, 2006), I opted for Opportunity Oriented, Problem Based Learning (Oganisjana & Laizans, 2015), which means that now that the futures scenarios are completed the learners were able to respond to some of the opportunities and potential problems, or risks that they could observe.

The learners were recommended to study the potential of multiple design techniques to better understand and potentially influence how learning practitioners can best utilise mobile-based technology to optimally design formal and informal learning solutions to augment and support the next generation learner.

They were asked to reflect upon how they were going to deliver their mobile learning course and what media and interaction elements, and interfaces they intended to include as each of these may require a different design structure and a holistic transmedia approach. They were encouraged to ask themselves what each of the interactive mobile elements adds to the learning process. Why are they essential? Do not over design the instructional framework.

Be clear about your instructional objectives. Make sure that you fully understand the key elements of the cognitive domain that is the intellectual aspects of the course, namely knowledge, comprehension, application, analysis, synthesis, and evaluation. Refer to Bloom's taxonomy (see model below and in the readings) and Kibler's psychomotor skill groupings to ensure you completely understand what and how to integrate these aspects into your instructional design.

In terms of mobile learning, make sure that you:

Exploit the affordances of mobile technologies

Personalise by making the instruction adaptive to the learner

Use mobile learning to mediate knowledge construction and to generate live feedback

Leverage the power of expanding the scope of knowledge covered in line with the learner's progress.

Self-improvement is a growing expectation

Include a good level of interactivity

Determine what the user interface will look like

Are you going to develop a native app or web app? (Unit One: Platforms)

Presentation of final idea

Description: What is it?

The purpose: why is it relevant?

How we got there?

Delivery: Demonstration

Which tech we used or would use?

Pedagogy: How does this change mobile learning in 2030-35

Who is it aimed at?

What are the benefits?

Are they sure their idea would work within the time horizon of 2030-2035?

Examples of the final project submissions from Sem. 2 (2018*)*

Figure 58 Fully interactive virtual reality language course with real-world conversation based on real-time AR communications in the country of the language

Figure 59 a) Avatar mentor with personalised interface, b) A VR game with ARIS AR mentor, c) A self/directed robotics course with interactive agent mentors.

8.2.6 Case study 3

CASE ASSERTION 3: Sem 1 (2018) – Earthskills and Environmental Science.

Task: Create a design brief for your future mLearning project for 2030-2035 integrating your multimedia and transmedia elements. This involves incorporating the future of the subject domain, the future student in terms of human change, learning climate and environment, learning tools, pedagogical advances, etc. set against the background of student-centred learning.

Submission: A Detailed Curriculum Design Brief for a university-level biodiversity course delivered in an interactive 3D world created in Unity Pro with fully interactive avatars and animated artifacts with additional AR directional and knowledge loaded ovelays.

This was a holistic and harmonious solution, both in terms of the approach to the transformational pedagogy, visualisation and interaction. The narrative is very complete in terms of curriculum coverage and topic interrelationship as well as the spread between the units and the learning frequency. Given the time restraints, the character build, general visualisation and representation are excellent, not least because the learner actually tried Unity and 3D world creation for the first time in this class.

***Evaluation*:** using course criteria and Creative Solution Diagnosis Scale (CSDS)

Table 14 Creativity assertion for case study 3

Course criteria	**Fraction**	**Score**
Originality	25%	7
Contribution to evolution of course	10%	8
Future focus	20%	7
Depth	20%	8
Reflection/analysis	15%	8
Social intelligence	10%	7

Table 15 Assessment for case study 3 using CSDS

Property of the Solution	**Indicator**	**Rating**
Relevance & Effectiveness	Correctness	8
	Performance	7
	Appropriateness	8
Problematization	Diagnosis	6
	Prescription	7
	Prognosis	8
Propulsion	Redirection	10
	Combination	8
	Reinitiation	8
	Redefinition	8
	Generation	8
Elegance	Safety	10
	Convincingness	7
	Pleasingness	8
	Completeness)	8
	Gracefulness	7
	Harmoniousness	8
	Sustainability	10
Genesis	Foundationality	7
	Transferability	7
	Germinality	9
	Seminality	7
	Vision	7
	Pathfinding	7
	Summary	188

Figure 60 Future course for earth skills and environmental sciences

9 Research findings

9.1 Research overview

I conducted quantitative research among the students who attended my classes at the University of Agder in the period since I revised the course Fall 2017 under the guidelines of the Norwegian Center for Research Data (NSD) approval from November 2018. I received 47 completed responses as indicated in the results shown below. I also conducted five qualitative research interviews using the same questionnaire with students who did not complete the questionnaire for reasons of personal privacy.

The respondents had an average age of 24. Gender split: Male 58%, Female 42%

Questionnaire regarding the Living Learning System as applied to MM 402

I have selected those charts that I consider provide the greatest insights into the quantitative research. The full research is included in the Appendix. For each chart I have provided a commentary and included the aggregated comments from the respondents to add greater clarity and understanding of the research results from their perspective.

9.2 Qualitative and quantitative research

9.2.1 The Learners

When it comes to the core skills needed for their future profession, 93.6% percent of respondents believed they needed to have a solid understanding of multimedia technology and multimedia theory, 66% felt that they should know the principles of interactive design, 55.3% graphic design and 51% considered applied multimedia to be really important. Upon entering the course only 36.2% felt that future studies would be important for the course and for their profession.

In starting the course, the respondents felt that they understood the overall objectives of the course to include developing skills in foresight (80.9%), increasing creative skills (68%), exploring and contributing to the future of learning (91.5%), mobile learning (74.5%) and practicing experiential learning and tech enhanced learning (both 61%).

70.2% of respondents believed that their prior knowledge of multimedia would help them a lot to complete the course while a further 23.4% believed that it would help them a fair amount.

When asked how they rated their prior knowledge of multimedia prior to taking the course compared to their peers, 32% felt that they were similar to their peers and 35.6% believed it was higher and 55.6 % thought they were about equal to their peers.

Whilst when a similar question was posed about their entry level of creativity compared to their peers, 30% felt they were more creative, 48% equally creative and 8.7% felt that they were less creative than their peers before they started the course.

The selection of the three course pillars of foresight (as a framework), multimedia and transformative pedagogy worked extremely well together in terms of delivering increased engagement, increased personal creativity and enhanced learner performance.

9.2.2 Increased levels of personal creativity

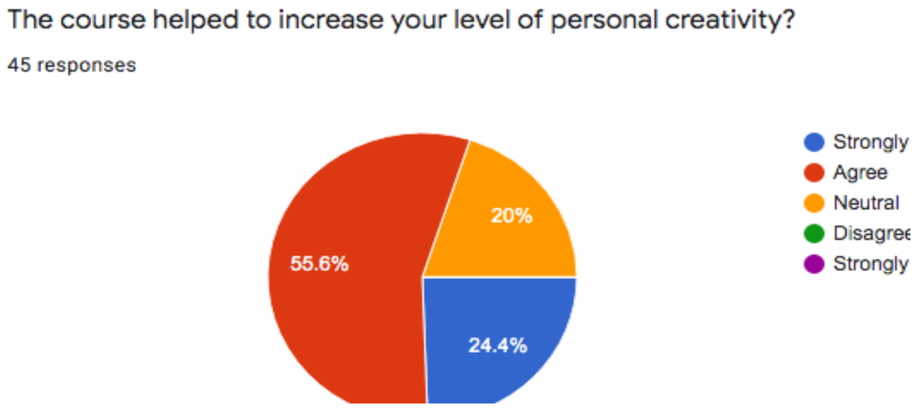


Figure 61 Increased levels of personal creativity

80% of respondents either strong agreed or agreed that the course increased their level of personal creativity. Nobody disagreed. 51% of the respondents observed this increase through the thinking techniques that they applied, 49% through the fact that they were motivated to try new things, 44% noticed that they had developed new skills and capabilities and areas of knowledge, 44% perceived the increase through the level of assignments and projects they delivered.

Learners were divided over the exact meaning of creativity. 60% believed that it was about imagining something in a different light or from a different perspective, or transforming a concept, material object or domain, 16% considered it to be the imaginative skill itself and 22% thought of it as creating something novel or unique. While the generally accepted definition is creating something novel with purpose

In terms of discussing how they apply these creative skills to the course itself responses 51% stated having to think about the future – placing yourself in a future landscape was the most important, 28% developing futures scenarios and 14% mentioned learning to use new multimedia tools.

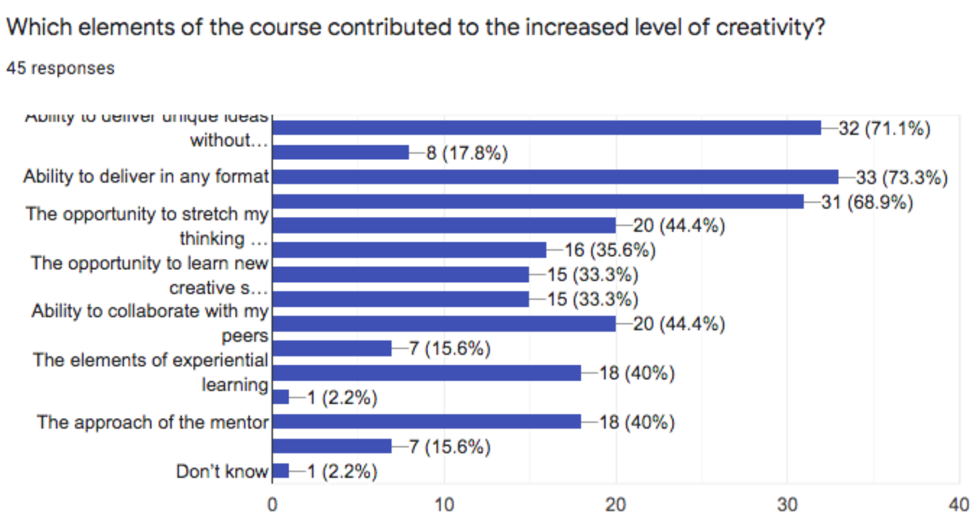


Figure 62 Elements of course that contributed to increased levels of personal creativity

When asked and which elements of the course contributed to their increased levels of creativity 71% felt that their ability to deliver unique ideas without fear of failure 73% felt that their ability to deliver in any format was critical for increased and increased level creativity and 67% of respondents felt that the mastering and use of multimedia provided the opportunity to stretch their thinking into new areas and new directions a further 44% reported to collaborate with their peers was critical to improving the level of creativity

67% of respondents strongly agreed or agreed that the course would significantly help them to be more creative in their specific profession, while 62% believed that the assessment criteria contributed to their increased personal creativity. They saw assessment not as a "tail wag dog thing" but integrated every week in the learning tasks in a way that drove creativity.

The learning, application, and creation of multimedia tools increased creativity

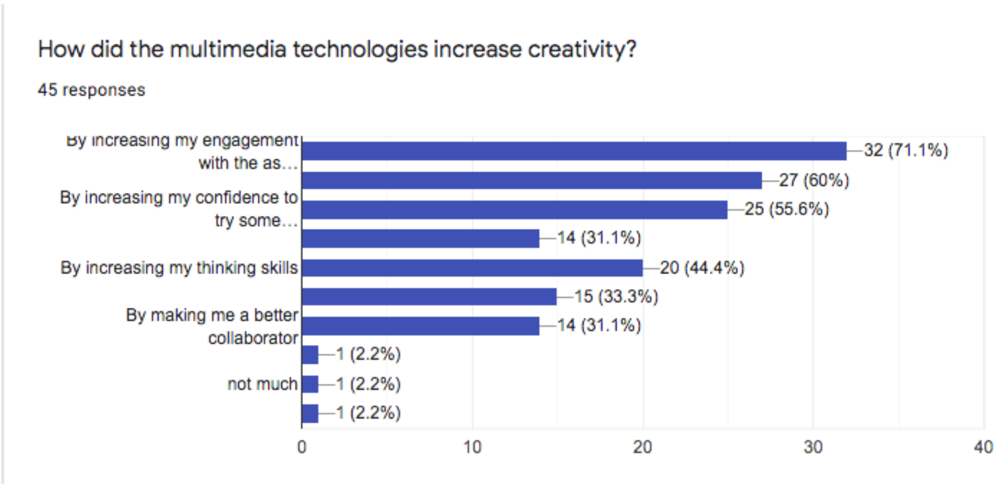


Figure 63 Multimedia contribution to increased creativity

In terms of which specific types of multimedia helped them to increase their creativity 47% said augmented reality, virtual reality (38%), graphic design tools (49%) and video (58%). Other key multimedia tools were graphics and visualisation tools (40%), Games design (38%) and 3D world design engines (38%).

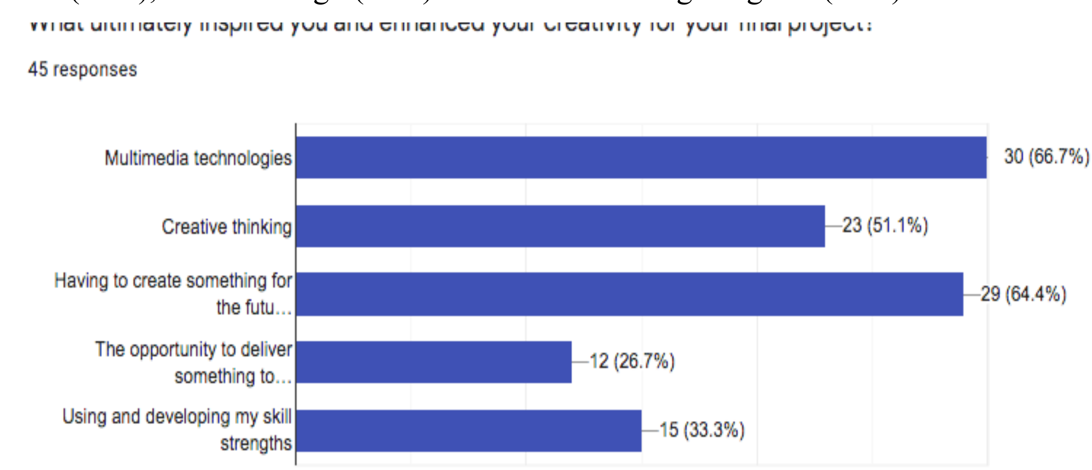


Figure 64 Creativity inspiration for final project

In terms of the final project, the key areas that contributed to the increase in their levels of creativity were the use and making of media technologies for learning

(67%), having to create something for the future (65%) and creative or alternative thinking techniques (51%).

The main ways in which multimedia helped increase levels of personal creativity were a) increasing engagements with assignments and projects (71%), by extending my creative abilities, (60%), by increasing my confidence to try something new (56%), by increasing my thinking skills (44%).

The course dynamics inspired increased creative more than parallel courses

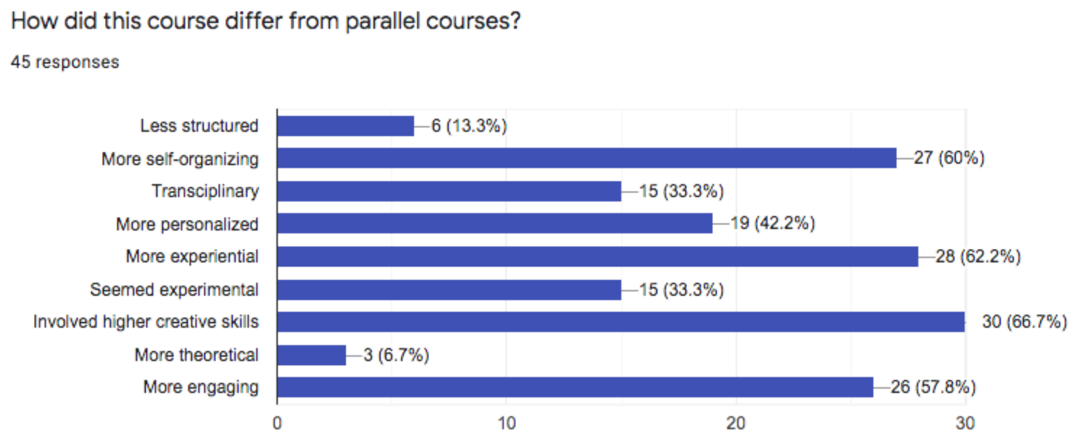


Figure 65 The course was better at increasing their level of personal creativity than comparable parallel courses

67% of respondents strongly agreed or agreed that the course was better at increasing their level of personal creativity than comparable parallel courses being taken that semester, some of whom felt that one of the reasons was because the course was more challenging for their creativity skills than the others.

In terms of actually discussing how they apply these creative skills to the course itself responses 51% stated having to think about the future – placing yourself in a future landscape was the most important, 28% developing futures scenarios and 14% mentioned learning to use new multimedia tools.

67% of respondents strongly agreed or agreed that the course significantly helped them to be more creative in their specific profession, while 62% believed that the assessment criteria contributed to their increased personal creativity. They saw assessment not as a "tail wag dog thing" but integrated every week in the learning tasks in a way that drove creativity.

When asked whether or how this course differed from parallel courses that the respondents were taking in the same semester, 67% felt that involved higher creative skills, 62% believed that it was more experiential 60% felt it involved more self-organised, self-directed, offering greater learner agency and 58% considered this course to be more engaging than all of the other courses they took during the same semester.

Respondents feel that the course complements parallel courses, whilst being much more open, creative and abstract and therefore more engaging and motivating. It was more fun and respondents claim to have ended up spending more time on it than the end credits value justified compared to the other courses, but it was still very much worth it. While it was seen as a more "alternative" course, the respondents found it to be a particularly good course especially how it was adapted to e-teaching.

Course sequence and flow was seen as a positive and more engaging than other courses in so much that the course allowed for more time to be spent elaborating ideas and experimenting with future concepts, as well as creating an inspirational environment for open discussions.

"Difference is too large to explain, simply all other courses are far less engaging."

This course was more fun! But the way lectures are done, feedback, assignments, it is more engaging. The course felt more like an enjoyable hobby than learning. The learners stated that the flexibility to choose delivery formats, with shorter and more meaningful assignments, made this course something they worked on continuously, rather than having to make a large effort every now and then as most other courses are. This structure was said to allow for more creativity.

The course successfully bridged the gap between imagining and doing. Entering the future world made us realise the possibilities that are already here. The respondents emphasised that there were so many positive differences in this course compared to others that made everything about it more engaging. As a concluding comment one respondent said, "It is hard to put in a sentence, but it was really engaging overall".

Other courses were seen as less engaging, less energetic, and less opportunity for creative self-expression.

