Nurturing the physical, digital, and biological learning spaces within a higher education ecology: an African LIS perspective

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Abstract

This conceptual paper highlights the importance of nurturing the physical, digital, and biological learning spaces within a higher education (HE) ecology. It emphasises the role of language, media and technology as conduits of information that enable the acquisition of knowledge and skills within the" fourth industrial revolution". The paper draws on the theoretical framework of TPACK to propose the trilogy of technological, pedagogic and content knowledge required by faculty to design, teach and assess exit level outcomes of HE programmes. By citing various teaching and learning theories, the paper theoretically unpacks what is recommended to produce a sound learning strategy that will help students become better critical and creative thinkers. It proposes various e-pedagogic opportunities to flip and extend learning time and reconfigure learning spaces, which have the potential to improve teaching and enhance learning. The paper advises that by changing learning outcomes from the mere reproduction of information to seeking its meaning and contextual application will help facilitate deeper learning and a mind-set shift from dualism and multiplicity to relativism. The paper acknowledges the transformational benefits of e-learning, learning management systems and the opportunity to collaborate with a diversity of students and research partners both nationally and internationally online. It also recognises significant challenges to integrating blended learning into a higher education curriculum as technology remains a disruptive and expensive innovation. The paper concludes that faculty members require incentives to become life-long learners to constantly update their knowledge and skills through policy and budgets

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that will support and reward innovative teaching. The paper proposes and influences the continuous review and development of each LIS curriculum for these academic programmes to stay relevant within the 21st century's 4IR rhetoric and beyond.

Keywords: Higher education, fourth industrial revolution, 4IR, TPACK, blended learning, engagement theory, dualism, multiplicity, relativism, pedagogy, andragogy, heutagogy, library and information science, LIS, curriculum, life-long students

Introduction and background

South Africa has one of the highest unemployment rates in the world, which rose to 29,1% in the third quarter of 2019 (Stats SA, 2019). There are a number of contributing factors to the current crisis, but when it comes to the solutions, the higher education (HE) sector has the ability to help address this socio-economic crisis. Unfortunately, underprepared students, large classes, high academic vacancies and classrooms with insufficient teaching and learning infrastructure jeopardise the standard of HE. The result, according to the Council of Higher Education (CHE), is that up to half of all students that enter HE do not finish their qualifications at all and only around half of the remaining students finish on time (CHE, 2014: 5). In order to address these challenges, it is important to understand the requirements for success and move towards an equity-based system for the betterment of the overall environment in comparison to a simplistic approach based solely on equality.

Current African socio-economic problems need to be solved by HE graduates who are able to apply their knowledge and skills critically and creatively within local contextual settings, i.e. "think global, act local" in order to transform themselves and the communities they live in. Language, media and technology act as important conduits of information, which enable the acquisition of knowledge and skills. Therefore 21st century literacies, for example computer, media and network literacies, are required by graduates to participate effectively in the knowledge economy of the fourth industrial revolution (4IR). Active participation in the 4IR requires engagement in the highly disruptive technologies which are blurring the lines between the physical, digital, and biological spheres, and are collectively referred to as cyber-physical systems (Schwab, 2016). Nurturing the physical, digital, and biological learning

spaces within a higher education (HE) ecology is thus vital to creating a healthy learning experience for students to acquire, question and create new knowledge, which can be applied in their local context.

