Technology-Enabled Challenge-Based Learning in a Global Context

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Abstract: Scalable educational technology enables digital learning experiences to effectively reach a global audience with new approaches to teaching and learning. One new model is challenge-based learning in a global context, which is an extension of problem-based, project-based and contextual teaching and learning. This article describes the theoretical and organizational foundations of the design of a challenge-based learning technology platform for higher education that supports global collaborative team problem-solving experiences. Case examples are provided by the concrete approaches used with Curtin University's *Challenge* platform to enable and support scalability, self-organizing and self-directing teams, automated assessment methods, and the support of creative transmedia narratives.

Keywords: challenge-based learning, transmedia narratives, collaboration, team learning

What is collaborative challenge-based learning?

Challenge-based learning is a new teaching model that incorporates aspects of collaborative problem-based learning, project-based learning, and contextual teaching and learning while focusing on current real world problems (Johnson, Smith, Smythe, & Varon, 2009). Online global learning challenges engage students' curiosity and desire to learn by making central the solving of open-ended problems as a member of a self-organizing and self-directing international team (Harris & Nolte, 2007). In particular, when delivered as a mobile learning experience using an application platform developed at Curtin University in Western Australia, such challenges can integrate 21st century tools, require collaboration, and assist students in managing their time and work schedules, while effectively scaling to large numbers of students. Set in the environment of a friendly competition where people experience game-like attributes such as automated feedback, points, leader boards, badges, and levelling up for rewards, challenge-based learning increases motivation toward high performance (Gibson & Grasso, 2007). Research on challenge-based learning is beginning to show impacts such as increased engagement, increased time working on tasks, creative application of technology, and increased satisfaction with learning (Johnson, Adams~~, & Apple~~, 2010; Roselli & Brophy, 2006).

Similar to problem-based and project-based learning, and borrowing liberally from those well-established approaches (see (Gibson et al., 2011) and the Buck Institute for Education (www.bie.org), the additional structure of global relevance, international collaboration, and team-based competition leads to a unique objective, expressed well in a recent report by the New Media Consortium (Johnson et al., 2009).

At the center of challenge-based learning is a call to action that inherently requires students to make something happen. They are compelled to research their topic, brainstorm strategies and solutions that are both credible and realistic in light of time and resources, and then develop and execute one of those solutions that addresses the challenge in ways both they themselves and others can see and measure.

The term challenge-based learning arose in the U.S. with the support of innovative technology groups such as Apple Education, the New Media Consortium, The Society for Information Technology and Teacher Education, and the U.S. Department of Education Office of Educational Technology. Here, we describe for the first time a unique application of challenge-based learning in higher education, supported by a new cloud-based mobile technology platform that can be used for bridging informal to formal learning, recruiting students into university, reaching larger numbers of people with game-based approaches, envisioning student engagement in work-integrated learning; and assisting students to acquire evidence of attainment of graduate capabilities such as leadership, critical thinking, creativity, communication skills, and experience in international team collaboration.

To explain how collaborative challenge-based learning can work in higher education, we will first present an organizational overview of how our implementation addresses a wide range of structures, human resources, and symbolic, semantic and policy issues and embodies the philosophy of our technical framework. These four perspectives will be familiar to students of organizational behavior (Bolman & Deal, 1991) and are useful as a frame of reference for understanding challenge-based learning as a transformative organizational innovation in higher education. In each of the perspectives, we will explain how the collaborative challenge-based approach relates to a range of teaching and learning methods; we then comment on what learners experience, what new roles are implied for instructors, and how the institution of higher education is changing to meet the new global imperatives of teaching and learning in the light of each perspective. We conclude the article by sharing a set of tenets for the design of collaborative challenges and introducing some details of a challenge-based learning technology platform.