Learner engagement increased creativity

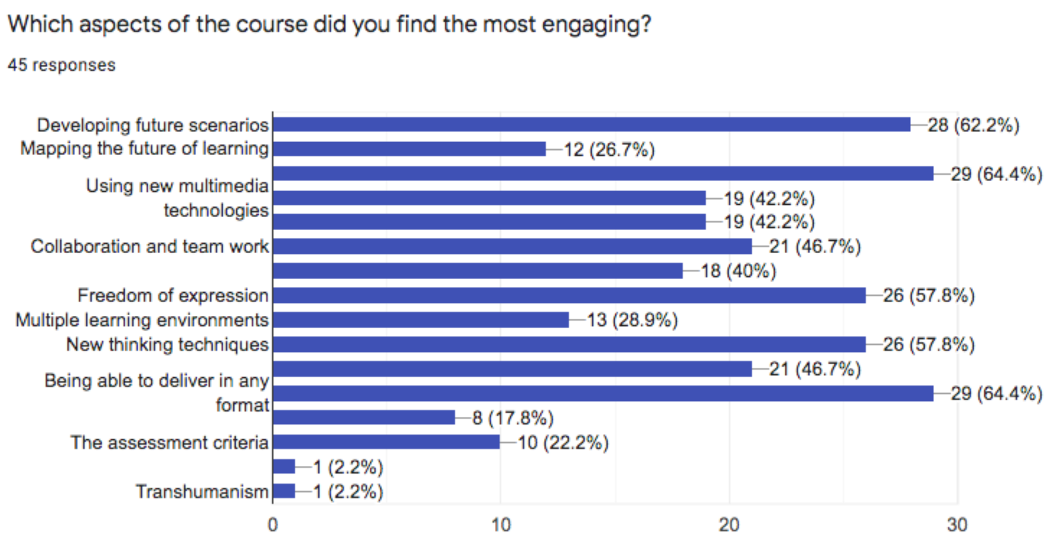


Figure 66 Most engaging aspects of the courses

When it came to which aspects of the course, they found the most engaging 62% believed it was about delivering future scenarios and 64% believed it was about learning about future technologies, also 64% said it was about being able to deliver in any format, 58% saw freedom of expression and learning new and alternative thinking techniques as the most engaging. Twenty-nine of the respondents provided additional comments about how extremely engaging the course was. They felt that class was more of a group discussion rather than a lecture. They added that the course was well structured, segmented up in small comprehensible units, that the overview of all aspects of the course was presented in such a way that provided a clear understanding of what was required to achieve a strong overall grade.

These aspects inspired the respondents to work and learn more on the subject than they would usually have done. By being able to express their ideas in fresh ways throughout the course kept them really interested the whole time and allowed them more creativity in the working process. The respondents claimed that by making them think completely outside the box, they were able to come up with more creative solutions than usual.

In terms of interesting and novel, 84% of respondents gave the course a score of 5 or 4. The respondents felt especially engaged at critical points along the course, namely applying creative thinking (64%), using multimedia technologies (62%) working in the future (51%) and the experiential workshop (42%).

Alternative thinking techniques contributed to increased creativity

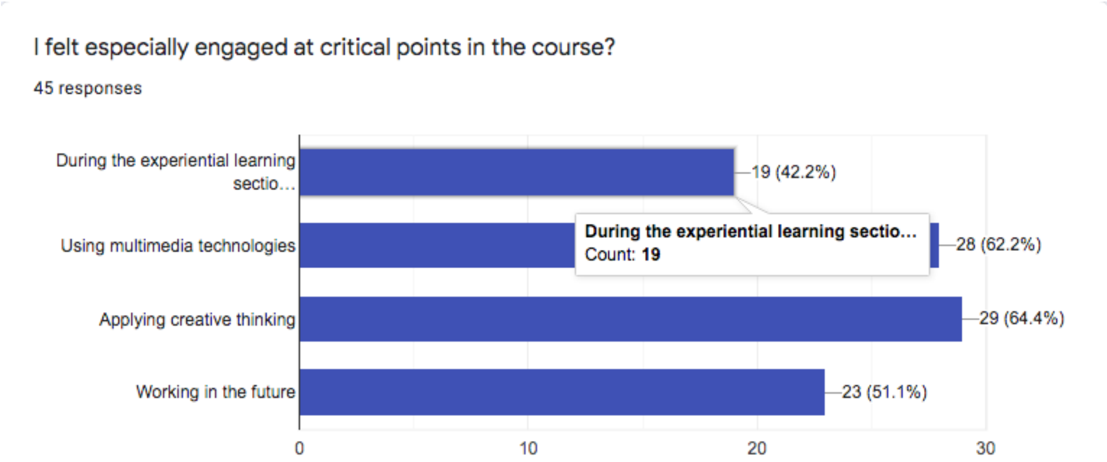


Figure 67 Critical points of increased engagement

The respondents felt like one of the main goals of the course was to get them to think for themselves and to challenge and adapt to new ways of thinking and analysing and developing knowledge.

In terms of interesting and novel, 84% of respondents gave the course a score of 5 or 4. The respondents felt especially engaged at critical points along the course, namely applying creative thinking (64%), using multimedia technologies (62%) working in the future (51%) and the experiential workshop (42%).

77% felt that their higher engagement was induced by the new learning modes and experiences.

9.3 Research Findings Analysis

The recreated MM 402 Future of mobile learning course introduced in 2017 successfully improved learner engagement, performance and increased learner creativity.

The pedagogical structure of the course, which followed the integration of the eight LLS pillars was found to be exceptionally positive in increasing learner engagement, learner creativity, learner satisfaction and overall performance.

In addition to the completion of the questionnaire, the majority of the 37 respondents to the questionnaire, plus the 5 interviewees painted an extremely positive picture of the course design and its impact on their learning performance and wellbeing.

Over 60% believed that the LLS, (which I introduced on the first day of the course) significantly increased their overall wellbeing and attitude towards learning.

Below I outline those key aspects of the course structure that were critical to increased awareness, creativity and improved performance.

9.3.1.1 Foresight and the future

Working in the future and understanding potential future drivers that can be somewhat identified today intrinsically led to more overall desire for deeper learning and in some cases simply for the joy of learning. Respondents claimed that it made them put more effort into the course content and assignments. The future context made it the most engaging because it was new and exciting. To quote a respondent "I have never attended a course with these types of aspects and challenges". The respondent appreciated the fact that during the course it also felt like one of the main goals was to make them think for themselves and to challenge us and make us adapt to new ways of thinking, and using knowledge.

Respondents believed that they were inspired to release their creativity by learning how to create the future and seeing how the future world could change with regards to learning and the possible role of future digital tools and devices in that learning process.

While they generally found the topic of pedagogy interesting, by going deeper into theoretical design of future learning, exploring how it could look in the future made it more engaging.

The respondents believed that with future focus and thinking techniques would be applicable for other courses and introducing them it would place a focus on future needs in education and skills.

9.3.1.2 Alternative thinking techniques

Learning to apply alternative thinking techniques Respondents emphasised how Interesting it was to explore the world of futurists, to gain insights into how to shape change and to learn the role that through digital tools and devices would likely play. The course made them think and see the use of technology from a new perspective and attaining a broad multimedia background, which was in itself engaging, and provided a vision of how the respondents' skills and interests have future potential. They stated that the course offered considerable freedom of expression and allowed for greater freedom in the creative thinking process, and not locked to a format that you may struggle with when trying to express yourself in a creative manner. This especially triggered new ways of thinking and approaching the unknown, which inevitably sparked intensive creative thinking.

9.3.1.3 The sense of freedom

Respondents reiterated the significance of feeling free because they could deliver the assignments and projects in a medium that they felt comfortable with, hence able to express ideas more clearly and expansively than purely through traditional text delivery. They also emphasised how engaging it was to have multiple choices and paths in which you could deploy their existing or recently learned knowledge by applying our personal practical skills to the theory of the course. Being able to be creative, Using own skills and interest in deliveries and project. As one respondent wrote “Being allowed to be creative makes it easier to be creative”. Another respondent added “Freedom is a motivator; creativity is the result”. Having choices is perceived to heighten creativity and engagement, creating more learner investment in the course enabling the learners to choose their project area/topic to work on.

Respondents felt like they were in complete control of their learning and the manner in which they should receive and deal with the course content. This feeling of control over their own ideas and execution allowed them to feel engaged and continuously ready to go on, rather than having to something because they were instructed to do so.

9.3.1.4 Experiential learning

A high percentage of the respondents related that they loved the workshop week in and that another project like that would have been both fun and rich in learning. The combination of individual and group assignments was said to be “awesome”. Learning more about what we can do with the tools in the interaction lab was very interesting. Also, they also enjoyed video making where they got to use their prior skills. They particularly liked how the course evolved during the semester and the fact that they felt like they were helping build the course narrative in real-time and that there was a continuous dialog and collaboration between the mentor and learners.

Experiential learning and sharing with teammates were particularly inspirational and seeing the end results as blueprints, scenarios and future artefacts and creating futuristic concepts with the technology was seen as something novel, fun, and engaging.

The experiential workshop found a means to being both individual and collaborative, therefore the workshop week was engaging, collaborating, and building on each other’s skills, making it more motivating, more rewarding and more creative.

9.3.1.5 Technology in – Technology out

The learners stated that the assignments themselves drove them to greater engagement and that the nature of the self- organised project work and the multi-media based experiential learning significantly increased their personal creativity levels because they could first learn about present and emerging technologies, then experiment with the technologies available in the lab or home and then use them to and being able to develop futuristic artifacts, which demanded thinking outside the box and to explore new concepts in an active, applied manner.

Respondents confirmed that the multimedia opened many possible ways to solve an assignment and having the freedom to choose one a preferred means sparked creativity.

9.3.1.6 Personalisation and self-direction

They liked the fact that the course felt really personalised. It gave them extra confidence. Equally, they stated that the emphasis on the course only being a stepping-stone in a longer future journey prevented plateau thinking and did wonders for increasing confidence and engagement. The ability to choose approaches and tools played a big part in the success of the course. The fact that they say it made them feel comfortable and interested in the course content and its execution driven by a high degree of self-determination.

They felt a sense of being understood, present and recognised because the interaction throughout the course was more conversational and casual. It made the course more intriguing. The respondents felt that the course made them feel more included and drove creatively in a positive way!

These aspects inspired the respondents to work and learn more on the subject than they would usually have done. By being able to express their ideas in fresh ways throughout the course kept them really interested the whole time and allowed them more creativity in the working process. The respondents claimed that by making them think completely outside the box, they were able to come up with more creative solutions than usual.

Also, the fact that there is "no wrong answer" makes it more liberating to try new things, and then you become more engaged. The constant positive reinforcements given on all assignments led to more confidence to try new things or think in new ways. Overall, the students felt that these factors made the course feel more personalised. Assessment was not a 'tail wag dog thing'. it was integrated every week in the learning tasks. This was a reflection on the competency-based assessment approach.

The self-organisation and self-direction aspect of the project-based work also drove higher engagement and overall helped developed greater insight into the purpose and objectives of the course.

9.3.1.7 Novelty and new learning modes

Curiosity was a major theme. The respondents expressed how the possibility to try out novel things and to explore new means to discovering information and building knowledge and opportunities, while trying to develop and apply new skills on future-focused topics kept them engaged and increased creativity. They thought that most of the course material, involved topics they had not thought about before, so it kept them engaged.

Respondents felt that the new learning modes made it easier to step out of their comfort zone and that thinking outside the box and engaging them in working with emerging technologies helped with their motivation and engagement They emphasised that the course left traditional thinking behind, the deeper they got into the unknown, the higher the engagement, the more productive and creative the collaborative work became.

They stated that the course should represent a larger part of the master's program, so that it could include more practical and technology application and help increase their thinking and creative skills even further. Alternatively, they suggested that through consultation between all teachers within the multimedia program, the course could be expanded and taught in more depth. They found the foresight part and progressive application to the future of mobile learning to be both unique and very valuable in terms of its focus on the future.

9.3.1.8 The teaching styles

The teaching style which was focused on meeting the key course objectives was seen as a major contributor to engagement and inspired increased creativity.

9.3.1.9 Using the creative skills in their future profession

And when asked whether or not they would use creative skills that they gained in the future then of the 29 responses are the vast majority said yes they were lovely word and that the course and help push the limits of their creative imagination in future projects and that this would really provide a strong platform from moving forward and one of the respondent said 1000 times yes absolutely without any doubt another without any doubt and I really liked the aspect that they had seen the future.

9.3.1.10 What could be improved?

When it came to what they thought they would change or improve to make it more creative they said that they would like to have a little more time to develop more detailed technology infused artifacts and develop more extensive working learning environments. They wished that this course could be extended for another semester.

They like the idea of being given assignments that were overly difficult, and they sometimes felt the assignments were even a little impossible to solve, but working through them, overall they managed to solve them.

They would like more time to learn about the working design and use of the multimedia tools before being required to undertake a particular project. They mentioned that there should be more dedicated workshops throughout the course so that students were even more capable and comfortable in what they were developing.

10 Conclusion

The transition into postnormal times defined by its high levels of complexity, confusion, and contradiction (and frequently chaos) is characterised by the emergence of industry 4.0, with its decentralised industries, business and economic, social and political structures, demands accelerated urgency in decision-making and futuristic solutions, and will continue to seek higher levels of employee creativity. Therefore, it is essential that future learning systems and approaches should be designed to deliver increased levels of creative learners with a repertoire of competencies that are optimised for the emerging future. Consequently, incorporating postnormal skills into the holistic framework of future curricula design is crucial and with it the need to meet the challenges of coming decades. This will require a future-focused platform that enables learners to project themselves into the future to explore and discover unexpected potential opportunities. My research confirms that by undertaking a foresight research approach for creating opportunities that support a plausible transformative education system based upon envisaged future change, we can begin to reduce the gap between the deficiencies of the current education system and future needs of the workforce.

The outcomes from the foresight research identified a clear need for a new learning system that would be based upon increasing the level of creativity achieved by emerging learners. With that in mind in 2016 and through 2017 after seeing the ineffectiveness of the master's Future of Mobile Learning course that I had developed two years earlier and had been teaching since 2014 at the University of Agder, which in turn was based upon a course I was teaching at the time at Georgia State University, I would develop a completely new learning system, which I ultimately called the "Living Learning System" (LLS). This system as described in detail in Chapter 6 was based upon 8 separate and integrated pillars. These pillars were selected in part as a response to the findings of the foresight research undertaken to create future scenarios for a future-focused education system. The LLS underscored the perceived benefits of a constructivist blended learning approach, an emphasis on decentralised learning techniques, a deeper application of immersion as a means to deepening learner cognitive involvement, greater learner engagement and creativity, an overall pedagogical framework that leveraged the science of foresight tools and processes, multimedia as a tool for delivery transmedia approaches to learning that enhance learner perceptions of the subject matter, experiential learning to expand practical and collaborative skills self-direction, personalisation and learner control and the learner ability to work in visionary worlds or in simulated environments. My interpretation of the aggregated power of the eight pillars was that they would meet not just the need for a greater level of creativity and creatives, but moreover would deliver an education that would be highly beneficial for future employability beyond the near term and encourage the creation of transdisciplinary approaches to education in line with the emerging needs of our discontinuously changing world.

Based upon the eight pillars of the LLS and the current understanding of our need for new skills (widely defined as 21st century skills) that meet the demands of the postnormal times, and the changing learner and the requirements for employability I significantly remodelled the MM 402 course on The Future of Mobile Learning. The new course was centred around four critical aspects namely: creativity, multimedia and transmedia, pedagogy and the science of foresight with foresight providing the course framework. The course had several supporting learner platforms all aimed at generating increased creativity. Foremost amongst these platforms ere mechanism to help the learner to think and create in a future landscape, create novel future scenarios, and apply alternative thinking approaches significantly as from my previous research I had found that these dimensions are potent triggers for increasing learner engagement and creativity. I believed that the dynamics of these levels of creativity could be further heightened and accelerated, when augmented multimedia is integrated into the learning approach. To supplement this approach, I created a new learning narrative that maximised the benefits of real, virtual, and moreover cognitive transformation, including mindfulness. The framework focused on a high level of personal efficacy and self-reflectiveness generated by the sense of presence, motivation, and emotional engagement. Part of the early work was focused on the reduction of the distance between the learner present self and the potential future self, by transporting the learner into futures landscapes, visions, and scenarios. With immersion at its core and increased personal ambience as its desired outcome, the use of the science of foresight, with its necessary alternative thinking approaches, proved to be a very effective tool for increasing learner engagement and creativity. While the LLS demonstrated a powerful potential new approach to the future of learning for advanced level students.

The combination of foresight and multimedia demonstrated the potential to create a higher level of immersion, when integrated with the other elements that make up the LLS. Immersion is critical to achieving a high level of motivation, engagement, and creativity, at least when a positive affect is achieved. It leads to a high level of personal efficacy and self-reflectiveness, generated by the sense of presence and emotional engagement and a feeling of control over the course and with that, also learner well-being. Without doubt, emerging learning technologies with rich interfaces such as augmented reality, virtual reality, simulation, etc. embedded into intelligent learning environments; and the power of personalised AI learning agents to create interactive simulation and representation can expand human imagination and the learner exposure to these technologies without doubt improved their creativity, particularly when they were able to work with them freely and fearlessly and in having to create futuristic artifacts in future world inspired by their own creative visioneering and expanded imagination.

The research undertaken as an essential part of this course as well as the my own assertions on their creative dynamics and performance as indicated by the four case studies in Chapter 7, clearly demonstrate that both the LLS and the Future of Mobile Learning course built upon its eight pillars achieved multiple goals, such as increased critical thinking, stretching the learners imagination, understanding the power of alternative learning techniques as well as more conventional linear approaches, working in unknown worlds with unstructured knowledge, learning and applying new skills, especially those around emerging multimedia, working experiential collaboration with new colleagues with disparate skills, but above all it increased their personal creativity. 80% of respondents made that clear in their responses and while it was influence by a mixture of benefits afforded by working with the future and learning new multimedia, the research indicates that increased engagement driven by a sense of freedom to express themselves and to cross the borders of their previously held boundaries of imagination with no fear, recognizing that there is not one, but many plausible futures, none of which are absolute, and an open mind, led to increased creativity, increased critical thinking and increased personal competencies in their multimedia skills and beyond. As several students commented: the more creative the course, the approach, the learning, and the environment including in the mind the more creative the output. The LLS and the course appear to have met that goal. Although as with any system or approach there is plenty of room for improvement. Learners would like to see more focus on experiential learning with VR and AR and other emerging technologies. They would like more opportunities to develop such tools. They would like to see a slower transition into the complex thinking techniques and they would like to be able to take their creations further throughout their other courses.

I believe that throughout this dissertation I have successfully answered the 10 research questions that I set out in Chapter 1.2.1. The chart below indicates in which chapters and sections the answers to those questions can be found.