The adoption of digital information and communication models allowed universities to do business on an international scale. While internationalisation of African universities, who now have to compete in the global HE market, has both institutional benefits and disadvantages, including the opportunity to collaborate with a diversity of students and research partners both nationally and internationally in research, curriculum and teaching methods can improve human resource capacity, while a brain drain and the commercialisation of HE are seen as risks associated with globalisation (Jowi, 2012: 158–159). Neoliberal commercialisation of HE has resulted in universities receiving less funding and being expected to fulfil more complex roles (Altbach, 2008: 5). Kerr refers to the term 'multiversity' to capture the English collegiate tradition, the German research idea and the American importance of service to society found within most modern universities today (Kerr in Altbach, 2008: 8). In South Africa servicing both the public and private sectors of our society requires universities to offer a wide range of specialised and generic programmes to cater for both the capitalist private sector and more socialist public sector (Altbach, 2008: 9). Ek, Ideland, Jönsson, and Malmberg (2013: 1305) capture the tensions between different institutional cultures that differ in their epistemologies of catering for the private market with more emphasis on creating skills and practical experience and with research on market-related problems (marketisation of HE), or trying to create more scientifically sound academic programmes (academicisation of HE). The authors conclude that the dominance of marketisation or academicisation within HE will depend on the aims of the education (vocational or generic), the prevailing traditions, academic associations and composition of the staff (Ek *et al*., 2013: 1316). However, the authors believe that the incorporation of both, for example in the peer review system, where the competition for recognition and resources ensures academic excellence, can also work very well together. Ek *et al*. (2013: 1316) thus question whether the tensions in their native country Sweden might actually be a result of the politicalisation and tighter governance of HE to conform to both at the same time? In the African context this often requires development, and in South Africa current developments in teaching and research is funded by the University

Capacity Development Grant (UCDG) programme. The University of Zululand's (UNIZULU) University Capacity Development Plans (UCDP) propose to build capacity in both research and the scholarship of teaching and learning through interventions such as the Post-Graduate Diploma in Higher Education, which seeks to professionalise teaching in the university. In addition, the strategic plan foregrounds the need to address the opportunities and challenges presented by technology. One of the key issues in UNIZULU's UCDP proposal is to enhance staff capacity in integrating technology into teaching and learning. The main research question the paper asks is how a good learning strategy can help transform students into critical and creative thinkers, who are capable of finding a niche in the 4IR. The objective of the paper is to highlight the importance of seamless learning by nurturing the physical, digital and biological learning spaces within a higher education ecology.

Literature review

The following literature and theory review introduces teaching methods to expand the classroom in time and space, including offering well planned and appropriately designed blended learning. Blended learning integrates the face-to-face and online components of a course so that they complement and extend one another. It starts with teaching the teacher to embrace life-long learning because although experts in their disciplines, unless they adopt appropriate teaching methods and technology to communicate their content knowledge to students, their expertise is normally insufficient.

The paper concurs with Garrison and Kanuka (2004: 97) that blended learning is particularly effective in its ability to facilitate a community of inquiry as seen in Figure 3. The community provides the stabilising, cohesive influence that balances the open communication and limitless access to information on the Internet (Garrison & Kanuka, 2004: 97).

