Drawing on the science of learning to inform tertiary teaching

Lorraine Bennett

Federation University Australia, Australia

Abstract

This paper describes an innovative, engaging and successful approach to building organisational and staff capacity to lead, design and implement quality and effective learning and teaching in tertiary education for an increasingly interconnected world. It links contemporary, evidenced-based information from neuroscience on how the brain learns and 'brain-friendly' learning strategies, to activity-based learning utlising play as a mode of engagement, learning and knowing. The outcomes of this approach are powerful and are changing teaching practice.

Introduction

Over the past two decades neuroscientists around the world have made substantial progress in understanding how the brain functions and how learning occurs in the brain. Most continents now have at least one Science of Learning Centre undertaking laboratory and classroom-based research into how the brain learns, including the newly established Australian Science of Learning Centre. This Centre is a collaboration led by the Australian Council for Education Research (ACER), in conjunction with several universities, notably the University of Queensland and the University of Melbourne.

Conferences on the 'Science of Learning' are also attracting great interest in many countries. In 2013, the Australian Council for Education Research (ACER) sponsored a conference on 'How the Brain Learns' which was attended by over 600 participants from all levels of education. Many of the papers presented at this conference challenged previous beliefs about the brain and learning such as, the brain is fixed and cannot be reprogrammed. Presenters reported on and cited studies which indicated that recent research on brain plasticity indicates that brain neuron networks can be strengthened and new neural pathways can be formed with appropriate activities and retraining throughout life.

The empirical underpinnings for the approach to organisational capacity building and staff professional learning and development, reported in this paper, are heavily influenced by the work of a number of international neuroscientists, health professionals and educational scholars interested in brain function and learning. These include Willis (2006, 2007 & 2014), Brown (2008 & 2010), Doidge (2010), Sousa (2011), Arrowsmith-Young (2013), della Chiesa (2013) and Howard-Jones (2013), to name just a few.

The work of Willis, a clinical neuroscientist and now educator, is particularly helpful in translating brain science findings into accessible concepts for educators. Willis draws upon her extensive research and clinical experience to identify what she refers to as 'brain-friendly' learning strategies. These strategies are based on brain function and on how the brain processes, retains, connects and retrieves information. Her 'brain-friendly' learning strategies include: allowing ample opportunities for repetitive and deliberate practise of activities;

offering students choice; providing motivation and engagement through activities by introducing an element of chance; providing activities that when completed, give a sense of achievement and pleasure (through a release of dopamine); incorporating fun and humour into learning activities; ensuring instant feedback of performance; fostering positive interaction with others; and being physically active. She also identifies barriers to learning including boredom, stress and fear. She explains that these emotions occur when the learning activities are not challenging enough, when they are far beyond the learner's current skill level, or when the learning environment is threatening. These inhibitors switch off the brain's receptors and prevent information passing into the brain's working and long term memory. The following diagram has been created to provide a simplified visual representation of Willis's explanation of 'brain-friendly' learning.

Play – A Catalyst for Learning

When Willis's 'brain-friendly' strategies are linked to the work of Brown, the founder of The National Institute for Play (USA), who is also a neuroscientist, the synergy between play and learning becomes enlightening, explicit and exciting. Brown has spent years studying play in animals and humans. He has compiled more than 6000 'play histories' of people from all walks of life, including serial killers to Nobel Prize winners. Brown describes play and learning as perfect partners. Writing about the brain and play Brown states that: *'The genius of play is that, in playing, we create imaginative new cognitive combinations. And in creating those novel combinations we find what works'* and that: *'Play seems to be a driving force helping to sculpt how the brain continues to grow and develop'* (2010, 37 & 42).

Education around the world, particularly tertiary education, is experiencing a major shift from a narrow focus on the teacher and the teaching process to a multifaceted focus on the student and the learning process. This shift requires new approaches to the preparation and support of teachers, the development of curriculum, the design of learning activities and assessment and the ways learning spaces are conceived and shaped. By combining the work of Willis and Brown we can access some powerful information and tools for informing the way educators design courses, prepare learning activities and create learning materials to achieve effective and sustained learning outcomes and experiences for the growing diversity of our tertiary education student profile.