Table 16 Location of answers to research questions

Research questions	*Response*	**Response**
1. **How are jobs, skills and workforce structures projected to change over the coming decade?**	There is a growing need for creatives with postnormal skills to meet the present and emerging jobs in the changing workscape.	Chapter 3.1
2. **What are the key skills needs and the role of creativity in the future workforce**	Creativity is increasing established as a critical employability competence to find novel solutions to higher levels of complexity, rapid adaptation and unexpected circumstances.	Chapter 3.3
3. **What do we mean by creativity in the context of postnormal times and how can it be delivered and evaluated?**	The specific concept and context for creativity and future creatives outlined	Chapter 4.1
4. **What are the weaknesses in the present education system in terms of delivering the level of creativity required to meet the needs of future jobs and workforce?**	The Need Gap The lack of focus on areas such as futures literacy, expanding paradoxes, divergent thinking, changing contexts abstraction and ambiguity, nomadic as well as linear thinking, etc.	Chapter 5
5. **What potential future approaches to education would best meet the changing demands of the future workforce?**	Undertook a comprehensive foresight study of the future of learning, which resulted in 5 preferred scenarios.	Chapter 6
6. **What type of future education system and learning approaches would be best suited to solving the issue of the need gap,**	A system based upon the combined needs of the future workscape, increased learner creativity and the outcomes of the foresight project on future education and learning	Chapter 7
7. **What future learning system could potentially deliver a higher level of creativity and a greater output of creatives?**	The three baselines that provide a platform for the LLS design. The LLS adaptive, constructivist, learning system comprising of eight	Chapter 7.

		separate or integrated pillars.	
8.	**How can we apply such a system to the design of future courses to increase learner creativity?**	A foresight-based approach incorporating futures thinking, multisensory, multimedia and transformative experiential pedagogy	Chapter 8
9.	**How can we prove/verify the higher levels of creativity were achieved?**	Various creative evaluation models and qualitive/quantitative research See the findings and conclusion	Chapter 9

Next steps

Using the LLS as a framework, I have subsequently developed four grad courses (3 masters, 1 PhD), namely The Future of Learning (Georgia State University, Atlanta, GA, USA) and the Future of Mobile Learning and The Future of Multimedia and Entertainment (University of Agder) and the ThinkFutures course for the University of Houston, where I am a senior lecturer and two courses for the Center for Futures Studies, at the University of Dubai, where I am on the Executive Board. The LLS formed the basis for the ADES (Institute for Advanced Design Studies) in Budapest Hungary program from 2020.

From observation and assertion, all the courses already implemented have demonstrated a strong sense of dynamic increase in creative outputs, however, it is imperative that I undertake further research on the true contribution of the LLS to significant increases in learner creativity across a wider range of transdisciplinary courses. The next steps require a comparative study between several different courses based upon the same system, but with very different subject matter. In that context I suggest undertaking three separate avenues of enquiry:

A) Leverage even deeper multimedia/futures-based learning experiences including those in fully augmented virtual environments and comparing them with the multimedia-based courses already designed in line with the LLS.

B) Design more advanced creativity evaluation techniques that are coupled with neurocognitive approaches.

C) Design a methodology that better understands the impact of designing and delivering courses using LLS for integrated unrelated domains such as life sciences, physical sciences and engineering and compare with those for individual specific domains in terms of learner creativity performance.

11 References

Abraham, A., Pieritz, K., Thybusch, K., Rutter, B., Kröger, S., Schweckendiek, J., Stark, R., Windmann, S., & Hermann, C. (2012). Creativity and the brain: Uncovering the neural signature of conceptual expansion. *Neuropsychologia*, *50*(8). https://doi.org/10.1016/j.neuropsychologia.2012.04.015

Ackermann, E. K. (2004). Constructing knowledge and transforming the world. In M. Tokoro & L. Steels (Eds.), *A learning zone of one's own: Sharing representations and flow in collaborative learning environments*. IOS Press.

Adams-Prassl, J. (2020). *Rewiring the Firm: Algorithmic management and the future of work Jeremias Adams-Prassl offers an in-depth analysis on how labour markets are being impacted by automation and artificial intelligence.* The Forum Network, OECD.

Agar, N. (2010). *Humanity's end: Why we should reject radical enhancement*. MIT Press.

Ajzen, I. (2011). The theory of planned behaviour: Reactions and reflections. *Psychology & Health*, *26*(9), 1113–1127. https://doi.org/10.1080/08870446.2011.613995

Al-Huneidi, A. M., & Schreurs, J. (2012). Constructivism Based Blended Learning in Higher Education. *International Journal of Emerging Technologies in Learning (IJET)*, *7*(1), 4–9.

Allhoff, F., Lin, P., Moor, J. H., & Weckert, J. (Eds.). (2007). *Nanoethics: The ethical and social implications of nanotechnology*. Wiley-Interscience, Cop.

Allison, B. Z., Brunner, C., Kaiser, V., Müller-Putz, G. R., Neuper, C., & Pfurtscheller, G. (2010). Toward a hybrid brain–computer interface based on imagined movement and visual attention. *Journal of Neural Engineering*, *7*(2), 026007. https://doi.org/10.1088/1741-2560/7/2/026007

Almeida, L. S., Prieto, L. P., Ferrando, M., Oliveira, E., & Ferrándiz, C. (2008). Torrance Test of Creative Thinking: The question of its construct validity. *Thinking Skills and Creativity*, *3*(1). https://doi.org/10.1016/j.tsc.2008.03.003

Amabile, T. (2013). Componential Theory of Creativity. *Encyclopedia of Management Theory*. https://doi.org/10.4135/9781452276090.n42

Ambrose, D. (2017). Interdisciplinary Invigoration of Creativity Studies. *The Journal of Creative Behavior*, *51*(4), 348–351. https://doi.org/10.1002/jocb.205

Ansell-Pearson, K. (2005). The Reality of the Virtual: Bergson and Deleuze. *MLN*, *120*(5), 1112–1127. https://doi.org/10.1353/mln.2006.0020

Arden, R., Chavez, R. S., Grazioplene, R., & Jung, R. E. (2010). Neuroimaging creativity: A psychometric view. *Behavioural Brain Research*, *214*(2). https://doi.org/10.1016/j.bbr.2010.05.015

Arends, R. (1998). *Learning to teach*. Mcgraw-Hill.

Ashby, F. G., Isen, A. M., & Turken, A. U. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review*, *106*(3), 529–550. https://doi.org/10.1037/0033-295x.106.3.529

Ashmarina, S., Mesquita, A., & Vochozka, M. (Eds.). (2020). *Digital Transformation of the Economy: Challenges, Trends and New Opportunities* (1st ed. 2020). Springer International Publishing : Imprint: Springer. https://doi.org/10.1007/978-3-030-11367-4

Askar, A. (2014). *Interactive Ebooks as a Tool of Mobile Learning for Digital-Natives: Interactivity, Preferences, and Ownership*. King Saud University

Baer, J. (1998). The Case for Domain Specificity of Creativity. *Creativity Research Journal*, *11*(2). https://doi.org/10.1207/s15326934crj1102_7

Baer, J. (2016). Implications of Domain Specificity for Creativity Theory * *Parts of this chapter were adapted from Baer, J. (2011e). Why grand theories of creativity distort, distract, and disappoint. International Journal of Creativity and Problem Solving, 21(1), 73–100, and are used with the permission of the editor. In *Domain Specificity of Creativity* (pp. 55–83). Elsevier. https://doi.org/10.1016/B978-0-12-799962-3.00003-3

Baer, J. (2017). Why You are Probably More Creative (and Less Creative) Than You Think. In *The Creative Self* (pp. 259–273). Elsevier. https://doi.org/10.1016/B978-0-12-809790-8.00014-5

Balaji, M. S., & Chakrabarti, Diganta. (2010). *Student Interactions in Online Discussion Forum: Empirical Research from 'Media Richness Theory' Perspective*. Journal of Interactive Online Learning, v9 n1 p1-22 Spring 2010.

Bankston, S. (2017). *Deleuze and the Becoming*. ISBN-13 : 978-0748617265; Bloomsbury Academic, 2017.

Barfield, W. (2015). *Cyber-humans: Our future with machines*. Springer.

Barker, J. A., & Kenny, C. G. (2011). Leading in uncertain times. *Innovation*, *9*(2).

Barman, P., & Bhattacharyya, D. (2015). *EFFECTIVENESS OF CONSTRUCTIVIST TEACHING METHOD : AN EXPERIMENTAL STUDY*. Www.Semanticscholar.Org. https://www.semanticscholar.org/paper/EFFECTIVENESS-OF-CONSTRUCTIVIST-TEACHING-METHOD-%3A-Barman-Bhattacharyya/3cee5e3b298e889db8d75dbcdc72944f8093c830

Beaty, R. E., Kenett, Y. N., Christensen, A. P., Rosenberg, M. D., Benedek, M., Chen, Q., Fink, A., Qiu, J., Kwapil, T. R., Kane, M. J., & Silvia, P. J. (2018). Robust prediction of individual creative ability from brain functional connectivity. *Proceedings of the National Academy of Sciences*, *115*(5), 1087–1092. https://doi.org/10.1073/pnas.1713532115

Beaussart, M. L., Andrews, C. J., & Kaufman, J. C. (2013). Creative liars: The relationship between creativity and integrity. *Thinking Skills and Creativity*, *9*. https://doi.org/10.1016/j.tsc.2012.10.003

Belgutay, J. (2019). *'Education system not focused on future careers'*. Tes. https://www.tes.com/news/education-system-not-focused-future-careers

Bell, D. (1973). *The coming of post-industrial society: A venture in social forecasting*. Basic Books.

Bell, W. (2003). *Foundations of Futures Studies: Volume 1: History, Purposes, and Knowledge (Human Science for a New Era Series)*. Transaction Publishers.

Bello, F., Vissel, Y., & Kajimoto, H. (2016). *Haptics, Perception, Devices, Control, and Applications*. Springer International Publishing Switzerland 2016, The two-volume set LNCS 9774 and 9775 constitutes the refereed proceedings of the 10th International Conference EuroHaptics 2016, held in London, UK, in July 2016.

Benedek, M., Jauk, E., Sommer, M., Arendasy, M., & Neubauer, A. C. (2014). Intelligence, creativity, and cognitive control: The common and differential involvement of executive functions in intelligence and creativity. *Intelligence*, *46*, 73–83. https://doi.org/10.1016/j.intell.2014.05.007

Bereiter, C. (2002). *Education and mind in the knowledge age*. L. Erlbaum Associates.

Bergsteiner, H., & Avery, G. C. (2014). The twin-cycle experiential learning model: Reconceptualising Kolb's theory. *Studies in Continuing Education*, *36*(3). https://doi.org/10.1080/0158037x.2014.904782

Bicchieri, C. (2006). *The Grammar of Society: The Nature and Dynamics of Social Norms*. Psycnet.Apa.Org; Cambridge University Press. https://psycnet.apa.org/record/2006-06579-000

Biggs, J., & Tang, C. (2007). *Using Constructive Alignment in Outcomes-Based Teaching and Learning Teaching for Quality Learning at University (3rd ed., pp. 50-63). Maidenhead: Open University Press.*

Bishop, P. C., & Hines, A. (2012). *Teaching About the Future*. Palgrave Macmillan.

Bishop, P., Hines, A., & Collins, T. (2007). The current state of scenario development: An overview of techniques. *Foresight*, *9*(1). https://doi.org/10.1108/14636680710727516

Bless, H., & Fiedler, K. (2006). *Mood and the regulation of information processing and behavior.* In J. P. Forgas (Ed.), Affect in social thinking and behavior (pp. 65–84). Psychology Press.

Block, N., & Dennett, D. C. (1993). Consciousness Explained. *The Journal of Philosophy*, *90*(4), 181. https://doi.org/10.2307/2940970

Blumberg, P., & Mccann, A. L. (2009). *Developing Learner-Centered Teaching: A Practical Guide for Faculty*. Journal of Dental Education 73(9):1125-1126 DOI: 10.1002/j.0022-0337.2009.73.9.tb04801.x.

Böck, M. (2004). Family Snaps: Life-Worlds and Information Habitus. *Visual Communication*, *3*(3), 281–293. https://doi.org/10.1177/1470357204045783

Bodenhamer, D. J., Corrigan, J., & Harris, T. M. (Eds.). (2015). *Deep Maps and Spatial Narratives (The Spatial Humanities)*. Indiana University Press.

Bogner, A., & Menz, W. (2009). The theory-generating expert interview: Epistemological interest, forms of knowledge, interaction. In A. Bogner, B. Littig, & W. Menz (Eds.), *Interviewing Experts*. Palgrave Macmillan UK. https://doi.org/10.1057/9780230244276$_3$

Bogner, A., & Menz, W. (2018). Collecting data with experts and elites. In U. Flick (Ed.), *The SAGE handbook of qualitative data collection*. Sage Publications.

Borton, T. (1970). *Reach, touch, and teach*.

Boyer, S. L., Edmondson, D. R., Artis, A. B., & Fleming, D. (2013). *Self-directed Learning: A Tool for Lifelong Learning*. Https://Journals.Sagepub.Com/Doi/Abs/10.1177/0273475313494010; Journal of Marketing Education DOI: 10.1177/0273475313494010.

Braad, E., Žavcer, G., & Sandovar, A. (2016). Processes and Models for Serious Game Design and Development. *Entertainment Computing and Serious Games*, 92–118. https://doi.org/10.1007/978-3-319-46152-6_5

Bradfield, R., Wright, G., Burt, G., Cairns, G., & Van Der Heijden, K. (2005). The origins and evolution of scenario techniques in long range business planning. *Futures*, *37*(8), 795–812. https://doi.org/10.1016/j.futures.2005.01.003

Braidotti, R. (2012). *Nomadic Theory: The Portable Rosi Braidotti*. Columbia University Press.

Brandl, J., Gombocz, W. L., & Piller, C. (1990). *Metamind, Knowledge and Coherence: Essays on the Philosophy of Keith Lehrer*.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, *18*(1), 32–42. https://doi.org/10.3102/0013189X018001032

Brown, T. (2008). *Design Thinking*. Harvest Business Review.

Bruner, J. S. (1966). *Toward a theory of instruction* (Nachdr.). Belknap Press of Harvard University Press.

Brunner, C., Birbaumer, N., Blankertz, B., Guger, C., Kübler, A., Mattia, D., Millán, J. del R., Miralles, F., Nijholt, A., Opisso, E., Ramsey, N., Salomon, P., & Müller-Putz, G. R. (2015). BNCI Horizon 2020: Towards a roadmap for the BCI community. *Brain-Computer Interfaces*, *2*(1), 1–10. https://doi.org/10.1080/2326263X.2015.1008956

Brunner, P., Bianchi, L., Guger, C., Cincotti, F., & Schalk, G. (2011). Current trends in hardware and software for brain–computer interfaces (BCIs). *Journal of Neural Engineering*, *8*(2), 025001. https://doi.org/10.1088/1741-2560/8/2/025001

Bruns, A., & Schmidt, J.-H. (2011). Produsage: A closer look at continuing developments. *New Review of Hypermedia and Multimedia*, *17*(1), 3–7. https://doi.org/10.1080/13614568.2011.563626

Bull, K. S., Montgomery, D., & Baloche, L. (1995). Teaching Creativity at the College Level: A Synthesis of Curricular Components Perceived as Important by Instructors. *Creativity Research Journal*, *8*(1). https://doi.org/10.1207/s15326934crj0801_7

Bull, S., & Kay, J. (2010). Open Learner Models. *Studies in Computational Intelligence*. https://doi.org/10.1007/978-3-642-14363-2_15

Bungay, H., & Vella-Burrows, T. (2013). The effects of participating in creative activities on the health and well-being of children and young people: A rapid review of the literature. *Perspectives in Public Health*, *133*(1). https://doi.org/10.1177/1757913912466946

Burleson, B. R. (2011). A Constructivist Approach to Listening. *International Journal of Listening*, *25*(1–2), 27–46. https://doi.org/10.1080/10904018.2011.536470

Burrows, M., & Gnad, O. (2020). Anticipatory Governance: The Role of Futures Studies in Regaining the Political Initiative. In R. Slaughter & A. Hines (Eds.), *Knowledge Base of Futures Studies 2020*.

Byron, K., & Khazanchi, S. (2012). Rewards and creative performance: A meta-analytic test of theoretically derived hypotheses. *Psychological Bulletin*, *138*(4). https://doi.org/10.1037/a0027652

Camacho, D. J., & Legare, J. M. (2016). Shifting gears in the classroom-movement toward personalized learning and competency-based education. *The Journal of Competency-Based Education*, *1*(4). https://doi.org/10.1002/cbe2.1032

Candy, S., & Kornet, K. (2019). Turning Foresight Inside Out: An Introduction to Ethnographic Experiential Futures. *Journal of Futures Studies*, *23*(3), 3–22.

Carpentier, N., & Christidis, Y. (2017). Translating an Academic Text into Sound Art: An Experiment with a Communication Studies' Text on Participation. In *Present Scenarios of Media Production and Engagement* (pp. 207–224). Edition Lumière.

Chen, I.-S., & Chen, J.-K. (2011). Creativity strategy selection for the higher education system. *Quality & Quantity*, *46*(3), 739–750. https://doi.org/10.1007/s11135-010-9411-z

Chen, R., Dannenberg, R. B., Raj, B., & Singh, R. (2020). Artificial Creative Intelligence: Breaking the Imitation Barrier. In *Proceedings of the Eleventh International Conference on Computational Creativity, ICCC'20, 7-11 Septemper, Coimbra, Portugal*. ACC = Association for Computational Creativity. http://computationalcreativity.net/iccc20/wp-content/uploads/2020/09/ICCC20_Proceedings.pdf

Cheng, C.-Y., Sanchez-Burks, J., & Lee, F. (2008). Connecting the Dots Within: Creative Performance and Identity Integration. *Psychological Science*, *19*(11), 1178–1184. https://doi.org/10.1111/j.1467-9280.2008.02220.x

Cheong, D., & Milojević, I. (2017). Trends and emerging issues for Brunei Darussalam: The futures deck and card game. *Journal of Futures Studies*, *22*(2), 85–100.

Chirico, A., Glaveanu, V. P., Cipresso, P., Riva, G., & Gaggioli, A. (2018). Awe Enhances Creative Thinking: An Experimental Study. *Creativity Research Journal*, *30*(2). https://doi.org/10.1080/10400419.2018.1446491

Chirico, A., Yaden, D. B., Riva, G., & Gaggioli, A. (2016). The Potential of Virtual Reality for the Investigation of Awe. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.01766

Chisholm, R. M. (2010). *Theory of Knowledge*. Prentice-Hall,, Foundations ofPhilosophy Series Prentice-Hall foundations of philosophy seriesISBN 0139141685, 9780139141683 144 pages.

Choi, J. N., Anderson, T. A., & Veillette, A. (2008). Contextual Inhibitors of Employee Creativity in Organizations: The insulating role of creative ability. *Group & Organization Management*, *34*(3). https://doi.org/10.1177/1059601108329811

Chuang, Y.-T. (2014). *Increasing Learning Motivation and Student Engagement through the Technology- Supported Learning Environment*. Creative Education, Vol.5 No.23, December 3, 2014.

Chung, A., & Rimal, R. N. (2016). Social norms: A review. *Review of Communication Research*, *4*, 1–28. https://doi.org/10.12840/issn.2255-4165.2016.04.01.008

Cigman, R., & Davis, A. (Eds.). (2009). *New philosophies of learning*. Wiley-Blackwell.

Citi GPS. (2016). *Technology at work v2.0—The Future Is Not What It Used to Be*.

Clardy, A. (2001). *Learning on their own: Vocationally oriented self-directed learning projects First published:* Human Resource Development Quarterly 09 January 2001 Volume 11, Issue 2 Summer 20000. https://doi.org/10.1002/1532-1096(200022)11:2<105::AID-HRDQ2>3.0.CO;2-5

Clark, K., & Smith, R. (2008). *Unleashing the Power of Design Thinking*. This article was first published in Design Management Review Vol. 19 No. 3.