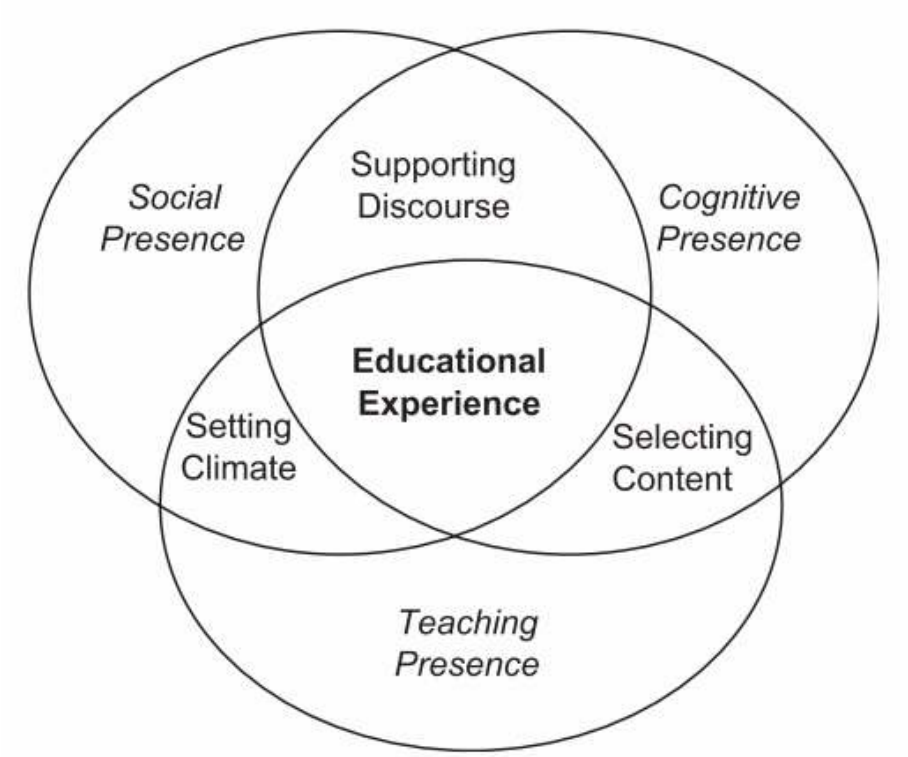

Figure 1: Community of inquiry (source Garrison & Kanuka, 2004:98)

Communities also provide the space for free and open dialogue, critical debate, negotiation and agreement — the hallmarks of higher education (Garrison & Kanuka, 2004: 97). Blended learning has the capabilities, through a learning management system (LMS), to facilitate these conditions and it adds an important reflective element with multiple forms of communication to meet specific learning requirements and styles (Garrison & Kanuka, 2004: 98). O'Brien and Toms (2008: 1) recommend that teachers adopt successful technologies which are not only usable but also engage users. The transfer of information through theory and practical lectures still forms the foundation for the acquisition of “three kinds of knowledge” that in turn provides the foundation of constructivism, i.e. physical, logico-mathematical and arbitrary conventional (De Vries in Georgescu, 2008: 48). The physical knowledge is more easily facilitated in practical lectures when students build networks, computers and multimedia productions by experimenting with physical hardware components like video cameras, computer components and network hardware. The logico-mathematical knowledge does not come as naturally to most students, as De Vries, in Georgescu (2008: 48), explains that this source of knowledge comes from the individual who introduces into objects characteristics that are not characteristics of

the objects themselves, for example, the Dewey decimal classification system, and deals with relationships between concepts and abstractions.

Theoretical underpinnings

The HE curriculum should promote an epistemological development in a student's conceptions of knowledge, i.e. from an understanding that all knowledge is either right or wrong, also known as dualism, to realising that there are multiple ways of investigating a problem or research question, called multiplicity, to the awareness that knowledge is actually provisional or temporary, and then to an insight that knowledge depends on the interpretation of information and scientific evidence with a variety of possible conclusions that can be drawn from it, which is referred to as relativism (Entwistle, 2008: 26).

Säljö in Entwistle (2008: 7) explored conceptions of learning, where the first two describe the learning implied by the majority of assessment methods, which depend on remembering factual information, and then reproducing it in summative tests and exams; the third category marks the start of a qualitative change, as information is seen as having a purpose beyond acquisition, i.e. it also has to be applied, while the transformation reaches an important threshold when learning becomes equated with understanding, seeking meaning and seeing things in different ways, which leads to personal transformational change and a sense of identity (Entwistle, 2008: 27).

Technology, pedagogy, and content knowledge (TPACK)

The integration of technology into the LIS curriculum is vital for graduates to acquire digital literacy in the different areas and sub-disciplines of information science as represented in FIgure 2 by Bwalya (2018: 5). Bwalya (2018: 5) highlights how the rapid changes in many of the sub-disciplines require the Information Science curricula to change in unison to stay relevant in changing times. Therefore, teachers in HE need professional development in more than just their LIS content knowledge: also their knowledge of students' thinking and learning, and knowledge of technology (Koehler & Mishra, 2009: 61) in order to design, teach and assess exit level outcomes of HE programmes effectively.