The effectiveness of linking the science of learning to activity-based learning, with a strong play focus, is demonstrated in this paper through a case study designed to build, shape and inform professional learning and development for staff in tertiary education. In this example, an activity-based approach informed by 'brain-friendly' learning concepts, that utilised play and play artefacts to heighten engagement and learning, was adopted to build and nurture teaching expertise through a Graduate Certificate in Education (Tertiary Teaching) (GCETT)

program. The impact of this approach has been significant and the outcomes have led to numerous innovations and improvements in teaching practice across the University and partner sites.

Method

The organisational and staff capacity building reported in this paper was provided through a voluntary Graduate Certificate in Education (Tertiary Teaching) (GCETT) award program offered to both academic and professional staff at Federation University Australia (FedUni), (formerly known as the University of Ballarat), and at partner sites. FedUni has developed a number of partnership arrangements with regionally-based Training and Further Education (TAFE) institutes, accredited private providers of higher education and other universities. This approach is a deliberate strategic priority designed to provide greater access for rural and regional students to participate in higher education within their local communties and to provide seamless pathways into the University's higher degree programs.

The University has a diverse student profile. Many students are from rural and low socio-economic communities and are first-in-family to study at a university. Some are returning to study as mature-aged students with several years work and/or family raising experience, while others are entering study with limited academic skills and prior study experience. In many cases these students are still haunted by the spectre of negative education experience. The University has in place a number of bridging and support programs to assist and mentor students, particularly in the pre-entry phase and in the first year of study. Understanding the diversity of the student profile is fundamanetal to the delivery of effective teaching and learning across the University's various sites and needs to underpin decisions about curriculum design, learning activities, teaching approaches and assessment strategies. It is this context and perspective which has shaped the design and implementation of the GCETT at FedUni.

Since 2011 the GCETT program has been coordinated and delivered through a University-wide Centre for Learning Innovation and Professional Practice (CLIPP). The program consists of four courses which is equivalent to one semester of full time study. However, staff undertake their study part-time, completing one course per semester over a 2 year period. The program sits at level eight in the Australian Qualifications Framework where Master degree qualifications are classified as level 9 and PhD programs at level 10. The following diagram provides a brief overview of the four courses within the program. The four courses are delivered using blended modes of delivery.

Snapshot of the GCETT pathways

	EDGCT5007	EDGCT5008	EDGCT5009	EDGCT5010
Course	Tertiary Teaching and Learning	Professional Practice in Tertiary Teaching	Contemporary Issues in Tertiary Teaching	Tertiary Teacher as a Researcher and Practitioner
Delivery Mode	Face-to-face plus independent group work and online engagement	Face-to-face plus online modules Four modules must be completed	Face-to-face plus online modules Four modules must be completed	Guided independent study with scholarly outcomes
Assessment	• Poster • ePortfolio	• ePortfolio • Negotiated task	• ePortfolio • Negotiated task	• ePortfolio • Negotiated project

The GCETT has been purposefully designed to enable participants to personalise and shape their learning throughout the program to meet their specific knowledge, skills and context requirements. Features of the program align directly with 'brain-friendly' learning strategies discussed in Willis's work and the contribution of 'play' to learning and development promoted in Brown's research and publications. In order to reinforce the underlying principles in the GCETT and to assist recall and implementation, the key features of the program are novelly linked to the letter 'C'. These features include:

Capacity building of individuals, 'communities of practice' and organisations. This is the primary driver for the GCETT. Throughout the four courses the participants are constantly encouraged to grow their knowledge and skill base by being exposed to a diverse range of literature, videos, discussions, learning activities and leading learning and teaching scholars. Peer-to-peer learning is facilitated through informal and formal activities and often the learner becomes the teacher and the teacher becomes the learner.

Customisation is fundamental to the program's approach. Participants are encouraged to relate the learning from the case studies and learning activities to their particular workplace learning and teaching circumstances. This work may take place in a library setting, in a single discipline undergraduate program or across a number of teaching sites. The negotiated tasks, which sit within the two middle courses in the program, provide opportunties for participants to research and to solve a 'real' issue in their workplace. Other participants use the negotiated task as an opportunity to develop learning resources or learning activities to address a threshold or troublesome learning concept within a course they are currently teaching.

