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between IQ and ability to transfer. Interestingly however once the isomorphism of the racetrack and the stock market tasks were explained, both subjects were quickly able to reach a high, and again comparable, level of predication accuracy within the next 25 trials. One of the comments made by the authors in their discussion of these findings is that the clear efforts of each subject to develop a new mathematical model separate to their shared expertise in an isomorphic domain is not really surprising and is to be viewed as something of a "a wise strategy" as "the alternative would be for these men to go through life trying to fit a model they developed for a highly specific situation (racing) to situation that were in need of entirely different models" (185).

The point may be linked to work by Medin and Ross (cited in Detterman 1996, p 18) concerning the specific characteristics of abstract thought, which suggests that induction/transfer is necessarily and appropriately "conservative", i.e. that transfer, particularly "far transfer", is rare and that this is due to an in-built and useful 'caution control' with regard to the use of prior learning in novel situations. Perhaps after all it is not the wisest course to make our way through the world looking to fit old solutions, models, skills, knowledge and so forth to every new situation we encounter. Besides, argue Medin and Ross, by taking the learning out of its domain, out of its appropriate problem space, information essential to its success as a problem solution may be lost.

On what basis might various candidates for transfer be vetted? Fisch, Kirkorian and Anderson (2005) with respect to their work in the study of learning transfer from television, offer an almost axiom-like formulation, which may describe something of the underlying vetting process governing all transfer: "The probability with which the content acquired [in a learning context] will be applied is a function of the associative strength of that content relative to all of the other competing material that is stored in memory." (383).

Some insight into the role of practice into the generation of this associative strength may be provided from the field of neuroscience, where experiments making use of magnetic resonance imaging (MRI) appear to indicate the brain sets up special and enduring circuits to deal with motor sequences practiced over and over again. In one study (reported in Haskell 2001, p 175-177) where subjects practiced a particular sequence of movements on a daily basis over just a five week period, a larger potion of the motor cortex was shown to be activated by a repetition of this particular sequence than by an unpractised one: more interestingly the phenomenon could still be observed in the subjects after a break of a year with no practice in the interim. Could it be that other learning e.g. cognitive and conative, works in a similar way?

3.3 Games, practice and expertise

A number of points based on the above may be made with regard to the study of transfer in and from digital games and, by extension, to the study of other forms of learning in and from digital games. The first point is simply that 'one-off shots' at producing transfer are probably best avoided. Transfer is too conservative a process for this to work. A second follow-up point is that research studies in the field need to be mindful of the sheer amount of practice and activity that may be needed to build up sufficient ‘associative strength’ to compete with other prior learning, cognitive skills, schema, heuristics etc . Quite how much practice is required is not known and will likely vary according to a number of factors (e.g. depth, breath, and sophistication of the learning, as well as individual differences, including learning style and cognitive ability, of the learner) but it might be that it exceeds what could possibly be provided within the time and effort confines of a typical research project or study. Researchers into the development of expertise, for instance, reckon its achievement in certain domains might take as many as 10 years experience or 10,000 hours of "deliberate practice" (see e.g. Goleman 1994 for overview)

Thankfully in attempting to study or control transfer we may not need to go quite so far. One obvious workaround for the impracticalities of providing sufficient deliberate practice to research participants would be to begin our research with game players who we know to have already put in considerable practice with games. In one revealing study for instance VanDeventer and White (2002) begin by identifying "outstanding video game-playing children" and seeking evidence of expert behaviour in observation and debriefing transcripts based on their game play. Although the young subjects in the researchers’ most advanced video game-playing group could not – on the basis of their age alone – have clocked up the amount of deliberate practice necessary for the development of expertise in other domains, it was clearly shown that they consistently demonstrate expert behaviour (e.g. strategising, automaticity, pattern recognition, meta-awareness) at "advanced levels" (46) in their game play.

Clearly such findings have implications for educationalists seeking to instil these skills and behaviours in the school environment. Staying with the issue at hand however we should perhaps be asking, as VanDeventer & White do at the end of their paper: did these advanced players bring their “expert proclivities to the video game environment, or were they acquired during play?" (46).

