Editorial for EJEL Volume 11 Issue 2

The articles in this issue demonstrate the widening range of possibilities for e-learning. The technologies continue to develop and change, and issues of adoption and innovation persist. Like any other technologies, e-learning hardware and software is best used when it is introduced to solve a real problem which has been carefully thought through. The articles show that there is tremendous promise and opportunity, but there are no quick fixes, and no one-size-fits all solutions.

Kyalo and Hopkins investigated attitudes towards online learning for continuous professional development in medical colleges in Kenya, which are facing financial and multi-site challenges. Online learning was found to be acceptable in principle, but the survey confirmed doubts about using online learning for practical and, particularly, for clinical subjects. Fears about the credibility of online qualifications did not seem to be warranted, but this could depend on the clinical or theoretical focus of a course. Motivation was seen a potential problem too, and although many of the staff who had previous experience of online learning were positive, the majority were decidedly neutral. The recommendation of the authors is to adopt a hybrid approach, which is likely to deal with many of these problems.

Hramiak asks whether experience of using blogs in teacher training can simply be cascaded into schools, or whether it is much more complex than that. Teachers’ confidence in using blogs came up against ‘inhibitors’ in the actual classroom. Time, access and support were issues. Not surprisingly, the use of blogs needed to be integrated with pedagogy, specifically with ways to support, share and reflect on experience and interaction, and with the curriculum. Strategically, there is a need for too.

They do flag up the issue of academics being “reluctant to adopt technology in their sessions with trainees”, which seems to point to a reluctance to ‘let go’, and embrace students opportunities to interact, and learn in different spaces, outside of the narrow circle of teacher-student interaction in the classroom. Perhaps this has some bearing on the reluctance of head-teachers to adopt whole school approaches too. This can be mission-critical, where issues such as firewalls are not solved, enclosing the school in its own walled garden, in which one of the major affordances of blogs – to reach out of the classroom, is prohibited.

Xanthou has developed a dynamic e-assessment tool which responds not just to whether the answer to a particular question is right or wrong, but also to the level of accuracy of the answer. It then raises or lowers the level of the following questions. This provides the student with the motivation to repeat the tests until they become familiar with the course content.

This includes both adaptive presentation and adaptive navigation – the latter in particular provides more than just a ‘programmed learning’ response, as the learner has freedom of choice which enables them to determine their own learning paths. She concludes that while physical contact with a tutor is clearly ideal, these adaptive
tools can “significantly contribute towards a more interactive, ... more efficient, meritocratic educational framework that cannot be reproduces using conventional ... means”.

Worrall and Harris conducted action research with a group of professionals hard pressed for time, and dissatisfied with the lack of responsiveness of their currently available networking platforms. They conclude that feedback needs to be improved, and they need to have more ownership of the site, as well as more facilities for private interaction in private chat rooms.

Florence Martin and Michele A Parker explore the adoption of synchronous online classrooms at university, using Roger’s model of diffusion of innovation. They found that availability and ease of use, and efficiency and reliability of the system were key extrinsic the motivators, although the faculty were wary of using particular tools if they lacked confidence.

Personal factors that rated highest for adoption were an interest in improving teaching and learning, supporting studies elsewhere. Archiving and play-back, and the audio and text chat feedback facilities were used extensively. Conferencing was used for online courses as well as to extend interaction in blended courses, and to offer virtual office hours.

Moten et al tackle the ever growing problem of online cheating, as availability and sophistication of such ‘services’ continues to grow. Procrastination and time-management, peer pressure and behavior, and a less personalized and distant relationship to students all played a role. The authors discuss a range of problems and possible solutions, but it remains an ongoing issue.

Kotsilieris and Dimopoulou explore the possibilities offered by 3D virtual worlds for students to interact via avatars, in ways which are not possible in the real world. They discuss the way Sloodle can be used to bring together Moodle and OpenSim, and their experience in setting up an experimental virtual class.

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Digital Games and the Hero's Journey in Management Workshops and Tertiary Education

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Abstract: Joseph Campbell's Monomyth not only provides a well-proven pattern for successful storytelling, it may also help to guide teams and team leaders through the challenges of change and innovation processes. In project "HELD: Innovationsdramaturgie nach dem Heldenprinzip" researchers of the University of the Arts Berlin and the Berlin Gameslab, part of the University of Applied Sciences HTW-Berlin, team up to examine the applicability of the Hero's Journey to change management using an adaptation of Campbell's pattern called „Heldenprinzip®“. The project's goal is not to teach the stages of the Monomyth as mere facts but to enable participants of training courses and interventions to actually experience its concepts using a portfolio of creative and aesthetic methods. While a pool of aesthetic methods - like drawing, performing or role-playing - is already being used, the Gameslab subproject qualitatively researches the potentials for enriching and complementing these methods with interactive digital media and games. This paper discusses three types of game based learning treatments to be used in training and intervention sessions as well as teaching the Monomyth in a game based learning university course. The first option is providing participants with a game that follows the Hero's Journey and inducing them to reflect on the experience and its relation to the learning goal. An alternative strategy is to make participants go through a game sequence broaching issues that are relevant for a stage or the journey of change in general. Last but not least, digital equivalents of the non-digital aesthetic methods can be constructed using digital games or digitally enhanced set-ups for playful interactions. All three treatments have their merits and pitfalls, which are discussed in relation to the identified game-based learning scenarios: self-study, blended game-based learning and face-to-face sessions. Furthermore, these scenarios are compared while specific techniques boundary conditions are highlighted.

Keywords: blended game-based learning, physically interactive digital games, hero's journey, innovation and change management training, teaching game-based learning

1. Introduction

Today's economy is fast changing and provides less and less certainties, thus making it mandatory for businesses to successfully innovate and adaptively change. There is a multitude of models available to support such processes by describing stages that should be considered and activities that should be tackled, thus reducing complexity. While Change Management models commonly include some thoughts about the culture and individuals in an organization that needs changing (see Todnem, 2005) such considerations tend to be missing in models of innovation processes (e.g. in Hughes & Chafin, 1996:92, 93). These, like the Stage-Gate®-Model (Cooper, 1990), tend to be sequential and resemble a metaphorical production line with little regard for the human condition. When thinking about innovation processes as being triggered and advanced by human ideas it becomes obvious that, while being excellent guides on what to do at which stage, innovation models tend to lack considerations on how motivation and creativity can be upheld in such seemingly unpredictable human-borne processes. Thoughts about individual change and growth (i.e. innovation) are certainly not new to humankind, which poses the question how knowledge about such change processes is and was collected and communicated.

1.1 The Monomyth

In 1949 Joseph Campbell, a mythologist, proposed that such knowledge has been transported in myths since the dawn of culture, especially in the form of stories that describe the journey of a hero. Campbell argued that all myths and stories, regardless of their cultural origins, share the same underlying pattern. Thus, he called this concept the Monomyth (Campbell, 1949). The Monomyth (figure 1) describes the change process as a three act structure: the hero starts off in the known world where something is amiss. She overcomes the inner and outer refusal, aided by well-disposed powers and travels into the unknown land of adventure. Learning by failing and mastering tests she finally gains an invaluable item or recovers lost knowledge. While the hero may be tempted to rest at this point, believing that she already gained all she ever desired, it is vital to return to the community...
and renew it with the boon. By doing so, the hero proves her abilities to master challenges in both worlds and gains the freedom to live.

Figure 1: The Stages of the Monomyth according to (Campbell, 1949)

1.2 Teaching the hero’s journey as a change-model

Just like the mythical hero, team leaders and members even projects and whole organisations have to navigate the path of change. Everyone in a team should know both the “Call” of the project and their own. Every project and every changing organisation needs to deal with resistance from without and within (Hauschildt, 1997). Severe challenges need to be mastered and gained boons must be integrated into the day-to-day business. A complete description of the Monomyth and its mapping to the management of innovation and change processes in the Heldenprinzip® (figure 2) would go well beyond the scope of this paper: How to teach this valuable instrument and enable learners to use it for their personal development as well as the anticipation and consideration of vital stages in an innovation or change process. We do not teach the Monomyth as an abstract concept. Instead, we strive to let the participants experience it, thus demonstrating the power of using the Monomyth to analyse, reflect on and predict individual and organizational change processes. Furthermore, the repeated reflection (Craik & Lockhart, 1972) and the active emotional experience support the memorization (Cahill et al., 1996) of the concepts covered. The existing and evolving content of our toolbox can be roughly divided into two strategies: on the one hand we are using non-digital creative and aesthetic methods – like drawing, performing, or role-playing – and on the other hand we are researching the applicability of digital media and games.

Both non-digital aesthetic methods and digital game based learning have been tested separately and conjunctively in three settings. Firstly, 12 team leaders and executives have been counselled in seven two-day workshops spread over one year in the seminar cycle “Ring of Leadership” (Denisow & Trobisch, 2012). Secondly, three small and medium-sized businesses (SMBs) have been accompanied on their journey. Last but not least, workshops have been conducted at conferences and in other settings, ranging from one hour up to five days. Needless to say, this wide range of settings entails quite diverse requirements and boundary conditions which are discussed along with the corresponding treatments below.
2. Digital game-based learning treatments

At HTW Berlin and especially in the gameslab, a comparatively wide definition of digital game-based learning is applied:

“Digital game based learning is the process of being taught and/or learning via digitally enriched play-/gamelike activities or by playing/designing/creating/modifying digital games.” (Bodrow et al, 2011)

The authors felt the need to propose this definition after an ongoing literature review did not yield a definition that was neither too broad nor too narrow, e.g. “So, let us define Digital-Game-based Learning as any learning game on a computer or online” (Prensky, 2001:146). For a further discussion of the latter and a delineation of DGBL from Serious Games and Edutainment see (Bodrow et al, 2011). Other authors circumvent a DGBL definition completely just referring to learning with games (Salen, 2010; Squire, 2011) or learning games (Klopfer et al., 2009). While the first concept matches game-based learning pretty well, the latter poses some problems. To begin with, it might lead to an immoderate focus on software products instead of the process of teaching and/or learning with them. Furthermore it begs the question of what should be considered a learning game. On the one hand this label could be restricted to games that were created with an explicit educational goal. Following the definition of (Prensky, 2001:146) this would result in a very narrow model and mode of application (Bodrow et al, 2011). On the other hand including commercial of the shelf (entertainment) digital games that can be used to teach something could be considered too, e.g. “Civilization, Rollercoaster Tycoon, and SimCity” (Klopfer et al., 2009:21). Unfortunately this basically implies that there can not be a single game that might not be considered a learning game. A valid but ignorable reason for this is that games are about learning to play them (Gee, 2003; Koster, 2005:34-46) in the first place. Rather, any game might be used to teach at least about two out of the following three points:

- its theme or narration, e.g. segregation and racial prejudices in “Of Orcs and Men” (Cyanide & Spiders, 2012).
its simulated model or procedural representation (Salen & Zimmerman, 2004:422; Bogost, 2007),
e.g. business models in tycoon games (Bodrow et al, 2011) or physics in “Portal” (Valve Corporation, 2007; Valve Corporation, 2012).

- game design and game art.

Thus a focus on learning games proves to be either to narrow or to broad, too. In contrast the proposed definition of digital game-based learning covers three more or less distinct scenarios: To begin with, learning by playing a digital game with or without individual reflection or group discussion. This covers learning in formal as well as informal – e.g. “stealth learning” (De Freitas & Maharg, 2011) or “interest-driven learning” (Squire, 2011:19-22) – settings. The second scenario is learning by designing and creating (e.g. Marlow, 2012) or modifying (e.g. Squire, 2011:174f; Monterrat et al., 2012) digital games. Wherein the produced game or mod might be created to generate either an entertainment or learning experience for the prospective player. The latter will be elucidated in 2.3 by referring to a digital game-based learning course taught by one of the authors. The third scenario covered by our definition is learning framed by playful interaction with digital media or game components. One approach that fits into this scenario is digital aesthetic learning, which will be presented in 2.4.

2.1 System-based learning – core-mechanics and rule-set-based reflection

One approach of learning by playing a digital game is based on the notion of games as systems which can be considered from three complementary perspectives. Firstly, digital games depict real or imaginary systems in a more or less abstract or condensed way (Salen & Zimmerman, 2004:422f). Secondly, digital games are (complex) systems themselves (Salen & Zimmerman, 2004:156). And last but not least, the act of playing the game creates a temporary system that encompasses the game and its players, their actions and the social space surrounding them (Salen & Zimmerman, 2004:471). With this in mind, learning with digital games can be considered as training systemic thinking in general (Salen et al., 2010). Furthermore, the player may learn about the represented system, its procedural properties and causal relationships, consciously or unconsciously engaging with its procedural rhetoric (Bogost, 2007). Thus, they may be enabled to reflect on their assumptions and procedures potentially changing their attitudes and behaviour. Depending on the context and learning goals, the game itself does not necessarily need to depict the target system very accurately. Indeed, in some cases, not at all. When focusing on training skills or discussing behavioural patterns, for example, it may suffice that the game triggers relevant reactions or patterns. These can than be discussed and brought into relation to the learning goals after or between game sequences. To further illustrate this, consider the following example of this approach in change and innovation workshops.

Besides focusing on the narrative of digital games, one can make participants experience the challenges of the Hero’s Journey by applying games with core-mechanics (Salen & Zimmerman, 2004:316f) or rule-sets that trigger the emergence of relevant issues. This might be both competencies needed constantly and specific skills or insights necessary to master a certain stage of the Heldenprinzip. While COTS-DGs with conventional input and output devices can certainly be used in workshop-settings, e.g. broaching the subject of monetary motivation via the digital game “Majesty 2: The Fantasy Kingdom Sim”. The relatively short duration of workshops in conjunction with oftentimes low gaming-experience of participants favours less complex and time-consuming games as teaching tools. These games should ideally (Busch et al, 2011):

- have a low learning curve and intuitive interface to reduce the threshold for non-gamers
- be fun, challenging and engaging for a wide range of participants
- be entertaining and easy to follow for spectators to allow watching and discussing their results
Figure 4: Leadership training with “Kinect Adventures”

To test and evaluate this approach we combined motion-controlled game-interfaces such as Microsoft's Kinect with large projections creating an engaging and entertaining set-up that can be used within the temporal/spatial limits of a short workshop. Instead of exploring a complex storyline, players are asked to prove their heroic skills in various mini-games. We found that there are COTS-DGs that can be used out of the box to challenge and improve a number of skills relevant to the concept of the Heldenprinzip. To exemplify this, consider the digital game collection “Kinect Adventures” featuring a two-player rafting game. Players have to actually jump to surmount obstacles and steer by moving their entire body left or right. If one player moves right and the other left, the boat continues straightforward, thus both need to coordinate their behaviour to steer the boat in such a way as to collect as many silver coins as possible. While there is sometimes a single course to follow, quite often multiple options are available, thus increasing the need to explicitly agree either on actions (left, right, jump) or a targeted path under extreme time pressure. Both the setting and the core-mechanics lend themselves very well to experience leadership and discuss related issues in general or targeted at change and innovation processes. While the core-mechanics reward good coordination, the setting on the one hand invokes the metaphor of sitting in the same boat and on the other typically gives rise to questions like: How does an “ideal” type of leadership might look like in the game? Is this congruent with working life experience?

In a workshop-setting we generally give a very short introduction to the game covering only the mode of interaction and the very loosely defined goal of collecting silver coins. After that, cycles of game-play and discussion are initiated. The play sequences typically cover less than two minutes while the discussions span between five and 15 minutes, sometimes even longer. The discussions cover three aspects. Firstly, asking the players about their experience: What worked out well? What did not work? How did both players feel in their preliminarily agreed upon role or modus operandi? Reported perceptions are immediately compared with the perceptions of the audiences, quite often revealing interesting disaccords which fuel the discussion. This typically introduces the next stage where connections to working life experiences are discussed, and insights and knowledge (usually in form of stories) are shared within the group. The last stage then focuses on who shall play next and which setting, strategy or ad-hoc rule shall be applied next. Interestingly, the latter shows both a tendency to bring up recurring patterns, like one player shall be the steersman, and innovate ideas, e.g. leading by indicating the course with one arm instead of issuing verbal commands or objectives.

We tested the application of the white-water rafting game during workshops in all three of the aforementioned contexts (Ring of Leadership, counselled SMBs and one-time workshops) getting almost exclusively positive results. Participants inter alia did not hesitate to draw parallels to real-life situations and relate the game results to personal experiences from their respective professional background while at the same time visibly enjoying themselves.

Only in a single one-time workshop, with participants ranging from innovation managers over seminar managers to a ludologist, the feedback was less enthusiastic. Especially the ludologist was rather
critical, arguing that we did not meet the potential of the medium. While the latter is certainly true, especially when comparing the rafting game with the concept of persuasive games and procedural rhetoric (Bogost, 2007), it rather depends on the applied schema. While the digital game itself is certainly neither very complex nor persuasive when considered with the aforementioned schema of “a game as a temporary system” in mind – encompassing: the player(s) and their audience, the social setting, even the between-game activities (Salen & Zimmerman, 2004:471,418) and the agreed upon ad-hoc rules – it is very complex, indeed. Furthermore, it reliably lets relevant topics, concepts and disaccords emerge. Nonetheless, the game-mechanics create a certain bias, favouring some leadership and communication strategies over others. As (Squire, 2011:22-26) notes, all games come with a bias. But as he points out this is not necessarily a downside. When addressing these biases, often learning occurs (Squire, 2011:26). We address these biases on the one hand by discussing the relation of game model and working life. On the other hand we use different – both COTS and self-made – digital games and discuss the strategies each game reinforces, thus highlighting how the rules of a system shape behaviour in sometimes unexpected ways. An important point to highlight here is that our role in such workshops is not that of the “Sage on the Stage” but rather of the “Guide on the Side” (King, 1993). King proposed that in contrast to the transmittal model, where knowledge is assumed to be simply transmittable from teacher to student, the professor should focus on facilitating the learning process of students by engaging them in active thinking and discussion. Related ideas go back a long way (see e.g. Dewey, 1938) and we believe that in change and innovation workshops it is the only sensible course of action, indeed. In our experience the participants as individuals and even more as a group possess a lot, in some cases even vast “amounts”, of practical knowledge. The digital games are thus not used to transport learning content but rather as stimulus to explicated implicit knowledge and trigger discussions amongst the participants. Consequently, this treatment is better qualified for face-to-face interventions than for blended game-based learning and least of all for self-study scenarios.

2.2 Story-based repetition and reflection

A contrasting approach to learning by experiencing and discussing the core-mechanics of a digital game is to focus on the narrative of a digital game. The Monomyth has been at least unconsciously used for thousands of years as a narrative pattern for telling stories about individual change and transformation (Campbell, 1949). After its analysis by Campbell and its adaptation by (Vogler, 1998) the heroes journey can be considered a standard tool for writers and movie makers. Not surprisingly, this concept is also well known in digital game literature (e.g. Rollings & Adams, 2003:93; Howard, 2008:5) and can be found in various COTS-DGs (see e.g. Busch et al., 2012). This affords the possibility to use such games for teaching the Heldenprinzip as described in scenario one of our DGBL definition.

While a good storyteller certainly adapts a story for the specific audience, it is told the same way to all listeners. Nonetheless, the perceived and remembered story may differ according to individual preferences and cultural imprint (Bartlett, 1932). Thus, we encourage players to discuss their experiences, strengthening the memorization of the model and the ability to analyze processes according to the Heldenprinzip at the same time. A digital game offers the benefit of players gaining actual agency and likely having a stronger feeling of identification with both story and hero. Furthermore, it is possible, either by simply using side-quests or even branching storylines (Iuppa & Borst, 2007:25), that players from the same group can experience different versions of a story. Both stronger identification and individual story should therefore enrich discussions where participants tell stories about their experience of success and failures while playing the game and acting out the story. This may multiply the known power of storytelling (Denning, 2001) by telling stories about experiencing both the actual plot and the meta-“heroes journey” of playing.

While the benefits of using COTS-DGs are obvious, there are some drawbacks too. According to our research most COTS-DGs that exhibit many/all stages and offer story variation are role-playing games, which bring up two significant problems. First, these games tend to require huge amounts of play-time. In COTS-DGs like “Neverwinter Nights” or “Dragon Age: Origins” even core-gamers may spend 30 or even more than 100 hours of play. This would be unfeasible in a coaching session and may strain even self-study or blended game-based learning scenarios (i.e. self-study play and group reflection). To test whether playing only a part of an COTS-DG and using this as an option to highlight key elements of a small number of related Monomyth stages we analysed several games under the focus of applying one of them in the Ring of Leadership setting. While a number of games could be identified that exhibit a strong usage of the Monomyth, it became apparent that only the first few
stages might be covered that way. This is due to the fact that playing further stages typically requires
on the one hand an understanding for the story so far and on the other about the core-mechanics and
rule-set of the game. While it is certainly possible to tell the story up to the point the workshop
participants take over, conveying the knowledge of the latter two (normally developed incrementally
by hours of game-play) seems to be tedious at best.

An important boundary condition in the context of the Ring of Leadership was the low level of gaming
experience that may be due to the relatively high mean age (44 years) of the participants. Thus, we
eliminated all games from the list that required extensive knowledge of the used rule-sets (e.g. the
“Dungeon & Dragons” rule-set in Neverwinter Nights 2) or timely and exact interaction with the
human-machine interface (e.g. Elder Scrolls IV: Oblivion). The COTS-DG “King’s Bounty: The
Legend” a tactical role-playing game qualified as a candidate due to the relatively good tutorial, the
presence of a story with Monomyth stages and its turn-based battle-system (see figure 3). The latter
seemed to be especially important as it favours strategy over fast reflexes, thus potentially reducing
the difficulty for non-gamers.

Figure 3: RoL participant playing a “King’s Bounty: The Legend” (Battle-Mode)

In the workshop, participants have been playing the game for one hour, subsequently discussing the
experience and its relation to their working life. On the one hand the intervention enabled participants
to identify and discuss key situations, like being thrown in at the deep end when facing new tasks or
managerial functions and the general fear of failure. On the other hand neither a feeling of
identification with the hero was reported nor enabled the game a lively discussion of the Monomyth.
The latter points may have been a result of a lack of exposure to the story-line due to the long time it
took players to complete the tutorial, thus covering only the “Call to Adventure”. An interesting side
effect we encountered when working with “King’s Bounty: Legend” in the “Ring of Leadership”
workshop cycle was related to the reaction of those participants having little or no gaming experience
when facing the challenge of handling the game mechanics. While players were provided with a
tutorial introducing the key aspects of gameplay and control, we still found it a significantly steeper
challenge to control the game for those who had never played a digital game before and therefore
e.g. never used a typical interface concept such as the “W-A-S-D” keyboard layout for moving up, left,
down and right respectively. For participants who had to start their digital gaming experience entirely
from scratch, the lack of any assumption about how to control the game beyond the basic tutorial had
two consequences: Firstly, depending on the individual progress in handling the game mechanics, while players were provided with a
tutorial introducing the key aspects of gameplay and control, we still found it a significantly steeper
challenge to control the game for those who had never played a digital game before and therefore
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down and right respectively. For participants who had to start their digital gaming experience entirely
from scratch, the lack of any assumption about how to control the game beyond the basic tutorial had
two consequences: Firstly, depending on the individual progress in handling the game, some of these
participants did not make it through the projected part of the storyline within the hour. Subsequently,
they did not experience the corresponding stage of the Monomyth — in this case the “Call to
Adventure” — at least not in the way we expected them to. Because secondly, those participants
retrospectively described their experience with the game as an adventurous challenge, nonetheless.
They reported that being exposed to a new medium and given the task to control it felt to them like the
equivalent to entering a “new world” which nicely correlates to the Monomyth. Posing such a
challenge to participants may result in a positive learning experience when successfully mastered and be used as a means of encouraging people to handle unexpected situations, manage the unknown and transfer their experiences into real-life situations, closely corresponding to the system-based learning approach described in 2.1. But it may also, as interviews following this session of the “Ring of Leadership” have proven, cause frustration. Participants given insufficient or no help were not able to reach the zone of proximal development (Vygotsky, 1978:86) and were denied the rewarding experience of mastering a task never encountered before. To stick with the terminology of Campbell’s Monomyth: They were not able to cross the threshold into the land of adventure. This implicates a potential to design learning units targeted at handling frustrating situations and strengthening frustration tolerance and resilience (for a literature review on resilience see Howe et al., 2012) again an important skill or process (Rutter, 2012:335) in the context of change management and the Monomyth. In any case though, our experience with the “Ring of Leadership” has confirmed the need for the trainers’ substantial knowledge about the participants’ gaming experiences. Which are not only constraining the choice of games to play but that of the setting, too. Especially in case that participants exhibit a very heterogeneous level of expertise placing one player per computer was found to be problematic as it led to a strong divergence in play-time and thus bored experts needed to be kept busy/happy while waiting on their pressured peers. A two on one computer setting offers the chance to place an expert and a novice each to equalize play-time and additionally spread the load of coaching novices. Nonetheless care needs to be taken in supervising the teams so that both are on equal footing and that the experts guides the novices into the zone of proximal development (Vygotsky, 1978:86) instead of dominating the other. Whether and how to intervene in the latter case depends both on the context and learning goals. It might actually be worthwhile to not intervene but let the novice express his feelings in the follow-up to highlight and discuss good mentoring practices, e.g. when covering the “Meeting the Mentor” scene of the Heldenprinzip. While the mentioned positive effects of this workshop session are worthwhile indeed and will be the source of further test settings, the intervention did not meet the Monomyth related goals. To counter this we have produced, with students of the aforementioned “Digital Game Based Learning” course, to date three modifications of COTS-DGs which integrate most or all stages in a condensed way.

