Examining the potential of game-based learning through the eyes of maths trainee teachers

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This paper reports the findings from a study of 25 maths trainee teachers which aims to examine their perceptions of the potential of game-based learning. Findings show that trainee teachers realised the potential of game-based learning and they are willing to use it in their teaching. A gap was identified between academics and game developers—the gap between their concepts of engagement. This gap might confuse the production and evaluation of game-based learning.

Introduction

Game-based learning (GBL) is a form of learner-centred learning that uses electronic games for educational purposes. Writers such as Prensky (2007), Quinn and Connor (2005) claim that electronic games are relatively more fun, more engaging and more motivating to use compared to other contemporary forms of new media and therefore have potential in education. Due to this potential, various academic research projects have been conducted to explore the role of games in education (e.g. McFarlane, Sparrowhawk and Heald 2002) or to explore the educational potential of games (Egeneldt-Nielsen 2005, Ke and Grabowski 2007).

The potential of games, whether they are designed to be educational or not, always relates to their capability for engaging players. Key proponents of digital GBL, Quinn and Connor (2005) claim that the elements of learning and engagement of games 'can be aligned to create a synergy that can be exploited to systematically design compelling learning experiences' (p.2). To 'engage' means to attach by pleasing qualities; to attract, charm or fascinate (Oxford English Dictionary 1989). Prensky (2007) identifies twelve characteristics of games and their inherent engaging elements, which suggest that games give us enjoyment and pleasure, intense and passionate involvement, structure, motivation, doing, learning, flow, ego gratification, adrenaline, social groups, emotion and spark our creativity. In game playing, there is in the literature a state called "flow" that represents the condition of an engaged player. Csíkszentmihályi (1996) defines flow as the mental state of operation in which the person is fully immersed in what he or she is doing by a feeling of energised focus, full involvement, and success in the process of the activity. Although academics do use the term in educational context (Claxton 2002), engagement is treated as a scale rather than a state in academia. For example, O'Brien and Toms (2008) define engagement as the ability of a computer application to initiate and sustain users' attention and interest over a period of time by providing adequate levels of aesthetic and sensory appeal, feedback, challenge, control, novelty, customisation, and motivation.

This study aims to examine the perceived potential of GBL among secondary mathematics trainee teachers at the end of their one year Postgraduate Certificate of Education (PGCE) training in Warwick Institute of Education. It addresses the following research questions:

- What ideas would trainee teachers generate about the potential of GBL?
- What would the justification for their choice of their top ranked GBL idea be?
- What would the self-evaluation of their justification be?

Methodology

25 Secondary Mathematics trainee teachers participated in this study in July 2008. They were selected at the time of the launch of the Bowland Maths materials (National Centre for Excellence in the Teaching of Mathematics, 2008). Bowland Maths materials include examples of GBL which were designed to support the Mathematics teaching in Key Stage 3. The data collection protocol of the study was designed as a role-playing activity; the researcher who organised the data collection played the facilitator role, while all trainees played the roles of subject matter expert in the study. The trainees listed their perceived potential of GBL in a five-minute brainstorming session. Then, they were directed to identify and justify the learning idea ranked as having most potential by answering the following questions:

- What is your top ranked potential of game-based learning for your students??
- Why do you choose it as the top ranked?
- What would you want the chosen GBL to be like?
- When could be the best time to use the chosen GBL for your students?
- Where the best setting for the chosen GBL could be situated?
- Who would benefit if you developed the chosen GBL idea successfully?

After that, a guided self-evaluation session was done using De Bono's (2000) Six Thinking Hats.

After the data collection, NVivo was utilised to prepare the data for qualitative analysis. Three analysis techniques were used in this study: pattern matching, narrative text coding, and logical model mapping. The pattern matching technique was used to juxtapose the trainees' perception with the potential identified through literature review. After that, the data was classified typologically using a narrative text coding approach, to investigate how trainees justified their perception. A logical model mapping technique was used to identify the possible gaps of knowledge and skills possessed by the trainees in producing their GBL.

Findings

The trainees generated 95 ideas, and they ranked their ideas based on the perceived potential. Table 1 shows the typology of top ranked ideas, classified using Bloom's (1974) three learning domains of educational objectives.

Domain	Perceived potential of GBL	
Affective (Attitude)	Appeal to different types of learners Second Life Circle Time Team building	Why love ring road rules Interactive online community school
Cognitive (Knowledge)	Simulation: distance / time / speed relationship Positive / negative fractions to obstacle course Problem solving Penguin tossing angles velocity	Show relevance of maths Analytical thinking Fraction grid game Developing avatars' maths skills
Psychomotor	Pupils as game testers	Choose topics for questions moving

(Skills)	Class investigations Use Interactive Whiteboard pods Use for an investigations activity Using real life applications Mapping / bearings finding treasure English / Drama student shoot 'em up	through a maze Simulate real world example of Mathematics Weekly pupil vs teacher competitions Investigate Bowland activities in groups Teacher creates maths world

Table 1: The typology of top ranked ideas grouped under three domains.