Contextualisation and culture are key considerations that underpin this program. This is primarily achieved by emphasising a student-centred approach to teaching. From day one, the importance of understanding the context, culture and skills levels of the diverse learners within the participants' course, is emphasised. Fundamental to this approach is the belief that if you are to actively engage your students in learning, you need to have an understanding of their prior learning experiences, their current skill levels and what interests them. Participants in the GCETT are encouraged to interpret case studies and issues from various cultural perspectives to reinforce the importance of considering issues from various viewpoints.

Collaboration and cooperative learning is encouraged throughout the program. In the workplace participants work in teams and if they do not, they should. That is the message delivered in the GCETT. Participants are encouraged to undertake partner or group learning activities to illustrate the importance of considering multiple perspectives. Various activities in the GCETT are also designed to demonstrate the multiplying effect of working together to solve problems to difficult teaching situations. Collaborative writing is also encouraged as is peer-to-peer mentoring by reading colleagues' draft papers.

Creativity is experienced in a number of ways throughout the GCETT. One example is the game development activity, where the participants are given a box of assorted craft items and asked to develop an age-appropriate game to introduce, reinforce or assess a key knowledge or skill concept which could be used in their teaching or workplace. Another example is where the participants are required to prepare a tangible artefact, that depicts a key word to describe their philosophy of teaching. This simple activity has been very effective in helping participants identify what they are trying to achieve in their teaching.

Choice and flexibility are frequently identified as positive elements of the GCETT in participants' evaluation surveys. As indicated previously, staff are encouraged to shape their learning to suit their requirements. The GCETT provides many opportunities for this to occur. In the poster task participants can elect to investigate any topic within a student, teacher, learning and teaching quadrant. The middle two courses in the GCETT enable participants to select modules of study from a range of face-to-face and online offerings. They can choose modules based on areas of interest, need or convenience. Many of the participants also work full-time and have family and other responsibilities, so travel to on-site sessions and workshops is not always convenient. However, it is worth noting that attendance levels are high and feedback from face-to-face sessions is very positive. We would be reluctant to remove face-to-face engagement from the program.

Continuous improvement, primarily through reflective practice and the provision of timely and accurate feedback is critical to sustaining engagement and achieving incremental improvements in practice throughout the GCETT. Although the staff regularly use online discussion forums and other means of providing informal feedback, the participants constantly ask for more feedback. Coincidently, that is exactly what staff report their students comment upon. Self and peer assessment is also practiced to develop skills in analysis, judgment and giving and receiving constructive feedback.

Connectivity is important for developing higher order thinking skills such as analysis, problem solving, divergent thinking and innovation. The team who deliver the GCETT work very closely to ensure that connections between the various modules and courses are made explicit and reinforced. For example, the work on assessment futures is directly linked to the modules on curriculum design and learning outcomes. The modules on action research link to the work undertaken in the negotiated tasks, and the skills acquired in the reflections on teaching module, are drawn upon throughout the program.

Communication through multiple modes is practiced throughout the program. Online learning is mainly managed and delivered through Moodle, but Blackboard Collaborate, Skype and video conferencing are also being introduced. Each year at least one two-day learning and teaching conference is also held at the main Ballarat campus. These events have been extremely well supported and have given the GCETT participants exposure to leading learning and teaching scholars, as well as opportunites to share their practice with colleagues.

Challenge in the GCETT is linked to the concept of incremental learning. The aim in the GCETT is to provide participants with progressive challenges that are within their skill level and knowledge, but provide opportunities to stretch and grow their capacity. The utilisation of ePortfolios in the GCETT is an example where participants are challenged to demonstrate growth in ability through posting more advanced reflections and uploading complex artefacts using audio, video, graphics and photographs. Participants are also challenged throughout the program to grasp new knowledge and learn new skills. Providing opportunites for celebrating achievement and progress is at the forefront of this program. Small and incremental successes and achievements are recognised and reinforced by the GCETT team and shared with colleagues.

Contemporary research, theory and technologies ensure that the GCETT is relevant and cutting edge. The program draws extensively upon recent and current studies from the Office for Learning and Teaching, which was formerly the Australian Learning and Teaching Council. These projects provide a wealth of information and data on current tertiary education

learning and teaching issues and trends. In addition, the program exposes participants to national and international scholars and research. Modules on the use of social media for learning and the exposure to emerging technologies also ensures that the program stays fresh and contemporary.