Might there be something about digital games that, more so perhaps than other educational technologies, encourages the development of expertise or expert behaviour? Well-known serious games analyst David Shaffer suggests that there is. In a 2006 article Shaffer (Shaffer 2006) introduces the concept of "epistemic frames" to help explain ways in which learners can use game experiences to help them "deal more effectively with situations outside the original context of learning" (223), i.e. use game experiences for transfer. In building his theory Shaffer makes use of the work of Crowley and Jacobs regarding “islands of expertise”, essentially topics about which learners, based on a sort of initial fascination, develop "relatively deep and rich knowledge" which, it appears, digital games and other immersive environments are so good at instilling. An example of a young student who developed an island of expertise in aspects of mathematics and art, based on her experiences with a serious game is offered as an illustration of how such islands can have an important effect on constructing an individual learner as an expert to his/her peers, teachers and self and became ultimately the basis for points of entry into new domains. On the basis of this and more extensive research data Shaffer develops a theory of “epistemic frames”, which are ultimately described as "the proverbial ‘hats’ or ‘glasses’ we don as we take on a variety of identities or perspectives in dealing with different situations.” (232).

Certain games then may give rise to the development of expert-like behaviour, giving rise in turn, as Shaffer has it, to certain broader role-based "ways of knowing" which strongly encourage transfer. Some commentators may take Shaffer’s emphasis on inhabiting or taking on various roles in games as the basis for an indictment of the relatively limited set of roles that chart-topping recreational games typically offer – solider, assassin, career criminal, army general, mythic hero, etc – but what games are “about” may not, in the end, emerge as the be all and end all for the learning that is gained or the learning that is transferred from games. Certainly it may be preferable, from a formal education perspective, that a game encourages younger players to inhabit, say, the role of a war correspondent rather than a war monger or a city planner rather than a career criminal, that our learners go straight, as it were, to the sort of pro-social pro-academic learning we would like them to transfer from: however virtual war mongers and virtual career criminals with a pool of transferable learning, in particular cognitive skills, are to be far preferred over unmotivated, uninterested learners who develop no deep and rich ‘islands of expertise’.

4. Conclusion: Does it really matter what games are about?

Transfer as a concept has received a lot of bad press over the century or so of its existence. The recent renewed interest in the use of digital games for learning appears to offer, as we have seen, a fresh perspective on the concept. Transfer of course also provides a useful perspective on games, and learning from games, and offers an alternative understanding of common questions such as, “Are games useful?” and “What do we learn from games?” The lack of empirical data – in the face of some otherwise positive indications – establishing the ‘transfer power’ of games may, it is suggested, be blamed upon the fact that many of the studies in question are based on the kind of ‘one-shot’, ‘in vitro’ approached that also underlay many classic transfer experiments. The literature indicates that even when the odds are well stacked in favour of this kind of transfer taking place it steadfastly refuses to make an appearance. The reason may lie in the fact that the development of transferable learning takes time and is based, as is the development of expertise, on a certain and perhaps considerable amount of reflective and deliberate practice.

The first prescription for the burgeoning serious game industry then perhaps is that they should make their games sufficiently compelling, to make sure players are sufficiently inspired and rewarded by their products, to ‘put in’ the requisite amount of deliberate practice in the first place.

The second major point to make is that when it comes to either designing games for transfer or using existing games for transfer the complexity and sophistication of the game rather than what it is ostensibly “about” may be the most important consideration. Many serious games for instance are unfortunately about the “right stuff” in terms of their educational message or stated learning objectives but are trivial in terms of the sophistication of their game play. Older games like many – but not all – of

those which those of us from generation X grew up playing were often trivial in this sense, capable of facilitated only a limited set of useful and transferrable skills and knowledge. Most titles, by contrast, in today's game charts, no matter what the genre – though there will be variation between genres – tend genuinely to be sophisticated in the sense being referring to and to bring with them the potential for players to gain deep and transferable learning across a range of domains.

Making games compelling and sophisticated in the way described of course is not a sufficient condition for learning transfer promotion and serious game designers may well sympathise with Robert Preston's character, Centauri, in the sci-fi film The Last Starfighter who, having devised a video game to recruit pilots for a real intergalactic war initially appears to be left without hero or reward when his teenage gamer refuses to fight. "I invent the game," he says, "find the kid, drag him up there, and he doesn't wanna be a Starfighter. I give up."