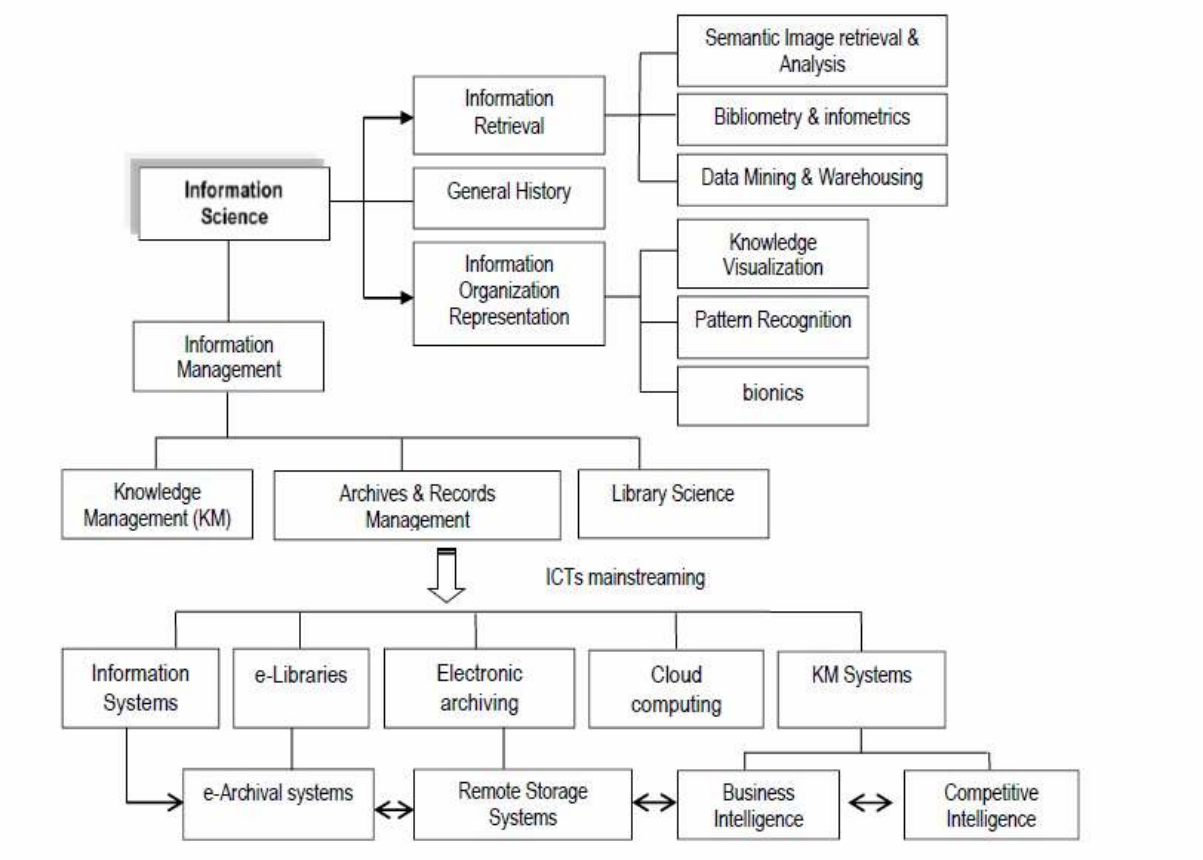

Figure 2: Areas and sub-disciplines of the Information Science domain (Bwalya, 2018: 5)

The development of the technology, pedagogy, and content knowledge (TPACK) framework was built on Lee Shulman's construct of pedagogical content knowledge (PCK) and included technology knowledge, which is considered vital for effective teaching with technology (Koehler & Mishra, 2009: 60). The multifaceted interaction among these three bodies of knowledge, i.e. content, pedagogy, and technology, both theoretically and in practice, produces the trilogy of knowledge needed to effectively incorporate technology assisted blended learning into the 21st century classroom (Koehler & Mishra, 2009: 61).