2.3 Creating and modding games – learning by teaching

In the DGBL course, students are expected to gain insights concerning games and play, learning theories and digital game-based learning on the one hand. On the other hand they have to realize a practical project: Either creating a digital game that can be used to cover working-life relevant themes like leadership, teamwork and conflict management. Or modifying a commercial off-the-shelf digital game (COTS-DG), creating an experience that can be used to reflect and discuss the stages of the Heldenprinzip. No matter which option students choose, they become acquainted with key issues of digital game-based learning by practical experience in a project based learning (Blumenfeld et al., 1991) setting. Especially the “relatively long-term, problem-focused” (Blumenfeld et al., 1991:370) and authentic project task seems to motivate our students in combination with their own interest in games and the opportunity to create something of value in a self-directed way (as proposed by Blumenfeld et al., 1991:375). Needless to say, the targeted grade is an important motivational factor but sometimes a source of in-group tension, too.

To make a good game or mod, students have to develop a solid understanding of the content they are covering, thus additionally learning what their games shall teach – thereby touching the concept of “learning by teaching” which has been shown to be very promising both in educational (Berliner & Casanova, 1989:12f) and business (Cortese, 2005:36&87) contexts. To cater for various set-ups and levels of gaming expertise the mods (see table 1) feature different play-times as well as complexity of rules and interaction. Furthermore, two mods feature a story that is a derivative work which thus may be known to a wide audience, enabling links to personal experiences while the others tell original stories, offering a fresh start. Due to their very recent completion, though, we cannot make informed statements about their effects in change and innovation workshops, yet. Nonetheless first experimental workshops with students have shown both potential but also problems. One interesting finding was related to an actual problem the student group designing the Mario mod had. After developing the story adaption (Neverending Story) and designing the first levels the group discovered that it would only be possible to place one text-sign containing less than 200 characters per level. This proved to be a major hurdle to tell a full-blown story. Without being able to use texts to highlight plot points and transport emotions the group had to tell their story basically via the level design. As a result of this and its short play-time it does not let the player experience a deep or complex story.
Nonetheless it proved to be an excellent help for later student groups to showcase the value of well designed levels to shape the player experience instead of focussing only on written in-game or cut-scene texts. Thus such game types or the deliberate curtailing of mod-tool functionality may be beneficial for storytelling courses in primary, secondary and tertiary education, indeed. Furthermore it showed the value of rapid prototyping and led to a redesign of the DGBL course. In the following semester students had to present their progress five instead of three times – the first presentation focusing on prototyping key functionalities thus avoiding unpleasant surprises later on.

Playing and analysing the Alice mod lead to mixed results. Warcraft 3 maps generally present a birds-eye view with a zoom-able fixed viewport orientation. The Alice mod group decided to enable a player character (PC) dependent viewport orientation instead. Thus the mod features a third-person view that rotates the viewport whenever Alice turns. This had two consequences: On the one hand students reported that the applied view led to a stronger identification with the PC. On the other hand, some players complained that it hindered their navigation and in one or two places – where glitches may twirl the PC for a short time – even made them dizzy. This highlights the need to enable players to customize the game even in mods as the viewport change did result in a positive immersion in general but some players would have benefitted from an option to choose the standard viewport orientation instead. Another finding related to customization was the missing option to select a difficulty level (DL). While the campaign of Warcraft 3 enables the player to choose between several DLs this is uncommon for mods. Due to the fact, that the mod should be playable by non gamers in workshops the mod DL was low – in consequence expert players in student workshops were both bored and twice as fast as novices. Thus student groups of later semesters were required to integrate script solutions in case the mod tool did not feature DL selection in the first place.

### Table 1: Created game modifications and their workshop relevant properties

<table>
<thead>
<tr>
<th>Modification of</th>
<th>Platform</th>
<th>Play Time</th>
<th>Interaction</th>
<th>Story</th>
</tr>
</thead>
<tbody>
<tr>
<td>Super Mario</td>
<td>PC</td>
<td>10 – 20 min</td>
<td>Side-Scroller, move &amp; jump via keyboard (easy)</td>
<td>The Neverending Story</td>
</tr>
<tr>
<td>Little Big Planet 2</td>
<td>PS 3</td>
<td>40 – 90 min</td>
<td>Side-Scroller, move, jump &amp; interact via controller (moderate)</td>
<td>&quot;Maui’s Heroes Journey&quot; (original)</td>
</tr>
<tr>
<td>Warcraft III</td>
<td>PC &amp; Mac</td>
<td>90 – 180 min</td>
<td>birds-eye view, point &amp; click via mouse, some optional keyboard accelerators, player can specialize in fighting abilities of avatar, mod uses various quest types (high interaction complexity but low difficulty due to mighty hero)</td>
<td>based on various &quot;Alice in Wonderland&quot; adaptions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 – 210 min</td>
<td>like &quot;Alice&quot; + selectable difficulty level, optional negative ending</td>
<td>&quot;The Plant of Live&quot; (original)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120 – 240 min</td>
<td>like &quot;Alice&quot; + selectable difficulty level, significant story-branching, optional positive ending</td>
<td>&quot;A Pirate's On-Shore Adventure&quot; (original)</td>
</tr>
</tbody>
</table>

While scenario two – learning by creating games/mods – could be applied in workshops. Our experiences with student game modifications projects confirmed the inking that it does certainly require higher gaming-experience and time-investment. Thus we did not apply it in change and innovation workshops up to now.

### 2.4 Digital aesthetic learning

While the first two of the hitherto discussed game based learning approaches for change and innovation workshops correspond to scenario 1. – learning by playing a digital game with or without individual reflection or group discussion – and the third to scenario 2. – learning framed by playful interaction with digital media or game components – one of the goals of our project was to experiment with interfusing the approaches of both project partners, i.e. combining digital game based learning and creative/aesthetic methods. The creative/aesthetic methods typically use techniques from fine and performing arts to create artefacts or experiences that are personally meaningful to the participants and, in the majority of cases, are presented to and discussed by workshop participants. Both creation and discussion explicate implicit ideas, opinions, fears, knowledge, etc, thus enabling
the individual and the group to share, learn from and work with them. One specific exercise that may exemplify the concept and fusion of both methods is the visualization of the hero at the respective stages of the Heldenprinzip. How does the hero look like, e.g. when in “Refusal of the Call”? How are their feelings mirrored in their posture and appearance? In non-digital exercises, participants either shaped manikins or themselves into a posture that represented their notion of this stage. The embodied aspect of the latter has the advantage that the participant can actually feel the “energy” of this stage but requires an atmosphere of mutual trust in the group to avoid negative feelings. The usage of manikins has the advantage that participants can see the figurine from all sides and shape it into postures that would not be possible to maintain by the participants themselves. Furthermore, the social risk is certainly lower. A potential downside is the relative sparseness of expression due to the abstractness of the manikin.

One corresponding digital exercise is using the “Spore Creature Creator” instead of manikins. While it is an integral part of the COTS-DG “Spore”, the editor itself would typically not be considered a game. Nonetheless, through its appearance and in combination with the exercise goals it induces an observably playful attitude. Using an easy to learn interface, it enables participants to build creatures that can be customized in body statue and colour as well as number and look of extremities and accessories, even animated with a special selection of moves. We applied this exercise in both our work with SMBs and in one-time workshops where it proved its potential for enabling participants to express their ideas and feelings as well as highlighting and discussing key points of innovation and change processes according to the Heldenprinzip.

While this instance of the concept “build hero at stage X and discuss” does not allow the embodied experience of the “participant as hero” approach, it extends the advantages of the manikin exercise by affording a wider range of expressions and adding entirely new possibilities of shaping, animating and comparing the virtual figurines. On the downside though, it certainly requires more time to produce those digital artefacts.

In a third approach, we try to combine the tangibility of physical interaction with the extended manipulability of a digital manikin by using 3D-sensing interfaces like Microsoft’s Kinect. This way, participants can control the movement of their avatar in the most intuitive way and even record a short performance or sequence of movements representing the respective stage. This approach has not yet been tested but seems a promising way to benefit from the digital representation while still giving participants a chance to actually experience the physical and emotional implications of shaping oneself into a certain posture.

**Figure 5:** Instances of the exercise “build hero at stage X and discuss” (Participant, Manikin, Spore)

Another example of augmenting a creative exercise with digital means is our use of Minecraft. This game places the player into an open world with its own rules and physics but without any specific goals, but to survive. In its “creative mode” it provides an ideal setting to do just that: create. Players can choose from building blocks to assemble structures or reshape entire landscapes in a Lego-like manner. We have been using this game in several workshops encouraging participants to e.g. build
their individual interpretation of the Hero's Journey as an actual path through the virtual world of Minecraft and found it to be a valuable tool for designing digital artefacts that go beyond the possibilities of their conventionally crafted counterparts. Again, the modus operandi was to give participants a short tutorial, then give them between 10 and 20 minutes to build and subsequently discuss their results in the group. While the same exercise would have been much more physical using real materials like paper, plastic or clay, the digital version makes up for that by overcoming the spatial and material limits of such a setting. The building blocks in Minecraft come in a broad variety of materials ranging from wood and cobblestone to ice and gold and can be arranged in physically eccentric ways, thus allowing the players to be free in creating the artefact that matches their idea of the respective issue, e.g. a stage of the Hero's Journey, best. Furthermore, the resulting artefacts are explorable and walkable for the player characters, thus making them easier to present and explain. Participants generally enjoyed working with Minecraft, sometimes so much so, that they got lost in just playfully exploring their digital environment and had to be reminded of their actual task. We also found that similarly to manual crafting exercises, participants became very creative in improvising with the given material. One player e.g. dug a very deep hole straight into the ground leading into a small cave surrounded by lava to visualize their perception of the Monomyth's nadir.

Comparing digital and analogue instances of creative and aesthetic methods, the question here is obviously not which instance is better in general but what is the ideal mode concerning the unique combination of learning goals, participants and boundary conditions. When considering the usage of such digital aesthetic approaches in relation to the identified game-based learning scenarios, self-study does not seem to be overly promising due to the missing group discussion. Depending on the software used and the extent of the practical work that participants are expected to deliver, the treatment of choice would be either pure face-to-face or blended learning.

2.5 Potential of dGBL in change and innovation workshops

To summarize the approaches described in this paper and illustrate further approaches in relation to their potential in change and innovation workshops consider figure six. The chart depicts goals and techniques that might be used in each of the three showcased approaches. While their potential is indicated by the size of the label, its placement indicates the most promising game-based learning settings (self-study, blended dGBL or face-to-face). To exemplify the interpretation of the chart consider scenario two – learning by creating games/mods. It could be used both to cover the Monomyth pattern and to learn about specific skills or insights one might need in change and innovation processes. But due to the need of special knowledge about games, game conventions and ideally even about modding tools its potential considering the target audience is rather small. In case it would be used nonetheless, it certainly makes sense to integrate it into a blended setting. Thus, both the typically high workload (i.e. no face-to-face-only setting) could be spread over a period of time and the probably high need for help from and interaction with the consultant (i.e. no self-study) could be realised.

In contrast, the usage of a digital game to trigger discussion and story-telling has a higher potential and might be used with the small subset of comparatively short games, even in face-to-face settings. An important point to stress here is that the position in the matrix was determined with the focus on innovation and change workshops and the characteristics of the participants today. In future settings or those that target other issues the assessment may differ. In game based learning courses for students or children it will most probably differ, indeed.

3. Conclusion

By digitally enriching the artistic exercises that are already used in the project to convey the Heldenprinzip and applying games to specifically train the skills necessary for mastering change and innovation processes, we are creating a flexible toolbox of game-based learning applications. The set of methods in this toolbox includes four main approaches:

- System-based learning, i.e. training systemic thinking abilities by exploring, mastering or manipulating the core-mechanics of a digital game, or by analyzing and varying its rule-sets while reflecting the results in group discussions.

- Story-based learning, i.e. familiarizing participants with a pattern for successful change processes by making them play through a sequence or entire storyline of a correspondingly structured game, subsequently reflecting experiences.
**Figure 6:** Assessment of the application of dGBL in change and innovation workshops

- Learning by teaching, i.e. empowering participants to create or modify a game meant to teach others and getting thorough insights into the respective matter in the process.

- Digital aesthetic learning, i.e. augmenting or re-designing learning and reflection methods from the field of fine and performing arts with digital means, e.g. using the mechanics of highly manipulable game worlds to allow participants to create digital artefacts and reflect on the results.

We have designed a number of exercises based on those methods and tested them with SMB managers, employees, coaches and students in tertiary education. The targeted group has been diverse in gender and age, yet relatively small in numbers. While more extensive testing is necessary to back up our findings, hitherto yielded results have been promising and on track with our goal: To create a toolbox that will eventually allow teachers and coaches to convey the concept of the Hero's Journey to individuals and teams in a creative, immersive and effective way, providing participants with a guiding structure that can help to master the challenges of innovation and change processes.

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Effective Game Based Citizenship Education in the Age of new Media

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Abstract: Educational systems worldwide are being challenged to respond effectively to the digital revolution and its implications for learning in the 21st century. In the present new media age, educational reforms are desperately needed to support more open and flexible structures of on-demand learning that equip students with competencies required in a globalized and multicultural world. Game-based learning represents one pathway to educational reform through its emphasis on performance. In this paper we describe the Statecraft X game-based learning program that blends performative game-based learning with dialogic pedagogy in the context of citizenship education. The Statecraft X curriculum was designed with the understanding that a digital game on its own does not necessarily lead to meaningful student learning. Rather, it is the students together with their peers and aided by their teacher who must work together to make meaning of their in-game experiences and connect these experiences to real-world events and issues through thoughtful reflection. With a view to addressing widespread shortcomings of citizenship education that reduce the curriculum to learning about citizenship, the Statecraft X game, played on Apple iPhones, provides students with a first person experience of governance by allowing them to take on the role of governors and thus to enact governance. Central to the SCX program is its dialogic pedagogy where teachers facilitate meaningful conversations among students and advance their understanding of citizenship and governance. In this paper, we report an implementation of the Statecraft X curriculum in a Social Studies class attended by 42 15-year-olds attending a secondary school in Singapore. Students’ understanding of governance and citizenship was assessed by means of an essay that students attempted at the end of the program. Students’ performance in the essay was compared with a comparable control group taught the same topic by traditional method. The results indicate that students of the intervention class outperformed the control class students. Our findings suggest that the Statecraft X curriculum has efficacy in achieving the desired curricular learning outcomes. These findings have implications for school leaders, teachers, and students with respect to introducing and integrating game-based learning in regular classrooms.

Keywords: citizenship education, game-based learning, dialogic pedagogy, new media, learning outcomes

1. Introduction

The 21st century is a time of new media propagation. With the speed and growth of digital access in both developed and developing nations, youths are now increasingly connected through open-ended platforms. Education policy makers increasingly recognize that it is in their interest to address these developments in order to sustain social stability and achieve progress. To allow educators to better meet the changing needs of their students, tools that effectively integrate new media, such as digital games, and curriculum would be most helpful. Leveraging the attributes of interactivity, play, immersion, and rich experience, digital technologies can make a significant contribution to 21st century learning.

The use of digital games for teaching and learning is today an important field of research in its own right. In the past decade or more, much has been written about the educational potential of games for learning (Barab et al., 2009; Gee, 2003; Shaffer, 2006). Proponents of game-based learning point to its role in supporting collaboration, problem solving, communication, and the 21st century skills needed by students. Illuminating the potential of games, Squire (2005) explains that games provide ways of seeing and understanding problems and creates opportunities to help students realise the complexity of the real world. This affordance of digital games has been quite successfully used for subjects such as science, mathematics, and languages. However, research related to the use of digital games for topics in social studies has been limited due to the open-ended nature of the subject.

Globally, citizenship education is one such complex topic that curricula find difficult to handle. Good citizenship cannot be taught; it has to be pondered over, experienced, and practiced (Sim & Print, 2005). Consequently, educating for effective citizenship remains a largely elusive goal in schools. All too often, schools only educate students about citizenship. This outcome does not translate into the dispositions and capacities for active citizenship widely sought in students’ post-school years (Selwyn,
Consequently, research evidence suggests that mature democracies face declining rates of civic participation (Banaji & Buckingham, 2010).

Notwithstanding, Kahne, Middaugh, and Evans (2009) report that teens with civic gaming experiences, for instance, playing games that simulate government processes or playing games that deal with social and moral issues, report much higher levels of civic and political engagement than those without these kinds of experiences. They further argue that educators should exploit the civic possibilities of games in curricula and in the classroom. They suggest that “[s]ocial studies educators . . . might be interested in using a game like Democracy in a government class. Democracy is a multidimensional political simulation in which players respond to varied constituencies, shape policies, and interpret data on approval ratings in an effort to win reelection” (p. 52). Raphael et al. (2010) echo this enthusiasm and advocate using games to advance civic learning. They articulate a conceptual framework and agenda for research and the design of games. They hypothesize that civic games can help players make connections between individual actions and larger social structures and also to link and contrast ethical reasoning and expedient reasoning in the civic action space.

We are unaware of any significant use of digital games in social studies. Well-known work of Barab and Dede, based on the multi-user virtual environments Quest Atlantis and River City, is oriented toward science education. The only relevant known work is by Lim (2008). Students are positioned as global citizens in Quest Atlantis. However, they are required to solve quests related to mathematics, English, and science. Consequently, citizenship and social studies are not the focus.

2. Designing the Statecraft X game

In Singapore’s education system, citizenship education is addressed via the social studies curriculum. Our research efforts in the classroom with the Statecraft X curriculum take place in the context of increasing recognition being given to the role of social studies in character development and nation building. While we strongly resonate with the suggestion by Kahne et al. (2009) to use digital games for social studies education, especially as it relates to the topic of governance, we are also sensitive to Poblocki’s (2002) critique against “bio-cultural imperialism” that may be embedded in digital games developed in North America. As cultural artifacts, digital games, especially commercial off-the-shelf games, always carry the potential for cultural bias.

In designing and developing our own educational game, Statecraft X, we attempted to minimize this risk by locating the game within a medieval fantasy kingdom. The medieval element unavoidably retains early European cultural associations. Although this is so, the likeness is limited to the beings of unique ethnicity in the game—namely the, elves, dwarves, trolls, and (medieval looking) humans—which are distinctively Western creations. The setting and backstory of Statecraft X, however, which features a peasant rising to become a king, and the in-game governor’s focus on social, industrial, and military development, is a cultural phenomenon applicable to any civilization or modern political entity. However, unlike Sid Meier’s portrayal of the clash of civilizations as historical “truth”—the target of Poblocki’s critique—the fantasy element ameliorates the cultural imperialism of grand narratives of human history created in the West. Thus, we sought to maximize the portability of our game’s adoption across national contexts. Furthermore, extant historical narratives also suggest that the lines of dispute that give rise to friction between nations often occur by virtue of differences among cultures and between civilizations (Huntington, 1993). Mitigating the potential for such conflicts should then be a prerogative, even in the design of games; given the socialized, empowering influence digital games are growing to have.

In the section that follows, we describe the theoretical underpinnings of the Statecraft X learning program which we believe is much suited for the new media context. The Statecraft X learning program comprises the game and a set of associated curriculum materials. We also illustrate the multiplayer mobile game Statecraft X. We then report an empirical study of the enaction of the Statecraft X curriculum in the classroom focusing primarily on student learning outcomes.

3. The Statecraft X learning program

The digital revolution and its concomitant consequences places tremendous pressure on traditional teaching and learning practices in the world of education. Now no amount of ‘learning to appeal to an all-knowing textbook alone’ can furnish students with the attitudes, values, beliefs, and knowledge needed to become good citizens. The Statecraft X learning program therefore aims to complement...
textbook use with an authentic educational game, together with curricular materials, that are mapped to the unit on Citizenship and Governance in the Social Studies curriculum for 15-year-olds.

Compared to traditional learning environments that seek to “school” students in knowledge of “what is right,” the Statecraft X curriculum creates room for negotiation and the challenging of normative assumptions (Ito et al., 2009a) to appeal to students for whom engagement with new media is a way of life. Our intention is for such a curriculum to allow youth to establish their personal learning focus, motivated by their own interests and social environments, to emerge from the educational platform provided (Ito et al., 2009b). Mindful of the intertwining of gaming and everyday living in the lives of 21st century students, our own game design sought to allow players to steer the unfolding narrative in the game (Williams, 2007). This element of control in the game facilitated players’ construction of rich personal game narratives and gave them a strong sense of autonomy.

Taking into account considerations for making the game and the accompanying curricular materials appealing to students, as well as our own educational values and philosophical commitments, we chose an inquiry approach to citizenship education. This approach is one of the approaches (others being social studies as citizenship transmission and, social studies taught as social science) in defining social studies curriculum by Barr, Barth, and Shermis (1977). This approach towards social studies as reflective inquiry aligned best with our pedagogical goals and objectives. We thus designed a curriculum based on inquiry learning (Dewey, 1938/1991).

3.1 Theoretical underpinnings of the Statecraft X learning program

In prior work, we proposed the performance–play–dialog (PPD) design model for game-based learning (Chee, 2011). Drawing upon this model, we view learning through the theoretical lens of performance (Bell, 2008; Schechner, 2003). As Carlson (2004) argues, performance is distinguished by three critical features: (1) patterned behavior entailing constant doing and redoing, (2) self-consciousness of the doing and redoing, and (3) a double consciousness of actual behavior compared against ideal behavior. From this perspective, learning through performance engages the learner in reflection, and it is deeply reflexive. It is a mode of learning that any concert pianist or competitive swimmer understands. Performance requires constant self-interrogation of how well one is doing compared with an ideal benchmark. By this means, performers improve their performance and thereby learn. Performance is inherently value laden, and it is deeply intertwined with the development of personal identity. Through performance-oriented learning, a person develops a keen sense of self-identity. Jarvis (2009) expresses this idea eloquently: “Learning to be a person in society: Learning to be me.”