Changing practice and behaviour is at the heart of this staff professional learning program. The purpose of the program is to stretch the participants' understanding of what is means to be an effective teacher and to develop approaches to learning and teaching which motivate, influence and engage students in learning. For the early career participants, it is about helping to shape their teaching philosophy and provide them with effective learning and assessment tools. For the more experienced teachers, it is about stretching them beyond their comfort zone. It is about encouraging them to explore and utilise emerging technologies, to share their learning and practice with colleagues and to continully reflect upon the impact of their teaching on student learning experience and outcomes.

Findings

A range of quantitative and qualitative data and feedback has been captured and analysed since 2011, when the GCETT program was refreshed and moved to a University-wide centre for reinvigorating and delivery. The underlying evaluation questions that are constantly being addressed are: *'to what degree is the GCETT achieving its intended outcomes?'*; *'how effective is the activity-based approach used in this program in engaging the participants?'*; and, *'what evidence is there to demonstrate the impact and effectiveness of the GCETT?'*

Significant evidence that demonstrates the impact of the GCETT is contained in enrolment and completion trend data. Table 1 depicts enrolment numbers per semester from semester 1, 2010 to semester 1, 2014, including a projected total for 2014. Prior to CLIPP taking responsibility for the coordination, redesign and delivery of the GCETT, there were 7 enrolments in 2010 across the two semesters. At the end of 2011, the first year of the refreshed program, there were 123 enrolments over the two semesters. This number grew to 266 enrolements in 2012 and 440 enrolments in 2013. As of census date in 2014 there were 267 enrolments in semester one, of which 51 are due to complete the program mid-year. This will leave 216 to progress in the course and the likelihood of a further intake of new participants in semester 2, 2014 of around 25. Therefore, the projected number of enrolments for 2014 will be around 510.
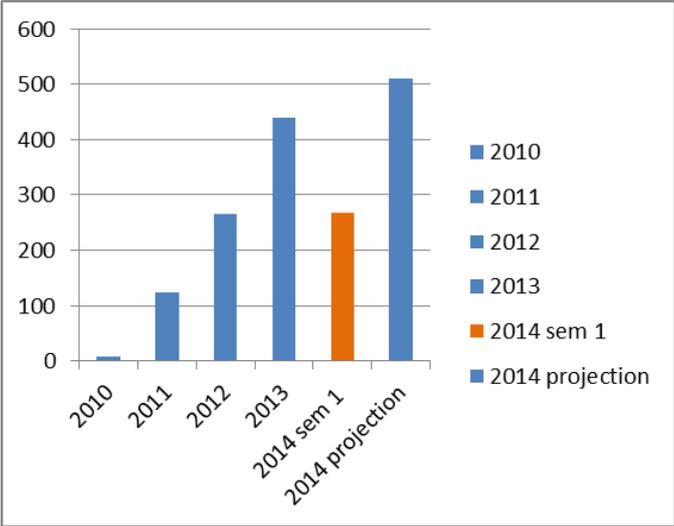

Table 1- GCETT enrolments per semester

Completion rates also provide evidence of the success of the program. The anticipated duration of the GCETT, which is studied part-time, is 4 semesters or two years. Since 2011, 73 participants have completed the program with another 160 due to complete at the end of 2014.

Analysis of performance tracked by assessment grades is another way of measuring the impact of the GCETT program. The following tables provide grade distribution data on three sample intakes over the course of the program. Table 2 depicts performance outcomes of the first 2011 cohort. It is clear from this data that the participants' performance improved significantly over the course of the program. For example, in the first course 8% of the participants achieved a higher distinction grade (HD) and by the end of the program this percentage had increased to 75% of participants with a HD grade.
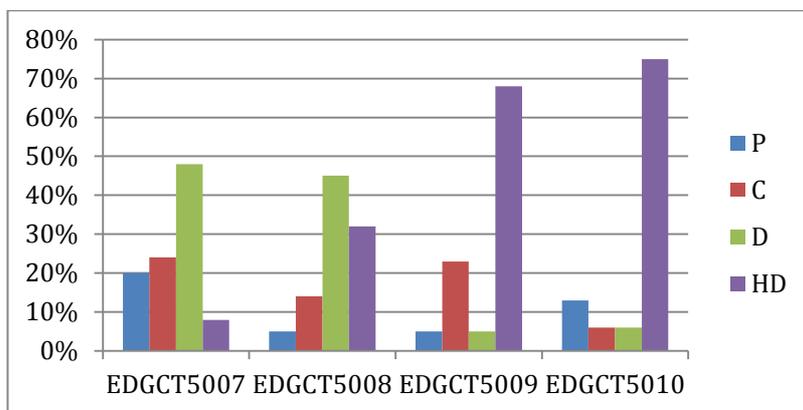