Clay, M., & Keith, L. (1989). *Knowledge and Skepticism*. Westview Press (1989), ISBN(s) 0813307775 0367153270 0813307783 9780813307770.

Clement, J. J. (2009). *The Role of Imagistic Simulation in Scientific Thought Experiments*. opics in Cognitive Science 1(4):686 - 710 DOI: 10.1111/j.1756-8765.2009.01031.x.

Conway, M. (2016). *Foresight infused strategy development: A how-to guide for using foresight in practice*. Melbourne Thinking Futures.

Cooper, P. A. (1993). *Paradigm Shifts in Designed Instruction: From Behaviorism to Cognitivism to Constructivism*. Educational Technology Volume 33, Number 5, 1993 ISSN 0013-1962.

Cowan, D. (2018a). *The FINANCIAL - Future jobs must be taught with tech*. Www.Finchannel.Com. https://www.finchannel.com/society/business-schools/75471-future-jobs-must-be-taught-with-tech

Cowan, D. (2018b). *Education of the future: Tomorrow's jobs must be taught with tech*. Raconteur. https://www.raconteur.net/public-sector/essential-education-future-jobs-tech/

Craft, A. (Ed.). (2004). *Creativity in education* (reprinted). Continuum.

Craft, A. (2005). *Creativity in Schools: Tensions and Dilemmas*. Routledge. http://oro.open.ac.uk/23285/

Craft, A., Chappell, K., & Twining, P. (2008). *Learners reconceptualising education: Widening participation through creative engagement?* Innovations in Education and Teaching International 45(3) DOI: 10.1080/14703290802176089.

Cropley, A. (2020). Creativity-focused Technology Education in the Age of Industry 4.0. *Creativity Research Journal*, *32*(2), 184–191. https://doi.org/10.1080/10400419.2020.1751546

Cropley, D. H., Kaufman, J. C., & Cropley, A. J. (2011). Measuring Creativity for Innovation Management. *Journal of Technology Management & Innovation*, *6*(3), 13–30. https://doi.org/10.4067/s0718-27242011000300002

Csikszentmihalyi, M. (1985). *Beyond boredom and anxiety*. Jossey-Bass Publishers.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the psychology of discovery and invention*. Harper Perennial.

Csikszentmihalyi, M., & Sawyer, R. K. (1996). Creative insight: The social dimension of a solitary moment. In R. J. Sternberg & J. E. Davidson (Eds.), *The nature of insight*. Mit Press.

Curry, A., & Hodgson, A. (2008). Seeing in Multiple Horizons: Connecting Futures to Strategy. *Journal of Futures Studies*, *13*.

Czerkawski, B. C. (2014). Designing deeper learning experiences for online instruction. *Journal of Interactive Online Learning*, *13*(2), 29–40.

Dabbagh, N., & Bannan-Ritland, B. (2007). *Online Learning: Concepts, Strategies, and Application*. Educational Technology Research and Development 55(6):667-669 DOI: 10.1007/s11423-007-9071-4.

Dacre Pool, L., & Sewell, P. (2007). *The key to employability: Developing a practical model of graduate employability*. Education Training, Vol. 49 No. 4, pp. 277-89. January 2007 Education and Training 49(4):277-289 Follow journal.

Dalgarno, B., Bower, M., Lee, M. J. W., & Kennedy, G. (2015). *Technology issues in blended synchronous learning*. Globally connected digitally enabled. Proceedings of the Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE 2015). http://www.2015conference.ascilite.org/wp-content/uploads/2015/11/ascilite-2015-proceedings.pdf

Dannenberg, S., & Fischer, N. (2017). Gaming Scenarios: Making Sense of Diverging Developments. *Journal of Futures Studies*, *22*(2).

Dator, J. A. (2017). Why Gaming, Why Alternative Futures? *Journal of Futures Studies*, *22*(2).

Davidson, R. J., & Begley, S. (2013). *The emotional life of your brain: How its unique patterns affect the way you think, feel, and live—And how you can change them*. Hodder.

De Jouvenal, B., Nikita, L., & Daniel J., M. (2012). *The Principle of Uncertainty*. Routledge, Book The Art of Conjecture Pages10 eBook ISBN9781351305686.

Deci, E. L., & Ryan, R. M. (2015). *Self-Determination Theory*. DOI: 10.1016/B978-0-08-097086-8.26036-4.

Dede, C. (2010). Comparing frameworks for 21st century skills. In J. A. Bellanca & R. Brandt (Eds.), *21st Century Skills: Rethinking How Students Learn*. Solution Tree.

Dede, C. J. (1992). The Future of Multimedia: Bridging to Virtual Worlds. *Educational Technology*, *32*(5). https://eric.ed.gov/?id=EJ446165

Dede, C. J., & Richards, J. (Eds.). (2020). *The 60-Year Curriculum: New Models for Lifelong Learning in the Digital Economy* (1st ed.). Routledge. https://doi.org/10.4324/9781003013617

Deleuze, G. (1995). *Difference and Repetition, Translated by Paul Patton*. Columbia University Press ISBN: 9780231081597 350 pages FORMAT: Paperback.

Deleuze, G., & Guattari, F. (1976). *Rhizome: Introduction*. Éditions de Minuit.

Deleuze, G., & Guattari, F. (1984). *Anti-Oedipus*. Athlone Press Ltd *University of Minnesota, ISBN 0-485-30018-4Translation by Hurley, Seem, Lane.

Deleuze, G., & Guattari, F. (1988). *A thousand plateaus*. London Athlone.

Dennett, D. C. (1996). *Kinds of Minds*. Basic Books ISBN(s) 0297818198 9780753800430 0753800438. Paperback Science Masters, June 12th 1997 0752839896 9780297818199.

Desailly, J. (2016). *Creativity in the primary classroom*. SAGE.

Desantis, D. (2015). *Making Music: 74 creative strategies for electronic music producers*. Berlin Ableton.

Deterding, Sebastian, Sicart, M., Nacke, L., O'Hara, K., & Dixon, D. (2011). *Gamification. Using game-design elements in non-gaming contexts*. Conference: Proceedings of the International Conference on Human Factors in Computing Systems, CHI 2011, Extended Abstracts Volume, Vancouver, BC, Canada, May 7-12, 2011CHI'11 Extended …, 2011 - Dl.Acm.Org. 10.1145/1979742.1979575.

Deutsch, D. (1998). *The Fabric of Reality: The Science of Parallel Universes and Its Implications (Allen Lane Science)*. Penguin Books.

Deutsch, D. (2012). *The Beginning of Infinity: Explanations That Transform the World*. Penguin Books.

Dewey, J. (1997). *How we think*. Dover Publications.

Dewey, J. (2015). *Experience and education* (First free press edition 2015). Free Press.

Dewey, J., & Deledalle, G. (1994). Logique. La Théorie de L'Enquête. *Revue Philosophique de La France Et de l'Etranger*, *184*(4), 478–480.

DeYoung, C. G., Hirsh, J. B., Shane, M. S., Papademetris, X., Rajeevan, N., & Gray, J. R. (2010). Testing Predictions From Personality Neuroscience. *Psychological Science*, *21*(6). https://doi.org/10.1177/0956797610370159

Dick, W. (1996). The dick and carey model: Will it survive the decade? *Educational Technology Research and Development*, *44*(3), 55–63. https://doi.org/10.1007/bf02300425

Dollinger, S. J., Clancy Dollinger, S. M., & Centeno, L. (2005). Identity and Creativity. *Identity*, *5*(4), 315–339. https://doi.org/10.1207/s1532706xid0504_2

Döringer, S. (2020). 'The problem-centred expert interview'. Combining qualitative interviewing approaches for investigating implicit expert knowledge. *International*

Journal of Social Research Methodology. https://doi.org/10.1080/13645579.2020.1766777

Dormann, C. F., Elith, J., Bacher, S., Buchmann, C., Carl, G., Carré, G., Marquéz, J. R. G., Gruber, B., Lafourcade, B., Leitão, P. J., Münkemüller, T., McClean, C., Osborne, P. E., Reineking, B., Schröder, B., Skidmore, A. K., Zurell, D., & Lautenbach, S. (2012). Collinearity: A review of methods to deal with it and a simulation study evaluating their performance. *Ecography*, *36*(1), 27–46. https://doi.org/10.1111/j.1600-0587.2012.07348.x

Drew, S. A. W. (2006). Building technology foresight: Using scenarios to embrace innovation. *European Journal of Innovation Management*, *9*(3), 241–257. https://doi.org/10.1108/14601060610678121

Drucker, P. F. (1993). *Post-Capitalist Society*. Butterworth-Heinemann.

Dunne, D. (2006). *Design Thinking and How It Will Change Management Education: An Interview and Discussion*. Academy of Management Learning & Education, 2006, Vol. 5, No. 4, 512–523.

Eden, S. (2014). Out of the comfort zone: Enhancing work-based learning about employability through student reflection on work placements. *Journal of Geography in Higher Education*, *38*(2), 266–276. https://doi.org/10.1080/03098265.2014.911826

EDU/CERI/CD(2008)14 Organisation de Coopération et de Développement Économiques Organisation for Economic Co-operation and Development DIRECTORATE FOR EDUCATION CENTRE FOR EDUCATIONAL RESEARCH AND INNOVATION (CERI) GOVERNING BOARD 21ST CENTURY LEARNING: RESEARCH, INNOVATION AND POLICY Directions from recent OECD analyses CERI 40th Anniversary International Conference on Learning in the 21st Century. (2008). https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=EDU/CERI/CD(2008)14&docLanguage=En

Efklides, A. (2011). Interactions of Metacognition With Motivation and Affect in Self-Regulated Learning: The MASRL Model. *Educational Psychologist*, *46*(1), 6–25. https://doi.org/10.1080/00461520.2011.538645

Elliott, S. N., Kratochwill, T. R., Cook, J. L., & Travers, J. F. (2000). *Educational psychology: Effective teaching, effective learning*. Mcgraw-Hill.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, Cognitivism, Constructivism: Comparing Critical Features From an Instructional Design Perspective. *Performance Improvement Quarterly*, *26*(2), 43–71. https://doi.org/10.1002/piq.21143

Estes, B., & Polnick, B. (2012). *Examining Motivation Theory in Higher Education: An Expectancy Theory Analysis of Tenured Faculty Productivity*. International Journal of Management, Business and Administration Volume 15, Number 1, 2012.

Executive Office of the President (USA). (2016). *Artificial Intelligence, Automation, and the Economy*. https://obamawhitehouse.archives.gov/blog/2016/12/20/artificial-intelligence-automation-and-economy

Farah, M. J., Illes, J., Cook-Deegan, R., Gardner, H., Kandel, E., King, P., Parens, E., Sahakian, B., & Wolpe, P. R. (2004). Neurocognitive enhancement: What can we do and what should we do? *Nature Reviews Neuroscience*, *5*(5), 421–425. https://doi.org/10.1038/nrn1390

Feist, G. J., & Barron, F. X. (2003). Predicting creativity from early to late adulthood: Intellect, potential, and personality. *Journal of Research in Personality*, *37*(2). https://doi.org/10.1016/s0092-6566(02)00536-6

Fenwick, Tara J. (2001). *Experiential Learning: A Theoretical Critique from Five Perspectives. Information Series No. 385.* ERIC Publications; Opinion Papers, Office of Educational Research and Improvement (ED), Washington, DC. ERIC Number: ED454418.

Fergnani, A., & Chermack, T. J. (2020). The resistance to scientific theory in futures and foresight, and what to do about it. *FUTURES & FORESIGHT SCIENCE*. https://doi.org/10.1002/ffo2.61

Fernandez-Abascal, Enrique G., & Martin Diaz, M. Dolores. (2015). *Emotion and Motivation*. Editorial Universitaria Ramón Areces, Madrid, Spain.

Fiedler, K., Nickle, S., Asbeck, J., & Pagel, U. (2003). *Mood and the generation effect*. Cognition and Emotion 17(4):585-608 DOI: 10.1080/02699930302301.

Fishbein, M. A., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Umass.Edu. https://people.umass.edu/aizen/f&a1975.html

Florida, R. (2002). *Rise Of The Creative Class.* Basic Books.

Florida, R. L. (2011). *The great reset: How new ways of living and working drive post-crash prosperity* (1. ed). Harper.

Florida, R., Mellander, C., & King, K. E. (2015). *Creative economies*. Martin Prosperity Institute Report.

Fogarty, R. (1997). *Problem-Based Learning and Other Curriculum Models for the Multiple Intelligences Classroom.* RI/Skylight Training and Publishing, Inc., 2626 South Clearbrook Drive, Arlington Heights, IL 60005; ERIC Number: ED405143 ISBN-1-57517-067-1.

Folsom-Kovarik, J. T., & Raybourn, E. M. (2016). *Total Learning Architecture (TLA) Enables Next-generation Learning via Meta-adaptation*.

Forbes. (2017). LMS 101: Rethinking Your Approach To Employee Training. *Forbes*. https://www.forbes.com/sites/paycom/2017/02/14/learning-management-systems-101-rethinking-your-approach-to-employee-training

Freire, P. (1989). *Learning to question: A pedagogy of liberation*. Continuum.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, *114*, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019

Frické, M. (2009). The knowledge pyramid: A critique of the DIKW hierarchy. *Journal of Information Science*, *35*(2), 131–142. https://doi.org/10.1177/0165551508094050

Friedland, R., Mohr, J. W., Roose, H., & Gardinali, P. (2014). The institutional logics of love: Measuring intimate life. *Theory and Society*, *43*(3–4), 333–370. https://doi.org/10.1007/s11186-014-9223-6

Future of Life Institute. (2017). *Superintelligence: Science or Fiction? | Elon Musk & Other Great Minds*. Www.Youtube.Com. https://www.youtube.com/watch?v=h0962biiZa4

Gabrielli, S., & Zoels, J.-C. (2003). Creating imaginable futures. *Proceedings of the 2003 Conference on Designing for User Experiences - DUX '03*. https://doi.org/10.1145/997078.997114

Galiani, S., & Schargrodsky, E. (2002). Evaluating the Impact of School Decentralization on Educational Quality. *Economía*, *2*(2), 275–314. https://doi.org/10.1353/eco.2002.0004

García-Ros, R., Talaya, I., & Pérez-González, F. (2012). The process of identifying gifted children in elementary education: Teachers' evaluations of creativity. *School Psychology International*, *33*(6). https://doi.org/10.1177/0143034311421434

Gardner, H. (2011). *Creating minds: An anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi*. BasicBooks.

Gardner, M. (1970). Mathematical Games. *Scientific American*, *223*(4), 120–123. https://doi.org/10.1038/scientificamerican1070-120

Georghiou, L., & Keenan, M. (2006). Evaluation of national foresight activities: Assessing rationale, process and impact. *Technological Forecasting and Social Change*, *73*(7). https://doi.org/10.1016/j.techfore.2005.08.003

Ghislain, M. N., Woodgate, D., Moxnes, Margrethe Synnøve, & Ristesund, Marie. (2017). *Interactions Within a Virtual Reality Environment for Learning Chemistry. Advances in Human Factors in Training, Education, and Learning Sciences.* ISBN: 978-3-319-60017-8. Springer. Proceedings of International Conference on Applied Human Factors and Ergonomics. s 221 - 233.

Gibbs, G. (1988). *Learning by doing: A guide to teaching and learning methods*. FEU.

Giddens, A. (1979). Time, Space, Social Change. *Central Problems in Social Theory*, 198–233. https://doi.org/10.1007/978-1-349-16161-4_7

Gidley, J. M. (2016). *Postformal Education: A Philosophy for Complex Futures (Critical Studies of Education, 3)*. Springer International Publish.

Glück, J., Ernst, R., & Unger, F. (2002). How Creatives Define Creativity: Definitions Reflect Different Types of Creativity. *Creativity Research Journal*, *14*(1), 55–67. https://doi.org/10.1207/s15326934crj1401_5

Godat, Meredith. (2012). *Collaborative learning and critical thinking in technology-enhanced environments: An instructional design framework*. PhD thesis, Queensland University of Technology.

Godsk, M. (2013). *STREAM: a flexible model for transforming higher science education into blended and online learning*.

Godsk, M. (2014). *Efficient learning design—Concept, catalyst, and cases*. Rhetoric and Reality: Critical perspectives on educational technology. Proceedings ascilite Dunedin.

Gotlieb, R., Jahner, E. E., Immordino-Yang, M. H., & Kaufman, S. B. (2015). *How Social-Emotional Imagination Facilitates Deep Learning and Creativity in the Classroom*.

Greene, M. (2020). *A new stock exchange focused on the long-term*. Www.Ted.Com. https://www.ted.com/talks/michelle_greene_a_new_stock_exchange_focused_on_the_long_term

Gunter, G., Kenny, R. F., & Vick, E. H. (2006). A Case for a Formal Design Paradigm for Serious Games. *The Journal of the International Digital Media and Arts Association*, *3*(1), 93–105.

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, *102*, 101586. https://doi.org/10.1016/j.ijer.2020.101586

Gutiérrez, J. M., & Meneses Fernández, M. D. (2014). *Applying augmented reality in engineering education to improve academic performance & student motivation*. Journal: The International journal of engineering education ISSN: 0949-149X.

Hancock, P. A., & Scallen, S. F. (1998). Allocating functions in human-machine systems. In R. R. Hoffman, M. F. Sherrick, & J. S. Warm (Eds.), *Viewing psychology as a whole: The integrative science of William N. Dember.* https://doi.org/10.1037/10290-024

Harel, I., & Papert, S. (1991). *Constructionism: Research reports and essays, 1985-1900*. Ablex Publishing Corporation.

Hayward, P., & Candy, S. (2017). The Polak Game, Or: Where Do You Stand? *Journal of Futures Studies*, *22*(2).

Heidig, S., Müller, J., & Reichelt, M. (2015). Emotional design in multimedia learning: Differentiation on relevant design features and their effects on emotions and learning. *Computers in Human Behavior*, *44*, 81–95. https://doi.org/10.1016/j.chb.2014.11.009

Hennessey, B. A., & Amabile, T. M. (2010). Creativity. *Annual Review of Psychology*, *61*(1). https://doi.org/10.1146/annurev.psych.093008.100416

Henriksen, D., Creely, A. E., & Henderson, M. (2020). *Folk Pedagogies for Teacher Transitions: Approaches to Synchronous Online Learning in the Wake of COVID-19*. Journal of Technology and Teacher Education Volume 28, Number 2, 2020 ISSN 1059-7069 Publisher: Society for Information Technology & Teacher Education, Waynesville, NC USA.

Herrington, A., & Herrington, J. (2007). *Authentic mobile learning in higher education*. AARE 2007 International Educational Research Conference, 28 November 2007, Fremantle, Western Australia.

Hiller, L. A., & Isaacson, L. M. (1979). *Experimental music: Composition with an electronic computer*. Greenwood Press.