Digital games such as MMORPGs allow players to naturally re-orientate learning away from learning about to learning to be (a type of person) (Thomas & Brown, 2007). This reorientation is very productive for citizenship education. Its success, or otherwise, is wholly dependent on whether an individual has learned to enact active and responsible citizenship. In the day-to-day affairs of nations, governments, civic organizations, and citizens, performing as a citizen is what counts. Knowing about citizenship has little value. In the PPD design model, performance is depicted as a developmental trajectory wherein a student learns to become an active citizen (see Figure 1). Performance, in turn, is cultivated through play and dialog, mirroring Dewey’s action–reflection dialectic (J. Dewey, 1910/1981; R. E. Dewey, 1977). Building on Shaffer’s (2006) framework that views game-based learning in terms of developing skills, knowledge, identity, values, and epistemology—that is, SKIVE—the PPD model further raises the standard of desired learning outcomes by requiring that knowledge and skills be integrated and leveled up to a seamless capacity to act and speak competently in ways befitting the enactment of a human role. We refer to this standard of learning outcome as VIP: values, identity, and performance. Via performative learning, students appropriate a personal understanding of citizenship and develop a citizen self-identity. To the extent that learning has been effective, the learner will perform in an informed and responsible manner when faced with problematic real world situations, such as being faced with a riotous crowd (depicted in the top right of Figure 1). Will the learner act in a manner becoming of a good citizen, or will he not?
In the PPD model, the construct play is instantiated by students playing *Statecraft X*. As a multiplayer client-server game, the game state is maintained on the server. The state of the game is persistent and represented by the “game cloud” shown in Figure 1. The game runs continuously regardless of whether any players are logged in. In-game events such as epidemics, bandit attacks, and invasion by a neighboring kingdom are triggered at times predetermined by the game administrator. A typical game session supports 20 concurrent players. They are divided into four factions, where a faction represents members who share an ideological affinity. The duration of each game session is typically three weeks. Epistemologically, the significance of engaging in play is that learning to be is experienced in the first person because the player takes the role of an agent or protagonist in the game. This first person orientation contrasts with traditional learning about where the learner is positioned in the third person with respect to what is being learned. Being engaged in an action space, learning is transactional (Garrison, 2001). It is further embodied through role taking (Mead, 1934), embedded through immersion into a virtual game world, and experiential in nature (Dewey, 1925/1988). As a mobile game played on a personal device, the mode of play is one that requires continuous partial divided attention. Students weave game play into their everyday activities, logging in from time to time to execute several actions, then logging out of the game.

As part of an inquiry curriculum, engagement in dialog is critical because it prompts reflection and sense making. In our design of the Statecraft X curriculum, dialog takes place in the classroom during scheduled lesson time. It is facilitated by a teacher. The construct of dialog draws upon the writings of Bakhtin (1981). Dialog has little in common with discussion, a word whose root is more closely related to the idea of conducting a judicial examination (Senge, 1990). Instead, “[e]ntering into dialog entails taking a stance. It is the means through which we develop openness to others different from ourselves and relate to people and ideas that remain separate and distinct from our own. Dialog is the means through which new ideas are born” (Chee, 2011). Through engaging students in dialog, we seek to cultivate a culture of expansive conversations where ideas are increasingly connected, juxtaposed, interrogated, and critically evaluated so that students can achieve deeper meaning making and understanding.

### 3.2 The *Statecraft X* game

The *Statecraft X* game supports students learning the topic of governance in the social studies curriculum for 15-year-old students. Through the PPD model, students learn governance and its relation to citizenship by enacting governorship, that is, by performing governance. During dialog,
teachers facilitate conversations and help students to “play between worlds” by making pertinent connections between issues arising in the game world and in the real world. They encourage students to be reflexive in their learning, directing them to the actions that they took in playing the game and thinking through the ensuing consequences. The game is typically played on Apple iPhones. Figure 2 shows a zoomed in view of part of a town in the game world of Velar. The buildings shown are the barracks on the left and the embassy (seen only in the capital city) on the right. Game resources are shown in the resource bar at the top of the screen. Students are assigned the role of town governor in the game. When the game begins, each student is the governor of one town. As students play the game, they seek to become the governor of more towns so as to expand their influence over an increasing number of the Velar citizens. In so doing, they also advance the cause of the faction they belong to. Akin to political parties, factions are bound together by ideologies of good governance. Students thus compete with one another in the game, as well as ideologically, with a view to eventually occupying the capital city of Velar and to governing the entire kingdom. Using a functionally equivalent Web version, the Statecraft X game can also be played on tablet devices such as the Apple iPad. Figure 3 illustrates the game’s world map, which allows players to traverse between different towns in Velar, on an Apple iPad.

Compared with most commercial games intended primarily to entertain, and secondarily, if at all, to educate, Statecraft X is fairly unique. Within the genre of medieval fantasy games, role-playing games, such as the Elder Scrolls series (Bethesda Softworks, 2012), can serve as creative stimuli with open-ended worlds for exploration and puzzle solving. Unlike Statecraft X, however, there is no complex network of socialization which is key to the players’ ability to perform and learn reflexively. Games from the Ultima series (Moby Games, 2012) are disadvantaged by their emphasis on the virtue system, where winning requires a one-track sense of virtuousness exhibited in gameplay decisions. Statecraft X avoids this problem because governors are given the liberty to act on a continuum of value systems—from that of a liberal, capitalist governor, to that of a tyrannical, authoritarian ruler—in a manner reflective of the realities of real world governance. Even within the scope of Civilization and its sequels (Firefly Studios, 2012), the identity of a civilization’s ruler is restricted to a variety of pre-designed character choices, each with its own specialized traits that influence the outcome of the game. Identity, in the case of Statecraft X, is left open with the intention that players themselves should construct their identities as they deem appropriate through personal interactions between themselves while gaming, during dialogic classroom sessions, and the diversity of interactions that they participate in within the physical world.

**Figure 2:** Zoomed in partial view of a town showing barracks and embassy

As students play Statecraft X, many challenges come their way. Apart from having to meet the basic needs of citizens in the town, such as needs for food, water, and housing, they must also develop and sustain a thriving economy. In order to do so, they must trade with neighboring towns to acquire the resources needed to build factories, healing centers, and army barracks. These resources comprise wood and ore. By design, however, each town can produce wood or ore but not both. If citizens’ needs are not adequately met, they become unhappy. They may even leave the player’s town in search of a better life in another town. Trying to increase a town’s economic wealth tends to take a toll
on citizens’ happiness as they are worked harder, paid less, or taxed more highly. As a game, therefore, a complex simulation with multiple embedded interdependencies runs continuously. Outcomes can play out in many different and often unpredictable ways for players. Through careful game balancing, several patterns of play typically emerge. The tension between achieving economic wealth and increasing citizen happiness is one such pattern. These tensions are the triggers for productive dialog. How can the challenges that players experience be dealt with? There are no right answers. There are only better or worse solutions, and these solutions are always contingent on what other players do as well as on game events that players have no control over. Such events include the influx of refugees, epidemics, bandit attacks, and invasion by a neighboring kingdom. Playing the game, students learn that effective governance is a complex challenge. It entails wrestling with conflicting demands and making value-laden trade-offs between alternative courses of action.

Figure 3: View of the game’s web-based world map played on a tablet computer

In the new media context, where communicative platforms function on a 24/7 basis, Statecraft X intentionally mimics this pattern of exposure for students, given that it is a 24/7 game. By design, it seeks to impress on students that, in the real world, governance is truly a 24/7 affair. Planning ahead is vital because there is an inherent latency (multiple in-game turns) between governor decisions and translation into game world actions. At the same time, governance is a full-time responsibility: governments do not have the luxury of taking a holiday.

4. Method

The empirical study reported in this paper examines the comparative learning outcomes of students who participated in the Statecraft X curriculum with those from a control class. The study took place over three weeks in January 2012. Learning outcomes were evaluated on the basis of a summative essay-writing task. As classroom researchers, we observed all classroom enactations of the Statecraft X curriculum. We also administered pre-intervention and post-intervention surveys to students in the intervention class. In addition, we conducted post-session interviews with the collaborating teachers after all sessions other than the first.

4.1 Subjects

The intervention class comprised 42 high ability students in the Express academic stream of the school where we conducted our research. Twenty-seven students were boys (64%) and 15 were girls (36%). On average, students were 15 years old. The control class consisted of 42 students from a comparable high-ability class. Nineteen of the control class students were boys (45%) and 23 were
girls (55%). Students belonging to the control class were taught by a separate social studies teacher using traditional classroom instruction.

### 4.2 Materials

Students from the intervention class played the Statecraft X game on Apple iPhones. The phones were loaned to them for the purpose of the research project. The students responded to an attitudinal survey on citizenship and governance at the commencement of the intervention and at the close. During the intervention, they were required to complete two online reflection posts that sought their responses to online source materials—one focusing on national defense and the other on government allocation of the national budget—and the underlying reasons for their responses. Students in the control class were taught using presentation slides. They also took notes and completed worksheets on the subject during curriculum time. A common summative assessment, lasting 40 min, was administered to students from both classes after the research intervention concluded. The assessment question stated:

Singapore has a number of well-known political blog sites such as mrbrown, Temasek Review, and The Online Citizen.

You are a concerned, responsible, and active Singapore citizen. You wish to set up your own blog site to address issues of deep personal concern. These issues may relate to sustaining economic prosperity, maintaining racial harmony, managing immigration, encouraging international trade, establishing strong national defense, handling diplomatic relations, and developing a global citizenry that remains rooted locally.

You are preparing the very first entry on your blog site. In preparation for this entry, write an essay of about 300 words to identify 3 or 4 issues that you are most concerned about, to express your views concerning these issues, and to suggest how the Singapore government should deal with the issues that you identify. To create a positive impact, make your statement as balanced, persuasive, and well supported by evidence as possible.

### 4.3 Procedure

The Statecraft X curriculum extended over three weeks, with two one-hour classroom sessions held each week. Game play took place entirely outside of classroom time. Students played the game on weekdays between 6:00–8:00 a.m. and between 2:30–10:00 p.m. On Saturdays, they were allowed to play the game from 6:00 a.m. to 11:00 p.m. Game play was not permitted on Sundays. This condition was imposed by the school administration. Access to the game was controlled by the server. Members of the research team led the first classroom session. They shared the backstory of the game and oriented students to the game interface. They also administered the pretest survey. The next four sessions comprised dialogic classroom sessions where students conversed about their in-game experiences and challenges. For the purposes of game play and dialog, the students were divided into two groups of 21 students each. The two participating teachers facilitated the dialogic conversations, with each teacher taking charge over one group of students. Teachers supported the students by helping them to make connections between the ideas contributed and to distill the ideas from the level of game experience to that of concepts, themes, and “big ideas.” In the process, students addressed the challenges of governance, moving fluidly between game-triggered experiences, textbook ideas, and personal knowledge and experience. They also listened critically to suggestions proposed by classmates to deal with the challenges faced, and they interrogated the suggestions of others as and when they saw fit. In the final class session, students delivered a speech to make a case for why they were best qualified to be elected to the governing council of Velar that would help govern the kingdom until the young heir to the throne came of age to be king, given the demise of his father. Following through with role-play induced by the backstory of the game and based on the quality of speech delivered, four students from each group were finally chosen as worthy members of the governing council. This selection represents an individual "win" outcome for the selected students. At the same time, the faction that attained the highest average score between economic wealth and citizen happiness was regarded as winners of the game. This outcome represents a group "win" condition.
5. Data analysis and results

Students’ essays were evaluated on the basis of a four-level rubric (see Appendix) encompassing four criteria: (1) multiple viewpoints with balanced, coherent perspective, (2) proposed solutions supported by strong evidence and argumentation, (3) disposition of active citizen, and (4) persuasiveness. To ensure objectivity in the evaluation, 20 scripts out of the total of 84 (24%), were first randomly selected and evaluated on each criterion by two qualified independent assessors: the second author, who holds a doctorate in education, and a history and social studies schoolteacher teaching these subjects at the upper secondary level. The measures of inter-rater agreement based on Cohen’s kappa were 0.78, 0.70, 0.81, and 0.83 on criteria (1) to (4) respectively, indicating a substantial level of agreement. On the strength of this outcome, the second author proceeded to evaluate the remaining essays. Figure 4 shows samples of students’ work from the control and intervention group. Notice the difference in the tone and content of the two essays where students write on Singapore’s economic situation.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple viewpoints</td>
<td>Intervention</td>
<td>42</td>
<td>2.74</td>
<td>.734</td>
<td>6.83</td>
<td>80</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>40</td>
<td>1.73</td>
<td>.599</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed solutions</td>
<td>Intervention</td>
<td>42</td>
<td>2.21</td>
<td>.782</td>
<td>5.48</td>
<td>80</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>40</td>
<td>1.38</td>
<td>.586</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disposition</td>
<td>Intervention</td>
<td>42</td>
<td>2.62</td>
<td>.697</td>
<td>5.22</td>
<td>80</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>40</td>
<td>1.80</td>
<td>.723</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persuasiveness</td>
<td>Intervention</td>
<td>42</td>
<td>2.55</td>
<td>.772</td>
<td>5.17</td>
<td>80</td>
<td>&lt; .001</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>40</td>
<td>1.65</td>
<td>.802</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 shows that, on all four essay criteria, students from the intervention group outperformed those in the control group. Their mean rubric scores, coded from 1 (lowest) to 4 (highest) based on the level of attainment on each criterion, were higher than those of the control students. The t-tests show that the hypothesis of equality of means between the two groups is rejected for each criterion.

Figure 4: Sample of students’ writing from the Control and Intervention groups

We used SPSS to run our data analysis. The results are summarized in Table 1 below.

(Control group)
Nowadays, there is an economic downturn and price of everything is increasing, such as daily necessities like oil and water. I feel that the government is not doing enough to sustain economic prosperity in Singapore. Though the Integrated Resorts have been built to attract foreign talent and encouraging international trade, it is not enough, and citizens are still suffering from poor economy.

(Intervention group)
The third and the final issue that I will be talking about will be Singapore’s economy. Yes. I agree that Singapore’s economy is above the world’s average and is prospering. But in a way I believe Singapore’s economy is still not stable enough and still relies on other countries for much work of her economy and trading. When the other countries that work together with Singapore economically fall Singapore will be greatly affected too. Therefore, I believe Singapore should rely on herself, and be a manufacturing country like what China is currently doing right now. At the same time, reaching out to every citizen and make sure that the citizens are not suffering in any debts which will affect the economy of Singapore. By protecting the citizens of Singapore, Singapore herself is also protecting herself. Somewhat, Singapore should always be ready for any form of crisis.
6. Discussion and Implications

In evaluating the student essays, we were struck by the extent to which essays of the intervention group students conveyed a strong sense of personal voice, awareness about current global and local issues, and an agency to act to achieve changes sought by the students. In contrast, essays of control group students showed a tendency to reproduce what was contained in the social studies textbook on the topic being studied, namely, the principles of governance. Some students from this group felt a sense of dislocation when attempting to respond to the essay question because they had prepared for this assessment by memorizing content. Excerpts of students’ essays are shown in Figure 4. As a curriculum innovation, the Statecraft X learning program signals a significant change in valuation applied to traditional student learning practices and outcomes. An inquiry curriculum represents a critically important pedagogical shift requiring a concomitant shift in classroom cultural toward critical thinking, questioning, and dialog.

Our collaborating teachers had the benefit of a professional development program held about a month and a half prior to the commencement of the research intervention. This program comprised face-to-face meetings with the teachers for two days during which the theoretical and pedagogical underpinnings of the Statecraft X curriculum were discussed. Teachers were furnished with a set of relevant readings prior to the commencement of the meetings. As part of the training, teachers played the game in their own time over the duration of the development program, using an iPhone loaned to them by the research team. This activity was instrumental in preparing them to teach the curriculum in class. Notwithstanding, it could not entirely equip them for what was to come because the training program afforded them no opportunity to teach the curriculum with real students. For this reason, as part of continuing professional development, we, as researchers, were present to further guide teachers. Subsequent to the observation of each lesson, we employed a structured interview technique to prompt teachers to reflect on their practice. We suggested ways to deal with the challenges that they surfaced for discussion. This handholding constitutes a critical part of our efforts to help teachers level up their capacity to enact a performance oriented game-based learning pedagogy in the classroom.

On their part, our collaborating teachers invested themselves in the process of learning to enact the Statecraft X curriculum in the classroom. We observed a genuine desire to master the pedagogy, and the teachers were open-minded and receptive to the feedback that we offered. Being their first attempt to teach using a game-based learning pedagogy, their journey was not always smooth. Notwithstanding, the teachers’ perseverance paid off, and they felt that their efforts were worthwhile at the conclusion of the intervention. Another critical factor at play in the research intervention was the full support of the school principal and the humanities head of department in the enterprise. The head of department invested the time to be present at all the classroom sessions so that she could personally observe the enaction of the curriculum and support the development of the teachers under her charge. By participating in this manner, the head of department also developed a deep personal understanding of Statecraft X’s game-based learning pedagogy, and she expressed her desire to extend the curriculum innovation to all classes in the same level in the next school year.

The outcomes of our work demonstrate that the Statecraft X game used in conjunction with a dialogic pedagogy has the potential to steer students toward a new media culture of learning where increased interactivity and openness to ideas are vital. The curriculum also necessitates transforming of teachers’ roles and practices from didactic classroom teaching to active facilitation, where the game provides a platform for students to enact governance to understand the relation between governance and citizenship. The teachers’ role is crucial for making pertinent connections between students’ experiences in the game world and the real world. This shift in role is necessary for alignment to the increasing importance that new media will play in 21st century classrooms.

Our study has implications for school leaders, teachers, and students. The Statecraft X game and curriculum were designed to develop key competencies including citizenship and lifelong learning skills for the 21st century. Any attempt to integrate an innovative pedagogy in the regular classroom teaching needs system support for it to be sustained. School leaders must be willing to provide this much needed system support. Over the course of our Statecraft X interventions in different schools, we observed that the program was most successful in the school where the subject head of department had taken a personal interest in the intervention. The students in this school benefitted markedly in their understanding of the concepts of governance and citizenship, and the participating
teachers developed the skills needed to facilitate meaningful classroom dialog. School leaders’ support is also required to provide teachers with the time and space to reflect on their evolving teaching practice. This support can take the form of reduced teaching contact time as well as moral and professional support.

In relation to teachers, there is often interest in adopting the use of games. However, this interest is typically clouded by viewing games as a resource to teach with so as to garner student interest. With this mindset, the power of using games as a tool to promote complex problem solving and deep reflection is lost, and the tool becomes domesticated into the traditional instructional agenda. To harness authentic educational games effectively, teachers need to master the skills of dialogic facilitation, learn to ‘let go of control’ in the classroom to encourage productive student talk, and be comfortable with having students think and work things out for themselves. Our research with the Statecraft X curriculum suggests that, on average, teachers need two rounds on intervention experience to effectively learn the ropes of the new practice. The challenges that teachers face can be overcome by professional development support that helps them to be reflective and reflexive of their practices. Receptiveness to innovative pedagogical ideas is vital for success.

During our intervention work in the schools, we realized that students also need to modify their expectations concerning learning. Some students complained of the game being “too hard to play”, indicating an unwillingness to invest the time and effort required in game play. Teachers need to help their students make the transition from traditional learning modes to more active involvement in the learning process. Most students in our study could quickly adapt to the changes. As with any new innovative pedagogy, gaining parental support is an important part of the process. Widespread misconceptions about games can stall efforts in innovation unless one is prepared to address them. Parents need to be regularly informed of the purpose, scope, and outcomes of the project.

The Statecraft X curriculum and its pedagogy exemplifies emerging interest in meaningful learning and enaction. Building on Dewey’s seminal idea on the transactional relation of interdependence between doing and knowing, the curriculum offers one instantiation of this vital idea. For any innovative curriculum to realize its full potential, all stakeholders need to be receptive to the curriculum’s underlying theoretical motivations. They need to recalibrate their goals and be ready to modify their existing thinking and practices, thereby demonstrating commitment to improving extant educational practices in the light of new demands for 21st readiness.

7. Conclusion

In this paper, we have described the need to engage students meaningfully in citizenship education. Existing school curricula need to be revamped to include new and more active platforms for student learning that are aligned to technological advances and changing social needs and values. The Statecraft X curriculum has been shown to be efficacious for citizenship education through a performance-oriented game-based learning pedagogy. This paper reported an implementation of the program with 42 students. The students using the Statecraft X game complemented by dialogic pedagogy outperformed a comparable control class in a summative essay writing task. Students’ essays were evaluated using a rubric consisting of four criteria: multiple viewpoints, proposed solutions, disposition of active citizen, and persuasiveness.