As graphically represented in Figure 3, technology knowledge (TK) requires life-long learning, as it constantly evolves over a lifetime of interaction and use of technology (Koehler & Mishra, 2009: 64). Pedagogical knowledge (PK) is a teacher's knowledge about the processes and practices or methods of teaching and learning (Koehler & Mishra, 2009: 64) like communicating, motivating students and scaffolding information and learning events. Luckin *et al.*'s concept of the pedagogy-andragogy-

heutagogy (PAH) continuum can be used to measure the pedagogical transformation within a programme as the teacher moves from pedagogy (teacher directed) to andragogy (student centred) to heutagogy (student directed) (Blaschke in Cochrane, 2014: 72).

Content knowledge (CK) is a teachers' knowledge about the subject matter to be learned or taught and is of critical importance for achieving the specific module outcomes (Koehler & Mishra, 2009: 63).

According to Koehler and Mishra (2009: 62), pedagogical content knowledge (PCK) is consistent with and similar to Shulman's notion of the transformation of the subject matter for teaching. Specifically, this transformation occurs as the teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge (Koehler & Mishra, 2009: 64). Technological content knowledge (TCK) is about using new technologies that can provide the representation and manipulation of data in new and productive ways, for example carbon-14 dating and X-rays in the fields of medicine and archaeology (Koehler & Mishra, 2009: 65). Technological pedagogical knowledge (TPK) is an understanding of how teaching and learning can be changed and enhanced when specific technologies are used in different ways (Koehler & Mishra, 2009: 65). TPK includes knowing the pedagogical benefits and limitations of a variety of technological tools as they relate to disciplinarily and developmentally suitable pedagogical strategies and designs (Koehler & Mishra, 2009: 65).

Koehler and Mishra's (2009: 66) perception of technology, pedagogy, and content knowledge (TPACK) goes past all three "core" knowledge components (content, pedagogy, and technology) and is an understanding that emerges from experience and in-epth interactions among content, pedagogy, and technology knowledge. TPACK is the foundation of effective teaching with technology, which requires a good understanding of the depiction of concepts using technologies; pedagogical techniques using technologies in helpful ways to teach content; knowledge of what makes concepts either easy or hard to learn and how technology can enhance learning and minimise some of the problems that students experience; knowledge of students' past knowledge and theories of epistemology; and knowledge of how

technologies can be used to develop new epistemologies or strengthen old ones (Koehler & Mishra, 2009: 66).