Table 2 – GCETT grade distribution for the first 2011 intake

In table 3 this improvement trend, although not as great, is confirmed with an increase from 12% to 38% of participants in the second 2011 intake achieving HD grades over the course of the program, and again in the 2012 intake which reveals an increase in HD from 11% in the first course to 36% in the fourth and final course (table 4).
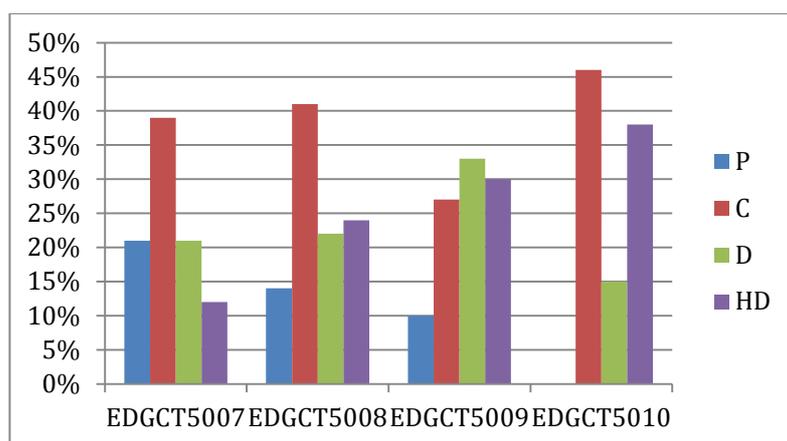

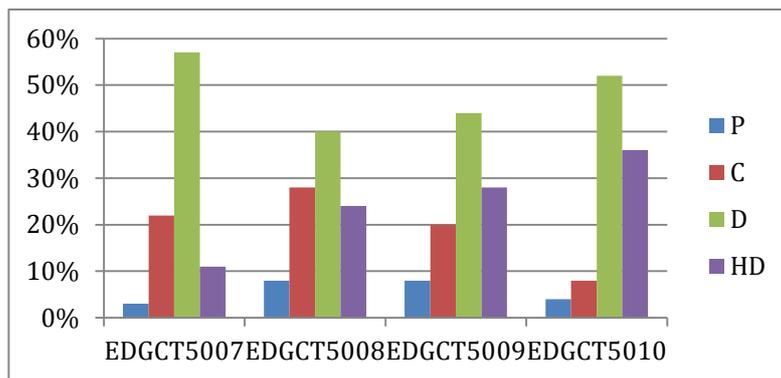Table 3 - GCETT grade distribution for the second 2011 intake

Table 4 - GCETT grade distribution for the 2012 intake

University administered student survey data also provides some insight into the impact of the GCETT on participants. Although the University systems have failed to capture data on a regular basis, the following 2012 data is available and provides some useful evidence of participant perceptions, especially when viewed in combination with other feedback. Table 5 indicates perceptions of teacher's strengths in the sample course EDCT5007.

EDGCT5007	Knowledgeable	Enthusiastic	Organised	Communicates clearly	Approachable	Useful feedback	Effective teacher
2012, S2	100%	100%	89.5%	94.7%	94.7%	63.2%	84.2%

Table 5 - Survey data on teacher's strengths (2012)

Table 6 also contains information from the first course in 2012 on teaching effectiveness. While generally reporting positive perceptions on teaching effectiveness, the data drew attention to the need to provide more regular, timely and contructive feedback. Since 2012 the provision of feedback across this program has become a priority.