If it is any comfort to frustrated serious game designers out there the teenage gamer naturally goes on to save the day and even the hoary old game designer manages to get a little kudos before the final credits roll. Whether this kind of happy ending can always result from games for transfer or transfer from games takes on a serious note however in contemporary western society where reskilling, upskilling, and lifelong and lifewide learning are not merely the rhetorical currency of governmental departments or the abstractions of academia but a genuine reality for all members of today's post-industrial workforce.

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3D Games-Based Learning Environments in Northern Ireland Classrooms: What do the Teachers and Pupils Think of This Technology?

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Abstract: 3D games as learning environments are widely believed to have potential benefits for the classroom, such as increased motivation and engagement, and to improve learning outcomes. But what do pupils and teachers in Northern Ireland think about this technology?

The aim of the study was to address this research question, and to observe the level of collaboration and the dialogue of small groups of students as they interact while playing the game.

Both qualitative and quantitative methodologies were employed. Five schools (1 class from each school) across Northern Ireland participated in this research, using custom designed 3D games. Ninety-eight 11-14 year old pupils (23 boys and 75 girls) were surveyed, using a self-rating questionnaire. Subsamples (25 pupils in groups of 2/ 3) participated in video recorded observations, while they used the games. In addition to this, 4 teachers were interviewed and 12 participated in focus group discussions.

Overall, the results revealed positive attitudes amongst teachers and pupils towards games-based learning. Observations revealed collaboration between the pupils, but highlighted how technical issues within the game can minimise the quality of thinking and dialogue taking place. The results also revealed gender differences across views and opinions, as well as highlighting differences in how teachers integrated the technology, which subsequently resulted in differences in pupils' attitudes towards the games across the different schools.

The results revealed that the potential of games to increase motivation and to improve learning was recognised by both teachers and pupils. The importance of the teacher's role was highlighted and how the implementation can affect pupils' attitudes, demonstrating the value of the teacher in determining the success of games-based learning. These results are important both for researchers and educational practitioners.

Keywords: Games-based learning, teachers, pupils, attitudes, learning, motivation

1. Context

The purpose of the study was to find out what teachers and 11-14 year old students in Northern Ireland schools thought about using 3D educational games in their classrooms, after using them for a short while. The games used were specifically designed to teach curricular topics through the use of interactive 3D technologies, with the intention of developing higher quality learning and thinking beyond that which might be expected through traditional classroom teaching methods. The opportunity for the current evaluation arose through a partnership between the Northern Ireland Curriculum Council for Examinations and Assessment (CCEA) and Caspian Learning, a provider of the 3D interactive learning environments, called ThinkingWorlds. The new Northern Ireland Curriculum has a specific emphasis on thinking skills, to be embedded into topics across the curriculum. In this context, the design of ThinkingWorlds was particularly attractive as it has a specific focus on different kinds of thinking skills (thinking behaviours as they describe them) and affords the opportunity to customise topics to particular curriculum demands. In addition, introducing games-based approaches into the classroom is consistent with an emphasis on more active forms of learning, including the use of ICT, which is being advocated as part of the revised curriculum. The evaluation was independently conducted and funded through a postgraduate research studentship. The results to be reported in this paper are from the first stage of a more extensive evaluation of the use and impact of games-based learning technology in Northern Ireland classrooms.

2. The promise of GBL for classroom learning

There are two main reasons usually advanced to support the integration of games-based learning (GBL) into classrooms – that they engage students and increase their motivation, and that they have potential thinking and learning benefits, more so than is expected from traditional classroom teaching methods. Both these reasons have guided the design of the current evaluation.

With regard to the motivational appeal of computer games in general, there is now substantial research which points to the amount of spare time that many children, teenagers and adults dedicate to computer game playing (e.g., Pratchett 2005). Central to game playing, it is argued, is the element of enjoyment and fun that games can provide (Sweetser & Wyeth 2005). Various theoretical constructs have been put forward to account for their motivational appeal, including ideas about the mix of *challenge*, *curiosity*, *control* and *fantasy* they afford (Malone & Lepper 1987), and because they provide an optimal level of involvement or immersion referred to as *flow* (Csikszentmihalyi 1990). Can this motivational appeal be translated into educational games? Research available would suggest a positive answer, see for example Tuzun (2007) and Virvou, Katsionis, & Manos (2005) who comment on the enjoyment and motivational/ engaging appeal that educationally relevant games can provide.