Structural: Well-defined vs Open-ended Challenges

The structural perspective refers to the *architecture* and *mechanisms* of the roles and responsibilities in learning. For well-defined problems, the traditional role of the learner is a novice who is listening, watching, and learning from an expert. The expert knows the answer and can check the veracity of the novice's solution. In contrast, with open-ended or ill-structured problems, any participant on the problem-solving team is as likely as any other to have something to add to and help create the solution (Jonassen, 1997). Experts don't have all the answers, even if they do have more wisdom about how to construct meaningful and relevant solutions. Feedback on well-defined problems is thus often relatively easy to automate, since there are usually finite right and wrong answers in a limited range of expressions. But in open-ended challenges, feedback on detailed criteria is needed, which requires new methods of expression of the learner's understanding, such as visualizations and causal maps (Eseryel, Ifenthaler, & Ge, 2013). As in performance assessment, a scoring matrix aides in the evaluation of open-ended solutions when used by the learner, peers, and experts (Kelsey, 2001).

Learners undertaking a collaborative challenge might experience either end of the spectrum from well-defined to ill-structured problems or a cycling between those ends, depending on how much scaffolding of process and content as well as timing of support is desired to help learners create, communicate, think critically, and collaborate. For example, in the *Curtin Leadership Challenge*, a self-guided challenge-based digital learning experience, individuals first learn in a structured way about their own values and preferences and compare their thoughts with what the literature says about socially responsible leadership and then are introduced to more open-ended decisions about leadership. In the *Balance of the Planet* sustainable-development challenge, the process of building a team is scaffolded, but the choice of which global problem to solve is left to the team to decide, and product rubrics with criteria for solution elements guide the team's decisions. For example, the team knows that it has to produce a seven-minute video as one of its products, and the video must convince the audience of the value of the team's solution, but no other help or advice is given, and the team must figure out not only what to represent but how to go about creating a video to meet those criteria.

Instructors in the world of collaborative challenge-based teaching and learning have a special role in constructing a problem space with key ideas, essential questions, resources, and evaluation criteria. Subject matter experts (SMEs) in a discipline work with a digital-media team and game-creation team to engineer the learning experience. For "Balance of the Planet," for example, the UNESCO Bangkok office, Curtin University Sustainability Policy Institute, and the Australian Sustainable Development Institute, with the support of the Deputy Vice Chancellor Academic, engaged in the design thinking process that led to the challenge. In the next section, we explain the human-resource journey of SMEs in leadership into the new world of challenge-based learning. The point we are making here is that a new structure of teaching, created via collaborations among SMEs working with learning-experience designers and technical teams, is arising as an innovation to create new structures of teaching and learning in response to the myriad changes taking place in higher education today (Grummon, 2010). Challenge-based learning is seen in this context as one of Curtin University's innovative responses.

Human Resources: Individuals and groups

The human-resource perspective refers to the people in the system: learners who form collaborative international teams, mentors who give advice to the teams, challenge authors who create and continuously adapt the digital learning experience, the platform creators and administrators, and the senior executives and external partners who support the challenge. This is the new face of instructional design teams in higher-education, challenge-based learning.

Learners experience a challenge as individuals but are also involved in the social processes of their group. Team members in the "Balance of the Planet," for example, must agree on a team name and a key problem they wish to solve. They must choose an approach and point of view toward their solution or proposal and collaborate to create key artefacts that are submitted for feedback and judging. The team can reach out to any expert in the world to help them with their solution. The challenge has numerous activities and scaffolds at the team's disposal to help with group development and team learning processes, based in five disciplines of organizational learning (Senge, Kleiner, Roberts, Ross, & Smith, 1994) as well as with individual exploration and personal growth in a community of practice (Lave & Wenger, 1991; Li et al., 2009). Individual and group experiences are integrated over time as team members undertake activities of their own choosing within the five disciplines of personal mastery, shared vision, mental models, team learning, and systems thinking (Senge, 1990). Students anonymously score each other's submissions and artefacts and gain extra points by offering elaborative comments that are accepted and used by others. Students on winning teams are invited to become mentors to future teams, are guided in their role, and are rewarded for their work. As mentors, they are observers on several teams and can share ideas, offer assistance, and promote exchanges of ideas among teams.