Many attempts at curriculum innovation and educational reform in schools have failed due to the perturbation and dislocation they bring to deeply entrenched classroom teaching practices. A confluence of positive forces at work in the school where we conducted our research allowed the strong empirical results that we reported to emerge. Our experience suggests that it is vital to nurture and orchestrate such positive forces in order to secure the desired educational improvements. Our ongoing research in additional schools and contexts will help us better understand both the positive forces that can be harnessed to enhance teaching practice as well as the negative forces that work to keep it stagnant.
## Appendix 1: Statecraft X: Rubrics for summative assessment task (essay): Active citizenship—Governance

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multiple viewpoints with balanced, coherent perspective</strong></td>
<td>- Writing displays little or no knowledge (factual &amp; functional) and understanding of society and governance</td>
<td>- Writing displays some knowledge and understanding of society and governance based on textbook facts alone</td>
<td>- Writing displays clear knowledge and understanding of society and governance, occasionally going beyond the textbook</td>
<td>- Writing displays clear knowledge (factual &amp; functional) and understanding of society and governance, going beyond textbook information and ideas</td>
</tr>
<tr>
<td></td>
<td>- Writing shows limited viewpoints or none at all</td>
<td>- Writing shows some viewpoints but with an unclear perspective</td>
<td>- Writing shows a variety of viewpoints, providing a coherent perspective</td>
<td>- Writing shows a variety of viewpoints (social, political, economic) with a coherent and critical perspective</td>
</tr>
<tr>
<td></td>
<td>- The writer seldom reflects on any issue that is raised (or gives only what the textbook says)</td>
<td>- The writer reflects on the issues raised, but in a limited way</td>
<td>- The writer reflects on the issues raised but is not able to interrogate them deeply</td>
<td>- The writer reflects on the issues raised and is able to interrogate them deeply</td>
</tr>
<tr>
<td></td>
<td>- No solutions are proposed to solve the concerns raised</td>
<td>- Proposed solutions pertain to needs of specific groups within the community</td>
<td>- Proposed solutions pertain to needs of majority of the groups within the community</td>
<td>- Proposed solutions pertain to needs of community as a whole (including specific groups)</td>
</tr>
<tr>
<td><strong>Proposed solutions are supported by strong evidence and argumentatio</strong></td>
<td>- The writer suggests only one or two solutions, or none at all</td>
<td>- The writer suggests several solutions, but they are not very effective or practical</td>
<td>- The writer suggests several solutions that are practical and fairly effective</td>
<td>- The writer suggests many solutions that are both practical and effective</td>
</tr>
<tr>
<td><strong>n [reasons/justifications and warrants for claims are provided]</strong></td>
<td>- The writer provides limited reasons, if any, to support any claims made, and these claims are largely invalid</td>
<td>- The writer provides some reasons for the suggested solutions, but they are weak</td>
<td>- The writer provides several convincing reasons for the suggested solutions</td>
<td>- The writer provides many convincing reasons for the suggested solutions</td>
</tr>
<tr>
<td></td>
<td>- No evidence is provided for any assertions made</td>
<td>- An attempt is made to provide evidence in support of the suggested solutions, but the cited evidence is largely invalid</td>
<td>- Weak but valid evidence is provided to support the suggested solutions</td>
<td>- Strong and valid evidence is provided to support the suggested solutions</td>
</tr>
<tr>
<td><strong>Disposition of active citizen [commitment, passion, agency/willingness to act]</strong></td>
<td>- The writer is unclear about the roles and responsibilities of an effective citizen (focuses on self alone)</td>
<td>- The writer is somewhat clear about the roles and responsibilities of an effective citizen</td>
<td>- The writer is clear about the roles and responsibilities of an effective citizen</td>
<td>- The writer is very clear about the roles and responsibilities of an effective citizen and indicates willingness to take appropriate action</td>
</tr>
<tr>
<td></td>
<td>- The writer shows very little sense of personal initiative toward taking steps</td>
<td>- The writer shows some sense of personal initiative toward taking steps to solve challenges</td>
<td>- The writer shows a moderate sense of personal initiative toward taking steps to solve challenges</td>
<td>- The writer consistently shows a large degree of personal initiative</td>
</tr>
</tbody>
</table>

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to solve any challenges faced by the nation

The writer shows indifference toward existing events, policies, and social structures (is not concerned enough to play a role in solving a social problem)

faced by the nation

The writer shows a little concern about existing events, policies, and social structures but does not challenge them

faced by the nation

The writer shows a moderate degree of concern about existing events, policies, and social structures and is willing to challenge them, but does not suggest better alternatives

toward taking steps to solve challenges faced by the nation

The writer shows a high degree of concern about existing events, policies, and social structures and is willing to challenge them, suggesting better alternatives (society becomes a priority)

Persuasiveness [cogency, invested, conviction, strong sense of personal voice]

Writing does not indicate anything about the writer’s personality

The writer is indifferent or has little concern about challenges faced by the nation

The writing is verbose with no concrete points made

Writing has to be read very carefully to get an idea of the writer’s personality

The writer cares about the challenges faced by the nation in a limited way

The writing is reasonably focused, but few concrete points are made

Writing provides a fairly clear idea of the writer’s personality

The writer cares about the challenges faced by the nation

The writing is to the point and effectively addresses the main ideas/issues, but better alternatives are rarely suggested

Writing readily provides a clear idea of the writer’s personality, especially from the perspective of a concerned citizen

The writer cares deeply about the challenges faced by the nation

The writing is to the point and effectively addresses the main ideas/issues, with better alternatives suggested frequently

Acknowledgements

The work reported in this paper was supported by research grant OER 2/11 CYS awarded to the first author. We wish to thank the principal, teachers, and students of Dunman Secondary School for collaborating in the research. We also thank Ming Hui Shoon for assistance as an independent rater of the student essays and also his active participation in the Statecraft X project.

References


Using Social Media to Support the Learning Needs of Future IS Security Professionals

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Abstract: The emergence of social media has forced educators to think differently about the way learning occurs. Students and practitioners alike are using new technologies to connect with peers/colleagues, share ideas, resources and experiences for extracurricular activities. The social business gaming platform considered in this study leverages the social networking concept (an activity that all students actively participate in) in an academic environment. The primary objective of this technology is to foster a sense of ‘thinking outside the box’ and analytical ability through a medium that is widely accepted by students and graduates who have entered the workplace. Both the environment and problems are developed to adapt to suit any academic course from conducting research to proposing business solutions. This study was undertaken in order to develop information systems security (ISS) skillsets through the creation and facilitation of social business gaming, which allowed students to measure their performances of understanding as part of their on-going learning. The online business game required students to apply what they have learned to problem situations and to further develop their understanding of ISS topics. The problems posed required that the learners had to prove that they understood the material being taught in the traditional lecture and could apply what they had learned in an online environment. The on-going assessment component of the gaming network was used not just as an assessment for grades but also as a learning tool. This research focuses on a group of final year undergraduate students completing Bachelor of Science in Information Systems (IS). The online social game was utilised as part of the continual assessment process to evaluate group interaction, role-playing, competition and learning in an ISS assignment.

Keywords: social media technology, social business gaming, digital game-based learning (DGBL), information systems (IS), information systems security (ISS) and student assessment and learning.

1. Introduction

Organisations actively use simulated environments to both test (e.g. psychometric) and train (e.g. virtual trading of stocks and case study analysis) employees. Indeed, research contends that digital game-based learning (DGBL) is effective and has a place as a learning tool in modern educational environments (Kili, 2005; Van Eck, 2006). In an educational context, third level institutions utilise simulations to educate doctors and dentists but to date social gaming has not been widely applied as a learning aid for business and IS (security) graduates. With the emergence of social media and mobile technologies, the nature of the traditional “workspace” has been given new meaning. No longer is the working domain bounded by the physical constraints of tangible office settings. Increasingly knowledge exchange, idea generation and decision-making occur in the “workspace” enabled by widely accepted social media technologies. Consequently, it is imperative that educators leverage “workspace technologies” such as Facebook, Twitter and Second Life in a constructive way beyond their more typical informal social use. This may be done to further develop the skillsets acquired by students through the traditional channels, essentially promoting the use of technologies that they will be required to utilise as qualified business and IS graduates.

Van Eck (2006) considers the complexity of understanding DGBL, the number of variables, constructs and the gaming environment. This study endeavours to move beyond a tightly controlled experiment to explore social media technology and how it may be leveraged to enhance and support the learning and assessment mechanisms utilised in an undergraduate, final year, IS security module. The objective of this research was motivated by the importance of providing students with a practical proactive knowledge of the implementation and management of IS security in business. Students learn how to, through the combination of a flexible social learning environment and role-playing, proactively plan, defend and attack a business. The online ISS knowledge environment used in this study adhered to an on-going assessment process, which clearly outlined the criteria of the game allowing students to both collaborate and compete against their peers in a series of challenges.

The subsequent section considers the area of learning, focusing on the weaknesses associated with traditional learning and highlighting how eLearning tools specifically social media technology may...
overcome many of these. Following this, the nature of ISS education is presented. The research approach is then outlined. The case is presented and discussed and finally attention is given to the conclusions of the study.

2. Theoretical foundation

The web offers unparalleled opportunities to education (Mioduser et al., 1999). The intensity of competition in the business market, advances in technology, and a strong shift towards a knowledge-based economy have each contributed to the demand for virtual learning environments (VLE) (Neville et al. 2009). According to Watson et al. (2007) research regarding the use of educational technology continues to be important because of the pace at which technology is being incorporated into academic curricula. While originally created for distance education, VLEs are now most often used to supplement traditional face to face classroom activities, commonly known as blended learning. E-learning supports both the learner and the educator in a number of ways, for example, differing learning styles can be catered for, which help educators reach more students in varied ways, and enable more students to learn the course material (Sulcic and Lesjak, 2001). If an organization or university does undertake an e-learning initiative they must develop an effective solution that recognizes the need for good learning practices, which incorporates good design and development guidelines (Sulcic and Lesjak, 2001). The learning dimensions advocated by Reeves and Reeves (1997) and Neville et al. (2005) for interactive learning and collaboration should be incorporated into the design of any learning environment. The dimensions, as follows, describe the characteristics of a learning environment (1): educational philosophy: which (2): learning theory, (3): goal orientation, (4): task orientation, (5): source of motivation, (6): role of the teacher, (7): metacognitive support, (8): collaborative learning, (9): cultural sensitivity and (10): structural flexibility.

Active learning approaches, such as case-based learning and problem-solving, have long been advocated as ways of fostering deeper learning (Healy and Neville, 2009; Boyce et al. 2001; Biggs, 1994) as well as an effective means of motivating learners (Papastergiou, 2008). For many years organisations have been using problem-solving scenarios such as business simulations to both test and train employees. Simulations enhance the learner’s logical reasoning, numeric abilities and spatial thinking through real world problem-solving scenarios. Realising the potential of such methods however requires active engagement from educators and learners alike (Baskerville, 2008; Healy and McCutcheon, 2008). For many educators, the lack of appropriate materials, learning management, assessment techniques and guidance are often perceived as barriers to student or employee engagement. In order to overcome these limitations VLEs are increasingly utilised beyond the realm of distance education “but are now in common use in traditional, campus-based institutions, supporting ‘mixed mode’ provision of learning resources and support” (Keller, 2005, p300). With the ‘right’ underlying pedagogical approach, social media technology provides educators with the technical platform to overcome these well-cited issues, providing third levels educators with a media to provide a more complete learning experience.

2.1 Social media in learning

Social media provides new opportunities for innovating and modernising Education and Training institutions and for preparing learners for the 21st century (Redecker et al., 2009). Furthermore, social media technologies have the potential to support and enhance teaching and learning in higher education (Ajjan and Hartsorne, 2008) providing learners with a chance to manipulate their learning environment and to participate actively in the learning process (Hrastinski, 2009). Up to recently, Web 2.0 technologies have largely applied only in a social sphere; however a growing number of businesses are adopting enterprise social software technologies. It is through these collaborative technologies that students and knowledge workers will gain enhanced insight in the knowledge at their disposal. These tools will also enable information workers to locate and connect people with certain expertise across organizations, bringing people, systems and data into alignment faster to respond to challenges and take advantage of competitive opportunities.

In an educational context Chen and Bryer (2012, p99) state that “publicly open social media sites provide students with access to more information and experiences than they would get in a closed environment alone. If properly facilitated and framed, such expanded exposures can benefit student learning by creating more connections across boundaries and over time”. Valjataga and Fielder (2009, p58) widely support the use of social media technology as a means of skilling students in preparation for the ‘real world’, “in order to be able to cope with many authentic challenges in
increasingly networked and technologically mediated life we need to construct opportunities for participants in higher educational settings to practice the advancement of self-directing intentional learning projects.” Research conducted by the Institute for Prospective Technological Studies (IPST) (Redecker et al., 2010) summarise the advantages of social media in learning through the 4 C’s 1) Content – social media technology facilitates access to a wide variety of freely available content, 2) Create – allows users the freedom to create their own digital content, 3) Connect- connecting learners to one another as well as to experts and teachers and 4) Collaboration- supports collaboration amongst learners and teachers in a particular project of subject areas (Redecker et al., 2010). However, Selwyn (2007) indicates that research is needed in the area of education, and their use of social media applications as online learning environments, and the learning affordances they may offer.

2.2 IS security education

In just a few decades, the use of IS has formalised information management and streamlined the administration of organisations (Galliers and Newell, 2001; Dhillon, 2006). One of the fundamental problems regarding ISS is for an organisation to choose the right kind of environment to function in. Strategic ISS issues relate to where the firm chooses to operate and the scope of the organisation’s relationship with other organisations. Investment in IS Security has increased, but so have the number and range of security breaches (CSI, 2009). While many organisations have engaged in identifying security issues and as a result developed appropriate IS Security policies, there is a clear mismatch between policies and what is done in practice. Researchers have termed this as a gap: in espoused theory (actions that people write) and theory-in-use (what people actually do). Therefore theories-in-use have degrees of effectiveness which are learned (Mattia and Dhillon, 2003). Espoused theory and theory-in-use are a part of the double-loop learning concept which creates a mindset that consciously seeks out security problems in order to resolve them. This results in changing the underlying governing variables, policies and assumptions of either the individual practitioner, function or the organisation. Considering the complexity of the subject area, it is evident that teaching the know-how and know-what of an ISS course to IS undergraduates requires a hands-on approach to adequately deal with some of the concepts and underlying principles. Using social media to move beyond the traditional learning environment ensures that students acquire a more complete and practical experience (Chen and Bryer, 2012), better preparing them as ISS professionals of the future.

3. Research approach

This research study outlines the adoption of a blended approach to learning by IS Security teachers / researchers within a university setting. The department facilitates a learning strategy of teaching, supporting and attracting learners. This study pursued a single case study approach, as per Darke et al. (1998, p281) "a single case may provide the basis for developing explanations of why a phenomenon occurs”. Undoubtedly, there remains a dearth of empirical research studies focused on the use of social media technology to support teaching and assessment in third level IS education. In light of this, Darke et al. (1998) claim that in areas within IS, where theory and understanding are not well developed, case study research is most appropriate. The case study selected for this research study was the IS department within University College Cork (UCC), Ireland. The IS department was selected because it is the primary group within the university to develop, customize and blend traditional learning approaches and eLearning technologies, this is reflective of the nature of IS disciplinary emphasis on people, process and technology, providing students with a complete learning and evaluation experience. The researchers examined the implementation of an online game designed to allow students leverage their classroom acquired know-what in the area of IS security in a simulated ‘real world’ environment, social media technology (Facebook). Table 1 provides a description of the game distributed to a class of 72 IS undergraduate students.

The authors investigated the degree to which the benefits of the game met the learning needs of the students. The analysis also expanded the on-going design of the game to provide an innovative approach to learner support that is more akin to the true essence of social learning. Figure 2 illustrates and Table 2 outlines the content developed to support the learners’ requirements, as determined through ongoing discussions and discussions with ISS professionals and reviews of current ISS literature. The objective of this study was twofold; it enhanced the students learning experience by enabling them to use theoretical ISS concepts in a practical way while facilitating their interaction with other learners. Secondly, this learning experience contributed to student’s preparation for their future careers as IS graduates in a workplace that is increasingly reliant on these types of
technologies. The next sections provide a description of the ISS module and the social game. This is followed by the results of the student's participation and an analysis of the results.

Table 1: ISS game description

| Student groups are required to form a fictitious security consultancy through, for example, Facebook. The consultancy will be composed of the 6 group members and provide a landing page only viewable to the public and used to document the everyday operations of the consultancy. A hidden section will be used to collect, store and share security resources, tools and information about 5 corporate security breaches. Access to this section of the 'company' will be submitted to the Coordinators. Students will therefore complete the following, illustrate solutions when appropriate:
| 1. Create a Fictional consultancy and provide public information about the company and the different (max 6) employees.
| 2. Select 5 security breaches and critically evaluate /discuss the breaches in terms of:
|  2a. ISS Controls before and after the breach
|  2b. Business impacts
| 3. Use Facebook and or Twitter to document the work undertaken to investigate the breaches selected.
| 4. Compare and contrast the selected 5 or more breaches and the techniques used by the ISS groups to protect corporate assets.
| 5. Store an asset electronically in the secured section of the Facebook page, on 6 USB keys and printed copies of the page. Create and document the ISS strategy used to protect your corporate asset.
| 6. A copy of the assets as well as the company details, logins/access to the corporate network and twitter accounts are to be submitted ...
| 7. Select one or more other student groups to determine if their ISS controls can be bypassed. Document the strategy used by your group to test another groups controls. The strategy used should be documented using a company / group twitter account.

Note: Extra marks will be awarded to the group/company which can obtain a copy of an asset protected by another group. A maximum of 2 assets will be rewarded.

4. Background to the study - social gaming environment

Problem-solving skills require the use of a number of different learning strategies and types of knowledge. The learner’s own experience, internal mental models, and other ‘cognitive structures’ are necessary to ‘construct’ their own knowledge when faced with new information or different situations. The game was created to facilitate and support understanding and learning of the links between ISS and its business applications. The creation of fictitious companies and corporate espionage components presented students with the opportunity to play the role of ISS practitioners protecting and simultaneously targeting corporate boundaries in an attempt to acquire and protect assets. This component proved very helpful in developing a corporate ISS strategy as the groups had to consider potential attacks to try and steal another group’s secret.

At the start of the teaching period, the class (72 students) is divided into teams of 6 members. We ask for volunteer team leaders at the first class meeting; then once each class member has introduced themselves the team leaders take it in turns to select team members. Each group is expected to meet at least once a week. Project Teams are asked to record minutes of all meetings and day-to-day operations through Twitter and these must be kept for review by the co-ordinators throughout the year (protected Tweets with group and coordinator access). Facebook and Twitter are both used to co-ordinate the work effort; thus planning of ISS tasks and workloads well in advance will form an essential element of the overall assignment.

The game is structured as part of the lecture series (24*2 hours) to gradually build knowledge of the ISS subject domains while simultaneously simulating ‘real world’ situations when the groups are asked to deliver a series of requirements to determine their level of understanding of the topics (Table 2) discussed in class. At the end of each assessment submission the goals for the next submission and lecture are set, based on the level of knowledge and understanding demonstrated by students up to that point. Groups submit and present their deliverables at agreed deadlines, this is a significant indicator of the understanding (or the lack thereof) achieved by the individual groups at each stage. This enables a post-mortem evaluation approach (Kasi et al., 2008).
Table 2: Topics taught and game outcomes

<table>
<thead>
<tr>
<th>Objective</th>
<th>Performances</th>
<th>Assessment</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do you address ISS business problems?</td>
<td>Students will understand how to identify assets &amp; allocate the right controls</td>
<td>Related exercises of case organizations</td>
<td>Analysis of Real cases &amp; solutions used to protect assets</td>
</tr>
<tr>
<td>How do you identify the ISS requirements of a business?</td>
<td>Students will see the connection between ISS controls &amp; business value</td>
<td>Provide the requirements of a business case</td>
<td>Business impacts of security breaches will be measured</td>
</tr>
<tr>
<td>How should you address analysis requirements?</td>
<td>Students will understand how to analyse problems</td>
<td>Illustrate a logical view of a solution</td>
<td>ISS strategies are selected, discussed &amp; evaluated</td>
</tr>
<tr>
<td>How can you use what you have learned to build a solution?</td>
<td>Students will understand the building blocks of an ISS solution</td>
<td>Provide step-by-step guide incorporating a Security life cycle</td>
<td>ISS plan developed</td>
</tr>
<tr>
<td>How do you use solve a security breach?</td>
<td>Students will address business &amp; ISS threats, controls &amp; disaster recovery</td>
<td>Provide a fake solution to a security breach based on a case description</td>
<td>Computer forensics of a breach presented</td>
</tr>
<tr>
<td>How do you use build an ISS report &amp; apply lessons learned?</td>
<td>Students will understand the skills necessary to convey technical ISS issues to mixed audiences</td>
<td>Feedback on presenting lessons learned from case assessments</td>
<td>Audit review conducted of a selected case</td>
</tr>
</tbody>
</table>

Understanding

<table>
<thead>
<tr>
<th>Goals</th>
<th>How to:</th>
<th>Details of Company, Structure &amp; secret submitted</th>
<th>Full ISS solution submitted for review &amp; feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submit Company through Facebook, roles, Twitter diary &amp; asset</td>
<td>Development of a preliminary report &amp; reported through protected tweets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop a strategy to protect the group asset. Target other groups to obtain their asset</td>
<td>Presentation through a preliminary report &amp; reported through protected tweets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present a walkthrough of the key elements of their strategies: failures &amp; successes</td>
<td>Presentation of solution, with detailed feedback provided.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will learn to compete against their peers through ISS bypass attempts.</td>
<td>Students will understand the complete process of protecting &amp; targeting an organization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students will learn to compete against their peers through ISS bypass attempts.</td>
<td>Students will understand the complete process of protecting &amp; targeting an organization</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An evaluation of published ISS breaches is also a requirement of the game. Groups are required to select 5 security breaches and critically evaluate/discuss the breaches in terms of the controls used before and after the breach. The business impacts are also investigated. These evaluations are then presented and discussed in class. In some instances 3 or 4 groups would have investigated the same case. However each had their own view regarding how the company reacted to and learned from a reported (published) incident. This often resulted in discussions and proposals of what should have been the course of action adopted by the case. Case analysis and discussion is a traditional form of an in-class exercise. This component was enhanced through the use of social media to store documents (reports, articles, videos and slides) and Twitter searches using # to find the discussions which occurred in real-time regarding, for example, the Sony1 or RSA2 attacks. The topics covered through the ISS business game/teaching case included: analysing ISS requirements; developing ISS strategies; creating ISS plans; ISS controls; Computer Forensics, Compliance, SecSDLC (systems development life-cycle); Secure Development, Designing Audit reporting and project management. This theory was selected and delivered according to academic and practitioner research. Table 2 outlines the how these topics were taught, applied and assessed through the ISS business game.


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Student groups submitted their secret / assets at the beginning of the game (Term 1). Additionally Figure 2 was used to illustrate a sphere of possible ISS controls aligned to potential corporate assets such as: data, information and knowledge. The sphere created by the researchers / game coordinators to illustrate the integration as well as the use of different ISS controls (informal, technical and formal). Each asset is mutually interdependent and of value requiring appropriate countermeasures. They are always at risk from attacks through the employees and computer systems that have direct access to the assets or corporate secrets. The sphere was used by the groups to determine the type of protection layer, in the form of countermeasures to prevent access to the inner layer from the outer layer, was needed. Technical controls were then identified and implemented between systems and the different assets, between networks and the systems, and between the Internet and internal networks. As illustrated, a variety of controls were used to protect the data, information and knowledge stored by a group. As employees/students can directly access each ring as well as the knowledge at the core of the model, unique approaches to IS Security are required by participants. Employees/students must become safeguards, which are effectively trained, implemented, and maintained, or else they, too, become a threat to the information and knowledge stored.

Figure 1: ISS controls and common attacks (created by the authors)

However while the same technologies, discussed in class and reviewed by the groups, empower ISS practitioners they also empower hackers and hacking organisations to subjugate different types of information systems. This threat became part of the game as students adopted the role of hackers and targeted the secret / asset of another groups to gain extra marks. Table 3 outlines the results of the hacking component of the game in the academic year 2011/2012. The groups primarily tried to use man in the middle and password bypass attacks. The most successful attack was conducted by group 1. The group emailed the class using a fake email address from one of the coordinators: Coordinator1@gmail.ucc.ie requesting that students were to email their secrets before 5pm on the day of the agreed 'secret' submission. 26 students emailed their group’s secrets to the fake account. This earned group 1 two extra bonus marks due to the limit of 2 and the fact that by the time the project concluded (despite being consistently targeted by other 11 groups) did not have their corporate secret stolen. This attack was also used to illustrate well published cases of man-in-the-middle attacks. That is despite the fact that this topic was covered during class (2
weeks before the attack occurred) to the amusement of the majority of the students, due to the simplicity of the attack, 26 students fell for it. This reinforced the importance of controls such as SETA (security, education, training and awareness). As outlined in the Table 3 groups were successful in acquiring another group’s asset as well as unsuccessful in protecting their own corporate assets.