EDGCT5007	Clear learning outcomes	Helpful learning experiences	Helpful learning resources	Adequate assessment	Effective feedback	Appropriate workload	Quality of teaching	Learner motivation	Learner experiences	Learner effectiveness	Course satisfaction
2012, S2	78.9%	78.9%	78.9%	78.9%	36.8%	73.7%	73.7%	89.5%	89.5%	94.7%	78.%

Table 6 - Survey data on teaching effectiveness (2012)

Analysis of the impact of the program to date

The following section provides a summary of the key themes that were identified in an analysis of 2012 ePortfolio postings and reflections. The analysis clearly demonstrates the impact of the GCETT on the participants' attitudes and teaching practice. The power of these reflections is in the overall picture they portray of the journey to date. The comments demonstrate engagement and activity in the following themes: collaboration and cooperative learning; building capacity; heightened awareness of learners and learning; linking theory to

practice; rethinking assessment and feedback strategies; development of innovative curriculum and teaching strategies using activity-based learning and games; taking responsibility for own professional learning; and, applying learning to workplace issues and contexts.

Participants' comments also provide evidence of the impact of participation in the GCETT. The following examples are typical of the feedback regularly provided.

> *Great to hear about the development of academic skills for transition from VET – HE*

> *It was great to meet all the other participants in the course. I enjoyed the 2 days.*

> *... gave me great inspiration for changing my delivery and assessment of a specific unit. Just edited document while listening. Thanks*

> *.... is amazing! One of the most clever things I've seen. Not everyone could 'pull this off'.*

> *Thank you for reminding us that it is ok to teach outside the square.*

> *Once again a pleasure to see you in action. Keep up the brilliant work.*

> *... is a mentor for us in this regard – we all love her!*

> *I have been given a new passion for teaching. In the past I have been trying the same old, same old.*

> *I have been given some good ideas and some inspiration.*

> *Many thanks for the detailed feedback you provided re our portfolios. It is great to see where progress has generally been made and areas where improvement could still be made. Your support throughout our studies has been greatly appreciated. You have always been able to meet individual needs for learners and this is a great support when we are all so busy with work, study, family etc.*

Feedback from senior management also demonstrates the impact of the program across the partner sites as evidenced in the following email:

> *As part of our review process I have surveyed all of our current GCETT participants. Attached is the feedback. What else can I say…well done!!!!! The participants and our Executive team, who I presented this info to, are all very impressed and recognise this course is making a REAL difference in our delivery and assessment strategies.*

The external evaluator for this program, a professor from another Australian university, reported:

> *... the outstanding impression is that the program is extremely well organized, it is innovative as well as being theoretically well grounded, and the participants feel that their practice has been impacted positively. The ongoing collaboration with students coming from all parts of rural Victoria is to be commended as*

there is no question they have gained enormous benefit from collaborating across activities and sharing knowledge and problems.

Discussion

Elements of activity-based learning, games and play artefacts are embedded throughout the GCETT. They are used to introduce concepts, to engage participants, to reinforce and assess learning and to foster a life-long love of learning. The use of artefacts inspired by games and play is readily accepted in early childhood and primary school education. In these sectors, play is validated and embedded in curricula as a means of fostering intellectual growth, creativity and innovation. However, in the main, games and play are not universally utilised or valued in tertiary education.

Of course, there are some early adopters and isolated examples of academics utilising interactive learning and game-based activities to engage learners. Mazur (2009) a physics professor at Harvard is one such pioneer. In the 1990s Mazur discovered that his students could provide the formulas and answers to complex physics questions, but when he delved further he found that they did not understand what the formulas and concepts meant in the real world. As a result he started to change his approach to teaching and began to focus on the learner and the learning activity. He moved away from a lecture 'sage on the stage' format to a 'guide on the side' approach. His insight is expressed in terms of the *'lecture is approaching its twilight phase'* and active learning is challenging to *'overthrow the style of teaching that has ruled universities for 600 years'* (Lambert 2012). The work of Mazur is examined in the GCETT.

There are also emerging exceptions to the rejection of play beyond primary education with the rise of game-based education in eLearning. In the online learning space, video games and the growing interest in 'gaming' is a current example of the use of games and play to foster learning. At my own University, over the past three years, scholars in biomedicine have been working on an animated immunology video game, in the style of 'Pac-Man' to help learners grasp complex terminology and processes involved in the spread and treatment of infection. The objective is to try to make physiology more accessible and memorable through activity, repetition and engaging audio and visual stimuli. Similar studies and projects on the use of playing video games to foster learning are being conducted around the world. The findings from evaluation of these approaches support the efficacy of game playing in education and reinforce both Willis's and Brown's views on the value of joy and fun, inherent in this mode of learning, to maintain students' engagement and interest.