Hiltunen, E. (2008). The future sign and its three dimensions. *Futures*, *40*(3), 247–260. https://doi.org/10.1016/j.futures.2007.08.021

Hines, A., & Suarez, J. (2017). Why Student Needs. *On the Horizon*, *25*(3). https://doi.org/10.1108/oth-06-2017-0030

Hines, A., & Whittington, A. (2017). Nine emerging student needs. *On the Horizon*, *25*(3). https://doi.org/10.1108/oth-05-2017-0028

Holland, J. H. (2006). Studying Complex Adaptive Systems. *Journal of Systems Science and Complexity*, *19*(1), 1–8. https://doi.org/10.1007/s11424-006-0001-z

Howkins, J. (2001). *The creative economy: How people make money from ideas*. Allen Lane.

Howland, J. L., & Moore, J. L. (2002). Student Perceptions as Distance Learners in Internet-Based Courses. *Distance Education*, *23*(2). https://doi.org/10.1080/0158791022000009196

Inayatullah, S. (1998). Causal layered analysis: Poststructuralism as method. *Futures*, *30*(8). https://doi.org/10.1016/s0016-3287(98)00086-x

Inwood, M. J. (2013). *Hegel*. Taylor & Francis.

Ireton, D. L., Pitts, J., & Ward, B. (2013). *Library Discovery through Augmented Reality: A Game Plan for Academics The International Journal of Technology Knowledge and Society 9(4):119-128 Unfollow journal DOI: 10.18848/1832-3669/CGP/v09i04/56407*. The International Journal of Technology Knowledge and Society 9(4):119-128, DOI: 10.18848/1832-3669/CGP/v09i04/56407.

Isaac, R. G., Zerbe, W. J., & Pitt, D. C. (2001). Leadership And Motivation: The Effective Application Of Expectancy Theory. *Journal of Managerial Issues*, *13*(2), 212–226.

Isabwe, G. M. N., Moxnes, M., Ristesund, M., & Woodgate, D. (2018). Children's Interactions Within a Virtual Reality Environment for Learning Chemistry. In T. Andre (Ed.), *Advances in Human Factors in Training, Education, and Learning Sciences* (Vol. 596, pp. 221–233). Springer International Publishing. https://doi.org/10.1007/978-3-319-60018-5_22

Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology*, *47*(6), 1206–1217. https://doi.org/10.1037/0022-3514.47.6.1206

Itin, C. M. (1999). Reasserting the Philosophy of Experiential Education as a Vehicle for Change in the 21st Century. *Journal of Experiential Education*, *22*(2), 91–98. https://doi.org/10.1177/105382599902200206

Izard, C. E. (2009). Emotion Theory and Research: Highlights, Unanswered Questions, and Emerging Issues. *Annual Review of Psychology*, *60*(1), 1–25. https://doi.org/10.1146/annurev.psych.60.110707.163539

Jackson, P., Jr. ,. Ph. D. (2018, March). *Toward Beneficial Human-Level AI… and Beyond*.

Jang, H. (2015). Identifying 21st Century STEM Competencies Using Workplace Data. *Journal of Science Education and Technology*, *25*(2), 284–301. https://doi.org/10.1007/s10956-015-9593-1

Jashapara, A. (2005). *The emerging discourse of knowledge management: A new dawn for information science research?* Journal of Information Science 31(2):136-148 DOI: 10.1177/0165551505051057 SourceDBLP.

Jasper, M. (2013). *Beginning reflective practice*. Cengage Learning.

Jenkins, H. (2014). *The Value of Media Literacy Education in the 21st Century: A Conversation with Tessa Jolls (Part Three)*. http://henryjenkins.org/blog/2014/09/the-value-of-media-literacy-education-in-the-21st-century-a-conversation-with-tessa-jolls-part-three.html

Jenkins, H. (2019). *Participatory culture: Interviews*. Polity Press.

Jonassen, D. H., & Land, S. M. (2012). *Theoretical foundations of learning environments*. Routledge.

Jung, R. E., Segall, J. M., Bockholt, H. J., Flores, R. A., Smith, S. M., Chavez, R. S., & Haier, R. J. (2010). Neuroanatomy of Creativity. *Human Brain Mapping*, *31*(3). https://doi.org/10.1002/hbm.20874

Kapp, K. M., & O'Driscoll, T. (2010). *Learning in 3D: adding a new dimension to enterprise learning and collaboration*. Jossey-Bass.

Karakas, F., & Manisaligil, A. (2012). *Reorienting self-directed learning for the creative digital era August 2012 European Journal of Training and Development 36(7):712-731 DOI: 10.1108/03090591211255557 Fahri KarakasFahri KarakasAlperen Manisaligil*.

Karwowski, M. (2017). *The creative self: Effect of beliefs, self-efficacy, mindset, and identity*. Elsevier.

Kassim, H. (2013). *The relationship between learning styles, creative thinking performance and multimedia learning materials*. Elsevier. Procedia-Social and Behavioral Sciences 229-237.

Kaszap, M., Yaïves, F., & Stan, C. A. (2013). *How Scenarios can Enhance Serious Games with Augmented Reality:* The International Journal of Technology Knowledge and Society 8(2013):25 DOI: 10.18848/1832-3669/CGP/v08i04/56305.

Katz, L. F., & Krueger, A. B. (2018). The Rise and Nature of Alternative Work Arrangements in the United States, 1995–2015. *ILR Review*, *72*(2). https://doi.org/10.1177/0019793918820008

Kaufman, J. C., & Sternberg, R. J. (2019). *The Cambridge handbook of creativity*. https://doi.org/10.1017/9781316979839

Keengwe, J., Onchwari, G., & Wachira, P. (2008). Computer Technology Integration and Student Learning: Barriers and Promise. *Journal of Science Education and Technology*, *17*(6), 560–565. https://doi.org/10.1007/s10956-008-9123-5

Kelley, D., & Littman, J. (2001). *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm*. IDEO ISBN 0385499841.

Kelley, T., & Kelley, D. (2013). *Creative confidence: Unleashing the creative potential within us all*. Crown Business.

Kennedy, B. M. (2000). *Deleuze and the cinema: The aesthetics of sensation*. Edinburgh University Press.

Kern, A., & Smyth, D. (2006). *"Spontaneity and Receptivity in Kant's Theory of Knowledge."* Philosophical Topics 34, no. 1/2 (2006): 145–62. http://www.jstor.org/stable/43155413.

Kienitz, E., Quintin, E.-M., Saggar, M., Bott, N. T., Royalty, A., Hong, D. W.-C., Liu, N., Chien, Y., Hawthorne, G., & Reiss, A. L. (2014). Targeted intervention to increase creative capacity and performance: A randomized controlled pilot study. *Thinking Skills and Creativity*, *13*. https://doi.org/10.1016/j.tsc.2014.03.002

Kim, K. H. (2006). Can We Trust Creativity Tests? A Review of the Torrance Tests of Creative Thinking (TTCT). *Creativity Research Journal*, *18*(1), 3–14. https://doi.org/10.1207/s15326934crj1801_2

Kim, K. H. (2011). Proven reliability and validity of the Torrance Tests of Creative Thinking (TTCT). *Psychology of Aesthetics, Creativity, and the Arts*, *5*(4), 314–315. https://doi.org/10.1037/a0021916

Kingsland, A. (1996). *Time expenditure, workload and student satisfaction in problem based learning. In L. Wilkerson, & W. Gijselaers (Eds.), Bring problem based learning to higher education: Theory and practice (pp. 73-81). San Francisco: Jossey-Bass.*

Kirkley, S., & Kirkley, J. (2004). *Creating next generation blended learning environments using mixed reality, Video Games and Simulations*. TechTrends 49(3):42-53 DOI: 10.1007/BF02763646.

Kirsh, D. (2009). Interaction, External Representation and Sense Making. In N. A. Taatgen & H. van Rijn (Eds.), *Proceedings of the 31st Annual Conference of the Cognitive Science Society* (pp. 1103–1108). Cognitive Science Society.

Klausen, S. H. (2010). The Notion of Creativity Revisited: A Philosophical Perspective on Creativity Research. *Creativity Research Journal*, *22*(4), 347–360. https://doi.org/10.1080/10400419.2010.523390

Klopfer, E., & Squire, K. (2008). *Environmental Detectives—The Development of an Augmented Reality Platform for Environmental Simulations*. *56*(2), 203–228.

Klopfer, E., Squire, K., & Jenkins, H. (2012). *Environmental Detectives: PDAs as a window into a virtual simulated world*. DOI: 10.1109/WMTE.2002.1039227 SourceIEEE Xplore Conference: Wireless and Mobile Technologies in Education, Proceedings. IEEE International Workshop.

Knight, J. F. ,., Carley, S. ,., Tregunna, B., Jarvis, S. ,., de Freitas, S., Mackway -Jones, K., Jones, K., & Smithies, R. (2010). *Trends in Educational Technologies: Serious gaming technology in major incident triage training: A pragmatic controlled trial.* Resuscitation , 81 (9), 1175 – 9. doi:10.1016/j. 2010.03.042.

Knight Lapinski, M., & Rimal, R. N. (2005). *An Explication of Social Norms*. Communication Theory 15(2):127 - 147 DOI: 10.1111/j.1468-2885.2005.tb00329.x.

Kolb, D. A. (1984). *Experimental Learning: Experience as the Source of Learning and Development*. Prentice-Hall.

Kolnhofer-Derecskei, A. (2016). Many Shades of Creativity. *Forum Scientiae Oeconomia*, *4*(4).

Kress, G. (2009). *Multimodality A Social Semiotic Approach to Contemporary Communication*. Routledge, Copyright Year 2010 ISBN 9780415320610.

Krishnan, K. (2020, April 13). Our Education System Is Losing Relevance. Here's How to Update It. *World Economic Forum*. https://www.weforum.org/agenda/2020/04/our-education-system-is-losing-relevance-heres-how-to-update-it/

Lakoff, G., & Johnson, M. (2003). *Metaphors we live by*. University of Chicago Press.

Lamb, R. L., & McMahon, D. D. (Eds.). (2015). *Educational and learning games: New research*. Nova Publishers.

Lankshear, C., Peters, M., & Knobel, M. (2000). Information, Knowledge and Learning: Some Issues Facing Epistemology and Education in a Digital Age. *Journal of the Philosophy of Education*, *34*(1), 17–39. https://doi.org/10.1111/1467-9752.00153

Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation* (1st ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511815355

Lean, J., Moizer, J., Towler, M., & Abbey, C. (2006). *Simulations and Games: Use and Barriers in Higher Education*. Active Learning in Higher Education 7(3) DOI: 10.1177/1469787406069056.

Leder, S. (2019). *Transformative pedagogic practice: Education for sustainable development and water conflicts in Indian geography education*. Springer.

Lee, Yi-Hsuan, Hsiao, Chan, & Ho, C.-H. (2014). *The effects of various multimedia instructional materials on students' learning responses and outcomes: A comparative experimental study*. Computers in Human Behavior DOI: 10.1016/j.chb.2014.07.041 Date: November, 2014.

Legrenzi, P. (2005). *Creativity and innovation i*. Journal Icon Volume 39 Issue 051.

Levy, F., & Murnane, R. J. (2004). *The new division of labor: How computers are creating the next job market*. Russell Sage Foundation; Princeton, N.J.

Li, J., Lin, Y., Sun, M., & Shadiev, R. (2020). *Socially shared regulation of learning in game-based collaborative learning environments promotes algorithmic thinking, learning participation and positive learning attitudes*. Interactive Learning Environments DOI: 10.1080/10494820.2020.1857783.

Long, D., McKlin, T., Weisling, A., Martin, W., Guthrie, H., & Magerko, B. (2019). Trajectories of Physical Engagement and Expression in a Co-Creative Museum Installation. *Proceedings of the June 2019 ACM Conference on Creativity and Cognition*.

Loriemerson. (2018, January 25). *What and Where Is the Interface in Virtual Reality? An Interview with Illya Szilak on Queerskins* [Interview]. https://loriemerson.net/2018/01/25/what-and-where-is-the-interface-in-virtual-reality-an-interview-with-illya-szilak-on-queerskins/

Lui, F., Zuo, M., & Zhang, P. (2011). *'Human-Machine Function Allocation In Information Systems: A Comprehensive Approach' (2011).* PACIS 2011 Proceedings. 117. https://aisel.aisnet.org/pacis2011/117

Mai, K. M., Ellis, A. P. J., & Welsh, D. T. (2015). The Gray Side of Creativity: Exploring the Role of Activation in the Link Between Creative Personality and Unethical Behavior. *Journal of Experimental Social Psychology*, *60*. https://doi.org/10.1016/j.jesp.2015.05.004

Mallory, M. E. (1988). Q-sort definition of ego identity status. *Journal of Youth and Adolescence*, *18*(4), 399–412. https://doi.org/10.1007/bf02139257

Maloney, W. F., & Molina, C. (2016). *Are Automation and Trade Polarizing Developing Country Labor Markets, Too?* World Bank, Washington, DC. https://doi.org/10.1596/1813-9450-7922

Manyika, J., Lund, S., Chui, M., Bughin, J., Woetzel, J., Batra, P., Ko, R., & Sanghvi, S. (2017). *Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages*. McKinsey & Company. https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages

Markley, O. (2011). A new methodology for anticipating STEEP surprises. *Technological Forecasting and Social Change*, *78*(6), 1079–1097. https://doi.org/10.1016/j.techfore.2011.01.008

Mayer, R. E. (2009). *Multimedia Learning*. Cambridge University Press.

Mayer, R. E., & Estrella, G. (2014). Benefits of emotional design in multimedia instruction. *Learning and Instruction*, *33*, 12–18. https://doi.org/10.1016/j.learninstruc.2014.02.004

McCaffrey, T. (2012). Innovation Relies on the Obscure. *Psychological Science*, *23*(3), 215–218. https://doi.org/10.1177/0956797611429580

McCombs, B. L., Daniels, D. H., & Perry, K. E. (2008). Children's and Teachers' Perceptions of Learner-Centered Practices, and Student Motivation: Implications for Early Schooling. *The Elementary School Journal*, *109*(1), 16–35. https://doi.org/10.1086/592365

McErlean, K. (2018). *Interactive Narratives and Transmedia Storytelling Creating Immersive Stories Across New Media Platforms*. Routledge ISBN 9781138638822 210 Pages.

McKinsey Global Institute. (2017). *A Future that Works: Automation, Employment, and Productivity*. McKinsey & Company.

McKlin, T., Lee, T., Wanzer, D., Magerko, B., Edwards, D., Grossman, S., Bryans, E., & Freeman, J. (2019). *Accounting for Pedagogical Content Knowledge in a Theory of Change Analysis.* Proceedings of the 2019 ACM Conference on International Computing Education Research (ICER '19), Pp. 157-165.

McRobert, L. (2007). *Char Davies's Immersive Virtual Art and the Essence of Spatiality*. University Of Toronto Press.

Mednick, S. (1962). The associative basis of the creative process. *Psychological Review*, *69*(3). https://doi.org/10.1037/h0048850

Mercer. (2020). *Win With Empathy. Global Talent Trends 2020.* https://workingnation.com/wp-content/uploads/2020/03/global-talent-trends-2020-report.pdf

Meuser, M., & Nagel, U. (2009). The Expert Interview and Changes in Knowledge Production. In A. Bogner, W. Menz, & B. Littig (Eds.), *Interviewing Experts*. https://doi.org/10.1057/9780230244276_2

Miettinen, R. (2000). The concept of experiential learning and John Dewey's theory of reflective thought and action. *International Journal of Lifelong Education*, *19*(1). https://doi.org/10.1080/026013700293458

Milgram, P., & Kishino, F. (1994). *A Taxonomy of Mixwed Reality Visual Displays*. IEICE Transactions on Information Systems, Vol E77-D, No.12 December 1994.

Miliszewska, I., & Horwood, J. (2006). Engagement Theory. *Proceedings of the 37th SIGCSE Technical Symposium on Computer Science Education - SIGCSE '06*. https://doi.org/10.1145/1121341.1121392

Millea, Jenny, Green, I., & Putland, G. (2005). *Emerging technologies: A framework for thinking: ACT Department of Education and Training: Final report*. Adelaide, South Australia: Education.au Limited, 2005. http://hdl.voced.edu.au/10707/54114.

Montuori, A. (2011). Beyond postnormal times: The future of creativity and the creativity of the future. *Futures*, *43*(2). https://doi.org/10.1016/j.futures.2010.10.013

Moran, S., Cropley, D., & Kaufman, J. C. (Eds.). (2014). *The Ethics of Creativity*. London Palgrave Macmillan Uk.

Moreno, R., & Mayer, R. (2007). Interactive Multimodal Learning Environments. *Educational Psychology Review*, *19*(3). https://doi.org/10.1007/s10648-007-9047-2

Morin, E. (2008). The reform of thought, transdisciplinarity, and the reform of the university. In B. Nicolescu (Ed.), *Transdisciplinarity: Theory and practice*. Hampton Press.

Morris, T. H. (2019). Experiential learning – a systematic review and revision of Kolb's model. *Interactive Learning Environments*, *28*(8). https://doi.org/10.1080/10494820.2019.1570279

Morrison, G. R., Ross, S. M., Morrison, J. R., & Kalman, H. K. (2019). *Designing effective instruction* (Eighth edition). Wiley.

Morrison, J. L. (1992). Environmental scanning. In M. A. Whitely, J. D. Porter, & R. H. Fenske (Eds.), *A primer for new institutional researchers*. The Association for Institutional Research.

Muckelbauer, J. (2009). *The Future of Invention: Rhetoric, Postmodernism, and the Problem*. State University of New York, Press [Paperback] Paperback.

Mughal, F., & Zafar, A. (2011). Experiential Learning from a Constructivist Perspective: Reconceptualizing the Kolbian Cycle. *International Journal of Learning and Development*, *1*(2). https://doi.org/10.5296/ijld.v1i2.1179

Mulhall, S. (2007). *The conversation of humanity*. University Of Virginia Press.

Mumford, M. D., Waples, E. P., Antes, A. L., Brown, R. P., Connelly, S., Murphy, S. T., & Devenport, L. D. (2010). Creativity and Ethics: The Relationship of Creative and Ethical Problem-Solving. *Creativity Research Journal*, *22*(1). https://doi.org/10.1080/10400410903579619

Murphy, P. K., & Alexander, P. A. (2000). *Contextualizing Learner-Centered Principles for Teachers and Teaching*. Sage Books, DOI:Http://Dx.Doi.Org/10.4135/9781483329512.N2.

Murray, L. C. (2015). Book Review: The problem-centred interview. *Journal of Mixed Methods Research*, *10*(1). https://doi.org/10.1177/1558689815577032

Nesbit, T. (2015). *Conclusion: Global Developments in Adult Education Policy*. Https://Doi.Org/10.1057/9781137388254_17; Palgrave Studies in Global Citizenship Education and Democracy. Palgrave Macmillan, London. https://link.springer.com/chapter/10.1057/9781137388254_17

Nicolescu, B. (2010). *Methodology of Transdisciplinarity–Levels of Reality, Logic of the Included Middle and Complexity*. Transdisciplinary Journal of Engineering & Science 1(1) DOI: 10.22545/2010/0009.