Table 3: Attack Attempts (Step 7 of Table 1)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Group</th>
<th>Attack Type</th>
<th>Attempt</th>
<th>Success</th>
<th>Failure</th>
<th>Hacked</th>
<th>Secret Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>85%</td>
<td>1</td>
<td>Man in Middle</td>
<td>4</td>
<td>2/72</td>
<td>3</td>
<td>4 Org Secrets</td>
<td>None Stolen</td>
</tr>
<tr>
<td>72%</td>
<td>2</td>
<td>Password bypass</td>
<td>6</td>
<td>1/72</td>
<td>5</td>
<td>1 Org Secret</td>
<td>None</td>
</tr>
<tr>
<td>62%</td>
<td>3</td>
<td>Man in Middle</td>
<td>4</td>
<td>0/72</td>
<td>4</td>
<td>0 Org Secrets</td>
<td>None</td>
</tr>
<tr>
<td>68%</td>
<td>4</td>
<td>USB Acquired</td>
<td>2</td>
<td>1/72</td>
<td>1</td>
<td>1 Org Secret</td>
<td>Secret Stolen</td>
</tr>
<tr>
<td>75%</td>
<td>5</td>
<td>All Attempted</td>
<td>6</td>
<td>0/72</td>
<td>8</td>
<td>0 Org Secrets</td>
<td>None</td>
</tr>
<tr>
<td>60%</td>
<td>6</td>
<td>Password bypass</td>
<td>1</td>
<td>1/72</td>
<td>1</td>
<td>1 Org Secret</td>
<td>Secret Stolen</td>
</tr>
<tr>
<td>59%</td>
<td>7</td>
<td>Password Guess</td>
<td>1</td>
<td>1/72</td>
<td>1</td>
<td>1 Org Secret</td>
<td>Secret Stolen</td>
</tr>
<tr>
<td>64%</td>
<td>8</td>
<td>Login left open</td>
<td>1</td>
<td>1/72</td>
<td>0</td>
<td>1 Org Secret</td>
<td>Secret Stolen</td>
</tr>
<tr>
<td>70%</td>
<td>9</td>
<td>Man in Middle</td>
<td>12</td>
<td>0/72</td>
<td>12</td>
<td>0 Org Secret</td>
<td>Secret Stolen</td>
</tr>
<tr>
<td>63%</td>
<td>10</td>
<td>SETA Failure</td>
<td>4</td>
<td>1/72</td>
<td>3</td>
<td>1 Org Secret</td>
<td>Secret Stolen</td>
</tr>
<tr>
<td>54%</td>
<td>11</td>
<td>None attempted</td>
<td>0</td>
<td>0/72</td>
<td>0</td>
<td>0 Org Secret</td>
<td>Secret Stolen</td>
</tr>
<tr>
<td>50%</td>
<td>12</td>
<td>Password Bypass</td>
<td>27</td>
<td>0/72</td>
<td>27</td>
<td>0 Org Secret</td>
<td>Secret Stolen</td>
</tr>
</tbody>
</table>

The game reinforced the need to recognise that the technical side of IS Security is a part of, but not always the answer to, the different IS Security challenges. Knowledge and expertise of the technologies necessary to alleviate IS Security risks are valuable. However ISS students must be familiar with critical business processes as well as ISS business impacts. Technological changes, in both secure hardware and software, are as constant as the increase in the number of threats to corporate IS Security. Forgetting the most basic types of attacks and the potential for employee mistakes are common issues for organisations in general. These errors were experienced by the student groups as outlined in Table 3. The mistakes made, as well as adopting the role of hacker, reinforced the material taught in class.

There is a pressing need for ISS practitioners to gain the knowledge necessary to diagnose problems, plan action and implement solutions. The game was utilised to allow students to apply the material taught in class to an environment they controlled. The use of social media enabled the students to build their own ISS solutions to potentially protect their assets and it enabled them to target another group without in any way interfering with the college network. The environment itself (Facebook and Twitter) allowed them the freedom to use a platform that was familiar, allowed shared work and access to external expertise.

5. Discussion

Research has increasingly advocated active learning strategies to enhance the effectiveness of the student learning experience (Biggs, 1994; Boyce et al., 2001; Ueckert and Gess-Newsome, 2008; Healy and Neville, 2009). Active learning strategies will initially challenge most students. However careful introduction can and does offer benefits even for those who were not originally technically oriented. A recent study shows that DGBL incorporated into a social network website is a feasible and sound model for teaching (Hwang, 2012). Research on the use of games as a teaching strategy indicates that the difficulties that may arise relate to the application of active learning methods, rather than with the method in and of itself (Healy and McCutcheon, 2008). Our experience of using the game presented in this study demonstrates that such difficulties such as the application of ISS theory can be overcome as students are supported to fully understand concepts and furthermore recognise the relationships among ideas (Ueckert and Gess-Newsome, 2008). Undoubtedly, this active approach engaged and motivated the groups to work with each other within the group as well as ‘compete’ against the other teams. Extant research supports the use of DGBL to motivate student learning (Papastergiou, 2008), in this study the feeling of competition pushed students to uncover new and interesting ways to better their classmates by trying to steal their organisational secrets. This level of engagement goes beyond the traditional methods of teaching and learning, allowing students to embrace concepts and theories that may be perceived as trivial and even boring when delivered in a classroom environment via traditional methods such as overhead projector or in class notes. In line with recent extant research in the field of DGBL (Lin, 2011; Hwang, 2012), the use of social media technology as a learning tool heightened the students’ interest in the subject matter.
The emergent nature of the module content must also be recognised from the outset and viewed as an opportunity for ongoing development of the student and group’s ISS understanding and skill-set. This coupled with the use of social media technology to teach and evaluate student’s understanding of the material is a work in progress; this need for continual re-crafting is supported by Hemmi et al. (2009). Nonetheless, one of the key advantages of the game is its hybrid orientation towards ISS and Business. Students are forced to realize, acknowledge and understand the integration of materials taught in the module and how these may be embodied in ‘real world’ scenarios. The resulting skill-set developed through such activity are twofold, meeting the calls for same in both academic and professional sources (Wankel, 2010; Chan and Reich, 2007).

6. Conclusion

In their recent study Tay and Allen (2011, p153) purport that “staff (educators) saw both the necessity of including greater use of social media in teaching and, at the same time, believed that neither social media technologies themselves, nor the informal and personal cultures of use that students had developed, would necessarily mean that this innovation would – without close attention to pedagogic design – reliably improve students’ outcomes.” Certainly, while social media technology has proven to positively enhance the student learning experience, it is imperative that academia continues to -

- **Engage** with social media technologies in order to further understand and leverage their capabilities
- **Ensure** that this convergence of the traditional and new provides students with a fulfilling learning experience
- **Adapt** to the changing needs of industry specifically focusing on developing students’ competitive skill-sets, preparing them for the challenges of the workplace

Unquestionably, Information and knowledge work is no longer confined to a small elite group of highly educated and specialized experts (Schön, 1995). Certainly, the most important changes driving knowledge and information workplaces are the evolutionary responses to the major demographical, technological, social and economic shifts in society and the rise of the internet based Knowledge Worker. Companies and universities face daunting challenges as they compete for the best talent. They face a diminishing demographic of young workers entering a multigenerational workplace. They will need to attract new talent, train, retain and create an engaged workforce. Workers will need to work longer in their lifetime than preceding generations. Workers will mainly be Knowledge Workers, utilizing the internet, computer technology and communications technology, and being assisted by knowledge processing platforms for their work. Working in physical office spaces with colleagues will diminish, giving way to virtualized teams in distant geographical locations. Employers will have to equip their employees with the best in connectivity tools where necessary to replace the lack of face-to-face communication. Organizational leaders are keenly aware that the workplace is changing and are already recruiting a new breed of employee. They are adapting their workplace policies and strategies to appeal to all generations. Therefore educators must adapt to the changing needs of industry and students in developing competitive skill-sets through traditional and innovative teaching approaches.

References


Game-Based Language Learning for Pre-School Children: A Design Perspective

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Abstract: During the last decade there has been a growing focus on preschool learning within education, especially with regard to the learning of basic literacies such as reading and writing. In addition to this many nation states increasingly focus on the basic literacy competences of the information society, ICT and English. This has, as suggested by for instance Scanlon and Buckingham (2007) boosted opportunities for the sale of educational material and hardware to children for home learning, but also for learning material that links content directly to the curriculum, to school work and to assessment. This paper will focus on the design of learning material for pre-school teaching and learning through the example of a game-based platform for learning English called Mingoville.com. Mingoville has been studied in connection with the project Serious Games on a Global Market Place (2007-11), where a number of games were followed into classroom environments across nations. Currently, the developers of Mingoville are working on a platform version that targets preschool learners and works on tablets as well as pcs and smartboards. The paper will discuss the implications of redesigning the platform for pre-school teaching and learning and how this affects game-based language teaching and learning with Mingoville.

Keywords: language learning, game-based learning, design for preschool learning

1. Introduction

The teaching of English is a growing focus of many nation states as English is considered to be a key competence in the information society (Graddol 2006). Consequently, many nation states focus on teaching English to the early stages of schooling, a strategy that may create both competent citizens and competitive nation states (Hansbøl & Meyer 2011, Shore & Wright 1997). In addition to this preschool levels are increasingly under pressure – from political actors as well as from parents - to introduce children to basic literacies such as reading, writing and understanding languages (Scanlon & Buckingham 2004). This calls for new learning designs and new learning materials for preschool and primary school levels.

Following Scanlon and Buckingham (2007) it can be argued that computers and software are heavily marketed to parents as a means of ensuring the academic success of their children in a context of increasing educational competition and marketization. Like early language skills in English, digital literacy is often conceptualised by nations, parents and schools as a competence that contributes significantly to successful learning. The consequence of these tendencies is that the market for digital learning material for children is growing and that commercial interests in learning and schooling increasingly interact with the school market for digital learning. One aspect of this is an extension of learning and learning materials into the home, a pedagogisation of leisure time in which parents will become educators and children learners. As Buckingham and Scanlon argue, “the home will increasingly come to be seen as an extension of the school, and…the kinds of ‘informal’ learning that might occur in the home will be increasingly curricularized” (Scanlon & Buckingham 2007). This home-school interaction is an interesting new space for research in game based language learning, as learning materials that are available online will inevitably support learning in a variety of environments. It can be argued that games often make connections between different sites of learning as they can be used for both entertainment and learning and therefore operate in between these activities.

This paper is based on the analysis of Mingoville.com, a game-based platform which addresses the market for teaching and learning English online in a global context – and which focuses on both home and school learning. Mingoville is an interesting focus for the study of game-based language learning because it targets young learners on a global market for education, and because it is a platform that continually seeks to adapt to the needs of parents, children, nations and schools. In connection with a recent research project¹ Mingoville was one of several game based platforms studied in research of

¹ Serious Games on a Global Market Place 2007-11. Funded by the Danish Council for Strategic Research
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the global market for game based learning\(^2\). In this project data were collected through interviews with educational actors such as teachers, pupils, school leaders, policy makers and platform developers, as well as through observations in classrooms (Egenfeldt-Nielsen, Sørensen & Meyer 2011). In 2012, an additional interview was made with a company representative of Mingoville who is a significant actor in the development of the platform for preschool learning. The purpose of this interview was to understand how the company has conceptualised and worked with a new version of the platform, a game based design for preschool language learning.

Drawing on these data, the paper asks how Mingoville is conceptualised as a game based platform for early language learning and what positions it may occupy in language learning in a global context.

2. Principles of early language learning

Early language learning is, as mentioned above, a strategic focus in many educational systems across the world, as language skills – specifically in English – are understood to contribute to forging competent 21\(^{st}\) century learners and citizens. Edelenbos et al (2006) for instance report that since the late 1990s there has been an increase in the early teaching of English in a number of countries in Europe. Similar tendencies are seen outside Europe (Meyer, Sørensen, Hanghøj & Birch Andreasen 2011, Graddol 2006). The idea behind these initiatives is generally that early language learning will produce successful language learners, a perspective that can also be found in research, where an early language start is often seen as an advantage.

However, where the political arguments for teaching languages to young learners are generally clear, the recommendations made by research are more cautious and often stress that the age of the pupils is not the only parameter for successful learning (Blondin et al. 1998, Edelenbos 2006).

This means that though there are indications that young learners are more open to and engaged in learning a new language – and that early beginnings may give them a head start on learning - issues such as pedagogy, teacher education and feedback, exposure, distribution of lessons and progression are also significant. This supports the idea that the design of learning material for young learners that address several of these contextual issues is of great significance to the quality of learning.

Experiences with the use of online learning in early language education shows that online material, if properly designed, can support learning in terms of provided input, continuity and positive feedback (Waschk 2004). These indications are significant as one of the challenges of early language learning is to provide exposure to the target language, time for instruction and learning and qualified feedback for learners. A platform like Mingoville may therefore provide language learning with added value in terms of supplying learners with more opportunities to encounter and produce language, and with qualified feedback that supports engagement and confidence in using the language. In this sense the platform may operate in between self-directed and teacher directed learning, i.e taking the role of a tutor or substitute teacher. In the role of a tutor the platform may relieve the teacher or provide instruction and feedback that the teacher cannot give, a role that may become increasingly significant as the pressure on teaching English to very young learners grows. The space for incorporating Mingoville preschool in language learning may therefore grow as political pressure increases at this level of schooling.

3. Games and language learning

Unlike most other school subjects foreign language learning has a long history of integrating games into learning, a history that began with paper, card and classroom games before digitalisation (Baltra 1990, Gaudart 1999, Li & Topolewski 2002, Crookall 2007, Ranalli 2008). Generally, games in language learning are associated with intrinsic motivation, meaningful exposure to the target language, as well as perceived associations between children’s language play and second/foreign language learning. Crookall (2007) for instance underlines “the need to integrate play into learning models” based on research in language play in children’s socialisation and early language play. Baltra similarly argues that “Playing is a very old and widespread form of learning and young children do their learning mainly through games or game-like activities. It is then not surprising that most educational activities in the preschool years try to simulate games” (1990, 446). Though the game

\(^2\) Other game based platforms studied were for instance Movie Star Planet, www.moviestarplanet.com and Global Conflicts, www.globalconflicts.eu
may be “over at school” (Baltra 1990) or after primary schooling (Gaudart 1999) due to academic pressure and the culture of serious learning, games have been continually associated with language learning and the development of communicative fluency in another language.

Outside formal education, games are often significantly involved in children’s encounters with other languages online – particularly English (Meyer 2006, 2001, Sørensen & Olesen 2000). In Denmark, most children are therefore familiar with English words, phrases and sounds before they start learning the language in school and they may associate game activities with this knowledge. Game based learning of languages therefore transcends the formal/informal context for learning – though the language may be learned in different ways in these contexts.

Games are often difficult to integrate into formal learning. However, a recent study (Egenfeldt-Nielsen 2011) concludes that “foreign language teachers believe that there is a larger potential for pupils to learn more from games in their subject compared to teachers of other subjects” (198). The same study points out that adaptation of computer games is generally higher in the lower grades of primary school and that – somewhat surprisingly - female teachers are more likely to use games than male teachers. This may indicate that foreign language teachers are more keen on using games for language education with young learners – and that games may have a specific role to play in the design of curricula for early language learning.

The intimate relationship between language learning and gaming to some extent derives from communicative approaches to language teaching and learning used in classrooms since the 1970s. These approaches underline the significance of the social aspects of language, for instance learners’ interaction with others in the target language and the use of authentic learning materials for learning (see for instance Garcia-Carbonell, Rising, Montero and Watts 2001, Hymes 1979). The idea of the learner’s immersion into an environment where situated response and learning is immanent, is something that game based learning and language learning may have in common – an argument that has been explored extensively by the journal Simulation and Gaming during the last two decades (see for instance Crookall 2007, Halleck 2007, Peterson 2010). One aspect of a communicative approach to learning a language is therefore role play and simulations as activities in which learners use language for meaningful communication with others and for simulated real-life purposes (Crookall & Oxford 1990, Coleman 1995, Wagner 1990).

This focus on contextualising language use through gaming affects teacher’s use of learning materials and activities in language education as well as the relationship between teacher and learners. Crookall (2007) for instance claims that the use of simulations and games are widespread and encouraged in language learning as the integration of game and simulation activities in language learning material has almost become a ‘guarantee’ of learner inclusion and creativity. Garcia-Carbonell et al (2001) similarly propose that games reorganise the authority structure of the classroom, in effect “declassrooming the classroom” (Sharrock & Watson 1987), thereby opening up the classroom to real-world communication and to more learner centered activities. Games then – if used appropriately - can provide contextualized input in language learning and provide challenge and competition to engage young learners in self-directed learning (Baltra 1990, Crookall 2007, Li & Topolewsky 2002, Garcia-Carbonell, Rising, Montero and Watts 2001).

Games, however, are not only immersive, as suggested by a number of the above mentioned research papers, they are also used for training and repetition of learned language (Hansbøl and Meyer 2011). This implies that research in game based language learning must distinguish between for instance game formats, genres and activities. In addition to providing engaging and contextualised environments for language learning games in primary education are thus often used to support the learning of skills through repetition and drills, for instance for basic vocabulary training. In continuation of this Wagner (1990) suggests that three types of game activities can be identified in language education: a) games for repetition and memorization b) games for problem solving and c) role play and scenarios. Type a) games are typically drill based exercises, for instance for vocabulary training, where the game acts a motivator and ‘motor’ for the production of language. Type b) and c) games, on the other hand, are more complex formats in which learners to a greater extent are active in defining and solving problems as an aspect of being immersed in social context. In Mingoville, type a) games dominate, even though the Mingoville Virtual World apparently provides a more contextualised framework for gaming (see below).
Generally, the significance of game based learning for young learners is underlined by the ways in which games and playful learning are associated with early language learning, as mentioned above (cf. for instance Crookall 2007). In addition to this, game based learning can offer an engaging and safe environment in which children can experiment and make mistakes – something that is specifically significant for young learners’ learning (Ortega 1997). According to Gaudart (1999) both simulations and games allow learners not only to practice forms they have already learned, but also to experiment with new structures. Thus, the non-threatening environment of learning with games offers the young learner an opportunity for practice as well as provides immediate and simultaneous feedback. Feedback is important for the young learner in for instance creating continuity in learning, increasing and maintaining motivation and in supporting learning processes where the teacher is not present or close to the child. The combination of game elements and drills may therefore help to open a space for gaming in primary schools across the world where focus is often both on learning basic skills, e.g. vocabulary, and on playful, child-centred learning.

Lately, new platforms such as those provided by handheld devices and tablets have begun to influence how children use technology for game based learning in and out of school and how technologies can be integrated into formal (language) learning. According to several studies, the affordances of the iPad in relation to teaching and learning can be associated with its portability, ubiquitous access, and situated and personalised learning (Melhuis & Faloon 2010, Kinash et.al 2012). These affordances have been connected with the needs of young learners to access technology easily and quickly in all kinds of learning environments (Melhuish & Faloon 2010). In addition to this, several recent studies (Burden et al 2012, Kinash et.al 2012) report that use of iPads at home and in school supports the use of applications that are game-based in nature. Kinash et al for instance mention that the integration of tablets in learning underline pupils’ request for not only more game based learning but for both “designing games” and “playing interactive games that help me learn” (2012, 21). In addition to this, Burden et al report that subjects such as mathematics, English and science are more likely to use iPads for teaching and learning. This tendency seems promising for a platform like Mingoville.

4. Mingoville – a language learning platform

Design is a conceptual matrix and a scenario for teaching and learning that is constructed against a background of theory and in relation to practice within a given context or contexts (Serensen 2009, 2011). In the case of Mingoville, design is one the one hand what changes Mingoville and on the other hand what keeps it stable. As a platform that constantly proliferates in order to reach users and adapt to markets, Mingoville is constantly changing. As a platform that conceptualises learning in certain ways, and that draws on narratives and characters of a specific universe in certain ways, Mingoville stays the same. This is the balance that design must manage, and that Mingoville straddles (Hansbøl & Meyer 2011).

Mingoville is marketed as a global educational resource, that presents itself through simplicity of tasks, design and access but simultaneously attempts to connect to many different kinds of educational needs. These are for example different contexts of learning (school and out-of-school) different age groups, purposes and technologies. Though Mingoville has been developed in a Nordic context of learning, the design and interface of the platform is designed for users worldwide. One aspect of this is the multilingual user design that allows users to e.g. use the dictionary in their own language. According to the webpage Mingoville presently has over 1.000.000 users worldwide, and testimonials from some of these users, for instance teachers and parents, can be seen on Mingoville.com.

Mingoville is licensed, but also free in a number of countries across the world. Currently Mingoville consists of two platform concepts: Mingoville School and Mingoville Virtual World. Originally Mingoville was a one platform concept, Mingoville School (before 2009). Mingoville School is targeted at individual users and contains more than 150 interactive lessons, creative lessons and teacher tools, with a focus on listening to, speaking, writing and reading English. Mingoville Virtual World is targeted at communities of users who can meet, chat and interact with each other through for instance gaming.

When the user accesses the Mingoville platform, he or she must choose between the two platform options, which are respectively presented as containing “learn now” and “play now” activities. The
references to playing and learning (and the tendency to both combine and separate these activities in the tasks) are related to the edutainment aspects of the design. These are summed up in the first principle of learning with the platform, which is *Learning English the fun way*. Another general principle of the platform is that the learner should be *immersed in the language*, a feature which is provided by the game content of the platform and the general use of English throughout the activities. Finally, the platform designers have conceptualised the platform as a learning environment that will support a variety of ways of learning English, as *Not all children learn the same way*.

![Figure 1: Learn now or play now](image)

Mingoville Preschool will be launched the summer of 2012 and will work on several platforms, most importantly iPads, that are seen as being specifically relevant for this age group. Since launching the Mingoville Virtual World in 2009, the company has increasingly focused on adapting Mingoville to the variety of platforms that are used both in and out of schools, for instance smartboards, smartphones and iPads – as well as books. The point of adapting Mingoville to many kinds of platforms is of course to get access to users through their preferred platforms, but also to take advantage of the ways in which different forms of interaction can be supported by different platforms and support different learners. The growing role of tablets (e.g. iPads) in education was in fact what inspired the company to develop the preschool version of Mingoville, as tablets are thought to support more intuitive navigation than pcs and to enhance the learning of English for children who are not yet confident users of the written language.

5. Negotiating play and learn in Mingoville preschool

Mingoville Preschool builds, as mentioned above, on the characters and principles of Mingoville School and Mingoville Virtual World, which are play and learn platforms the child must choose from after having logged on to Mingoville.com. Mingoville preschool is therefore in some ways an extension of the original platform design which it aims to adapt to the target group in question, i.e. preschool children. Preschool children are in this context understood primarily as children aged 5-7, but can of course also be younger or older children – there are no restrictions in platform usage. As systems of schooling will vary in different parts of the world (Anderson-Levitt 2003), the term preschool learning can refer to both initial schooling and to learning before school, for instance at home or in kindergarten. In Denmark children start school at the age of 7, and there has historically been a clear division between school learning (focused on formal learning and curricula) and preschool pedagogy (focused primarily on play). This division is currently under pressure, as policy makers increasingly curricularize preschool learning by introducing competences and aims that are used to assess children’s behaviour and skills (Jensen, Brostrøm & Hansen 2010, Hansen, Bech & Plum 2004). Early learning is therefore a contested field, and possibly a field that will embrace the combination of play and learn approaches that Mingoville preschool offers.
The idea and practice of preschool teaching and learning challenges teachers and pedagogues, as early learning makes new demands on the organisation and practice of teaching. As national curricula are adapted to incorporate an earlier start in English, teacher education cannot always keep up with the teaching of competences that teachers need to teach very young children. Many teachers of languages in primary school are not qualified language teachers (Edelenbos 2006), a fact that may contribute to leaving a space open for a platform like Mingoville – a space for e.g filling in the role of assistant teacher, and thereby relieving the pressure on the teacher. In our field studies of Mingoville we observed that the lack of qualified teachers in schools in combination with an increased focus on the early teaching of English often opens up the market for Mingoville in countries that have decided to implement a strategy of early English but have not yet had the means to educate teachers to support this strategy. This has for instance been the case in Chile, where a nationwide strategy to increase the English competences of children from the age of 6, Habla Ingles, has involved Mingoville (School) as a significant actor in education, as licenses have been bought to teach all children English at this level. The role of Mingoville is in this case meant to be that of an assistant or substitute teacher who will provide the learner with structured tasks and constant feedback in the process of learning – and in a context where teachers are generally not yet ready to take on the task of teaching English to young learners.

6. Feedback and teacher intervention in Mingoville Preschool

Feedback must be a significant aspect of the design of learning material for very young children, as these children need guidance and confidence in using the language. Providing language input is therefore not sufficient to support the learning of the child, learning material must qualify the learning of the language. Feedback and teacher intervention are thus significant issues in the analysis of how a game based platform like Mingoville can support language learning, and for instance provide input and continuity in learning.