Another example of an emerging approach to eLearning and teaching in tertiary education that is particularly suited to the use of games and play, is the 'flipped classroom'. This approach is both discussed and frequently modelled in the GCETT. In this approach, the traditional lecture is replaced by a model where students are directed to pre-class readings, videos, podcasts and online discussions, thus freeing the lecture time for active learning, problem solving, peer interaction, collaboration, and personalised just-in-time learning. The use of customised and contextualised games and play artefacts are ideal in these settings. Some examples are games based on quick recall of content from the pre-lecture activities, games which require students to place in correct sequence steps in a process they read about, or games which require students to apply information from the pre-lecture material to new contexts. Games can be used effectively to gauge levels of understanding, to reinforce and practise concepts and to assess student learning in a fun and supportive way. Key benefits are that feedback is instant and learning is incremental.

The use of 'audience response systems' such as clickers and more recently digital devices such as iPads and mobile phones, lend themselves to this interactive approach to student engagement. Not only are most contemporary students comfortable with this form of engagement, they enjoy the experience and are familiar with accessing and sharing information through these devices. The GCETT offers modules on interactive learning using clickers and social media as ways of engaging learners and providing instant feedback.

Linking of neuroscience and play is at the very heart of the GCETT approach to building staff capacity to engage with learners and to adopt student-centred approaches to learning. The approach is current, evidenced-based and exciting. The potential to advance ways we engage with and foster positive learning experiences and outcomes for diverse learners is enormous. The GCETT provides the impetus for a new wave of conceptualising, designing and supporting tertiary education curriculum, learning activities, innovative assessment and learning spaces.

However, the road to this apporach is not smooth and unincumbered. A recent proposal to advance and disseminate this approach to building staff capacity received the following critique:

> *There are two significant, related, problems with the proposed work. (i) As most experts in the field of education and neuroscience will acknowledge, few of the outcomes from brain research have clear or direct implications for educational practice, (ii) the focus of the proposed educational work is very diffuse - game-based learning (on its own) is a huge area, with many possible approaches. There are few people working in the education/neuroscience interface who still give credence to the idea of 'brain friendly' educational methods...It is unclear whether the dissemination and engagement strategies will have a strong impact on the sector.*

And yet, government leaders around the world refer to the need to be able to respond to the new global economy. They look to universities to lead and foster the development of innovation, problem solving and creativity skills required for this environment. The GCETT discussed in this paper addresses this challenge by demonstrating that these attributes can be fostered and developed through games and play artefacts. This is not a new idea in the corporate world. Organisations such as Microsoft, Boeing and NASA have been using play activities and games, and providing creative work spaces to stimulate and foster innovative thinking for some time. The ideas and approach to building organisational and staff capacity presented in this paper provides an opportunity for tertiary education to catch up.

Practical implications
This paper contains many ideas that ICED delegates can use to build the capacity of their staff to engage students in productive learning experiences and outcomes. The case study and discussion demonstrate that by linking 'brain-friendly' learning strategies, based on the work of neuroscientist and educator Judy Willis MD to the work of neuroscientist and play theorist Stuart Brown MD, it is possible to create an exciting and evidenced-based framework to ignite student learning across all sectors of education. This paper suggests that the clues to this approach are contained in a corpus of 'C'words: capacity building; customisation; contextualisation and culture; collaboration and cooperative learning; creativity; choice; continuous improvement; connectivity; communication; challenge; contempory and change.

One final practical note: in the first workshop of the GCETT, participants are given a set of juggling balls. Their task is to learn to juggle during the course of the program. They are asked to document their learning in any way they choose and to reflect on what approach they used and what strategies they found effective in mastering the skill. Once they are able to juggle, part two of the exercise requires them to teach someone else to juggle. This is proving to be a very practical, enlightening and effective way of analysing what is involved in both learning and teaching a new skill. Some staff have even formed juggling groups and are conducting practice sessions. This simple activity has sparked lunch room conversations about learning and overcoming challenges. What a wonderful outcome!

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