Instructors in the challenge-based learning framework are designers of the digital-learning experience who put in most of their time in up front and then take a backseat during the implementation while individuals and teams are learning, working, communicating, creating, and submitting artefacts. Most of the input from subject-matter-expert authors is gathered during the design phase and is embedded into the digital experience through the public scoring rubrics, artefact descriptions for final submission, and scaffolding activities which the team members can choose to experience or ignore. Some research indicates that students undertake more than is expected because the quest for points and attaining the winning condition are strong attractors for performance (Haskell, 2013). Instructors do not intervene during implementation, which allows the individual and team to "self teach"; SMEs on the design team return to active duty at the end of the challenge when they form into panels to judge final submissions. This dramatic shift of focus goes beyond the "sage on the stage" as well as the "guide on the side" (Wiggins, 1989) to a stance where students learn by grappling with a problem or challenge using designed resources and experiences. Other subject experts in the world at large are human resources who serve at the pleasure of the team (Carroll, 2000).

A great variety of human resources can be found in higher education, and they span a wide range, from subject experts with deep knowledge of research and discipline content but little knowledge of learning theory and teaching, to teaching experts who combine subject knowledge, to learning scientists, digital media and instructional designers, tutors, student life counsellors, scholarship and admissions staff, administrators, career counsellors, and many more. In a challenge-based higher-education system where there is a shared vision and aspiration for producing global impacts, nearly all of these human resources can play helpful, targeted roles before, during, and after each phase of design, implementation, and evaluation. Subject specialists can respond with advice when a team asks. Teaching-focused experts can co-design the challenge-based digital experiences with media and instructional designers. Counsellors and leadership experts can help train and support the mentors. Learning scientists can assist in researching the cognitive and non-cognitive effects and analyzing the data collected automatically by the technology. Scholarship leaders can be part of the reward structure; and so on. There is room for everyone to gather around the metaphorical circle of the issues at the center of technology-enabled, challenge-based learning in a global context.

Symbolic: Dramatic aspirations

The symbolic perspective refers to the soul of the program, its aspirational vision and the stage it sets for creativity, meaning, and the importance of the effort (Bolman & Deal, 1995). The symbolic dimensions of challenge-based learning in a global context include addressing complex societal, economic, and environmental problems and fragmentation (Conklin, 2001), saving the world from destruction and raising the hopes, learning capacities, and economies of all people. These are a set of aspirational objectives that might at first seem impossible to reach, but note: the game-like nature of a challenge creates a new virtual space for thinking and action where any kind of inquiry and expression is possible, similar to the virtual illusion of a fine art form (Langer, 1954). A global challenge is a call to dream, create, and be entrepreneurial in spirit for the good of others, which draws upon and requires one to integrate competence, autonomy, and relatedness (Ryan & Deci, 2000)

Learners who have participated in global, challenge-based learning programs relate that they were attracted by the idea of making new global friends, creating a new idea or solution that could change the world, and by the hopes of being recognized and rewarded for being the best in the world in the competition (Gibson & Grasso, 2007). These symbolic hopes for increased intercultural understanding, increased skills and powers of influence, and increased self-efficacy and confidence are real, measurable impacts that follow from the playful learning and effort in challenge-based learning (Harris & Nolte, 2007).

Instructors in fields such as theatre, music, film, digital media, creative writing, and performance art are experienced in the integration of genres common to many creative processes. Especially useful in innovation and entrepreneurial thinking are the skills of improvisation, brainstorming, and trusting one’s instincts that are so central to the construction of expression and evaluation in the arts (Amabile, 1996). These interdisciplinary, team-based creation processes are critical paths for the symbolization of any inquiry and expression and now need to be codified into a new method of curriculum design for challenge-based learning. The design method for the future of digital learning experiences is a team-based effort of people knowledgeable in subject matter, dramatic narrative, mechanics of game-like interactions and rewards, digital-media artists and communicators, and computational science tools for algorithms and visualizations (Gibson, Aldrich, & Prensky, 2007). The mission of such interdisciplinary teams when creating challenge-based learning experiences is to create a symbolic space for transmedia narrative (Passalacqua & Pianzola, 2011) to be introduced as well as to evolve through the participatory culture (Jenkins, Purushotma, Clinton, Weigel, & Robison, 2006) shared by those who take up the challenge.