Earlier studies in Mingoville have indicated that the platform can support self-directed learning and that the game elements of the platform can contribute to directing and engaging the child in learning (Hansbøl & Meyer 2011). Research has also shown that the role of the teacher is significant in providing continuity, meaning and qualitative feedback on the language learning that the child is involved in with Mingoville (Hanghøj, Hansbøl, Sørensen & Meyer 2010). However, in our field studies we often observed that teachers found it difficult to have a role in the interaction that the children had with Mingoville, and that some teachers would try to direct the learning, and others would let children explore the platform on their own (Meyer 2010). The difficulty of teachers’ intervention was partly related to the fact that Mingoville was understood as a game based learning environment and that gaming was understood as something that children usually engage in and explore without the intervention of a teacher or adult. In addition to this, analysis showed that teacher intervention in learning processes with specifically Mingoville School was in some cases replaced by the presence of an avatar teacher (a Mingo acting as a teacher) in the platform - and that this teacher avatar might sometimes act as a substitute teacher by giving both positive and corrective feedback to the pupil (Meyer & Sørensen 2011). In Mingoville Virtual World there is no teacher avatar, as the Virtual World is meant to support play and learn activities, primarily out of school. Restrictions and intervention in the platform are, however, built into the safe chat function, which does not allow the child to write his or her name, address, telephone number etc. Adult intervention is thus indirectly present in Mingoville Virtual World, however not in the form of feedback on the pupil’s work with the language.

Mingoville Preschool targets very young children and their learning both in and out of school and must therefore work with feedback and teacher intervention in a number of different ways. The platform is, as mentioned earlier, meant to be interacted with by the child alone (or with a parent or peers) outside school – in e.g. kindergarten or at home – as well as in school where it should be adaptable to learning processes planned and directed by teachers. Adult intervention may be extremely significant if Mingoville preschool is to move beyond drilling and into contextualised and curricularised learning. Therefore, the designers of Mingoville preschool are currently working on a teacher guide which aims to support teachers in using Mingoville preschool for young learners at the preschool or early school levels.

Feedback and intervention in Mingoville school is supported by a number of design features, some which are platform internal and some which are platform external and require the presence of an adult guide, parent or teacher. Internal feedback includes primarily positive feedback that is integrated into the loop of tasks, so that the child will get the feeling of being constantly led on to new tasks, and
supported in his or her understanding that he or she is doing well. The nature of the internal feedback has, according to the company, been under pressure in some parts of the world, where there is a strong tradition for assessment and testing of pupils rather than confidence building. The company however insists that the role of the internal feedback is primarily to support engagement in learning (positive feedback) and guidance (corrective feedback) and not to assess pupils’ performance. This may be particularly significant in connection with very young children who are just starting to learn the language.

Figure 2: Matching images with sounds in Mingoville Preschool

A significant design factor in connection with platform internal feedback has, according to the company, been to relate feedback to the game features of the platform, i.e. to implement feedback as an aspect of reward. Reward is understood as something that will support both extrinsic and intrinsic motivation (Malone 1981), in the sense that rewarding children for learning will give the child satisfaction with learning and achievement and therefore, it is suggested, motivate the child to play and learn for his or her own purposes.

One way in which the platform works with rewarding the child is through the feature of a tree that grows from a seedling that the child plants. The tree becomes a visualization of the growth of the child’s knowledge, as the child completes more tasks and fills up the growing tree with vocabulary learned. The metaphor of the tree thus works both as a visualization for the child of his or her achievements and for the parent or educator who may be interested in the child’s educational progress. In this sense the reward tree addresses the issues of continuity, progress and performance in language learning by supplying an organic image of learning and achievement to the child as well as to possible educators/parents. This to a large extent counters the idea of testing and assessing performance as part of curricularized knowledge.

The child’s reward of playing the games in Mingoville school is therefore both for the child and the educator/parent seeing the growth of knowledge represented by the vocabulary learned and the tasks done that make the tree grow. In addition to this the child is rewarded ‘in kind’ as the growth of the tree is paralleled with the filling of a pink bar in the right hand part of the picture that will eventually allow the child to acquire items that the child may want in order to customize his or her Mingsos. Whether this kind of game related feedback will contribute to the intrinsic motivation of children for learning English remains to be explored by research, however, the purpose of this analysis is primarily to identify aspects of feedback that may support the child in playing and learning on his or her own, and in responding positively to feedback by persisting in solving tasks.
If we turn to the company’s idea about platform external kinds of feedback, the teacher has a significant role to play as the classroom manager and gate keeper of the use of games in school. Whereas platform internal feedback is related to using the platform as the sole approach to learning the language, the company sees the role of Mingoville Preschool in schools as being just one way of engaging in learning, where the child is engaged in different kinds of activities and participates in different kinds of learning, e.g. self-directed, teacher directed or peer to peer led. In school, using Mingoville may, according to the company, in itself be a reward, for instance if the child or children are allowed to play the games in a classroom environment of learning. When it is positioned as being a reward after learning Mingoville may transform its purpose and identity from something to be learned with to something that can be played with while maintaining the pupil in learning. Similarly, the platform can be an inspiration for different activities in the classroom that do not involve using the platform, but refers to what has been learned through Mingoville. The vocabulary learned in Mingoville can for instance be used in classroom games defined by the teacher or pupils, or be part of a group work that children are engaging in and that is managed by the teacher. This proliferation of platform uses in classrooms may support the interplay of playing and learning that may be relevant for this age group – and may involve Mingoville in many kinds of learning. The versatility and adaptability of Mingoville will therefore contribute to negotiating national and local interpretations of feedback, interaction and learn and play practices in preschool education and learning.

7. Conclusions

Games are notoriously difficult to integrate into formal education. At the same time the digitalisation of learning games provides teachers and learners with materials and possibilities for both self-directed and teacher led learning in a variety of contexts. Learning games can be used for both entertainment and learning and can therefore make connections between different sites of learning – or operate between them as a third space or a third actor in education and learning.

Mingoville Preschool is a game based platform that uses its versatility and adaptability to address needs in the market that arise from a growing political and parental pressure on introducing English to preschool children. In this role Mingoville situates itself between formal and informal contexts for learning and between play and learn activities that can and should be negotiated locally. Mingoville also addresses the need for increased input in language learning, and for qualified feedback and children's language production. Feedback becomes a major issue in the design of a game based learning platform like Mingoville, because platform internal and external ways of providing feedback will contribute to ensuring a space for the platform in preschool learning. An analysis of the redesign of the platform from school to preschool orientation confirms that forms of feedback are proliferating with the redesign of the platform and that positive and organic approaches to and visualisations of
feedback dominate in accordance with tendencies within Nordic and European approaches to language learning. These are believed to work well with new forms of interaction provided by emergent technologies like iPads that may support intuitive forms of navigation that will suit the needs and the learning of very young learners. However, a challenge for the distribution of the platform in different local contexts will be the integration of game based learning material in curricula, school cultures and home environments. How will Mingoville Preschool correspond to the needs of different pupils, school cultures etc.? To what extent will the teacher guide developed by the company assist teachers in using games, and how will for instance the use of iPads change learning environments for very young learners? These questions must be researched in context through empirical investigation. Further research will therefore, it is expected, provide information about how Mingoville Preschool supports children in practice, how it is negotiated, and how new features of design will help the distribution of the platform in learning and entertainment environments.

I have presented Mingoville as an example of how the design of a learning platform for English as a foreign language can be conceptualised for preschool children. My analysis suggests that designers of game based material for young language learners should be aware of the following:

- There is a growing market for teaching English to young learners, where game based learning may have a significant role to play, as there is a strong connection between game based learning and language learning both in and outside school. New technologies such as tablets may support, qualify and intensify the ways in which games are used for language learning.

- Game based learning through digital platforms can provide learners with more time for interacting with the language and increased exposure to the target language, as pupils can work with the language in their own time and space after school. However, what is significant in relation to specifically young learners is not only to provide input, but to qualify exposure to the target language with continuity in tasks and immediate feedback that will engage the learner in continuing to learn.

- Feedback should be adapted to the variety of contexts in which the child can learn the language, i.e. both in school with a teacher and outside school with a parent or alone. However, though careful design and market opportunities may support the role of game based material for young learners both in and out of school, there are still many barriers to using games in formal language learning. Supporting children in learning a language with games before they start school may pave the way for game based learning in school – however, more empirical research is needed to understand how exactly game based learning can be transformed from preschool to in-school language learning.

References


Ortega, L. (1997) ‘Processes and outcomes in networked classroom interaction: Defining the research agenda for L2 computer-assisted classroom discussion’, *Language Learning & Technology* vol. 1, no.1, pp. 82-93


Abstract: For a child to learn through Problem-Solving in Serious games, the game scaffolding mechanism has to be effective. Scaffolding is based on the Vygotskian Zone of Proximal Development (ZPD) concept which refers to the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers. Scaffolds in serious games are learning stimulators. The effectiveness of these learning stimulators lies in the way they are managed or regulated. Scaffolds that are not regulated could lead to expertise-reversal effect or redundancy effect which inhibits learning. In the current classroom application of serious games, the game-based learning stimulators remain the same for everyone (“blanket scaffolding”) – the learning stimulators are not managed or regulated. In order to make scaffolding in serious games more effective for classroom use, the calibration of the game’s learning stimulators has to be enabled – this would help in meeting the changing needs of the learners. The concept of fading which is critical to scaffolding is introduced to serious games, to facilitate the fine-tuning of the learning stimulators to the changing needs of the learners. This paper seeks to address the issues in the design and implementation of a Fine-Tuning System for serious games based on the fading concept. Also discussed in this paper are the factors to be considered in the implementation of the Fine-Tuning System in serious games. These include fading decisions; fading and learning rates; optimal scaffolding distance; classroom culture and collaborative learning. The adverse effects of neglecting fading such as expertise-reversal effect and redundancy effect are also discussed.

Keywords: expertise-reversal effect, redundancy effect, fading, adaptable, serious game, fine-tuning system, problem-based learning, scaffolding, ZPD, peer-tutoring

1. Introduction

“The ZPD is the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers” (Vygotsky, 1978). Scaffolding situations are those in which the learner gets assistance or support to perform a task beyond his or her own reach if pursued independently when “unassisted” (Wood, et al., 1976). Scaffolding is the guidance required in bridging the gap between what a child knows and what he is supposed to know. For this to take place, scaffolds (learning stimulators) are used. These learning stimulators are gradually removed as the child becomes more knowledgeable. Serious games which are games that go beyond entertainment to educating the players (Rankin, et al., 2008) require an effective scaffolding mechanism to guide and stimulate learning. An ineffective scaffolding mechanism can lead to expertise-reversal effect. Expertise-Reversal Effect is demonstrated when instructional methods that work well for novice learners have no effects or even adverse effects when learners acquire more expertise (van Merrienboer & Sweller, 2005). It is important therefore to fade the support as the learner gains expertise. In essence each time the player attains the game (learning) goal the scaffolding level is reduced. “A critical piece to the concept of scaffolding is fading. If the scaffolding is successful, students will learn to achieve the action or goal without the scaffolding. For students to practice the action or goal without the scaffolding, the scaffolding must fade” (Guzdial, 1994). Introducing the Fine-Tuning System (FTS) to serious games, would enable calibration of learning support in the games. The FTS works with a scaffolding regulator which facilitates the generation and fading of support. This paper focuses on the design and implementation of the FTS. Subsequent sections would cover related work on serious games and scaffolding; current application of scaffolding in children’s serious games; problems and solutions; the fading concept; eliminating “Expert Reversal Effect”: The Essence of fading; scaffolding approaches based on fading; the basis of
the FTS; design considerations; the fine-tuning system; Challenges and Limitations; conclusions and future research.

2. Related work on serious games and scaffolding

An analysis of literature surrounding the design and development of serious game reveals an array of models and frameworks that ensure effective pedagogical and design principles. Table 1 below presents a number of these models and frameworks along with a brief description of the expected learning process. Regarding the learning process, providing guidance to students has been necessary to enhance their learning experience (Melero, et al., 2011). The ZPD is a critical concept to consider when providing scaffolding (Dennen, 2004). Assisting students within their ZPD is a personalized process (Dennen, 2004). Though some of the models have instructional support features such as system feedback, debriefing etc, the vital piece of individualizing this support is ignored. There’s the challenge of providing instructional support for many children in a class, each with different needs (Dennen, 2004). None of the frameworks show how the guidance provided by a serious game can work effectively for multiple ZPDs found in the classroom.

Table 1: Models and frameworks for serious games

<table>
<thead>
<tr>
<th>Model/ Framework</th>
<th>Learning</th>
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<tbody>
<tr>
<td>Problem-Based Gaming (PBG) Model</td>
<td>This model is founded on the basis of Problem-Based Learning (Kiili, 2007). It is based on the experiential learning theory (Kolb, 1984). The model describes learning as a cyclic process through direct experience in the game world and a reflection on this experience. The model emphasizes reflective thinking and also makes it clear that reflection may take place in isolation or with collaboration with other people. According to (Kiili, 2007) the feedback that the game provides from a player’s actions should support reflective thinking and knowledge construction by focusing a player’s attention to relevant information from the learning point of view. This is only possible if the feedback (a form of scaffold) is ZPD-specific. Little emphasis is laid on scaffolding which is not enough to tag the framework suitable for the dependent learner.</td>
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<tr>
<td>RETAIN design and evaluation Model</td>
<td>This model aids in the evaluation of how well the academic content is endogenously immersed and embedded within the game’s fantasy and story context, promoters transfer of knowledge, and encourages repetitive usage so that content becomes available for use in an automatic way. (Gunter, Kenny, &amp; Vick, 2008). This model is restricted to the standalone system, thus little or no emphasis on collaboration, which only networked users engage in. For the dependent learner, collaboration is an important part of the learning process.</td>
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<tr>
<td>Input-Process-Output Model</td>
<td>In this model there is an instructional program that incorporates certain features or characteristics of games that trigger a cycle that includes user judgement/ reaction, user behaviours and system feedback. The instructional content is paired with appropriate game features to produce self motivated game-play. This engagement in game-play lead to the achievement of training objectives and specific learning outcomes (Garris, et al., 2002). The system feedback here is discussed in relation to motivation with little emphasis on its effect on performance. There’s also the debriefing process that provide the link between the game cycle and the achievement of learning outcome (Garris, et al., 2002). According to (Garris, et al., 2002), debriefing is a fundamental link between game experiences and learning. Though debriefing is essential for scaffolding (as indicated in this framework), there should also be collaboration through interaction with peers.</td>
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<td>Game Object Model (GOM)</td>
<td>The Amory and Seagram’s Game Object Model (GOM) attempts to create dialectic between pedagogical dimensions and game elements (Amory &amp; Seagram, 2003). In GOM, educational games are considered to consist of a number of components (objects) described through abstract and concrete interfaces which represent the pedagogical/ theoretical and design elements respectively. The abstract to concrete interface in GOM represent a transition from conceptualization to realization. In GOM, Game Space Object includes Visualization Space Objects which drives cognitive apprenticeship. The GOM has evolved, so there is GOM</td>
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<td>Model/ Framework</td>
<td>Learning</td>
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<tr>
<td><strong>version II</strong></td>
<td>GOM version II establishes the need for collaboration in the learning process (Amory, 2007). In GOM, the place of scaffolding through instructional support is unclear.</td>
</tr>
<tr>
<td>Kiili Experiential Gaming Model</td>
<td>The model describes learning as a cyclic process through direct experience in the game world and learning is defined as a construction of cognitive structures through action in the game world (Kiili, 2005). This is described to consist of a solution loop, an experience loop and solution bank (Kiili, 2005). Solution loop: The player generates solution required to overcome challenges. The solution process is most fruitful if it is performed in groups (Kiili, 2005) Experience loop: Here the player tests the solutions. This model discusses the flow experience and links it to the clarity of goals and appropriateness of feedback. Also vital is reflection, described here as reflective observation of the feedback. This leads to the construction of schemata and enables the discovery of new and better solutions to problems. The model substantiates that problems can be solved collaboratively, but also makes it clear that critical reflection and knowledge construction occurs in a private world (Kiili, 2005). Reflection and collaboration which are essential for PBL are emphasized in this model. Scaffolding is also a critical aspect of this model. This model emphasizes flow and covers reflection, collaboration and scaffolding which are elements of PBL.</td>
</tr>
<tr>
<td>The Game-based Learning Framework</td>
<td>According to (Staalduinen &amp; Freitas, 2011), this model is constructed by integrating instructional design theories and educational game design models. The following make-up the framework Contextual background: a game design should always be embedded in an educational theory. The framework is designed for multiplayer games within a constructivist perspective. Game elements and learning outcomes, including feedback and debriefing Game-play and player motivation: This is based on flow theory, with regard to clear goals, active player feedback and sense of control. This is combined with engagement theory to incorporate challenge, fantasy, curiosity, and control. (Staalduinen &amp; Freitas, 2011) The framework has a learning, instruction and assessment column. Essential to a good learning experience is the alignment of the three columns (Staalduinen &amp; Freitas, 2011). This framework says nothing about how the player learns, so collaboration and reflection is not emphasized. It is suppose to serve as a checklist and a reminder for designers of serious games (Staalduinen &amp; Freitas, 2011).</td>
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<tr>
<td>6“I”s Model</td>
<td>A Hierarchy of serious game elements – identity, immersion, interactivity, increased complexity, informed teaching and instructional. This model functions as a hierarchy with identity as the basic foundational element (Annetta, 2010). This model is based on the constructivist viewpoint that people learn through ascertaining prior schema and ultimately constructing new knowledge by connecting a new experience to a prior experience (Annetta, 2010).The model also introduces the idea of informed learning. Specifically, this entails embedding scaffolds (learning support) into a game design and unique to educational games, the idea of embedded assessments for educational learning outcomes (Annetta, 2010). There is also the concept of immediacy which refers to those communication behaviours that reduce perceived distance between people (Thweatt &amp; McCroskey, 1996) cited in (Annetta, 2010). According to (Annetta, 2010) photorealistic environments and facial movements and expressions by other players (in a multiplayer context) and nonplayer characters increase immediacy. Immediacy just as informed learning scaffolds learning and thus could facilitate PBL.</td>
</tr>
</tbody>
</table>
The table uses an analysis of frameworks to show the extent to which serious games have adopted the principle of scaffolding. From the analysis of these selected frameworks, it appears that scaffolding has been relatively unstudied by researchers in this field. It however seems that distributed intelligence is being assumed to be scaffolding in serious games, there is an argument that this is not scaffolding "if the support does not fade, then one should consider the activity to be distributed intelligence, not scaffolded achievement" (Pea, 2004). Also neglected is fading which is essential in scaffolding.

3. Current application of scaffolding in children’s serious games

The learning stimulators (scaffolds) are structured in such a way as to keep the child focused on the learning goal. These learning stimulators in serious games include the feedbacks and hints. Good feedback can significantly improve learning processes and outcomes if delivered correctly (Shute, 2007). Formative and summary feedbacks are the two distinct types of feedback found in serious games. Formative feedbacks are the games’ real-time reaction to the actions taken by the child in the game. It is often the response the child or player-learner look-out for when testing his hypotheses in the game. Summary feedback is a delayed response – often in the form of a progress report that the child can reflect on to improve his actions in the game. Hints are regarded as pointers to the problem solutions - problem solutions should be complex enough to require many interrelated pieces and should motivate the students’ need to know and learn (Hmelo-Silver, 2004). The pointers are expected to guide the child to the problem solutions. The structuring of these pointers (hints) would determine how effective they’ll be in the game.

In the current application of scaffolding, these learning stimulators are often used in conjunction with expert/teacher debriefing. Here the teacher’s response or feedback to the child on assessing the child’s progress-report often aims at re-focusing the child towards the learning goal. It often externalizes self-reflection by directing appropriate questions to the child (Hmelo-Silver, 2004).

This current application of scaffolding in children’s serious games is depicted in (Obikwelu, et al., 2012) conceptual model of the scaffolding mechanism in serious games.

![Figure 1: The serious game scaffolding model (Obikwelu, et al., 2012)](image)

It is important that the scaffolds are adapted to the learner. In the current application of scaffolding this is not the case -the learner is adapted to the scaffolds. The scaffolds remain the same despite the changing level of expertise of the learner. “Support should be calibrated and sensitive to the changing needs of the learner” (Puntambekar & Hubscher, 2002).

4. Problems and Solutions

An analysis of the literature depicts scaffolding in serious game as

- Instructional support/ debriefing given by an expert/teacher after game-play (Garris, et al., 2002)
- Inculcating learning through the mastery of a challenge (Gunter, et al., 2006) and Learning support embedded into game design (Annetta, 2010).
Instructional support through debriefing is given by an expert/teacher after game-play (Garris, et al., 2002). However the problem with this approach is that it is not possible for one person to provide support for the multiple students learning at different rates within their ZPDs. (Puntambekar & Hubscher, 2002) The Zone of Proximal Development refers to the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers (Vygotsky, 1978). It is difficult to provide the adaptive and dynamic support that is tailored to every individual in a classroom situation (Puntambekar & Hubscher, 2002).

Inculcating learning through the mastery of a challenge as described by (Gunter, et al., 2006) and learning support embedded into game design (Annetta, 2010) is faced with the problem of unsuitability for multiple ZPDs. In the complex environment of the classroom, there are multiple Zones of Proximal Development (ZPDs) that have to be taken into consideration while building scaffolding (Puntambekar & Hubscher, 2002). These multiple ZPDs are not taken into consideration while embedding learning support into serious games. The critical need to providing the right amount of support for every learner is over-looked. All learners get the “same” scaffolding − “blanket scaffolding”, contradicting the very notion of scaffolding (Puntambekar & Hubscher, 2002). If the support does not fade, then one should consider the activity to be distributed intelligence, not scaffolded achievement (Pea, 2004).

5. The fading concept

In scaffolding, the ultimate goal is the removal of scaffolds, since we want students to be able to complete the task independently (McNeill, et al., 2006). This removal of scaffolds is referred to as fading. Because excessive or insufficient support can hamper the learning process, it is critical to determine the right type and amount of support and to fade at appropriate time and rate (van Merrienboer, et al., 2003). The danger of fading learning support that is not individualized is that it may fade too quickly and reside outside of a child’s ZPD (McNeill, et al., 2006). There is need for the individualization of this embedded learning support to suit multiple ZPDs. For this reason the concept of generating and fading scaffolds is introduced. This would be done by introducing a scaffolding regulator to create a fine-tuning system within a serious game.

6. Eliminating “expertise reversal effect”: The essence of fading

Feedbacks are the most important scaffolds in serious games. Feedback can broadly be categorized into corrective and explanatory feedback. The choice of feedback in the game should be based on the child’s prior knowledge of the concept to be learned. Explanatory feedback is used to guide novice students in the process of meaning making; it promotes deeper learning than when corrective feedback is used alone (Moreno, 2003). The feedback could have a positive or negative influence on learning. If the feedback is inappropriate for the learner, it would be ineffective and thus deter learning. Thus the feedback should be adaptable and sensitive to the changing need of the learner. Fading would facilitate this. It is important to note that feedbacks could be visual or auditory, thus enabling the fading and calibration of visual and auditory content in games would help meet the changing needs of the learner. Kalyuga et al (2000) demonstrated that if experienced learners attend to auditory explanations, learning might be inhibited (Kalyuga, et al., 2003). Auditory explanations may also become redundant when presented to more experienced learners (Kalyuga, et al., 2003).

“Kalyuga et al (1998) and Yeung et al. (1998) proposed that, for experienced learners, eliminating redundant material is advantageous because it reduces the cognitive load associated with processing redundant information in working memory” cited in (Kalyuga, et al., 2003). As the learner gain expertise, the scaffold should be removed. Providing additional text is redundant for experts and will have negative rather than positive effects, thus demonstrating the expertise reversal effect. The most important instructional implication of this effect is that, to be efficient, instructional design should be tailored to the level of experience of intended learners (Kalyuga, et al., 2003).