In general, the trainees were aware of the potential of GBL. Most of them regard fun / entertaining, engaging and ease teaching as the rationale for choosing the top ranked ideas, as shown in Table 2.

Rationale	Mentioned	Examples included…
Fun / entertaining	6	Consolidate fractions using in a fun way
Engaging	5	Engaging practical application
Ease teaching	5	Easy to implement
Useful for all ages, ability groups and cultures	4	Involves cross cultures, ages, abilities
Working together	4	Opportunity for whole class to work together
Promote affection toward learning / subject matter	3	Could help pupils to see the beauty of maths.
Beneficial learning	2	Beneficial to learning
As enhancement	2	Goes beyond normal curriculum
e-learning / distance learning	2	They can be in school even if they are [physically] off school
Competition	1	Element of competition and wanting to 'beat the teacher'.
Simulation of real life/ virtual reality	1	Real life interaction, navigation, most entertaining whilst learning.
Interactivity	1	Interactive game

Table 2: Rationale justifying the top ranked potential.

When the trainees put on the white hat, most of them were able to be realistic by listing facts about possible difficulties they might face. For example, Trainee No. 9 mentioned that, to put GBL into practice, "will take a lot of organisation, planning and need to sort out game and investigation". Trainee No. 10 echoed that "[it] requires a moderator to organise…time needed". ICT requirements, particularly computer software, hardware and Internet access should be ready for successful implementation (Trainees No. 11, No. 22, No. 23 and No. 25.)

Two contradictory questions were used to guide critical thinking and positive thinking: why it will / will not work? (See Table 3.) Ten key arguments were presented for each type of thinking. The majority of the trainees regarded their ideas as fun, interesting, exciting or engaging—reasons why they would work; however most of them thought their idea would appeal to certain learners only, mainly because of social barriers.

Black hat (critical thinking) Why it will not work			Yellow hat (positive thinking) Why it will work		
Arguments	Ref	S	Arguments	Ref	S
Appeals to certain learners only / social barriers	19	11	Fun, interesting, exciting and engaging	18	15
Depends on games' quality	9	8	Effective teaching materials (reusable, updatable, variety)	9	7
Access to software, hardware or Internet	7	6	Autonomous / self-paced / flexible learning	9	7
Technical constraints / monitoring	6	5	Learners' preference / ease learning	8	7
Potential for ICT mishaps / overexcitement	5	5	Subject matter relevance / related to real life	6	6

Return on investment / educational usefulness	5	4	Competitiveness	6	5
Practicality	5	4	Teamwork / social interaction / collaborative learning	4	3
Costly (development / implementation / maintenance)	4	4	Ease teaching (prepare, teach, monitor, etc)	3	3
Requires self-motivation / teacher's motivation	3	3	Assessment (self-assessment, assessment for learning)	3	3
Irrelevant contexts	3	3	Rewards to learners	2	1

Table 3: Self-evaluation on why perceived GBL ideas will work / will not work. Ref = references; S = sources.

The red hat was worn to generate opinion based on positive or negative feeling, or both. Most of the trainees had positive feelings about their perceived ideas, as shown in Table 4, while four negative views were collected.

Frequency of mentioned	Positive words mentioned
4	Fun; like
3	Engage; work; good; love; interesting

Table 4: Positive words mentioned when the red hat was virtually worn.

The green hat was used to evaluate the perceived ideas creatively. Most of trainees focused on adding features or inter-platform operability to their game ideas. Three of them suggested getting students involved in the creation of GBL (Trainee No.4, No. 9, and No. 21).

Conclusions

The trainee teachers could identify the potential of GBL and were willing to use it in teaching. The most popular rationale for using GBL amongst trainees was 'engagement', but the nature of the generated ideas was not as engaging as those described by game designers. Furthermore, the trainees' perception of GBL is not similar to that of game designers because of the general mismatch between the ideas generated by trainees and the engaging elements found through literature review. Game designers and developers see engagement in a game as a matter of success or failure in total (Fullerton, Swain and Hoffman 2004, Koster 2005). The aim of the engagement in game playing is to reach the flow state (Prensky 2007). On the other hand, the trainees generally regarded learning as an assessable activity, thus they perceived engagement in learning as something measurable, perhaps in terms of degree, level or percentage. This finding echoes the attempts of measuring engagement in academia (Dondi and Moretti 2007, O'Brien and Toms 2008, Kearney 2007). Such a diverse conception could result in fatal confusions in GBL production and evaluation, since what might be thought as a failed game in creative industry could be rated as relatively less engaging game in academia. Further research should focus on bridging or blending the gaps.

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