The potential of games to develop active and critical learning outcomes is also widely recognised (Gee, 2003). The potential that GBL may hold for infusing and encouraging a variety thinking skills has been noted by several authors (Henderson, Klemes, & Eshet 2000; Herrington & Oliver 1999; Lim, Nonis, & Hedberg 2006). Such a claim is of particular interest to researchers and practitioners as the development and improvement of higher order thinking is a major aim of educationalists today (McGuinness 2005).

As well as the more general benefits that might accrue due to the introduction of GBL into classrooms, their introduction also raises wider educational questions about 'who will benefit' (access and opportunity) and potential negative side-effects. For example, it has been suggested that GBL could create both a gender and a digital divide, supposedly favouring those who are accustomed to and experienced with games technology.

2.1 GBL in classrooms – What do the teachers and students think?

A 2005 survey of 1,000 teachers from England and Wales, focussing on the use of computer games for learning, found that many teachers (almost 1/3) had used entertainment games in the classroom. Many (59%) would consider doing so because they felt such games would be motivational, engaging and fun. In addition to this, some teachers felt that games had the potential to enhance a variety of skills, e.g., ICT, concentration, and thinking skills (Futurelab 2005). A similar student survey conducted in 2006 reported a high number of students (62% of 2,334 students sampled in England and Wales) who would like to play video-style games in lessons, as they felt they would make classes more interesting and help them learn in a better way (Futurelab 2006).

*A*gain, wider educational questions are raised in some of these surveys. For example, teachers may be sceptical of using GBL, fearing it might be a threat to their primary role as an educator, which could subsequently result in negative teacher attitudes. However, studies of the classroom management of GBL points to the importance of the teacher's role in the successful mediation of students' use of GBL. For example, Sandford, Ulicsak, Facer, and Rudd (2006) concluded that 'far from being sidelined, teachers were required to take a central role in scaffolding and supporting students' learning through games' (p.4).

In addition to concerns about classroom roles, teachers recognised numerous other potential barriers that may inhibit the uptake of GBL, for example: access to equipment, time restrictions, limitations of ICT facilities, and the game's relevance to the subject/ curriculum (Futurelab 2005).

3. Aim of this research

The purpose of this exploratory study was:

- To establish the views of teachers and pupils after they have gained some experience using 3D games-based learning environments.
- To observe how small groups of pupils interact while using the technology, exploring both their level of collaboration and their dialogue.

4. Methods

4.1 The games

This study employed the use of two custom made games (Thinking Worlds applications) designed specifically for two areas of the Northern Ireland Curriculum – Citizenship (a new area of the Northern Ireland revised curriculum) and German modern language.

The Citizenship game was about understanding prejudice and stereotyping and included 5 tasks, which provoked a variety of thinking, for example, comprehension, classification, and recognising sound arguments. The German game was about developing language skills in the context of staying with a German family and consisted of 6 tasks focussing on, for example, comparing and contrasting, asking questions and drawing conclusions.

4.2 Participants

Five post primary schools (including teachers and pupils) from Northern Ireland participated in this research in May/June of the 2006-2007 school year. Four of the schools/ classes participated in pupil observations, pupil questionnaires, teacher interviews and focus groups, and one school participated in pupil questionnaires and teacher focus groups only.

Four teachers participated in interviews and 12 teachers took part in the focus groups. 98 pupils (23 male and 75 female) completed a questionnaire and 25 were observed and video recorded (2 of which can be discounted as the observation was very brief). All the pupils were selected from Year 8,9 and 10 German Modern Language (School 1 [21 pupils] and 3 [14 pupils]), and Citizenship classes (Schools 2 [19 pupils], 4 [18 pupils], and 5 [26 pupils]) with ages ranging from 11-14.