Nincarean, D., Alia, M. B., Halim, N. D. A., & Rahman, M. H. A. (2013). Mobile Augmented Reality: The Potential for Education. *Procedia - Social and Behavioral Sciences*, *103*, 657–664. https://doi.org/10.1016/j.sbspro.2013.10.385

Novak, J. D. (1990). Concept mapping: A useful tool for science education. *Journal of Research in Science Teaching*, *27*(10), 937–949. https://doi.org/10.1002/tea.3660271003

Nuzzo, A. (2019). The "Absoluteness" of Hegel's Absolute Spirit. *Hegel's Philosophy of Spirit*, 207–224. https://doi.org/10.1017/9781108164184.011

OECD. (2016). *New forms of work in the digital economy*.

OECD. (2018). *Good Jobs for All in a Changing World of Work: The OECD Jobs Strategy*. OECD. https://doi.org/10.1787/9789264308817-en

Oganisjana, K., & Laizans, T. (2015). Opportunity-oriented Problem-based Learning for Enhancing Entrepreneurship of University Students. *Procedia - Social and Behavioral Sciences*, *213*. https://doi.org/10.1016/j.sbspro.2015.11.416

Oliveira, A. L. (2018). *The digital mind: How science is redefining humanity*.

Onarheim, B., & Fris-Ovarius, M. (2013). *Applying the Neuroscience of Creativity to Creativity Training*. Frontiers in Human Neuroscience; Frontiers.

Pace, V. L., & Brannick, M. T. (2010). Improving Prediction of Work Performance Through Frame-of-Reference Consistency: Empirical evidence using openness to experience. *International Journal of Selection and Assessment*, *18*(2). https://doi.org/10.1111/j.1468-2389.2010.00506.x

Padbury, P. (2020). An Overview of the Horizons Foresight Method: Using the "Inner Game" of Foresight to Build System-Based Scenarios. *World Futures Review*, *12*(2). https://doi.org/10.1177/1946756719896007

Papert, S. (1987). Information Technology and Education: Computer Criticism vs. Technocentric Thinking. *Educational Researcher*, *16*(1). https://doi.org/10.3102/0013189x016001022

Papert, S. (1993). *The Children's Machine: Rethinking School in the Age of the Computer*. BasicBooks, 10 East 53rd St. https://eric.ed.gov/?id=ED364201

Park, B., Knörzer, L., Plass, J. L., & Brünken, R. (2015). Emotional design and positive emotions in multimedia learning: An eyetracking study on the use of anthropomorphisms. *Computers & Education*, *86*, 30–42. https://doi.org/10.1016/j.compedu.2015.02.016

Park, B., Plass, J., & Brünken, R. (2014). *Cognitive and affective processes in multimedia learning*. Elsevier, Learning and Instruction, 2014.125-127.

Parsons, T. D., Silva, T. M., Pair, J., & Rizzo, A. A. (2008). Virtual environment for assessment of neurocognitive functioning: Virtual reality cognitive performance assessment test. *Studies in Health Technology and Informatics*, *132*, 351–356.

Patston, T. J., Kaufman, J. C., Cropley, A. J., & Marrone, R. (2021). What Is Creativity in Education? A Qualitative Study of International Curricula. *Journal of Advanced Academics*, *32*(2), 1932202X2097835. https://doi.org/10.1177/1932202x20978356

Pearce, M. T., Zaidel, D. W., Vartanian, O., Skov, M., Leder, H., Chatterjee, A., & Nadal, M. (2016). Neuroaesthetics. *Perspectives on Psychological Science*, *11*(2). https://doi.org/10.1177/1745691615621274

Pegg, A., Waldock, J., Hendy-Isaac, S., & Lawton, R. (2012). *Pedagogy For Employability.* York, UK: Higher Education Academy.

Pekrun, R. (2006). *The Control-Value Theory of Achievement Emotions: Assumptions, Corollaries, and Implications for Educational Research and Practice*. Springer Science + Business Media, LLC Published online:

Perry-Smith, J. E., & Shalley, C. E. (2003). *The Social Side of Creativity: A Static and Dynamic Social Network Perspective*. The Academy of Management Review 28(1):89-106 DOI: 10.2307/30040691.

Persaud, R. (2007). Why teaching creativity requires more than just producing more 'creativity'. *Thinking Skills and Creativity*, *2*(1). https://doi.org/10.1016/j.tsc.2006.11.001

Peters, M. A. (2004). Editorial. *E-Learning and Digital Media*, *1*(2). https://doi.org/10.2304/elea.2004.1.2.1

Petersen, J. L. (1997). The 'Wild Cards' in Our Future: Preparing for the Improbable. *The Futurist*, *31*(4), 43–47.

Piaget, J. (1954). *The construction of reality in the child*. Routledge. https://www.taylorfrancis.com/books/e/9781315009650

Piaget, J. (1977). *The development of thought: Equilibration of cognitive structures*. Viking Press.

Pivec, M. (2007). Editorial: Play and learn: Potentials of game-based learning. *British Journal of Educational Technology*, *38*(3), 387–393. https://doi.org/10.1111/j.1467-8535.2007.00722.x

Plass, J. L., Heidig, S., Hayward, E. O., Homer, B. D., & Um, E. (2013). *Emotional design in multimedia learning: Effects of shape and color on affect and learning*. Learning and Instruction journal (2013) 1e 13. www.elsevier.com/locate/learninstruc.

Polak, F., & Boulding, E. (1973). *The image of the future, Transl. And abridged by Elise Boulding.* Elsevier.

Polanyi, M. (1981). *The logic of liberty: Reflections and rejoinders*. University Of Chicago Press.

Popper, K. R. (1969). *Conjectures and refutations, etc. (Third edition, revised.)*. Routledge & Kegan Paul.

Popper, R., Georghiou, L., Keenan, M., & Miles, I. (2010). *Evaluating Foresight: Fully-Fledged Evaluation of the Colombian Technology Foresight Programme (CTFP)* (ISBN 978-958-670-842-5). Universidad del Valle.

Porter, L. W., & Lawler, E. (1968). *Managerial attitudes and performance.* Homewood, Ill, R.D. Irwin.

Puccio, G. J., & Cabra, J. F. (2019). Organizational Creativity: A systems approach. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity*. https://doi.org/10.1017/cbo9780511763205.011

Puentedura, Ruben R. (2010). *SAMR and TPCK: Intro to Advanced Practice*. http://hippasus.com/resources/sweden2010/SAMR_TPCK_IntroToAdvancedPractice.pdf

Rankin, J. R., & Sampayo, S. (2011). *A Survey Of Real-World Applications Of Serious Games Technology*. The ACRI Games Technology Laboratory La Trobe University Australia.

Raybourn, E. M. (2014). A new paradigm for serious games: Transmedia learning for more effective training and education. *Journal of Computational Science*, *5*(3), 471–481. https://doi.org/10.1016/j.jocs.2013.08.005

Real Insurance. (n.d.). The Real Future of Australian Education. *Real Insurance*. https://www.realinsurance.com.au/news-views/future-of-australian-education

Reed, M. S., Evely, Anna C., & Cundill, Georgina. (2010). *What is social learning?* Ecology and Society. ISSN 1708-3087.

Reich, R. B. (1992). *The work of nations: Preparing ourselves for 21st century capitalism*. Vintage Books.

Richards, J., & Dede, C. (2020). *The 60-Year Curriculum: A Strategic Response to a Crisis*. Er.Educause.Edu. https://er.educause.edu/articles/2020/10/the-60-year-curriculum-a-strategic-response-to-a-crisis

Riggs, S. (2019). *The Future of Narrative Immersive environments*. San Francisco, CA, USA Immersive Design Summit 2019.

Robson, E., Robson, R., Eduworks, E., York, N., Corvallis, N., Robson@eduworks, E., & Com. (2014, November). *Automated Content Alignment for Adaptive Personalized Learning*.

Rogoff, B. (1997). Evaluating development in the process of participation: Theory, methods, and practice building on each other. In E. Amsel & K. A. Renninger (Eds.), *Change and development: Issues of theory, method, and application*. L. Erlbaum.

Rooney, P. (2012). A Theoretical Framework for Serious Game Design. *International Journal of Game-Based Learning*, *2*(4). https://doi.org/10.4018/ijgbl.2012100103

Root-Bernstein, M. (2014). *Inventing Imaginary Worlds: From Childhood Play to Adult Creativity Across the Arts and Sciences*. Rowman & Littlefield Education.

Rotherham, A., & Willingham, D. (2009). 21st Century Skills: The Challenges Ahead. *Educational Leadership*, *67*.

Rubenson, D. L., & Runco, M. A. (1992). The psychoeconomic approach to creativity. *New Ideas in Psychology*, *10*(2). https://doi.org/10.1016/0732-118x(92)90021-q

Runco, M. A., & Jaeger, G. J. (2012). The Standard Definition of Creativity. *Creativity Research Journal*, *24*(1). https://doi.org/10.1080/10400419.2012.650092

Sandler, R. L. (2014). *Ethics and emerging technologies*. Palgrave Macmillan.

Sansone, C., Fraughton, T., Zachary, J. L., Butner, J., & Heiner, C. (2011). *Self-regulation of motivation when learning online: The importance of who, why and how*. Published online: 27 February 2011 Association for Educational Communications and Technology 2011.

Sardar, Z. (2010). Welcome to postnormal times. *Futures*, *42*(5). https://doi.org/10.1016/j.futures.2009.11.028

Sawyer, K. (2008). *The future of learning in the age of innovation. Review for the Beyond Current Horizons Programme*. Futurelab.

Sawyer, R. K. (2013). *Zig Zag: The Surprising Path to Greater Creativity*. Jossey-Bass.

Sawyer, R. K. (2014). The future of learning: Grounding educational innovation in the learning sciences. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences, Second Edition* (pp. 726–746). Cambridge University Press.

Schejbal, D. (2012). In Search of a New Paradigm for Higher Education. *Innovative Higher Education*, *37*(5), 373–386. https://doi.org/10.1007/s10755-012-9218-z

Schenck, J., & Cruickshank, J. (2014). Evolving Kolb. *Journal of Experiential Education*, *38*(1). https://doi.org/10.1177/1053825914547153

Schreer, O., Feldmann, I., Renault, S., Zepp, M., Worchel, M., Eisert, P., & Kauff, P. (2019). *Capture and 3D Video Processing of Volumetric Video*. IEEE. 10.1109/ICIP.2019.8803576, 22-25 Sept. 2019, Conference Location: Taipei, Taiwan.

Schunk, D. H. (2012). *Learning Theories An Educational Perspective, 6th Edition*. Pearson Education, Inc., publishing as Allyn & Bacon, 501 Boylston Street, Boston, MA, 02116.ISBN-13: 978-0-13-707195-1.

Scott, G., Leritz, L. E., & Mumford, M. D. (2004). The effectiveness of creativity training: A quantitative review. *Creativity Research Journal*, *16*(4). https://doi.org/10.1080/10400410409534549

Seaman, J., Brown, M., & Quay, J. (2017). The Evolution of Experiential Learning Theory: Tracing Lines of Research in the JEE. *Journal of Experiential Education*, *40*(4). https://doi.org/10.1177/1053825916689268

Selvi, K. (2007). Learning and Creativity. In A.-T. Tymieniecka (Ed.), *Phenomenology of Life—From the Animal Soul to the Human Mind*. Springer Netherlands.

Şendağ, S., & Gedik, N. (2015). Yükseköğretim Dönüşümünün Eşiğinde Türkiye'de Öğretmen Yetiştirme Sorunları: Bir Model Önerisi. *Eğitim Teknolojisi Kuram ve Uygulama*, *5*(1). https://doi.org/10.17943/etku.35232

Sfard, A. (1998). On Two Metaphors for Learning and the Dangers of Choosing Just One. *Educational Researcher*, *27*(2), 4–13. https://doi.org/10.3102/0013189X027002004

Sharples, M., Taylor, J., & Vavoula, G. N. (2016). A theory of learning for the mobile age. In C. Haythornthwaite, R. Andrews, J. Fransman, & E. Meyers (Eds.), *The Sage handbook of E-learning research*. Sage Reference.

Shirani, F. (2015). Book Review: Andreas Witzel and Herwig Reiter, The Problem-Centred Interview. *Qualitative Research*, *15*(1). https://doi.org/10.1177/1468794114535037

Shirley, D. A., & Langan-Fox, J. (1996). Intuition: A Review of the Literature. *Psychological Reports*, *79*(2), 563–584. https://doi.org/10.2466/pr0.1996.79.2.563

Siemens, G. (2004). *Connectivism: A Learning Theory for the Digital Age*. elearnspace.

Siemens, G., & Tittenberger, P. (2009). *Handbook of Emerging Technologies for Learning*.

Simonton, D. K. (1975). Age and Literary Creativity. *Journal of Cross-Cultural Psychology*, *6*(3), 259–277. https://doi.org/10.1177/002202217563001

Singal, N., Pedder, D., Malathy, D., Shanmugam, M., Manickavasagam, S., & Govindarasan, M. (2018). Insights from within activity based learning (ABL) classrooms in Tamil Nadu, India: Teachers perspectives and practices. *International Journal of Educational Development*, *60*. https://doi.org/10.1016/j.ijedudev.2017.08.001

Sinnott, J. D., Demick, J., & Andreoletti, C. (2003). *Postformal Thought and Adult Development*. Springer Link; Springer US. https://link.springer.com/chapter/10.1007%2F978-1-4615-0617-1_12

Slater, B. H. (2006). *Aesthetics | Internet Encyclopedia of Philosophy*. Http://Www.Iep.Utm.Edu/a/Aestheti.Htm#H2. http://www.iep.utm.edu/a/aestheti.htm#H2

Snyder, T. D., De Brey, C., & Dillow, S. A. (2019). *Digest of Education Statistics, 2018*. National Center for Education Statistics. US Department of Education. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2020009

Son, H. (2015). The history of Western futures studies: An exploration of the intellectual traditions and three-phase periodization. *Futures*, *66*, 120–137. https://doi.org/10.1016/j.futures.2014.12.013

Spector, J. M. (2012). *Foundations of educational technology*. Routledge (London & New York) isbn 978-0-415-87471-7 189 pp.

Spies, P. H. (2019). Process-Based Evaluation of the Potential Affectiveness of Futures Studies as a Profession. *World Futures Review*, *11*(4), 308–319. https://doi.org/10.1177/1946756719862117

Sramova, B., & Fichnova, K. (2008). *IDENTITY AND CREATIVE PERSONALITY*. Institute of Experimental Psychology, Slovak Academy of Sciences, Studia Psychologica 2008 | 50 | 4 | 357-369.

Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG). (2015). ESG. https://www.enqa.eu/wp-content/uploads/2015/11/ESG_2015.pdf

Stanza. (2020). *Amorphoscapes by Stanza*. Stanza.Co.Uk. https://www.stanza.co.uk/amorphoscapes/

Steier, F. (1995). Reflexivity, Interpersonal Communication, and Interpersonal Communication Research. *Social Approaches to Communication*, 63–87.

Stein, M. I. (1953). Creativity and Culture. *The Journal of Psychology*, *36*(2), 311–322. https://doi.org/10.1080/00223980.1953.9712897

Steinberg, S. R., & Kincheloe, J. L. (2010). *Power, Emancipation, and Complexity: Employing Critical Theory*. Power and Education 2(2):140 DOI: 10.2304/power.2010.2.2.140.

Sternberg, R. J., & Lubart, T. (1999). The Concept of Creativity—Prospects and paradigms. In *Handbook of Creativity*. Cambridge University Press.

Strada Institute. (2019). Strada Institute for the Future of Work 2019. *Strada Institute*. https://stradaeducation.org/institute-for-the-future-of-work/

Swarts, P. (2010). *Perspectives on ict4e in the developing world*. Global e-Schools and Communities Initiative (GeSCI).

Tan, A.-G. (2015). Convergent Creativity: From Arthur Cropley (1935-) Onwards. *Creativity Research Journal*, *27*(3), 271–280. https://doi.org/10.1080/10400419.2015.1063892

Taylor, E. W. (2008). *Transformative learning theory*. The Jossey-Bass New Directions Series Adult and Continuing Education, Volume 2008, Issue 119 Special Issue:Third Update on Adult Learning TheoryPages: 5-15, https://doi.org/10.1002/ace.301.

The neuroscience of creativity (SOP10 2014). (n.d.). https://www.apa.org/news/podcasts/speaking-of-psychology/neuroscience-creativity.

Tinagli, I. (2012). *Norway in the creative age*. https://www.irenetinagli.eu/norway-in-the-creative-age-2012-en/

Tobias, S., Fletcher, J. D., Bediou, B., Wind, A. P., & Chen, F. (2014). Multimedia Learning with Computer Games. *The Cambridge Handbook of Multimedia Learning*, 762–784. https://doi.org/10.1017/cbo9781139547369.037

Torff, B., & Sternberg, R. J. (2001). *Understanding and teaching the intuitive mind: Student and teacher learning*. Lawrence Erlbaum Associates.

Torrance, E. P. (1969). What is Honored: Comparative Studies of Creative Achievement and Motivation*. *The Journal of Creative Behavior*, *3*(3), 149–154. https://doi.org/10.1002/j.2162-6057.1969.tb00122.x

Tseng, S.-F., Tsao, Y.-W., Yu, L.-C., Chan, C.-L., & Lai, K. R. (2016). Who will pass? Analyzing learner behaviors in MOOCs. *Research and Practice in Technology Enhanced Learning*, *11*(1). https://doi.org/10.1186/s41039-016-0033-5

Turkle, S. (2005). *The Second Self*. MIT Press, Cambridge, Massachusetts London, England.Twentieth Anniversary Edition Computers and the Human Spirit , ISBN 0-262-70111-1.

Turkle, S. (2011). *Alone Together: Why We Expect More from Technology and Less from Each Other*. Basic Books, 2011 ISBN: 0465022340, 9780465022342.

Turkle, S. (2016). *Reclaiming Conversation: The Power of Talk in a Digital Age Paperback* –. Penguin Books; Reprint Edition Paperback. ISBN-13 : 978-0143109792.

Um, E., Song, H., & Plass, J. (2007). *The Effect of Positive Emotions on Multimedia Learning*.

UNESCO Bangkok and Commonwealth of Learning. (2004). *SchoolNet Toolkit*. UNESCO Bangkok; Commonwealth of Learning.

University of Cambridge. (2021). *LibGuides: Reflective Practice Toolkit: Models of reflection*. Cam.Ac.Uk. https://libguides.cam.ac.uk/reflectivepracticetoolkit/models

Vakoufari, M., AngelakiI., C., & Mavroidis, I. (2014). *Self-Esteem and Loneliness as Factors Affecting Distance Learning Students*. European Journal of Open, Distance and E-Learning 17(2) DOI: 10.2478/eurodl-2014-0022 LicenseCC BY-NC-ND 3.0.