7. Scaffolding approaches based on fading

Supportive Scaffolding: As supportive scaffolding fades, the task is the same as it was before, but the goal is for the learner to have internalized the procedures and concepts which had been scaffolded (Jackson, et al., 1998). This entails fading the hints and feedbacks (in the game) widely associated with scaffolding.
Intrinsic Scaffolding: As the scaffold fades, the task is changed, but associations should remain so that the learner can progress from simpler, more structured or more concrete tasks to variations in which more of the underlying complexity or abstractness is introduced (Jackson, et al., 1998). The difficulty of the task is hidden from the player and gradually introduced as the scaffold fades.

Reflective Scaffolding: It is the support for thinking about the task (e.g. planning, making predictions, evaluating). It also doesn’t change the task itself, but instead it makes the task of reflection explicit by eliciting articulation (Jackson, et al., 1998). An example is the art of conversation in serious games - the player character conversing with the Non-Player Character (NPC). The fading options here could include gradually disabling the conversions starting with the most to the least helpful.

8. The Basis of the FTS

Scaffolding implies a coupling between two changing levels: the level of competence embodied in the student on the one hand, and the level of competence embodied in the level of scaffolding (Geert & Steenbeek, 2006). Discrete levels of support can provide the necessary flexibility such that each student is facilitated in performance and learning without being stifled by too much scaffolding or being left to flounder by too little scaffolding (Guzdial, 1994). Scaffolding involves calibrated support for diagnosed learning targets (Azevedo & Hadwin, 2005). On this basis there is need to enable the calibration of this support in serious games. This is made possible in the FTS by the scaffolding regulator. The adjustment can be made by the player-learner, teacher or an internal decision process. According to (Guzdial, 1994), adaptable scaffolding is the scaffolding which can be changed or faded by the user while adaptive scaffolding is one which changes or fades based on an internal decision process.

9. Design considerations

9.1 Fading rate

In principle, the serious game should be designed with sufficient learning support for all the ZPDs. To achieve this, there is need for a scaffolding regulator which is designed to fine-tune learning support to suit each ZPD. The learning support for various learners could be regulated by the teacher from a centralized point using the scaffolding regulator. This is done by gradually fading the support as learners complete tasks within the game. “The rate of fading depends upon the child’s level of development and competence. A teacher is fading when the level and/or the amount of support is decreased over time” (van de Pol, et al., 2010). The rate of fading for various learners will be established and categorised into a number of distinct groups. The learners for which the rate of fading is slower would be categorized as the non-expert peers, while the learners for which the rate of fading is faster would make-up the expert group.

The fading decision can either be made by the teacher or the child. Based on the fading decision, fading rate can be categorised into two major types: Perceived Fading Rate and Actual Fading Rate.

Perceived Fading Rate: This is the fading rate adapted by the teacher with the assumption that it is the most suitable for the students.

Actual Fading Rate: The rate at which a child fades the support as determined by the child himself. A child’s learning rate can be extrapolated from the Actual Fading Rate. “One problem is that it may be hard for the child to make fading decisions” (Jackson, et al., 1998)

9.2 Collaborative learning

“When a child’s ability, or competence, is assessed on some static, independent test, this measure reflects his actual level of development; and this is true whether the measure is a standardized test or the laboratory experiment familiar to developmental psychologists” (Brown & Reeve, 1985). The child’s transition from this actual level of development to his potential level of development would require collaboration with a more knowledgeable peer. “Vygotsky argues that what children can do with the assistance of others is “even more indicative of their mental development than what they can do alone” (Vygotsky 1978)” cited in (Wagner, 2007).

“According to Vygotsky’s theory, problem solving skills of tasks can be graded on (1) those performed independently by a student; (2) those which can be performed with help from others and (3) those that
cannot be performed even with help. The second situation occurs in the classroom collaborative environment” (Pivec, et al., 2003). The term “collaborative learning” refers to an instruction method in which students at various performance levels work together in small groups toward a common goal – The success of one student helps other students to be successful (Gokhale, 1995). Proponents of collaborative learning claim that the active exchange of ideas within small groups not only increases interest among the participants but also promotes critical thinking (Gokhale, 1995). It is important to understand that collaboration is not the same as co-operation. When people are co-operating, they are adjusting their actions so that each player achieves their individual goals, whereas collaboration is about actions being adjusted in order to achieve a shared goal (Watkins, 2009). It can be argued that most two-player games designed to enhance collaboration end up facilitating co-operation. Collaboration which is a core tenet of the FTS requires that the trainer and students play non-traditional roles such as interaction and collaboration with each other within the educational process (Pivec, et al., 2003). Collaborative learning aims to promote dialogue. Dialogue enhances understanding when learners explain to each other (Watkins, 2009).

9.3 Peer tutoring

Peer tutoring is one type of peer collaboration (Hoysniemi, et al., 2003). Peer-tutoring is an approach in which one child instructs another child in material on which the first is an expert and the second is a novice (Damon & Phelps, 1989). “As a form of collaborative learning, peer tutoring is important because it provides the kind of social context in which normal discourse occurs: a community of knowledgeable peers. This is the main goal of peer-tutoring” (Bruffee, 1995) In peer tutoring the expert peer assumes the role of the tutor and the non-expert peer is the tutee. Peer-tutoring involves people from similar social groupings who are not professional teachers helping each other to learn, and learning themselves by teaching (Topping, 1996). Peer-tutoring is characterized by specific role-taking: at any point someone has the job of tutor, while the other is in a role as tutee (Topping, 1996). Peer group influence requires an effective peer tutor training course based on collaborative learning, one that maintains a demanding academic environment and makes tutoring a genuine part of the tutors’ own educational development (Bruffee, 1995). This form of collaboration have the following advantages – the teacher would have more time to spend instructing students with more severe academic deficits and the expert-peer who is the student tutor would acquire teaching skills and improve his own academic performance as a result of the tutorial experience (Harris & Sherman, 1973). In addition there is the tendency of the non-expert peer establishing a trusting relationship with a peer (expert) who holds no position of authority which might facilitate self-disclosure of ignorance and misconception, enabling subsequent diagnosis and correction.

10. The “fine-tuning system” (FTS)

Figure 2 shows how this system works within the serious games context. It depicts the relationship between fading, game progress and knowledge gained. As the scaffold is faded the distinction between the expert peer and non-expert peer become obvious.

Prior to fading, everyone – expert and non-expert would make satisfactory game-progress with little knowledge gained. This is because the learning support for the entire target ZPDs were embedded in the game. This support is gradually faded, and at point B the game-progress for some of the students would fall below a set threshold. These students would be regarded as the non-expert peer. At this point those who still make satisfactory game-progress are regarded as the expert peer. As soon as this distinction is made, the expert peer and the non-expert peer are made to collaborate through peer-tutoring. This collaboration would considerably improve the game-progress made by the non-expert peer and thus significantly increase the knowledge gained in the field through game-play.

Furthermore figure 3 is a graphical illustration of the relationship between a child’s competence and fading.

Vygotsky, pointed out that a person can imitate only that which is within her developmental level (Vygotsky, 1978). From this viewpoint, we can argue that the target scaffolding level should be within the target learners’ learning bandwidth. This implies that fading can only go as far as the potential/target competence.

The dotted curve in figure 2 represents the non-expert peer who is yet to attain the potential competence which the expert peer has already attained at the target scaffolding level. It is important
to note that fading beyond the target scaffolding level would not make a difference in the child’s competence.

**Figure 1:** The “fine-tuning system” (FTS)

There is no distinction between the expert and non-expert peer, as they both make good game progress. Though knowledge gained is low.

The distinction between the expert and non-expert peer in relation to the game progress made at the low scaffolding level emerges. Higher knowledge is gained with the expert peer still making good game progress.

The expert and non-expert peer engage in collaborative learning in the form of peer-tutoring. The expert peer is the tutor while the non-expert peer is the tutee. It is expected to improve their game progress beyond the game-progress threshold at low scaffolding with higher knowledge gained.

**Figure 3:** Graphical illustration of the relationship between a child’s competence and fading
11. Challenges and limitations

The capture and use of the Learner log

The learner log should contain information related to the Learner-game and Learner-teacher interaction.

Learner-game interaction: From this interaction it is expected that individual data such as the time-spent on game-play, number of attempts and progress report should be captured by an e-learning system. This is a challenge as most game design tools are not compatible with the available e-learning systems.

Learner-teacher interaction: The e-learning system should be able to capture relevant information that would enable the teacher monitor individual player-learner’s progress and respond appropriately. The teacher might have to assume a variety of (sometimes challenging) roles (Arnab, et al., 2012). The teacher is also faced with the challenge of determining an appropriate fading-rate based on player-learners’ learning rate. Furthermore the teacher determines at what stage in the process, collaboration (peer-peer interaction) becomes expedient. Blending video games with classroom learning might facilitate the adoption of constructivist epistemology at classrooms, where the objectivist perspective is still at the centre today (Tuzun, 2007). “Constructivism is an epistemology used to explain how people know what they know. The basic idea is that problem-solving is at the heart of learning, thinking and development. As people solve problems and discover the consequences of their actions – through reflecting on past and immediate experiences – they construct their own understanding.” (Lamon, 2002) “According to constructivism theory, learners construct knowledge (rather than acquiring it) individually through their interactions with the environment (including other learners) based on their current as well as prior knowledge, authentic experience, mental structures, and beliefs that are used to interpret objects and events in relation to the context and environment in which learning takes place. The learner is an active processor of information and creator of personal knowledge” (Thomas, 2010). “Objectivism sees knowledge as a passive reflection of the external, objective reality. This implies a process of “instruction,” ensuring that the learner gets correct information”.

Peer-Peer Interaction: Peer-tutoring is the collaborative learning style recommended in this paper. There are other collaborative learning styles such as reciprocal peer-tutoring which could be useful. The teacher facilitates the collaboration and is thus faced with the challenge of determining which style would best suit the learners. The classroom culture is also an hindrance here, as ”(1) The teachers have seldom experienced classrooms being run in a collaborative fashion (2) The culture of schools does not foster collaboration work by teachers themselves (3) The dominant values in today’s schooling, especially under the influence of hyper-accountability emphasise individualism” (Watkins, 2009).

Technical Limitation

“Time alone is not sufficient for video game implementation in a school context and it should be supported by a reliable, strong and available information technology (IT) infrastructure” (Tuzun, 2007). Unavailability of computer laboratories is a hindrance to the successful implementation of any game-based learning strategy. With current student volumes, computer laboratories where available can barely be enough for teaching about basic IT skills (Tuzun, 2007).

12. Conclusions and future research

The zone of proximal development, scaffolding, and dialogue are especially useful concepts or frameworks for school learning (Tinzmann, et al., 1990). Dialogue, scaffolding, and working in one’s zone of proximal development can be accomplished in collaborative classrooms (Tinzmann, et al., 1990). The proposed system (FTS) is designed to help drive Problem solving through scaffolded game-play. It recommends adapting instructional support to learner need against adapting learner needs to rigid instructional support. Designers of serious games need to consider the target group’s ZPDs, while introducing the “scaffolding regulator” feature to serious games, since the “scaffolding regulator” is used in the calibration of instructional support. Neglecting fading could lead to expertise reversal effect which can deter the learning effectiveness of the game. The whole framework aims at helping dependent learners complete tasks independently by impacting their individual ZPDs through...
effectively scaffolded game-play and peer-tutoring. In future work, we will aim to test this system (FTS) and thereby validate its usability for teachers and the classroom environment.

The benefits of this approach open up potential for adopting PBL in classrooms through game-play. Further research will evaluate the framework within the context of a serious game with children aged 10-11 in order to be able to make modifications or generalizations to the framework.

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A Platform Independent Game Technology Model for Model Driven Serious Games Development

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Abstract: Game-based learning (GBL) combines pedagogy and interactive entertainment to create a virtual learning environment in an effort to motivate and regain the interest of a new generation of ‘digital native’ learners. However, this approach is impeded by the limited availability of suitable ‘serious’ games and high-level design tools to enable domain experts to develop or customise serious games. Model Driven Engineering (MDE) goes some way to provide the techniques required to generate a wide variety of interoperable serious games software solutions whilst encapsulating and shielding the technicality of the full software development process. In this paper, we present our Game Technology Model (GTM) which models serious game software in a manner independent of any hardware or operating platform specifications for use in our Model Driven Serious Game Development Framework.

Keywords: game technology model, platform independent game technology model, serious games engineering, model driven engineering, games based learning, model driven serious games development

1. Introduction

Game-based learning (GBL) refers to both the innovative learning approach derived from the use of computer games that possess educational value and other software applications that use games for learning and education purposes (e.g. learning support; teaching enhancement; assessment and evaluation of learners etc.) (Tang, Hanneghan, & El-Rhalibi, 2009). These computer games, designed for non-entertainment purposes, are also widely known as serious games. The preliminary results (Jenkins, Klopfer, Squire, & Tan, 2003) of GBL are demonstrating great educational promise. As computer gaming becomes a digital culture deeply rooted amongst the new generation of learners, many researchers and practitioners agree it is now appropriate to exploit gaming technologies in order to create a new generation of educational technology tools to equip learners of all ages with necessary skills via GBL (FAS, 2006).

However, the absence of high-level authoring environments and support for non-technical domain experts (or teachers) to create custom serious games are impeding many who wish to adopt this innovative learning approach (Tang & Hanneghan, 2010). Despite efforts to create serious games through bespoke in-house development, using open source or royalty-free game engines in collaboration with a team of developers and ‘modding’ (or modifying) commercial-off-the-shelf games by utilising a game editor application, the adoption rate of GBL in the mainstream is still low. Many of these tools and technology platforms for producing serious games are readily available but most of these tools require substantial knowledge in games development which hinders non-technical domain experts from adopting games-based learning.

Advancements in software engineering are making the creation of high-level serious games authoring environments for non-technical domain expert more accessible. The MDE (Model Driven Engineering) approach allows aspects of serious game software to be represented formally as an abstract model which can be automatically transformed into more refined software artefacts and subsequently into serious game software applications. This approach enables non-technical domain experts to produce serious games for the use of GBL easily and quickly (and possibly at a lower cost) through Domain Specific Modelling Languages (DSML) and therefore lowers the barriers that hinder the production of these applications. We believe that MDE can help to facilitate the adoption of GBL.

In this paper, we present our platform independent Game Technology Model for use in our Model-Driven Serious Game Development Framework. Aspects of serious games represented in our Game Content Model (Tang & Hanneghan, 2011) will be translated into the Game Technology Model where additional computational information are added into this refined model. In the next section, we describe MDE and how this approach can benefit serious game development for game-based
learning. We then revisit our Model-Driven Serious Games Development Framework before we review in Section 3 and analyse a selection of relevant game engines or game software frameworks in Section 4. Consequently, we identify core technologies used in the creation of game software in Section 5. In Section 6, we detail our Game Technology Model and describe this model in relation to our existing Game Content Model. In addition, we explain the application of Game Technology Model in our model-driven serious games development approach. Finally, we conclude the paper with a brief discussion on Game Technology Model in Section 7 and outline future work in this exciting and promising research area in Section 8.

2. Model driven engineering and serious games development for game-based learning

Model-Driven Engineering (MDE) refers to a software development approach that relies extensively on the use of graphical or logical models to represent aspects of software and automates the transformation of models into more refined software artefacts. Models are primary artefacts in the development process expressed using a Domain Specific Modelling Language (DSML) to formally represent the structure, behaviour and requirements of a particular domain. Aspects of models are analysed and translated through transformation engines and generators to synthesize software artefacts consistent with these models. This approach can help in alleviating the platform complexity and expressing domain concepts effectively (Schmidt, 2006).

MDE is generally domain specific and only suitable for developing software specific to a targeted platform with the aim to automate manual coding. Expertise of programmers is embedded into the underlying framework and code generators allowing domain experts to provide complete specifications of the problem domain without worrying about the technical aspects of software development (Kelly & Tolvanen, 2008).

At the core of MDE is the model. A model is defined as “a simplification of a system built with an intended goal in mind [that] should be able to answer questions in place of the actual system” (Bézivin & Gerbé, 2001). Technically a model is described as a set of statements that effectively describes a system-under-study (SUS) (Seidewitz, 2003). Effectively, a model is a graphical or logical representation of a SUS (Favre & Nguyen, 2005). In a software context, models are used as a form of conceptual representation of a software system to facilitate the production of concrete software (Bézivin, 2004). In a model-driven approach, the model is used to assist the system modeller to more accurately describe the SUS. The model is expressed by the system modeller through statements, which are expressions that hold truths about the SUS. The validity of the model of the SUS is dependent on the correctness and completeness of statements describing it. Statements can be expressed informally through natural language, but are best constructed using formal notations which adhere to the grammar of the formal language. Such formal languages are generally termed as modelling languages or Domain-Specific Modelling Language (DSML). In the context of game-based learning, MDE can provide the environment for domain experts to produce a serious game via modelling (either using language or visual tools) without worrying about the intricacy of game development. We believe that this approach can help to simplify the route to serious games production and therefore ease the adoption of game-based learning in mainstream education and training.

MDE notably promises great benefits to its practitioners. From a software development context, MDE offers an increase in productivity, promotion of interoperability and portability among different technology platforms, support for generation of documentation, and easier software maintenance (Kleppe, Warmer, & Bast, 2003). In addition, it can also lead to production of better code quality and reliability due to integration of domain rules into the DSML which minimises modelling error and increases the reliability of mapping from model to code (Kelly & Tolvanen, 2008). From the perspective of the non-technical domain experts’ who wish to produce serious games, the MDE’s ability to encapsulate technical aspects of development via a DSML massively lowers the barriers that hinder the production of serious games for use in game-based learning.

3. A model driven serious games development framework

Our Model-Driven Serious Game Framework (featured in Figure 1) consists of nine parts namely: (1) User Interfaces (UI), (2) Models, (3) MDE Tools, (4) Components Library, (5) Code Templates, (6) Artefacts, (7) Technology Platform, (8) Operating Platform and (9) Software. The loosely coupled configuration allows framework developers to flexibly substitute modules whilst maintaining the
The integrity of relationships among the modules via well-defined interfaces. It also clearly divides the views of entities whilst promoting a structured and systematic workflow (Tang & Hanneghan, 2010).

At the core of this framework is a three-layer model abstraction that offers a higher level of encapsulation and greater interoperability support for serious games. These models are: Game Content Model (GCM), Game Technology Model (GTM) and Game Software Model (GSM) respectively. The Game Content Model represents the logical design specification of a serious game whilst the Game Technology Model is a computationally dependent model of the serious game but one which remains independent of technology or language platform. The Game Software Model, by definition, represents the transformed model of the serious game specific to a chosen technology platform. These models are then transformed into more refined artefacts using specific MDE tools (3) before generating the appropriate software artefacts. Transformation of models from one viewpoint to another is triggered automatically.

In our framework, the Game Technology Model transformation engine reads the Game Content Model and represents the game as a software model. The Game Technology Model is read by the Game Software Model transformation engine which reorganises the game as a software model compatible with a specific game software framework such as Unity, Unreal and XNA (or a proprietary built game software framework) by replacing game logical software constructs with the corresponding physical game software constructs. Finally, the Game Software Model is interpreted by a generator to compose software code (6) from predefined code templates (5) through mapping techniques. Game software framework constructs and code templates are defined by framework developer with reference to the specification of Game Software Model (see Figure 2).
3.1 Game content model

The Game Content Model represents a game ontology from an interactive content viewpoint. It is used to document the design specification of a computer game and will be utilised as the master model for building other game models in our model-driven serious games development framework. Since we focus mainly on serious games, we have limited the current scope of our game ontology to cover the game concepts used in the documentation of role-playing and simulation game genres because we believe they are the most suitable for utilisation within the context of education and training compared to other game genres but the nature of this ontology is that it can support further concepts in the future with ease.

Our Game Content Model improves upon the existing work of the Game Ontology Project (GOP) (Zagal, Mateas, Fernández-Vara, Hochhalter, & Lichti, 2005), Rapid Analysis Method (RAM) (Järvinen, 2007) and the Narrative, Entertainment, Simulation and Interaction (NESI) model (Sarinho & Apolinário, 2008). Whilst there is a degree of commonality with these models in definition aspects of games with these models, they lack the formalism required for model translation and are devoid of the concepts that are essential in describing characteristics of a game from a software engineering perspective. We have selectively combined these with our study on game design, game development and serious games in order to introduce additional concepts required to represent the game, organising these concepts into a meaningful object-oriented structure which helps us during the translation process using MDE tools later. The topmost level of our game content model consist of ten interrelated key concepts that best represent the rules, play and aesthetic information of a computer game and they are Game Structure, Game Presentation, Game Simulation, Game Rules, Game Scenario, Game Event, Game Objective, Game Object, Game Player and Game Theme (Tang & Hanneghan, 2011).

The game structure provides the form and organises the game into segments of linked game presentations and game simulations. In our framework, we refer game presentation as a medium for presenting game information which is composed of media and Graphical User Interface (GUI) components. Whereas game simulation is defined as an environment which simulates a game scenario in accordance to the definition of game rules and game physics. The interactions between game objects and the results of an interaction in a game simulation are defined using game rules. A game simulation can be used to host multiple game scenarios aligned with the storyline. Each game scenario is setup using a selection of game objects to create an environment, a sequence of game events and a set of game objectives that challenges both player skills and knowledge of the game. The game player can control game object(s) and interact via hardware or graphical user interface controls. And finally, the game theme describes the “look and feel” of the game. The relationships between these key concepts are illustrated in Figure 3.

In our model driven approach, the formal description of a serious game, compliant to our Game Content Model, is subsequently translated into a computational representation independent of operating platform: the Game Technology Model. The remainder of this paper details the workings of our Game Technology Model for use in our Model-Driven Serious Games Development Framework.
4. Game engine analysis

In the past, games software were written as singular entities in assembly languages that were tightly coupled with the underlying hardware platform to utilise hardware resources efficiently and hence provide a seamless gaming experience (Bishop, Eberly, Whitted, Finch, & Shantz, 1998). However, this approach permits little code reuse and low code scalability which results in complex games being both costly and timely to develop. Coding these games is also a highly specialised skill.

A game engine or game software framework is the technical and economic solution for writing modern, complex games. It consists of subsystems or software components that perform a number of distinct tasks (such as graphic rendering (2D or 3D); game physics computation such as collision detection; collision reaction and locomotion; programmed intelligence; user input; game data management and other supporting technologies) to operate the game software. These software

Figure 3: Overview of the game content model (Tang & Hanneghan, 2011)
components are built to manage, accept, compute and communicate data with other software components without fail. Not all game engines support the entire feature set required for all game genres, since integrating these technological components under a single framework would be a prohibitive task. Furthermore, not all computer games software will require the entire collection of software components to function.

The early streamlined approach to game engine architecture (illustrated in Figure 4) were composed of the software components that handles input, audio, graphic representation and the dynamics (game mechanics) (Bishop, et al., 1998).

Figure 4: Aspects of game software illustrated in shaded rectangles are elements of a game engine while game logic and level data are regarded as content that defines a game (Bishop, et al., 1998).

Modern day game engines are capable of computing complex 3D scenes with dynamic objects; rendering realistic graphics; planning and deciding actions for non-player characters (NPC); and supporting multiple players concurrently over a network. The architecture of the Delta3D engine documented by Draken, McDowell & Johnson (2005) in Figure 5 exhibits the addition of software components such as character animation, scene graph and networking to assist the development of modern 3D games with multi-player support.