Challenge-based learning is an approach to teaching that is well suited to the aspirational aims of higher education, and when focused on a global context, is particularly fit to support its global mission. Supporting the structural, human resources, and symbolic perspectives is the technological know-how to reach and engage people at scale around the world.

Technical: High tech - high touch

Technology enables collaborative challenge-based learning in a global context to be authentic and fully empowered for creating, testing, and sharing ideas on a scale and speed of impact that was unimaginable a few years ago. However, this is not an argument from the standpoint of intoxication with technology (Naisbitt, Naisbitt, & Philips, 1999) with its attendant desire to find a quick fix, or as part of professing a love of gadgets, or the desire for a magical automated solution. Instead, there are three pragmatic rationales for thoughtfully and carefully integrating technology into challenge-based learning in a global context.

First, computational tools and methods have transformed the landscape of science and our understanding of complex phenomena, leading to the observation that social and psychological research, including the learning sciences, have a new game-changing foundation (Gibson, 2012) that will advance as interdisciplinary teams construct challenges for learners. Second, social network tools such as Facebook and Twitter, as was evident in the Arab spring (Lotan et al., 2011), illustrate the self-organizing power of some technology enablers, which has the potential to be harnessed for deliberative democracy and social-change leadership (Boeder, 2005; Habermas, 1990) to make the world a better place. Higher education has an ethical imperative to provide students with opportunities, guidance, and rewards for using technology for these ends. Third, powerful computational tools and global social networks are evidence of how computers change the way we think (Turkle, 2004). In *Balance of the Planet*, for example, by the use of technology to form and manage a work team, reach an international scientist for comment, find a solution and adapt it, and create complex communications and artefacts for others to judge, technology is a lens to see the world in new ways as well as a tool to envision, create, and take action for social, environmental, and economic justice, the triple bottom line of sustainable development (Sachs, 2012).

Second, learners on a globally distributed team are remote from each other in time and space, so technology is critical to the team's success. Learners in *Balance of the Planet* must use a wide variety of technologies for communication, creating documents and media, sending files, and keeping track of progress in order to submit a final product such as a video and a substantial, well-referenced, co-authored paper. The challenge-based learning philosophy of enabling technologies is to use them to introduce options but not to confine learners to any particular method, tool, or process. The sole driver of production is a highly detailed description of final submissions with publicly available scoring guides for both the video and extended report. This stance gives the learner and team maximum flexibility to find and creatively use technologies to meet their own aims. The digital learning experience design embeds a core set of technology requirements but leaves open how high tech and high touch the team envisions its solution.

Third, not only can instructors determine the expectations and resource constraints and set the digital stage for performance by working with a multidisciplinary design team, but so can the students. This kind of intensive, team-based design makes economic and pedagogic sense because one goal of *technology-enabled*, collaborative, challenge-based learning is to reach massive, open, online scale with a new kind of blended learning. Instead of blending face-to-face with online learning, the new blend is 1) well-structured and ill-structured problems, 2) individual and team learning, 3) dramatic transmedia narrative experience (Passalacqua & Pianzola, 2011) and practice-based acquisition, and 4) high tech and high touch. The economics of creating such a stage for challenge-based learning make sense in the long run because of scale, repeatability, and taking advantage of socially and algorithmically driven automation during the implementation phase. Pedagogically, a challenge is an invitation to perform to criteria, similar to a performance assessment or capstone project, and is therefore intended neither to be all things to all people nor to deliver all of education for all purposes.

Design Principles

In this section, key design principles for challenge-based learning are presented before a brief discussion of Curtin's "Challenge" platform. The principles are grouped into "ubiquitous and transformative technology" and "game-inspired teaching and learning" and build on the four perspectives outlined above. The tenets have emerged based on observations of innovative technologies being applied to the design problem of building a supportive technology infrastructure for challenge-based learning at Curtin University.