Van Audenhove, L., & Donders, K. (2019). Talking to People III: Expert Interviews and Elite Interviews. In M. Puppis, H. van den Bulck, K. Donders, & L. Van Audenhove (Eds.), *The Palgrave Handbook of Methods for Media Policy Research*. https://doi.org/10.1007/978-3-030-16065-4_10

Veletsianos, G. (2016). *Emergence and Innovation in Digital Learning: Foundations and Applications* (G. Veletsianos, Ed.). Athabasca University Press. https://doi.org/10.15215/aupress/9781771991490.01

Veletsianos, George. (2010). *Emerging Technologies in Distance Education.* Edmonton, AB: Athabasca University Press. https://www.aupress.ca/books/120177-emerging-technologies-in-distance-education/

Vita-More, N. (2020). *Transhumanist Manifesto*. https://natashavita-more.com/transhumanist-manifesto/

von Glasersfeld, E. (2001). Radical constructivism and teaching. *Prospects*, *31*(2), 161–173. https://doi.org/10.1007/bf03220058

Von Neumann, J., & Arthur Walter, B. (1996). *Theory of Self-Reproducing Automata.* University of Illinois Press, Urbana, IL.

Voros, J. (2003). A generic foresight process framework. *Foresight*, *5*(3), 10–21. https://doi.org/10.1108/14636680310698379

Vygotsky, L. S. (1980). *Mind in Society: The Development of Higher Psychological Processes.* Cambridge, MA: Harvard University Press.

Wagner, T. (2015). *Creating Innovators: The Making of Young People Who Will Change the World*. New York, N.Y. Scribner.

Wallas, G. (2014). *The art of thought*. Solis Press.

Wankel, C., & Blessinger, P. (2013). *Increasing Student Engagement and Retention Using Classroom Technologies: Classroom Response Systems and Mediated Discourse Technologies*. Emerald Publishing Limited.

Ward, T. B., Finke, R. A., & Smith, S. M. (1995). *Creativity and the Mind*. Boston, Ma Springer Us.

Weick, K. E., & Sutcliffe, K. M. (2015). *Managing the unexpected: Sustained performance in a complex world* (Third edition). Wiley.

Weimer, M. (2013). *Learner-centered teaching: Five key changes to practice*. Jossey-Bass.

Weinberger, D. (2010). *The Problem with the Data-Information-Knowledge-Wisdom Hierarchy*. Harvard Business Review. https://hbr.org/2010/02/data-is-to-info-as-info-is-not

Whitchurch, C. (2008). *Shifting Identities and Blurring Boundaries: The Emergence of Third Space Professionals in UK Higher Education First published: 29 September 2008*. https://doi.org/10.1111/j.1468-2273.2008.00387.x.

Whittingham, R. (2015). *Giddens, structuration theory and strategy as practice*. DOI: 10.1017/CCO9781139681032.009.

Wilber, K. (2000). *A theory of everything: An integral vision for business, politics, science, and spirituality*. Shambhala.

Williams, M. (2011). *Problems of knowledge: A critical introduction to epistemology*. Oxford University Press.

Winne, P. H., & Azevedo, R. (2014). *Metacognition from Part I - Foundations*. The Cambridge Handbook of the Learning Sciences , pp. 63 - 87, Edited by R. Keith Sawyer online by Cambridge University Press: 05 November 2014.

Witzel, A. (2000). The problem-centered interview. *Forum: Qualitative Social Research*, *1*(1). http://nbn-resolving.de/urn:nbn:de:0114-fqs0001228

Woodgate, D. (2011). The Sense Event. *Academia.Edu*. https://www.academia.edu/4153908/The_Sense_Event_From_sensation_to_imagination

Woodgate, D. (2017). *How future multimedia will augment student interaction, engagement and collaboration*.

Woodgate, D. (2018a). *Foresight as a Tool for Increasing Creativity in the Age of Technology-Enhanced Learning.* Communications in Computer and Information Science. ISSN: 1865-0929. 940s 21 - 35. doi:10.1007/978-3-030-00825-3_3.

Woodgate, D. (2018b). *Future Robotics: Adaptive Learning – Postnormal skills*. World Learning Summit, Kristiansand.

Woodgate, D. (2019). *Immersive spatial narratives as a framework for augmenting creativity in foresight-based learning systems.*

Woodgate, D. (2020, February). *HMR (Human Machine Resources) Development in the Post-quantum Era*. MOI Innovation Summit, Abu Dhabi, UAE.

Woodgate, D., & Isabwe, G. M. (2018). Developing Future Vision Landscape and Models of Technology Enhanced Learning. *INTED2018 Proceedings*. https://doi.org/10.21125/inted.2018.1608

Woodgate, D., & Lichty, P. (2017). *Matrix Redux*. The Well. ople.well.com/conf/inkwell.vue/topics/502/Matrix-Redux-1-page01.html

Woodgate, D., & Pethrick, W. R. (2004). *Future Frequencies*. Fringecore.

Woodgate, D., & Veigl, H. (2020). *Exploring the Future of Universities through Experimental Foresight*. World Future Review. ISSN: 1946-7567. 12 (4). s 322 - 336. doi:10.1177/1946756720976714.

World Economic Forum. (2016a). *The Future of Jobs*. World Economic Forum. http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

World Economic Forum. (2016b). *The Global Risks Report 2016 (11th Edition)*. https://www.mercer.com/content/dam/mercer/attachments/global/wef-global-risks-report-2016-mercer.pdf

World Economic Forum. (2018). *The Future of Jobs*. World Economic Forum.

Wouters, Pieter, van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). *A Meta-Analysis of the Cognitive and Motivational Effects of Serious Games*. Journal of Educational Psychology © 2013 American Psychological Association 2013, Vol. 105, No. 2, 249 –265.

Wright, G. B. (2011). Student-Centered Learning in Higher Education. *International Journal of Teaching and Learning in Higher Education*, *23*(3).

Wu, H. K., & Dunning, D. (2018). *Hypocognition: Making Sense of the Landscape Beyond One's Conceptual Reach*. Review of General Psychology 22(1):25-35 DOI: 10.1037/gpr0000126.

Yin, Y. H., Xie, J. Y., Xu, L. D., & Chen, H. (2012). Imaginal Thinking-Based Human-Machine Design Methodology for the Configuration of Reconfigurable Machine Tools. *IEEE Transactions on Industrial Informatics*, *8*(3), 659–668. https://doi.org/10.1109/TII.2012.2188900

Yoon, S. A., & Wang, J. (2014). *Making the Invisible Visible in Science Museums Through Augmented Reality Devices*. TechTrends 58(1) DOI: 10.1007/S11528-013-0720-7 Volume 58, Number 1.

Zabelina, D. L. (2018). Attention and Creativity. *The Cambridge Handbook of the Neuroscience of Creativity*, 161–179. https://doi.org/10.1017/9781316556238.010

Zhang, J., Yin, Z., & Wang, R. (2015). Recognition of Mental Workload Levels Under Complex Human–Machine Collaboration by Using Physiological Features and Adaptive Support Vector Machines. *IEEE Transactions on Human-Machine Systems*, *45*(2), 200–214. https://doi.org/10.1109/THMS.2014.2366914

Žižek, S. (2004). *Organs without Bodies: On Deleuze and Consequences*. Routledge & CRC Press. https://www.routledge.com/Organs-without-Bodies-On-Deleuze-and-Consequences/Zizek/p/book/9780415519045

Žižek, S. (2006). *The parallax view*. MIT Press.

Zund, F., Ryffel, M., Magnenat, S., Marra, A., Nitti, M., Kapadia, M., Noris, G., Mitchell, K., Gross, M., & Sumner, R. W. (2015). *Augmented Creativity: Bridging the real and virtual worlds to enhance creative play*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.705.8429&rep=rep1&type=pdf

12 List of figures and tables

12.1 List of Figures

12.2 List of Tables

13 Appendices

13.1 Glossary of terms

Accelerated learning: Adapting to a student's preferred learning style to optimise their skills and learning pace.

Amorphoscapes: A technique that uses generative, concept randomisation made either physically or with computer code to create new perspectives, paradigms, context and constructs for future drivers, influences and implications.

Artificial General Intelligence (AGI): the hypothetical ability of an intelligent agent to understand or learn any intellectual task that a human can. Often, linked to the Singularity.

Artificial Intelligence (AI): Development of computer systems able to perform tasks that usually require human intelligence.

Augmented Reality (AR): is an overlay of computer-generated content on the real world that can superficially interact with the environment in real-time. With AR, there is no occlusion between CG content and the real-world.

The Becoming: Leveraged from the Deleuzian term, the Becoming is the affirmation of a positivity of difference or true transformation. It is the process or flux at which change is observed, recognised and accepted.

Brain computer interface: Direct communication pathway between an enhanced or wired brain and an external device.

Claytronics: is an emerging concept that combines nanoscale robotics and computer science to create individual nanometer-scale computers called claytronic atoms, or catoms.

Cognitive feedback: The process of presenting the personal information about the relations in the environment, relations perceived by the person and relations between the environment and the persons' perceptions of the environment

Cognisphere: Is a term I used to express the concept of the learner as the holistic environment where fully immersive learning experiences increase the potential for the ideation of next big ideas.

Competency-based assessment: Systems of instruction, assessment, grading, and academic reporting that are based on students demonstrating that they have learned the knowledge and skills they are expected to learn as they progress through their education.

Context-relevant multimedia: Delivery of content through multimedia that optimises the format and gives greater meaning to the content

Convergence: Merging of distinct entities into a unified whole that extends their individual power or create a new entity

Creativity: The ability to make new things or think/imagine new idea that meets the requirement of novelty and purpose

Crossmedia: which means one story, many channels.

Cultural change: Modification of a society through innovation, invention, discovery, or contact with other societies.

Cyborg: A contraction of "cybernetic organism", is a being with both organic and biomechatronic body parts.

Decentralised learning: No core content – a body of loosely related materials that different students explore in line with their own personal learning needs.

Deep learning: Deep machine learning based on a set of algorithms that attempt to model high-level abstractions in data by using multiple processing layers, with complex structures or otherwise, composed of multiple non-linear transformations.

Diffusion of innovation in education: The spreading of new ideas, technologies, etc. through educational innovation.

Directable robots: Reflects a human-robot relationship and interaction in which the human maintain control, but the robot is able to protect its own existence.

Eduenterprises: A term I coined in 2012 to reflect the growth in non-institutional education providers.

Egosyntronic: A term from psychoanalysis, which refers to the behaviors, values, and feelings that are in harmony with or acceptable to the needs and goals of one's ego, or consistent with one's ideal self-image.

Exascale computing: Computing systems capable of at least one exaflop or a billion billion calculations per second (10^{18}). That is 50 times faster than the most powerful supercomputers being used today

Experiential learning: Process of learning or meaning-making through experience, and is more specifically defined as "learning through reflection on doing".Enabling the individual to make discoveries and experiments with knowledge firsthand.

Extended Reality (XR): refers to all real-and-virtual environments generated by computer technology and wearables. The 'X' in XR is a variable that can stand for any letter.

Fluid interfaces: Integrating digital interfaces more naturally into our physical lives, enabling insight, inspiration, and interpersonal connections.

Frontline Panels: A group of multidisciplinary experts who work at the forefront of change and have the potential to significant influence the future.

Futuirisation: To bring an entity into the future or make it future-ready or future-proofed

Gamification: Application of typical elements of game playing (e.g., point scoring, competition with others, rules of play, design) in other activities including education, specifically instructional design.

Haptic interfaces: Manual sensing and manipulation of surrounding and environments through the sense of touch.

Heterarchy: A form of management or rule in which any unit can govern or be governed by others, depending on circumstances, and, hence, no one unit dominates the rest. Authority within a heterarchy is distributed.

Human-Machine Resources (HMR): Replacing Human Resources as a function and a workforce stewardship ecosystem.

Human development: Reflecting the changes in the human condition. Expanding the richness of human life, rather than simply the richness of the economy in which human beings live, understanding how humans are adapting to social, cultural and technological change and the impact it has on their learning abilities and approaches.

Human machine interface (HMI): Interface method between the human and the machine (computer, devices, etc.)

Humanoids: A humanoid is a non-human entity with human form or characteristics and behaviours.

Ideosphere: like the noosphere (i.e., the realm of reason)—is the metaphysical "place" where thoughts, theories, ideas, and ideation are regarded to be created, evaluated, and evolved.

Imaginal Thinking: Refers to thinking in a multi-dimensional associative structure of "images" in time and space. It is also an associative structure of experiences, perceptions or pieces of imagination.

Innovation: Act of introducing relevant new things, ideas, methods, etc. (novelty, feasibility, viability, purpose and context).

Instructional design: The process by which instruction is improved through the analysis of learning needs and systematic development of learning experiences.

Interopceptive: The ability to identify, access, understand, and respond appropriately to the patterns of internal signals – provides a distinct advantage to engage in life challenges and on-going adjustments.

Internet of Things (IoT): the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data.

Latent factors: variables that are not directly observed but are rather inferred from other variables that are observed.

Learner: One who learns any knowledge or skill in any environment or format. NB often used in place of student,

Learning: Process of filtering, selecting, organizing and integrating information based upon prior or newly acquired knowledge.

Learning devices: Tools that create, support, deliver, enable learners to access, study and interface with content and formats across, multiple contexts and environments, through social and content interactions.

Learning pathways: The chosen route, taken by a learner through a range of learning activities, which allows them to build knowledge progressively and through personalised transitions. Choice moves away from the tutor to the learner.

Lifesharing: Here I refer to Lifesharing as a process that evolves from a collaborative worksharing contribution within a mutually supportive learning environment.

Lifeworlds: All the immediate experiences, activities, and relationships that make up the world of an individual learner.

Machines: Any system with ordered structural and functional properties that performs a task. This includes artificial devices molecular machines, automata (autonomous robots)

Machine learning (ML): Subfield of computer science that evolved from the study of pattern recognition and computational learning theory in artificial intelligence

Meshworks: An interlaced networked structure prominent in the emerging discussions on quantum communications.

Metabrain: Any human system that engages the intelligence of all of the participants in the collaborative environment.

Metaeconomics: A humanizing of economics by accounting for the imperative of a sustainable environment and an ethical approach to wealth distribution that is not based upon microeconomics.

Mixed Reality (MR): an overlay of synthetic content that is anchored to and interacts with objects in the real world—in real time. Mixed Reality experiences exhibit occlusion, in that the computer-generated objects are visibly obscured by objects in the physical environment

Multimedia: Using more than one medium of expression or communication for creating or delivering learning content.

Multimedia enhanced experiential learning: Designing and implementing experiential learning through multi-media-based activities to enhance learner performance.

Multisensory learning: Presenting all information to students via three sensory modalities: visual, auditory, and tactile.

Nanosateliltes: miniaturised satellite, or smallsat has a low mass and size and works at low altitudes for collecting scientific data or working with quantum communications over short ranges for personalised communications systems.

Neuroscience: (Educational) Neurochemistry and experimental psychology deal with the structure or function of the nervous system and brain. Its growing relationship to education relates to monitoring how students, learn, what is learning, assessment, and performance feedback.

Neuroaesthetics: A relatively recent sub-discipline of empirical aesthetics that takes a scientific approach to the study of the aesthetic perceptions of any object that can give rise to aesthetic judgments.

Neurocreativity: A deep understanding of how creativity works in the brain.

Opportunity hacking: Seek out optimised future potential by exploring and mapping early signals/framing future drivers.

Nootropic: Supplements to improve cognitive functioning

Open Learning Models: Machine representation of the learner as a support mechanism, aid for learning.

Performative: Being or relating to an expression that serves to affect a transaction.

Personal ambience: Based upon sensation and encounter, Personal Ambience is what we let in when the experience or sensation, reach the "visual heartbeat level", going beyond the five senses.

Plausible futures: A term used in the science of foresight to describe future potential scenarios that are likely to happen rather than just could happen.

Plutopia: Multiple potential utopias

Positive affect: The extent to which an individual subjectively experiences positive moods such as joy, interest, and alertness.

Posthuman: a person or entity that exists in a state beyond being human.

Postformal education: Connects postformal psychology with post-formal approaches to education Integrates diverse "alternative" pedagogies into a postformal education philosophy

Postnormal times: A concept developed by Ziauddin Sardar as a development post-normal science, seen as an in-between period where old orthodoxies are dying, new ones have yet to be born, and very few things seem to make sense.

Prosumer: a consumer who becomes involved with designing or customizing products for their own needs.

Rhizomatic thinking: Base upon a philosophical concept developed by Gilles Deleuze and Félix Guattari in their Capitalism and Schizophrenia (1972–1980) project. A non-linear, nomadic thinking techniques that connects disconnects and forms meshworks that are not necessarily on a continuum.

Robotics and AI for learning: new roles in teaching and learning aids, deep learning and computer vision as well as robots teaching other robots how to think and interact with the world.

Foresight: Also known as "studies of the future." A complex, comprehensive process of techniques, modelling, visioneering, horizon scanning for early signals and other approaches aimed at creating the future visualised through detailed future concept platforms and scenarios.

Self-extension: A step beyond self-actualisation in the "hierarchy of needs" identified by Woodgate (Future Frequencies, 2004). Different meaning than Belk (1988). It refers to the augmented self and the augmented human's ability to go beyond what is expected of him or herself often through technological enhancement.

Self-Conscious Machine: (1) A body that responds to stimuli; (2) a method of communication; and (3) an algorithm that attempts (with little success) to deduce the reasons and motivations for these communications.

Self-developing artificial intelligence: AI programs that improve themselves generation after generation without human input.

Self-learning: This model adopts the idea of inquiry-based learning where students are presented with scenarios to identify their own research, questions, and knowledge regarding the area. As a form of discovery learning, students are provided with more opportunity to "experience and interact" with knowledge, which has its roots in autodidacticism. In essence, the learner takes more responsibility with the teacher as mentor. Sometimes referred to as unschooling or child-directed learning.

Sensory enhancement: Techniques designed to augment sensory input to the central nervous system, which will augment sensory reception such as touch, vision and hearing.

Sense Event: A phrase I coined to describe the experiences of sensation and encounter, when body, mind, culture and environment are harmonised and engaged with meaningful intensity.

Serious games: Serious games are a subgenre of serious storytelling, where storytelling is applied "outside the context of entertainment, Serious games are often used for simulation in training and education, where the value of fun and challenge can be added to the pedagogical aspects.

The Singularity: The point in time or development when artificially intelligent machines equal or surpass humans in intelligence.

Situative perspective: The situative perspective acknowledges the social world in which we all develop—we learn through interaction with other beings in the world, as well as with cultural and material tools and objects.

Social change: Any significant alteration over time in behaviour patterns and cultural values and norms., usually manifested as social consequences.

STEEP: an acronym for Social, Technological, Economic, Environmental, and Political categories. They are good “starter” categories when one is doing environmental scanning (that is, looking for signals of change).

STREAM: A flexible for transforming higher science education into blended and online learning.

Student-centred learning: Refers to a wide variety of educational programs, learning experiences, instructional approaches, and academic-support strategies that are intended to address the distinct learning needs, interests, aspirations, or cultural backgrounds of individual students and groups of students. It reflects the shift from student to learner as the centre of learning.

Superhumans: The term superhuman refers to humans or human-like lifeforms or humans with enhanced qualities and abilities that exceed those naturally found in humans. These qualities may be acquired through natural ability, self-actualisation, self or technological aids such as implants.

Synthetic characters: Development of virtual agents with an extensible brain architecture that that integrates deliberate goal pursuit with coherent improvisation to achieve believable behaviour and can be directed through a centralised narrative control mechanism. Advances in AI have enabled synthetic characters to be self-developing.