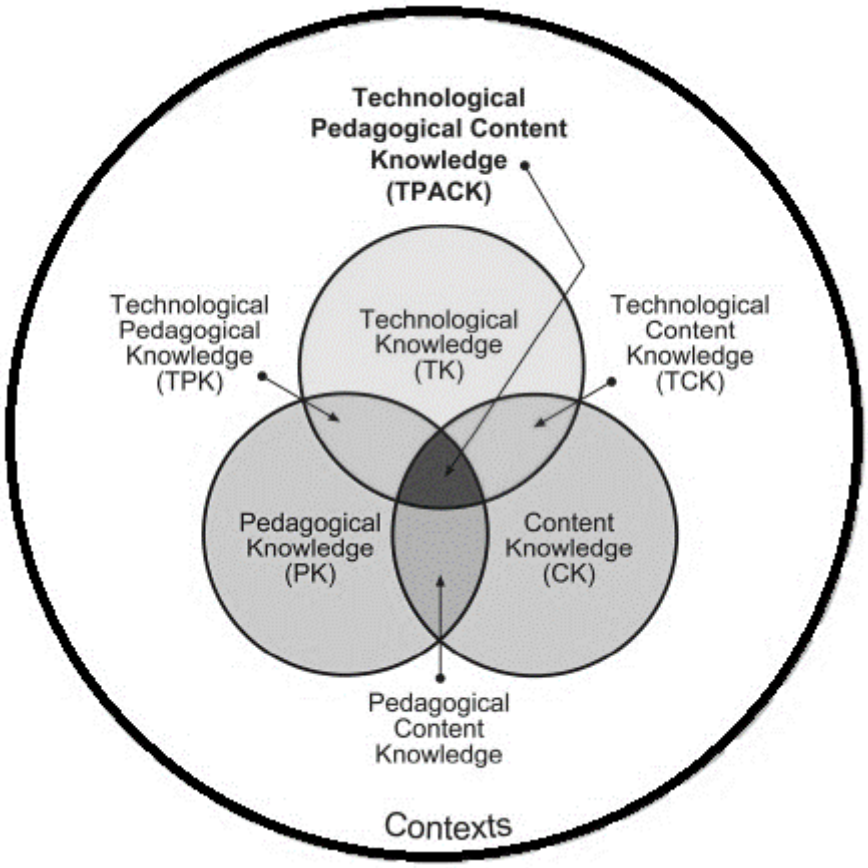

Figure 3: The TPACK framework and its knowledge components

(source Koehler & Mishra, 2009: 63)

Designing seamless physical, digital and biological learning spaces in an LIS programme

In a blended HE learning environment students are encouraged to learn in different spaces, i.e. through physical interactions between lecturer and students in the classroom, through digital information and communication models in an online platform like an LMS or social networks, and most importantly using their personal learning styles and biological intellect.

Seamless learning allows students to learn whenever they are curious, in a variety of learning spaces and situations (Berge & Muilenburg, 2013: 98). LIS departments constantly have to assess their teaching and learning practices to implement new

methods and educational technologies that support digital information and communication models favoured by a generation of students with different learning styles, expectations and information literacy needs. These include the traditional language literacies of reading and writing and finding information, and important modern literacies, which include digital literacy, network literacy, media literacy, visual literacy and cultural literacy (Lapuz, 2014: np), with the latter being important to integrate and use when Africanising the LIS curriculum to solve local problems. At UNIZULU the Information Studies department has encouraged the adoption of the pedagogy of Connectivism (Siemens, 2004a in Evans, 2013: 7) where language, media and technology act as the conduits of information, promoting greater student participation, engagement, collaboration and interaction between networked students, who can socially construct an active learning experience within various learning spaces (face-to-face, e-learning, research, self-learning, informal learning, work integrated /experiential learning, mentorship /tutorship and community outreach) in a blended HE learning ecology.

The importance of well-designed physical and digital learning spaces

According to Kampylis and Berki (2014: 10) the way physical or virtual spaces are designed has a major impact on creative thinking and learning and can bring people together and encourage their interaction and collaboration. Designing classroom seating in a conference style layout instead of classroom style in a physical environment has a large impact on the interaction of students in class. Flipping the lecturer and student face-to-face classroom experience by giving the traditional lecture information to the student in the form of online homework and then bringing the creation of projects and assignments that better instil critical thinking and writing skills of the discipline into a leader led classroom environment (Hodges, 2015: np) should also be considered in the design.

Another consideration in designing a good learning strategy is the right combination of learning events, which according to Leclercq and Poumay (2005: np) constitutes a sound learning strategy necessary for the successful transfer of knowledge and skills to a diverse group of students with different learning styles. The eight learning events proposed by the authors places “meta-learns” in the centre, which refers to the student’s all-important self-reflection at the end of a learning process and is vital for

converting contextualising information into knowledge (Leclercq & Poumay, 2005: np). “Creates”, as a learning event, involves creating something new, such as a portfolio. Introducing “experiments” allows the student to test personal hypotheses, for example computer simulations, or visual problem appraisal and solving. “Practices” include formative assessments that allow students to show and learn from their mistakes in a low-stakes environment. “Explores” allows personal exploration by a student, for example the world wide web searches on electronic databases. “Receives” allows the traditional didactic transmission of information, e.g. lecture, content delivery and recommended readings; however, the time and space of this event can be flipped and expanded by also allowing students to receive the same and additional resources via the LMS before class. “Debates” encourages social interactions, collaborative, cultural fluency using online forums and wikis in Moodle. Finally, “imitates”, as a learning event, encompasses learning from observation and imitation.

Identifying risks and providing support for biological learning spaces

Arndt (2012: 41) believes that lecturers should take biological needs and neurobiological processes into account when designing productive and useful learning environments. The author believes that mental resources and characteristics, such as their emotional well-being and a sense of security, will impact on the student’s willingness to learn, (Arndt, 2012).