Ubiquitous and Transformative Technology

The first group of tenets concerns the "embedded, anytime, anywhere" nature of technology and information combined with the radical impacts this access and structure has had on the way we think about work, creativity, and the nature of thought itself. For example, embedded computers (Wolf, 2001) in the kitchen might mean that the refrigerator knows when milk and eggs are needed, can place and pay for the order at the store, and notify the owner to pick them up on the way home from work. Access to information at any time has changed entertainment; for example, people can now "binge watch" (Jenner, 2014) an entire season of a show in one sitting, which was impossible a few years ago. Access to information on the go, anywhere has led to telecommuting (Ye, 2012) as well as to "internet addiction" (Yellowlees & Marks, 2007). These kinds of cultural and psychological changes reflect a growing reliance on a new form of technology enabled knowledge and thought which is mobile, distributed across one's social connections, media and devices (Pea, 1993), and which requires as well as develops transmedia narrative expression and navigation skills, among other new media skills (Jenkins et al., 2006).

These two ideas – ubiquitous mobile computing and the transformation of work, creativity and thinking – suggest a need to rethink the digital environment for teaching and learning to be fit for purpose in this new landscape. In challenge-based learning by global teams, we have found four specific ways to reshape digital learning experiences.

Computational thinking, tools, and toys. This approach assumes that people will learn better in a technology environment if given interactive, highly visual, and playful ways of engaging with and exploring ideas. The foundations of the idea have roots in the algorithmic and data revolution in science (Stanton, 2012) as well as in philosophy through computational epistemology (Thagard, 2002). As a design principle, words are minimized, and doing something with one's hands and mind is maximized. Directions about how to do something are kept to a minimum. Interactions are made as obvious as possible or easily discoverable, and the goal is to get the person to move things around, try things out, and to create his or her own words and concepts while displaying a real-time view of the data of interest.

Groups self-organizing around shared goals. This approach acknowledges the social adhesion of knowledge production and creative problem solving when there is a shared vision (Senge et al., 1994). Instruction about and presentation of knowledge is kept to a minimum. Groups are allowed to form, adjust membership, and disband at will. Groups decide upon and develop their own specific focus (e.g. influencing the future of transportation) within a larger challenge concept (e.g. saving the world from various impacts of global warming). Unification of the group's production efforts is facilitated by having a concrete submission format for a final product that has been formed to provide evidence of highly detailed criteria with enough structure to ensure a fair comparison across groups. For example, a challenge might be to produce a seven-minute video explaining how the group's concept will save the world, which must show the concept in action, explain how it works, and convince the audience to join in, help, or try the solution. The video will be scored using a 10-point rubric with highly specific elements that help guide the group's decision-making about the video.

Find and use any knowledge, person or thing at any time. This principle acknowledges the ubiquitous, distributed nature of knowledge (Wenger, McDermott, & Snyder, 2002) and allows the group to reach out across the globe as well as through space and time to find any idea from any time or to engage with any mind or resource they can find. Points are subtracted for not acknowledging sources of reference, while significant extra points are given for utilizing and elaborating on the ideas, works, and words of others. Supports are given concerning how to acknowledge others. Encouraging this outreach, uptake, synthesis, and inclusion into the group's work is seen as key to collaboration and is a training ground for assembling ideas, scholarly thought, agents, and allies into one's creative, team-based problem solving and products.

Social, epistemic, and Bayesian networks as the new teacher's aide. This principle acknowledges a common feature of social network communities and in fact all kinds of networks. Thumbs up on Facebook, five-star ratings on Netflix, and publicly displayed trust measures on eBay are examples from industry and telecommunications of a kind of social currency that can be part of a digital learning experience design. Coursera, the MOOC company, for example, utilizes social voting to help scale its assessments (Pappano, 2012). As people engage with a particular digital learning experience, the data network of which resource nodes they used and how they used them begins to form a basis for analysis. The general form of the data, when properly collected and stored, is called a Bayesian network (Mislevy, Steinberg, &

Almond, 2003) from the practice of changing the weights associated with each node during the training of the data network (Baker, Chung, & Delacruz, 2008); and when the digital learning experience has been designed to replicate an authentic professional frame of thinking and action, then the analysis of the network can be considered an "epistemic network analysis" (Shaffer et al., 2009). Since the network can be used to make predictions, guide people to new resources, and make assessment judgments, we can think of this design element as supporting a new digital teacher's aide.