Techarts: Are the combination of arts and technology both in the creative process and in the aesthetic output. Recently, arts have moved beyond the digital to include genetics, artificial intelligence, and nanotechnology.

Telepresence: Set of technologies, including virtual reality, which allow a person to feel immersed in an environment as if they were present, to give the appearance of being present, or to have an effect, via telerobotics, at a place other than their true location.

Transdisciplinary: Is defined as learning or research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches. This approach is increasingly reflected in course and department structures.

Transformative learning spaces: Beyond the classroom. Learning environments that optimise the benefits of emerging transformative learning and are tailored to the student and content.

Transhumanism: A loosely defined movement that has developed gradually over the past two decades. It promotes an interdisciplinary approach to understanding and evaluating the opportunities to transform the human condition by developing and creating widely available sophisticated technologies to greatly enhance human intellectual, physical, and psychological capacities.

Transmedia: Expands the scope of a storyworld by adding multiple stories told through different media channels. It differs from

Virtual reality: Also known as immersive multimedia or computer-simulated reality, is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence that environment in a way that allows the user to interact with it. Virtual realities artificially create sensory experience, which can include sight, touch, hearing, and smell.

Workscape: Is the holistic ecosystem in which work is undertaken and includes the envoironment, jobs tasks and skills.

xMedia: The integration and interaction of multiple media formats to develop a deeper, immersive experience – see Crossmedia**.**

13.2 A list of abbreviations

AEM: Association of Equipment Manufacturers
AGI: Artificial General Intelligence
AI: Artificial intelligence
API: Application Programming Interface
APX: means “approximable” a set of nondeterministic polynomial time
AR: Augmented Reality
AV: Augmented Virtuality
BCI: Brain-computer Interface
BDS: Body, Data, Space
CAL: Causal Layered Analysis
CAS: Complex Adaptive Systems
CDCS: Creative Solutions Diagnosis Scale
CFA: Confirmatory Fact Analysis
CMII: Capability Maturity Model Integration
CPS: Cyber Physical Systems
CPSS: Creative Product Semantic Scale
CTML: Cognitive Theory of Multimedia Learning
DIKW: Data, Information, Knowledge, Wisdom
DJ: Disc Jockey
EL: Enterprise Linux
FCPL Futures Concept Platform
FLA: Functional Requirements Analysis
FMRI: Functional Magnetic Resonance Imaging
F2F: Face to Face
GDP: Global Domestic Product
GPS: Global Positioning System
HCAI: Human-centred Artificial Intelligence
HCI: Human computer interfaces
HMR: Human-machine Resources
H2H: Human to Human
H2M: Human to Machine
ICT: Information and communications technologies
ISD: Instructional Systems Design Framework
LIDAR: Light Detecting and Ranging (3D scanning)
LLL: Lifelong learning
LLS: Living Learning System
LMS: Learning Management System
LX: learning experience
LXP Learning Experience Platform
MIT: Massachusetts Institute of Technology
ML: Machine Learning
MLT: Multimedia Learning Tools
MOOC: Massive Open Online Course
MRI: Magnetic Resonance Imaging
NASA: National Aeronautics and Space Administration
NLP: Natural Language Processing
NSD: Norwegian Centre for Research Data
OECD: Overseas Economic Development
OER: Open Education Resources

PMU: Prince Mohammad Bin Fahd University
PNC: Price Waterhouse Coopers
RDCA: Reisman Diagnostic Creativity Assessment
SAT: Scenario Assessment Tool
SDL: Self-directed Learning
SDT: Self-determination Theory
SEM: Semester
STEAM: Science, Technology, Engineering, Arts, and Maths
STEEP: Society, Technology, Economics, Environment and Politics
SXSW: South by Southwest
TAFFD: Transdisciplinary Agora for Futures Discussion
TTCT: Torrance Test for Creative Thinking
TFL: The Futures Lab, Inc.
UiA: University of Agder
UAE: The United Arab Emirates
UNESCO: The United Nations Educational, Scientific and Cultural Organisation
UNIPED: University Pedagogy
VCAI: Vast Creative Abu Indicator
VIEW: Virtual impact enable wearables
VR: Virtual reality
WEF: World Economic Forum
XR: Extended Reality
ZPD: Zonal Proximity Development

14 Errata list

p. 4, fourth paragraph, text line 2, replace “my” by “the”
p. 6, second paragraph, text line 4, deleted “all from the University of Agder”
p. 8, first paragraph, text line 1, replace “round” by “on”
p. 8, third paragraph, text line 1, replace “I took an open-ended learning design approach” by “an open-ended learning design approach was preferred”
p. 8, first paragraph, text line 3, replace “I was even permitted” by “Permission was given”
p. 10, third paragraph, text line 1, replace “I looked at” by “special attention was given to”
p. 11, third paragraph, text line 1, replace “I was cognizant at the time” by “At the time I was cognizant”
p. 12, first paragraph, text line 1, replace “I designed” by “and its design”
p. 12, second paragraph, text line 3, replace “I refer” by “is referred”
p. 12, second paragraph, text line 18, replace “I would add” by “to be expanded with”
p. 12, fourth paragraph, text line 2, replace “round” by “on”
p. 12, first paragraph, text line 1, replace “I put more emphasis” by “more emphasis was placed”
p. 13, second paragraph, text line 4, replace “that I was” by “to be”
p. 13, second paragraph, text line 8, replace “I saw” by “we could”
p. 13, fifth paragraph, text line 2, replace “I introduced” by “were introduced”
p. 14, second paragraph, text line 2, deleted “I decided that”
p. 14, second paragraph, text line 3, replace “I should undertake” by “was undertaken”
p. 14, second paragraph, text line 4, replace “student, firstly using” by “student. Firstly, by using”
p. 14, third paragraph, text line 1, replace “I chose” by “for choosing”
p. 15, third paragraph, text line 10, deleted “I decided that”
p. 15, third paragraph, text line 13, replace “I was also motivated” by “It was critical”
p. 15, fourth paragraph, text line 1, replace “amongst others together with Rune Andersen, Maurice Isabwe” by “together with Rune Andersen, Maurice Isabwe, we”
p. 15, fourth paragraph, text line 6, deleted “all of which I was associated”
p. 16, second paragraph, text line 3, replace “I wanted” by “It was necessary”
p. 16, second paragraph, text line 6, replace “I had” by “It was necessary”
p. 16, third paragraph, text line 2-3, replace “although I wanted the new system to be” by “while ensuring that the new system would be”
p. 16, fourth paragraph, text line 1, deleted “I decided that”
p. 16, fourth paragraph, text line 1, deleted “I would embark upon”
p. 16, fourth paragraph, text line 5, replace “I also wanted to introduce” by “Emphasis was given to the introduction of”
p. 19, fourth paragraph, text line 3, replace “I used” by “was used”
p. 20, second paragraph, text line 1, replace “which I used” by “which were used”
p. 20, second paragraph, text line 2, replace “framework of my” by “framework of the”
p. 20, second paragraph, text line 11, replace “I then undertook qualitative and quantitative research” by “Qualitative and quantitative research were undertaken”

p. 23, first paragraph, text line 1, replace “my Literature Review” by “the literature review”
p. 23, third paragraph, text line 2, replace “my literature review” by “the literature review”
p. 24, second paragraph, text line 2, replace “my research” by “the research”
p. 24, fourth paragraph, text line 1, deleted “my”
p. 25, second paragraph, text line 1, replace “my assumption” by “the assumption”
p. 25, third paragraph, text line 5, deleted “Educational policy making was explored at a deeper level through the writings of Praest ().”
p. 26, first paragraph, text line 18, replace “my understanding” by “the understanding”
p. 27, first paragraph, text line 4, replace “my problem” by “the problem”
p. 27, first paragraph, text line 5, replace “my research” by “the research”
p. 27, third paragraph, text line 10, replace “I felt like it was critical that I had” by “It was critical to have”
p. 30, fourth paragraph, text line 1, replace “my other” by “the other”
p. 30, fourth paragraph, text line 4, replace “my other” by “the other”
p. 32, second paragraph, text line 1, replace “my interview” by “the interview”
p. 32, third paragraph, text line 1, replace “my interview” by “the interview”
p. 33, second paragraph, text line 1, replace “my interview” by “the interview”
p. 34, second paragraph, text line 9, replace “my in-class” by “the in-class”
p. 34, third paragraph, text line 11, replace “The goal he told me would be to” by “Their research goal is to”
p. 35, first paragraph, text line 1, replace “my interview” by “the interview”
p. 35, third paragraph, text line 5, replace “my understanding” by “the understanding”
p. 34, fourth paragraph, text line 9, replace “my graduate” by “the graduate”
p. 38, third paragraph, text line 6, replace “World Innovation Conference” by “MOI Innovation Summit”
p. 41, third paragraph, text line 12, replace “My role as” by “The role of”
p. 41, third paragraph, text line 18, replace “my roles” by “the roles”
p. 41, fourth paragraph, text line 1, replace “my existing” by “the existing”
p. 42, first paragraph, text line 1, replace “my personal conversations over the years with my” by “the personal conversations over the years with the”
p. 43, second paragraph, text line 2, replace “my work” by “the work”
p. 43, second paragraph, text line 3, deleted “my”
p. 43, fourth paragraph, text line 5, replace “my interview” by “the interview”
p. 44, third paragraph, text line 2, replace “my decision” by “the decision”
p. 44, fourth paragraph, text line 13, replace “my discussion” by “the discussion”
p. 54, first paragraph, text line 13, replace “I am considering” by “it is considered”
p. 54, first paragraph, text line 20, replace “integrity, but I believe that its” by “integrity. However,”
p. 55, fifth paragraph, text line 25, deleted “I”
p. 55, fifth paragraph, text line 26, replace “I needed” by “it was necessary”
p. 59, second paragraph, text line 5, replace “I” by “was”
p. 60, first paragraph, text line 1, replace “In this section, I will deal” by “This section deals”
p. 60, first paragraph, text line 3, replace “I will discuss” by “This includes”
p. 60, first paragraph, text line 5, replace “I will also explain the” by “The”
p. 60, first paragraph, text line 6-7, added “are also covered”

p. 60, first paragraph, text line 7, replace “Finally, I will also consider” by “Finally, consideration is given to”
p. 63, second paragraph, text line 4, replace “I would” by “One could”
p. 63, second paragraph, text line 8, replace “I mentioned earlier how important” by “As mentioned earlier,”
p. 63, second paragraph, text line 12, replace “I cite” by “reference is made to the”
p. 65, second paragraph, text line 21, replace “as I am finding my” by “as reflected in our”
p. 66, second paragraph, text line 20, replace “abilities, all of which as I will demonstrate in Chapter 8 are” by “abilities. These are demonstrated in Chapter 8 as”
p. 66, third paragraph, text line 1, replace “I developed that” by “have been developed which”
p. 66, third paragraph, text line 6, replace “I will also describe some” by “Some”
p. 66, third paragraph, text line 7-8, added “are presented”
p. 66, third paragraph, text line 8, deleted “In this context I have created and curated two major STEAM conferences and experiential events (University of Texas 2014, and Georgia State University 2015) to advance the STEAM concept which is aimed at the use of technology, mathematics, and engineering alongside the arts to create imaginative designs, ethical thinking and creative approaches to both real-world problems and innovative learning and teaching techniques”
p. 67, second paragraph, text line 1-2, replace “I have taken the liberty of reflecting upon an” by “included here are sections of an”
p. 67, second paragraph, text line 5, replace “I have known and followed Howard’s work for decades and in” by “In”
p. 67, first paragraph, text line 7, replace “I was keen to discuss with him” by “our conversation focused on”
p. 69, second paragraph, text line 2-3, replace “I will demonstrate new and combined evaluation models” by “new and combined evaluation models are presented”
p. 69, third paragraph, text line 7, replace “In my case, I” by “In this case, we”
p. 69, third paragraph, text line 9, replace “my primary” by “the primary”
p. 69, third paragraph, text line 12, replace “I will set out some” by “Accordingly, some”
p. 69, third paragraph, text line 13, added “are outlined”
p. 70, first paragraph, text line 8-10, replace “I have further explored this aspect of creative engagement and increased creative abilities through the lens of immersion and personal ambience (Woodgate, 2011)” by “I have further explored”
p. 75, first paragraph, text line 7-8, replace “I have outlined the key drivers and influences on these changes” by “The key drivers and influences on these changes are outlined and”
p. 75, first paragraph, text line 13-14, replace “the trends towards transdisciplinarity” by “This is all part of the growing trend towards transdisciplinarity:”
p. 75, first paragraph, text line 17, replace “performance, no” by “performance. Not”
p. 75, third paragraph, text line 18, deleted “I have”
p. 81, third paragraph, text line 9, replace “I have consulted on” by “This is the experience gained from consulting on”

p. 81, fourth paragraph, text line 3-4, replace “I will develop a comprehensive creativity enhancing strategy” by “a comprehensive creativity enhancing strategy is included”
p. 81, fifth paragraph, text line 3-4, replace “system, I delved into why and how that gap was expanding and current” by “system, further research was undertaken to determine why and how that gap was expanding, together with deeper investigation of current”
p. 82, second paragraph, text line 11-12, replace “fellow” by “former President”
p. 86, second paragraph, text line 7, replace “I was able” by “it was possible”
p. 87, third paragraph, text line 1-2, replace “my Foresight (TFL)” by “my foresight consultation company’s (The Futures Lab, Inc., TFL)”
p. 88, second paragraph, text line 10, replace “I look to” by “are used”
p. 88, third paragraph, text line 2, deleted “I will provide”
p. 88, third paragraph, text line 3, added “are provided”
p. 88, fourth paragraph, text line 7, replace “I chose a future” by “A future”
p. 89, first paragraph, text line 1, added “was applied”
p. 89, first paragraph, text line 4-5, replace “In this case, I determined that I ” by “It was determined that we”
p. 89, first paragraph, text line 21-22, added “This technique is not dissimilar to the catalog of the unexpected and future relevant attributes developed by DeSantis”
p. 89, third paragraph, text line 1, replace “I built” by “was built”
p. 89, fourth paragraph, text line 8-9, replace “I applied the ten theories of change (Giddens, 1979; Whittingham, 2015),” by “At this junction, the ten theories of change (Giddens, 1979; Whittingham, 2015) were applied,”
p. 90, second paragraph, text line 1, replace “I used the integral futures model (Wilber, 2000) (Fig.22)” by “The integral futures model (Wilber, 2000) (Fig.22) was applied”
p. 90, fourth paragraph, text line 1-2, replace “I created several models from different perspectives of the domain using systems dynamic modelling” by “Several models from different perspectives of the domain using systems dynamic modelling were created”
p. 91, fourth paragraph, text line 1, replace “I commenced” by “we commenced”
p. 92, second paragraph, text line 2, replace “I call” by “is called”
p. 92, second paragraph, text line 9, replace “I call” by “is called”
p. 97, first paragraph, text line 1, replace “I call the Stage 4 of the foresight process” by “The Stage 4 of the TFL foresight process we call the”
p. 97, first paragraph, text line 9, replace “I then” by “The process was then”
p. 97, second paragraph, text line 1, replace “I used” by “This work resulted in”
p. 97, second paragraph, text line 2, deleted “based”
p. 97, third paragraph, text line 6, replace “played with” by “considered”
p. 98, second paragraph, text line 2, replace “we first” by “we first”
p. 98, second paragraph, text line 18, replace “I applied all four techniques” by “All four techniques were applied”
p. 99, second paragraph, text line 6-7, replace “I surmised in my” by “outlined in the”
p. 101, second paragraph, text line 2, replace “I created” by “This resulted in”
p. 101, third paragraph, text line 1, deleted “I”
p. 102, first paragraph, text line 3, replace “I have” by “has been”

p. 103, third paragraph, text line 1-2, replace "I received written feedback from 9" by "nine of the participants provided detailed feedback"
p. 105, second paragraph, text line 4, replace "I felt that these" by "These"
p. 106, second paragraph, text line 1, replace "I designed" by "to be designed"
p. 107, first paragraph, text line 4, replace "Accordingly, I started to map" by "The next step involved mapping"
p. 107, first paragraph, text line 5, replace "As a result, I developed" by "This resulted in the development of"
p. 108, second paragraph, text line 1, replace "I describe the reasoning and role for each pillar of the LLS" by "the reasoning and role for each pillar of the LLS is presented"
p. 108, third paragraph, text line 1, replace "I started my consideration of this element around" by "The consideration of this element was based on"
p. 108, third paragraph, text line 29, added "to be"
p. 108, third paragraph, text line 1, replace "I foresaw" by "This inspired"
p. 109, second paragraph, text line 9, replace "I envisaged that constructive" by "Constructive"
p. 110, third paragraph, text line 12, replace "I see knowledge construction in this type of thinking structure involving" by "Knowledge construction in this type of thinking structure involves"
p. 110, first paragraph, text line 22, replace "I feel that these" by "These"
p. 111, fourth paragraph, text line 3-4, replace "What I am referring to is the apparent displacement of a concept (the shift of its position against a background)" by "The apparent displacement of a concept (the shift of its position against a background) is"
p. 112, third paragraph, text line 3, deleted "that I believe"
p. 112, fourth paragraph, text line 14, replace "I am referring" by "reference is made"
p. 112, fourth paragraph, text line 18, replace "of with which I have been involved over the past few years" by "with"
p. 112, fourth paragraph, text line 19, deleted "my"
p. 113, second paragraph, text line 1, replace "I mention" by "it is mentioned"
p. 113, second paragraph, text line 10, replace "I do not want to discuss here" by "is not discussed here"
p. 113, second paragraph, text line 20-21, replace "The reason why I deem a solid understanding of the dynamics of knowledge as a cognitive domain is relevant in this element is" by "A solid understanding of the dynamics of knowledge as a cognitive domain is relevant in this element,"
p. 113, second paragraph, text line 22, replace "acquisition, as well as" by "acquisition. There are also"
p. 113, second paragraph, text line 24, replace "experiences, which" by "experiences. This"
p. 114, third paragraph, text line 2, replace "I am focusing" by "the focus is"
p. 114, third paragraph, text line 4, replace "I will not deal here with such" by "Such"
p. 114, third paragraph, text line 6-7, added "are not tackled here"
p. 115, third paragraph, text line 1, replace "I consider this emphasis on identity to be significantly important as research draw" by "This emphasis on identity is significant as research portrays"
p. 116, fourth paragraph, text line 4, deleted "I believe that"
p. 172, first paragraph, text line 1, added "The first of these is"
p. 172, deleted paragraph "The thinking behind…"

p. 172, second paragraph, text line 1, replace “A basket of” by “A broad arrange of”
p. 172, second paragraph, text line 3, added “futures wheel and”
p. 172, second paragraph, text line 4-5, replace “Each has the role of deepening and extending the future context, role, and the purpose” by “Each deepens and extends the future context, role and overarching driving concept”
p. 203, deleted lines “and will now be… in2022.”
p. 203, added lines “In that context…performance”

All American spellings have been changed into British English spelling.
Words with apostrophes such as “don’t” have been changed to “do not”
All in-text references have been checked and are included in the Reference list
The over usage of the word “I” has been redressed and changes have been referenced in the Errata List.