Learning analytics has recently emerged as a research field that can improve teaching and learning and also identify the causes and effects of student access and success within a HE ecology, which were not well understood and supported before. This includes identifying constructs that are the driving forces behind certain behaviours and academic performances and providing the necessary support structures to offer proactive financial, academic, mentor and often more importantly psychological, wellbeing and health support to improve the student experience.

The Department of Information Studies and UNIZULU have put in a proposal through the South African, Swedish Universities forum (SASUF) to collaborate with Uppsala University (UU), Royal Institute of Technology (KTH) and University of the Witwatersrand (Wits) on a learning analytics project titled "Data, Information and Knowledge Exchange for Higher Education Development". The purpose of the project

is to model data from a South African higher education (HE) ecology to understand and support risks that can affect the quality of students' education and hence their employability. Learning analytics will be used to improve teaching and learning by identifying causes and effects of different underpinning processes that were not well highlighted or supported in HE before. The project envisages solving challenges in accessing large amounts of high-quality data, managing data with privacy preserved settings and developing new methods to analyse the data. The project will identify constructs to both student access and success in HE, where background matters, context matters, support matters and teaching matters (Green, 2018: np).

Challenges of integrating technologies into learning events

There are many challenges posed by integrating blended learning into HE curricula. Ensuring a mainstream technology module stream throughout the length of the qualification would provide students with knowledge, skills and the correct attitude when working with ICTs, multimedia and computer networks in the data, information or knowledge sectors. Hence, key to module development at the micro level will be the integration of appropriate technologies and digital media into the learning events in order to ensure the digital literacy module and programme outcomes are achieved by graduates.

Incorporating engaging technologies into the curriculum at the macro level is supported by appropriate exit level outcomes and requires staff to receive sufficient training in blended teaching and learning theories and the use of the technologies. Any technology integration requires thorough testing and user acceptance before it is rolled out. Poor access to networked devices will definitely impede the participation of students in the e-learning experience and should be a priority in teaching and learning policies and strategy. In other cases, access to these technologies could be a distraction, for instance students accessing social media instead of engaging in a learning event. Plagiarism and the "copy and paste" culture that has arisen in the digital learning environment requires ethical development on the students' part by consciously using similarity checking and referencing software in a formative manner to discourage and improve their writing styles, while better understanding the learning events content. Protecting user's privacy rights on LMSs and how to distribute the

costs of expensive infrastructure required to offer and access e-learning resources are important problems that need to be addressed. For instance, subsidising student devices, and managing the software, which could include a tracking and data recovery solution if the device gets lost or stolen, would at the same time improve the safety and security of students and their data.

Assessment of digital outcomes of academic programmes can also sometimes be problematic. Knight (2001) gives the example of how exam results used to judge students' success are quite reliable but their deceptive objectivity comes from examining students only on those aspects of the module's content that can be reliably graded, while the students' skill at designing, managing and completing practical work goes unmeasured by examinations, even though it is a part of the curriculum and covered in the practical lessons. For instance, the following question which appears in a summative assessment and exam of my third-year networking course:

"Discuss how physical and logical network diagrams are used within networks. (20 marks with max time 36 min.)", could be asked in a way to encourage students to engage with the learning outcome in a more complex manner using the appropriate technologies, which should increase the validity of the module outcomes, e.g.: "Demonstrate how physical and logical network diagrams are used within networks by designing both these diagrams for an Internet café using Microsoft Visio and the product price list provided. Marking criteria requires you to produce an inventory and configuration table designed as a database in Microsoft Access to support your diagrams. All files can be uploaded to their respective links on the Learning Management System (LMS) (40 marks with max time 72 min.)." In doing this, the usability of the assessment decreases because more time is taken; however, the validity of the assessment and module outcomes would increase drastically.