Game-Inspired Teaching and Learning

The student experience in challenge-based learning is inspired by elements of game-based learning. The following principles underscore how the context of a game with worthwhile rewards motivates people to undertake a challenge.

<u>You are the hero of your own story.</u> This tenet addresses relevance and heroic action as the core of motivation to undertake a challenge. It also ties to personalization, while at the same time giving over to the person the authority to create the path he or she chooses to follow (in contrast to personalizing by selecting the next item for the person based on what has recently been accomplished). What games do well is give the feeling of heroic action quite often (e.g. once every few seconds or minutes) rather than only at the time of choosing to enroll in the experience (Prensky, 2001).

<u>Work on your own time, on your own path.</u> This element addresses freedom, creativity and choice. Since the person can leave at any time, and might come back for only short stays, the learning design has to be thoughtfully constructed to allow short bursts of activity as well as meaningful sequences that unfold during concentrated periods of time. The heart of a game is having interesting decisions to make and complex consequences for one's actions (Aldrich,

2005). Digital learning design thus needs many decision points and many alternative ways to re-experience a setting, problem, or task.

Failure is expected and welcomed. This principle captures the idea that through dedicated practice, people gain skill and can become experts. In games, the player is given ample resources, which, while limited, are not so precious as to stifle risk. By sacrificing or losing from time to time, one learns how to win big at a later time. This is learning by trial and error, in which the cycle of learning is quick and the endorphin rush of winning small keeps people engaged (Howard-Jones, Demetriou, Bogacz, Yoo, & Leonards, 2011).

Feedback, points, leader boards, and winning. These elements rest upon transparency of goals, access to data about progress, and comparison data that contextualizes to others and to accumulated gains. These principles have historically been explored as part of assessment theory (Black & Wiliam, 1998; Wiggins, 1989) and recently have been re-configured within the computational environment of digital learning environments (Baker et al., 2008; Gibson & Clarke-Midura, 2013).

Next, we briefly outline a case of combining the learning theories and design principles just outlined into a new online e-learning platform developed to support challenge-based learning at Curtin University in Perth, Western Australia.

Brief Example: Curtin Challenge Platform

"Challenge" is a web-based, mobile-ready application platform for active digital learning experiences and event-level data collection (Gibson & Jakl, 2013). Digital learning experiences launched on the platform present content in short, interactive tasks and track a learner's behaviors, products, and decisions at the event level in high resolution (many frames per second) allowing near real-time as well as post-hoc analysis of cognitive and behavioral change over time.

The teaching and learning approach of the platform uses challenge-based learning (Johnson et al., 2010) to shape the learning process and evidence-centered design (Mislevy, 2011) to inform the assessment process. Students largely teach themselves through self-organized activity, open-ended inquiry during exploratory learning, and creative self-determined expression within the bounds of required products that will be judged by peers, the world at large, and experts. The Curtin teaching and learning platform supports any number of people from thousands to tens or hundreds of thousands via technology-enhanced, digital learning experiences.

“Challenge” is designed to support self-directed learning, self-organizing international teams, open-ended problem solving, automated documentation and assessment of learning, social network validation processes, expert judging, and a variety of levels of recognition and awards. “Challenge” enables individuals to build up a private, safe, and trusted longitudinal record of digital engagement and to make progress at the individual level while working alone or with others. Individuals can participate numerous times in several different challenges and can gain a collection of micro-credentials that stand as evidence of meeting university-level progress and achievement.

Summary

A new blend of e-learning approaches known as challenge-based learning supports the development of capabilities for global leadership, entrepreneurship, and ethical decision-making. Students in challenge-based learning experience a mixture of 1) well-structured and ill-structured problems, 2) individual and team learning, 3) dramatic transmedia narrative experience and practice-based acquisition, and 4) high tech and high touch technology approaches. Higher education has the requisite organizational resources – the structures, human resources, ethical aspirations and technical know-how – to create and support scalable, self-organizing learning communities and semi-automated processes for content creation and assessment feedback to bring these experiences and their content experts to the world. Design principles from ubiquitous computing, transformational uses of technology, and game-inspired engagement elements form a new basis for teaching and learning.

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