Figure 5: Architecture of the Delta3D game engine (Darken, et al., 2005).

Current generation commercial game engines such as Unreal Engine, CryEngine and EgoEngine are packed with grander features and sophisticated tools that enable creation of high quality game software. The game engine architecture explained by Gregory (2009) (see Figure 6) illustrates the typical logical architecture of a modern 3D game engine. It consists of layers abstract to game specific software components which are wired for maximum reusability (software components are shown shaded) and interoperability across different platforms (through the Platform Independence Layer). The Game-Specific Subsystems and Gameplay Foundations are components that can be re-written to adapt other components for other game genres with minimal changes to the remaining software components (some changes are still necessary as these components may be written specifically for the chosen game genre for optimal performance and reliability).
In this study, we are interested in the fundamental game engine technologies abstracted from any particular game genre. We raise the following questions: What are the core technologies needed to run a serious game? How can we best represent these game technologies in a model for use in a model-driven approach? In the remainder of this paper, we address these research questions.

5. Core technologies for game software

Computer games are typically structured to consist of user interface components such as menus for game configuration and selection of game scenarios, and the simulation of a scenario (game level) which demands the game player’s interaction with the system. It is common at the start of a scenario to have cut-scenes to present the story that drives the game as a precursor for immersion and motivation building. Within the simulation of a scenario, the game software cyclically performs a series of tasks successively using a time step of typically 30-60 iterations (frames) per second. These tasks typically include handling input from processing network data from other clients (in multiplayer games), human interface devices and Graphical User Interface (GUI), simulating motion and artificial behaviour, checking for collisions, updating the internal state of game objects, rendering visuals on the screen and processing other tasks such as audio and sending out data packets (Llopis, 2005).

Components of game engines vary depending on technology features and are often constrained by particular game genres, technology platforms (hardware) and visual dimension of the game world (2D or 3D), but there are some common technology components across all game engines. These are the core technologies that enable the creation of a variety of game software solutions, each featuring creative and compelling content. The core technologies we identified are graphics (renderer), animation, audio, input, game physics, user interfaces, networking and game resources management. In the following subsections we describe these core technologies in brief.
5.1 Renderer

The renderer is key component to any 2D or 3D graphic engine that is responsible for graphics-related computations and rasterised screen output. The 2D renderer provides the interface for graphic hardware and draws 2D graphics, whilst the 3D renderer provides additional functionalities such as loading 3D models, rendering and managing textures, applying different type of materials and blends to the texture, rendering static and dynamic lighting in the scene, displaying viewports and virtual screens, and providing control to the virtual camera. Other features which are found in a renderer also include particle systems and post-processing used for visual effects. In recent years, 3D graphic engines have gained significant popularity over 2D graphic engines due to the consumer demand for 3D games, whilst most 3D engines also support creation of 2D games through some clever exploitation of the technology, such as orthographic projection (Gregory, 2009). However, 2D graphic engines are still relevant, particularly on lightweight platforms such as the mobile and web platforms.

5.2 Animation

The animation component is responsible for determining the next pose of a 3D model or the next frame of a sprite, independent of its spatial position within the world. A 2D animation component would extend the functionality of a 2D graphic engine to include management of animation state which is why many would regard the animation subsystem to be part of the renderer. However, the animation data is different from graphic data and therefore it should be processed separately by the animation component. The 3D animation component for 3D is conceptually similar to the 2D setup, retrieving animation data from a file in order to modify the skeleton or vertex mesh of a 3D model (i.e. Skeletal vs. Morph Target animation (Gregory, 2009)). Advanced facilities such as blending (transitioning from one animation state to another), inverse kinematics (IK), decompression of animation data, animation playback and procedurally animating free-form body movement are also packaged within this component.

5.3 Audio

The audio component offers facilities to interface with the audio hardware and manage the playback of audio. In a 3D game engine, the audio subsystem is extended to include 3D audio model which allow game players to perceive sound originating from a positional source.

5.4 Input

The input component handles all the input events triggered by game players either via traditional human interface devices (HID) such as keyboard, mouse, joystick or newer gestural devices such as the PlayStation® Move and Microsoft® Kinect. Each input event is managed by the input subsystem to trigger specific instructions including GUI events and in-game commands.

5.5 Game physics

Game physics is the component that applies the law of physics making the game world to behave realistically. Motion, collision detection and collision reaction are the generic forms of computation performed by the game physics component. The complexity and scope of game physics are dependent on game genre and type of game. For example, games such as Gran Turismo (http://www.gran-turismo.com/) would expect the physics computation to be very realistic whereas the game physics in Need for Speed (http://www.needforspeed.com) is more forgiving and tuned to accommodate the game-play.

5.6 User interfaces (UI): graphical user interface (GUI), media and heads-up display (HUD)

Game software uses GUIs both in-game and out-of-game as a graphical means for accessing functions or commands within the system. Buttons, list-boxes, checkboxes, radio-buttons, textboxes, tabs and scrollbars are each examples of commonly used GUI components. For critical game information that affects game-play, HUD elements such as a digital counters, analogue gauges, mini maps and horizontal graphical bars are also often used to notify game players about the changes of game state and so aid in the game-playing process.
5.7 Video player

Media such as text, graphics, sound and video are also widely used in games for presenting game related information. The intricate process of video playback is carried out by the video player component. Video playback is often used in game to show cinematic cut-scenes and perform the majority of the storytelling (some games may opt to use scripted animation using the animation component to provide seamless continuity from cinematic to game-play).

5.8 Game resources management

Game resources or game assets are usually produced using Digital Content Creation (DCC) tools. These can include 3D models, textures, materials, fonts, 2D sprite sheets, collision data, animation data, sound files, level data and others. The game resource management is the component that provides the facilities for loading and unloading these resources into the game system.

5.9 Artificial intelligence (AI)

AI provides Non-Player Character (NPC) abilities to decide, plan and act in a game scenario. Commonly used AI techniques in games include goal-driven decision making, path finding and perception traces which are adjusted to provide a challenging and yet balanced form of game-play. Again, these techniques can vary depending on games genre. Real-time strategy games such as Command and Conquer (http://www.commandandconquer.com/) use a wide range of AI techniques such as chasing and evading, flocking, path-finding and case-based reasoning, whereas games such as Need for Speed would rely heavily on waypoint navigation.

5.10 Networking

The networking component is used in games software to facilitate multi-players. It handles all the aspects of communication between client and server. Elements of networking component include authorisation, authentication, structuring and filtration of game messages, low level communications, task interface, protocols, network introspection, and data interpolation and extrapolation (Chris Carter, Rhalibi, Merabti, & Bendiab, 2010). This component is excluded from use when game software is developed solely for single player on local machine.

6. Game technology model (GTM)

Game technologies used to be closely coupled with a given hardware platform. As practice in software engineering advances towards the trend of interoperable software code, the game industry is adopting this approach to allow rapid release of game titles on multiple platforms through the introduction of a platform independence layer, as seen in the game engine architecture diagram in Figure 6. The responsibility of platform independence layer is to ensure that all components in the game engine behave consistently across different hardware platforms. This is similar to the functionality of a platform independent model from a model viewpoint.

![Figure 8: Overview of game technology model](image)

The Game Technology Model in our model-driven framework represents serious games in a manner that is computationally independent of any operating platform. This is responsible for ensuring all components in the game engine behave consistently across different hardware platforms. Our proposed Game Technology Model in Figure 8 features two primary layers: the Game Specific Systems layer and the Core Components layer. The Game Specific Systems layer consists primarily of the Game Context System, which sets up the game and manages dynamic switching between the presentation context and simulation context, and the Game Simulation System, which populates the...
world with game objects (both static and dynamic) and triggers the game events that form part of the game-play within a particular game scenario. It uses facilities provided by the core components layer to enable smooth running of both the Game Context System and Game Simulation System. Our analysis of game engines in Section 4 and the study into game processes and its key components have influenced the selection of core components in our GTM. We have selected User Interface, Video Player, Game Physics, Animation, Graphic, Audio, Artificial Intelligence, Input, Networking and Game Resource Management as core technologies in our Game Technology Model’s core components layer. In addition to the core components, other components which are commonly used and deemed useful in game software includes the math library, random number generator and unique object identifier management. We have chosen to set aside networking as a service component instead of being a core component which developers can choose to use when developing multiplayer games. In our Game Technology Model, all the network data are treated as streams of input and this is handled by the message handler which is described in the networking component. In addition to the core components, other components which are commonly used and deem useful in game software includes the math library, random number generator and unique object identifier management. Although some of these components are readily built into certain technology platforms, this must be included in the Game Technology Model in order to achieve platform independence.

6.1 Game context system

Looking deeper into our Game Technology Model (see Figure 9), the responsibilities of Game Context System are to set up the application by initialising the input hardware, graphic hardware and audio hardware, specifying access paths for resources, switching between different contexts and freeing up hardware resources prior to shutting down the game application. In our Game Content Model, we break down a game into sections known as game context. A game context describes the type of game content to be presented to game players which can be either in the form of a game presentation or a game simulation (Tang & Hanneghan, 2011). We regard game scenarios as content to a game simulation. Separating game scenario from game simulation enables us to use the same game scenario in a different yet compatible game simulation setup. These contexts are loaded into the Game Context System’s Active Contexts Stack based on the flow of the game defined. This stack-based approach allows multiple contexts to be rendered in the correct order, producing a layered effect as described in (C. Carter, El Rhalibi, Merabti, & Price, 2009).

Each context has its own methods for: initialising the data or components required; an update method which updates state of the context; and a render method which presents the visuals on the screen. Update and render routines are invoked at 30-60 time steps per second. The updates can also be multithreaded using fork-join parallelism (Kim & Agrawala, 1989). The clean-up method is invoked when a context is popped out from the active contexts stack to free off resources. Game contexts which are frequently used can be placed in a resource pool to avoid constant loading and unloading which could result to performance slowdown.

**Figure 9: Game context system**
The transition from one context to another is triggered by the event trigger. An event trigger monitors a defined event which can be an application event (a range of game application related of events such as “onMediaEnd”) and simulation events (such as simulation event “onSimulationEnd”, “onSimulationPause” and “onObjectiveUpdate”), an input event (user input detected via hardware interface or graphical user interface (GUI)) or a time-based event. When the condition of the event is met, it notifies the Context Manager to push out the expired context and pop in the next context into the Active Context stack. Each event trigger is synchronised with the main update method which can be monitored by a manager such as the Game Mechanic Trigger and the Input Trigger whereas Time Trigger and proximity trigger are monitored in the respective update methods (which are also synced with the main update method) of the class it composed of.

At the top-most level of the game software is the serious game application itself which uses the game context system and provides the necessary interfaces for the game player to interact with the game. The game player component as described in the Game Content Model is composed of a reference to a game object which acts as an avatar, a set of attributes that determines the game player’s vitality or performance, a set of control maps which wires input events to the associated action of the avatar, a structure to store virtual items that player can own in the game and a statistical log of the player’s performance which are integrated into the game.

A game can be dependent on a fixed time step or variable time step. In our Game Technology Model, we favour for simplicity over complexity and hence has opted for fixed time step implementation. Within the game update method it checks for any input and application events and synchronises with the update method for each context.

6.2 Game simulation system

When an instance of a simulation context is made active, the Game Simulation System loads in the associated description of game scenario. A game scenario, in our model, is represented by a game environment (that is composed of a collection of game objects), a set of game events, a set of virtual cameras, a difficulty indicator and a set of game rules (which dictates the outcome of the interaction from two game objects) (Tang & Hanneghan, 2011). Game objects required for construction of the game environment are created and organised in a scene graph allowing the rendering of graphic components in the correct order. Data associated to game objects are stored in a collection which can be fetched and updated directly rather than having to traverse through the scene graph.

The Game Simulation System maintains two scene graphs; a scene graph for media, GUI and HUD (2DGraph scene graph); and a scene graph for proximity triggers and game objects which make up the game environment. The scene graph that stores the game environment will be rendered to the image buffer before the 2D scene graph to allow final construction of the render frame which has the media, GUI and HUD overlaid on top of the game environment.

Figure 10: Game simulation system

At each update routine of the Game Simulation System, all game objects have their transform and animation updated. Object state, game data and other computationally demanding process such as collision check of the game objects are updated at different time intervals to avoid performance slowdown. Dynamic objects which no longer exist are removed from scene graph and data associated
are destroyed during runtime. The events defined in the game scenario are also triggered in the update routine of the Game Simulation System. All update and render routines are in synchronization with the main game loop.

6.2.1 Game scenario

A game scenario holds all the relevant data and data structures that represent a level in a game. Most of the description of a game scenario can be represented as data but descriptions such as game interaction rule and game scoring rule are automatically embedded in the respective game object Update() method whereas events are encoded in the game scenario Update() method for optimal performance using our MDE tool. In addition to triggering game events, the Update() method in a game scenario checks if all game objectives are met and updates the game objects within the game environment scene graph.

6.2.2 Game object

A game object is the primary data structure which will be processed in the Game Simulation System using the facilities provided by the game component. Game objects consist of attributes that hold value of existence such as objects attributes, position, mass, solidity state and size of inventory (which defines the amount of objects associated to itself), and behavioural characteristics which are represented in the form of motion, action, attribute updates, sound and intelligence. These can be represented into three distinct classes namely Actor, DynamicObject and StaticObjects.

In terms of mapping the game object from Game Content Model to Game Technology Model, the object attributes and animation sequences are easily mapped from the definition in Game Content Model into the structure. Action definitions of the game object such as animation, sound, motion can be invoked from the Update() method. These are grouped into the relevant action state of the game object as defined in the Game Content Model. This approach allows easy pairing with input event or decision making in AI. The input or AI components will only need to change the activeState of the object to trigger the paired action. Each action is marked in a conditional statement using a unique identifier as illustrated in Figure 11. At each game object update call, it checks the activeState which is changed when certain input event is triggered or AI decisions are called. Input events are updated at the main game loop whereas AI routine is done right before the invocation of the actions.

```java
If(this.actionState == 2) //Pick
{
    collisionObject = PhysicManager.checkCollision(this, GameEnvironment)
    If(collisionObject.type == "HealthPack")
    {
        AnimationManager.SetSequence(this, "Pick")
        this.health.add(25.0f) //health is a vital
    }
    ElseIf(collisionObject.type == "Key")
    {
        AnimationManager.SetSequence(this, "Pick")
        this.inventory.add(object);
    }
}
```

Figure 11: Example of action definition in a game object

Within each action, further query can be invoked to determine the actual state of an object. This could be in the form of collision checking to determine if a game object is within the boundary of another game object (which is defined by a game interaction rule in Game Content Model) or checking an attribute’s value or inventory of the game object as illustrated in the pseudo-code in Figure 11. An action, as described in the Game Content Model, consists of method calls to the relevant components such as physics and animation to update and transform the game object which is automatically transformed from specification of game design in our framework. It also consists of commands to invoke playback of audio files and relevant data updates to vital and inventory. The main update call will traverse the game environment scene graph and update all the states, data and transforms before executing the render routine.
The `Render()` method of a game object processes and displays the object appearance on the screen using facilities in the renderer component. In conventional approaches, all transforms are computed prior to the actual rendering process. In our data-driven approach, all the transform and rendering is computed by the renderer through an overloaded `Render()` method. This approach separates game logic from component computation simplifying transformation and generation of code.

### 6.3 Representing the game technology model in a model driven framework

In our framework, we favour the use of open data format such as eXtensible Markup Language (XML). XML is a specification for defining how information is stored (Bray, Paoli, Sperberg-McQueen, Maler, & Yergeau, 2008) like any other earlier form of initiatives such as the CASE Data Interchange Format (CDIF) (Flatscher, 2002) and Portable Common Tool Environment (PCTE) (ECMA, 1997) introduced for use to store software engineering data. It offers great flexibility for defining the data format for representing models. In addition, XML can easily accept additional information from the automated transformation process between the models for MDE. Furthermore it is also well supported by MDE technologies such as Eclipse Modelling Framework (EMF) and Generic Modelling Environment (GME) (Ledecezi et al., 2001) making it the ideal choice for representing data-model. This makes XML is a viable option for defining data-model in our model driven framework.

### 6.4 Transforming the game content model into the game technology model

In our model driven serious game development framework, the Game Content Model is generated by our software tool, SeGMEnt (Serious Games Modelling Environment) (see Figure 12 and Figure 13 for screenshots of SeGMEnt). SeGMEnt is a web-based serious games modelling environment implemented using Adobe Flash. It is designed to allow non-technical domain experts to document serious games components either by entering required data through a data entry dialogue or via a visualisation environment for those aspects that involves positioning of in-game components in the virtual world, construction of an environment and layout of GUI components on-screen. It encapsulates the concepts of Game Content Model into the different design viewpoints namely structure, object, simulation, presentation, environment and player using the appropriate UI model. The Game Content Model generated from SeGMEnt is represented in XML format.

The Game Content Model then undergoes a transformation to be translated into the Game Technology Model, a computational model independent of platform, using a MDE tool. The MDE tool can be developed using existing MDE technologies such as EMF and GME as described in (Tang & Hanneghan, 2012) or implemented using any programming languages with XML parser facility. In our model-driven serious games development framework, we have developed a custom transformation tool in PHP. The transformation of Game Content Model to Game Technology is mainly a process of refining data and reformatting it into a computation independent model by reorganisation of data into programmatic structures. This also involves the addition of programmatic statement calls to the relevant Game Technology Model component's function to process the relevant data. There are two approaches to have a Game Content Model translated to a Game Technology Model. The first approach is to interpret the source model (Game Content Model) and then weave the additional information into the source model in order to produce the target model (Game Content Model). This approach would require the source model to be well structured and the translation process is just merely locating the token of information and weaving in the additional information into the source model to create the target model. The second approach is to traverse through the entire source model to locate the required token of information and a new target model is composed by structurally reformatting data in the source model and adding in the additional information. In our case, we opted for second approach because it does not constraint us to the structure of the source model.

The process of model translation from Game Content Model to Game Technology Model as described earlier requires (1) traversing the XML document structure in search for the marked elements which will be (2) reformatted and may include more information to construct the new model or artefacts. In PHP, there are various approaches for traversing XML document structure and this includes the Simple XML (core library in PHP 5.0), XML Expat parser and XML DOM (Document Object Model). In our prototype, we decided to use the Simple XML approach mainly because it is a simpler approach to traverse a document structure. This validates the notion that creation of a proprietary model translator and a code generator can be simple. In our approach, we specify the path of the XML structure to locate the marked data. Once marked data has been located, data can be accessed and
re-marked with additional information. Whenever there is more than one child node in the structure, the `foreach()` construct is used to iterate over the tree structure as shown in Figure 14.

![Figure 12: Modelling game structure in structure designer within SeGMEnt](image)

Figure 12: Modelling game structure in structure designer within SeGMEnt.

![Figure 13: Modelling game object in object designer within SeGMEnt.](image)

Figure 13: Modelling game object in object designer within SeGMEnt.
Figure 14: Snippet of code from the game technology model translator to locate a marked data and iterating through the tree structure

The new model or artefact is created by transforming data into a refined new format of data through the process of string concatenation. By using the string object, we can easily add in additional information and format data to the desired format. An example of Game Content Model generated from SeGMENT is shown in Figure 15 and the Game Technology Model which is transformed using our proprietary tool is shown in Figure 16. The Game Technology Model will later be transformed into Game Software Model before it is used for generation of artefacts which can either be software code or a compiled software artefact. The transformation of Game Technology Model to Game Software Model is described briefly in Section 3 and will not be covered in depth because it is outside the scope of this paper.

7. Discussion

Our Game Technology Model is based on a data-driven architecture and includes the essential game specific systems and core components of software which facilitates the operation of serious games defined using Game Content Model. This data-driven architecture exhibits loose coupling allowing core technologies to be swapped and giving developers the flexibility to select the preferred components in order to support a particular genre of serious game. Although our Game Technology Model is currently designed to accommodate only simulation and role-playing genres of serious games, our Game Technology Model can also be extended easily to support a wide range of genres by simply swapping the relevant core technologies with more specialised technologies.

The architecture of our Game Technology Model can be used by developers to create their own proprietary game software framework. Alternatively, the Game Technology Model can be regarded as a generic virtual wrapper for existing game software frameworks. The functionality of each component defined in the Game Technology Model act as interfaces that wrap a different implementation of a game technology. This allows serious games software to be produced on different technology platforms through code generation which reads the Game Technology Model and translates it into software artefacts.
In our model driven framework, the Game Technology Model is represented in XML to make marking and locating of marked information easier, and therefore simplifying the task of model transformation. Framework developers will need to have a deep understanding of the Game Content Model and Game Technology Model before they can transform the Game Content Model to the Game Technology Model. In our framework, we choose not to be constrained by the structure of Game Content Model and have opted to implement our MDE tool that locates the marked information in the Game Content Model and rebuilds the Game Technology Model from scratch. Development of the MDE transformation tool is proven to be much simpler and straightforward especially with modern XML programming interfaces such as Simple XML in PHP.

Figure 15: XML describing the fireman game object generated from SeGMEnt

```xml
<gameObject>
  <id>fireman</id>
  <objectAttributes>
    <mass>75.0</mass>
    <solid>true</solid>
    <id>health</id> <startValue>100.0</startValue> <endValue>0.0</endValue>
    <id>energy</id> <startValue>100.0</startValue> <endValue>0.0</endValue>
  </objectAttributes>
  <objectAppearance>
    <spriteSource>asset/fireman/sprite.png</spriteSource>
    <spriteDimension> <height>20</height> <width>20</width> </spriteDimension>
  </objectAppearance>
  <objectAction>
    <id>idle</id>
    <animation> <startFrame>1</startFrame> <endFrame>3</endFrame> </animation>
  </objectAction>
  <objectAction>
    <id>walkLeft</id>
    <motion> <forceValue>5.0</forceValue> <forceAngle>-180</forceAngle> </motion>
    <animation> <startFrame>4</startFrame> <endFrame>8</endFrame> </animation>
  </objectAction>
  <vitalUpdate>
    <attributeID>energy</attributeID>
    <arithmeticOperator>-</arithmeticOperator>
    <constant>0.1</constant>
  </vitalUpdate>
</gameObject>
```
Figure 16: XML definition of the game object in game technology model. Elements in bold are
translated token of information from game content model which has been reorganised
into programmable format

Although we have gone through a lot of detail describing the technical aspects of the implementation
it should be born in mind that the model driven engineering approach hides all of these from the
actual domain experts and we include this only for completeness. From the model-driven serious
games development viewpoint, our Game Technology Model plays a significant role in the generation of interoperable software artefacts. In the context of GBL, our Game Technology Model (as well as Game Content Model and Game Software Model) and our model-driven serious game development framework is a point of reference for developers who wish to implement high-level authoring tools such as SeGMEnt for non-technical domain experts to produce a range of serious games for use in game-based learning.

8. Conclusion

In this paper, we have analysed the architecture of game engines, identifying the core components and presented our Game Technology Model based on our Game Content Model for use in our model driven approach in an attempt to address the lack of high-level authoring tools for serious games targeted at non-domain experts. Our Game Technology Model is a computational representation of game software that is independent of implementation platform and hardware platform. The introduction of the core components layer provides flexibility for specifying the preferred components and hence promoting a higher level independence over the choice of game technologies. This architecture may appear bureaucratic, but it is unlikely to raise many performance concerns for demanding real-time computation since models are used primarily to represent content and logic for use in the generation of software artefacts using MDE tools through different levels of refinement. Availability of a Game Technology Model and high-level authoring tools such as SeGMEnt provides the opportunity for domain experts to prototype-play-test-evaluate and make further improvement on the designs of serious games without having to face the technical barriers that exist in development of serious games for GBL.

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