Johnson (2015: np) believes that solvable challenges include blending formal and informal learning and improving digital literacy among staff and students, while competing models of education (like online distance learning versus traditional blended learning), personalising learning and tracking complex thinking are difficult challenges to overcome. Wicked problems include balancing our connected and unconnected lives, keeping education relevant and introducing rewards for innovative teaching (Johnson, 2015).

Conclusion

One of the core missions of higher education (HE) institutions is to teach and train, and, specifically, to add to the sustainable development and holistic improvement of society (UNESCO, 1998). For LIS departments to fulfil this core mission, they should reflect on their teaching and assessment practices, curriculum development initiatives and educational technologies initiatives. The ever-changing pedagogical-andragogical-heutagogical landscape in HE is demanding greater validity in professional development, learning strategies and events, meta-learning and the assessment of learning. Using the appropriate technologies to facilitate learning and learning analytics requires action research, i.e. practice, reflection, refinement and practice again to establish what works and to accommodate ever-changing student needs and learning styles. Designing and delivering this balance of learning events would depend on training, experience, resources, support and the discipline-specific outcomes that need to be achieved. Faculty's technology, pedagogy, and content knowledge needs to provide students access to engaging content using language, media and technology as enablers of information to acquire knowledge and literacy skills within the 4IR.

LIS departments constantly have to review their teaching and learning practices to implement new teaching methods and educational technologies. In doing so departments will support digital information and communication models favoured by a generation of students with different learning styles, expectations and information literacy needs. However, student background matters, contextual setting where they study matters, the multi-layered support structures matter and faculty preparedness and teaching methods matter when it comes to student success in HE (Green, 2018: np).

Further initiatives to support teaching and learning at UNIZULU include the Vice-Chancellor's Excellence in Teaching awards; the mentorship programme for academic staff and novice and expert staff development capacitation programme; opportunities for staff to complete their PhDs (24 have done so in the past two years); to professionalise higher education teaching (PGDHE) and plans to introduce an early warning system to identify students at-risk.

The paper concludes that to offer technology assisted learning in HE various resources are required in terms of suitable physical venues with well supported digital technologies, experienced information literate lecturers, who are pedagogically able to design and develop well-structured learning events that scaffold multimedia resources which students are able to seamlessly access and understand on demand via digital technologies and networks. This will facilitate students' conceptual understating and their ability to apply new meaning to universal knowledge for different contextual settings, i.e. "thinking globally and acting locally" in society and their communities of enquiry.

Recommendations for the LIS curriculum

In order to retain its relevance, the Information Science discipline needs to keep evolving to meet current socio-economic development needs and keep abreast with trends and advancements in information resources management (Bwalya, 2018). This includes how to retrieve, organise, analyse, categorise, manipulate, store and protect data, and also how to design systems that serve the social, cognitive and emotional requirements of the people who access and use information. Information scientists exist in every sector of industry – including the tech, government, education, healthcare and finance sectors. At the macro level the purpose of a generic LIS programme is to produce information graduates that can design, develop and utilise information systems (ISs) using a variety of technologies for various information services. The programme or exit level outcomes of the degree need to be strategically linked to major module streams of information retrieval, information organisation and representation, information management and digital literacy in mainstream information communication technologies (ICTs). Exit level outcomes need to be determined in consulting these sectors and professional bodies (LIASA). A pedagogic shift to incorporate technologies, research, work integrated learning (WIL) and community engagement into all major streams will allow students to find a niche and apply their knowledge and skills within their local communities.

At the meso-level main module streams in information retrieval, information organisation and representation, information management should run from the 1st to 3rd year so module stream outcomes link to and validate exit level outcomes.

Academic vacancies in departments need to be filled as a priority. Staff need to professionalise their TPACK and experience in order to redesign learning spaces for engaging seamless learning. TPACK can be facilitated by lifelong learning and a survey of faculty knowledge, where deficiencies can then be developed through various academic support initiatives and UCDP projects.

At the micro-level of the programme, academics and instructional designers should design learning events that complement student learning styles by integrating technologies and digital media into the learning events. Programme reviews should ensure that learning outcomes link to and validate module and programme outcomes.

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