4.3 Procedure and measures

Before the study began all teachers attended a training day aimed at demonstrating and practicing how to use the games. After this, the evaluation took place in 2 German and 3 Citizenship classes. The games were used during class time, and all classes were held in the ICT facility. It is important to note that this evaluation took place within a larger scale pilot study and so how the teachers implemented the technology (e.g., number of tasks covered and duration of use) was beyond the control of the experimenter, and inevitably varied across schools.

In the classes an opportunistic sub sample of approximately 5/6 pupils per class, working in pairs (and in one case a group of 3) were observed and video recorded as they interacted with the 3D games. These pairs/ groupings were decided by the pupils or according to seating arrangements. This allowed for experienced and comfortable working relationships and it encouraged natural discourse between the groupings.

After observations were completed, all pupils in each class also completed a questionnaire entitled ‘School Pupils’ views on the use of 3D games-based learning environments in the classroom’. This measure was designed specifically for this research and took 5-10 minutes to complete.

This questionnaire measured a variety of dimensions, including frequency of game use (in and outside of school), enjoyment, ease of use, perceived learning outcomes and perceived engagement etc. The questionnaire included 7 scaled items, which were answered along a 5 point Likert scale, ranging from ‘A little’ to ‘A lot’ e.g., ‘How much did you enjoy using the game you used in class?’ Following questionnaire completion, four teachers also participated in a one-to-one semi-structured (audio recorded) interview, lasting approximately 30 minutes. These teachers plus other teachers (involved in the overall trial of the games, but not this in depth evaluation) were later invited to a focus group session, lasting approximately 2 hours.

4.4 Analysis

The teacher interview data was transcribed. From the transcriptions key themes and findings were extracted. Analysis was performed on the student questionnaires using SPSS, from which descriptive summary statistics were extracted, and inferential statistics were used to compare differences between gender and schools. The video recorded observations were also transcribed and analysed to

decipher the extent of collaboration taking place and to evaluate the discussion between the pupils whilst using the games. This analysis was guided by previous research in the area, e.g., Herrington & Oliver's (1999) classification system to distinguish higher order thinking as evident from discussion. Only a preliminary report from the video recordings is included in this paper.

5. Main findings

5.1 Teachers' views on games-based learning

The following is a summary of the main points which arose from both the focus groups and from the one-to-one interviews. Teachers made specific comments on how they had incorporated the games into their lesson plans, their perceptions of how the students used and responded to the games, and raised more general issues related to integrating games, and ICT, into their classrooms.

5.1.1 Use of games

There were clear variations among the teachers in how the games were adopted. Some teachers incorporated the games into their lesson plans and integrated them well within their curricular schedule (for example School 1 used specific tasks to compliment what was being taught in class that week) whilst others gave the pupils the freedom to choose their own tasks and to explore the environments with little or no guidance (for example, School 3 took a less structured approach, allowing the pupils the freedom to choose tasks). Despite this, all teachers agreed that the games should/ would be best used as a tool to enhance previous learning in a topic, i.e., as a consolidation tool or reinforcement/ revision exercise, to be supported by other forms of written work.

5.1.2 Quality of pupils' thinking and learning

The teachers agreed that the applications were an appropriate educational tool (and a potential assessment tool). After having used the games improvements/ differences in the quality of pupils' thinking were mentioned, for example, debates and independent thinking was highlighted as was the use of different types of thinking skills such as comparing, contrasting and categorizing. One teacher also suggested that the 3D games improved the quality of thinking in a way which is not easily facilitated within regular classroom activities. Several learning outcomes were also noted e.g., learning vocabulary and grammar and appreciating other people's opinion. However, in certain instances it was also felt that the pupils were thinking more about the technical aspects of the game rather than the curriculum content, e.g., how to make the character run. Plus, three of the four teachers interviewed commented on the benefits the games had particularly on their weaker students.

More collaboration between pupils was mentioned by the teachers, as was an increase in team work and communication. It was suggested that such collaboration may have enhanced both independent learning (as the pupils relied less upon teacher support) as well as the pupils' self confidence.

5.1.3 Motivation and engagement

Some teachers recognised the pupils' enjoyment and noted how lessons flew by and how pupils answered questions more enthusiastically. Others were less convinced, claiming that motivation was only slightly increased and that, in some circumstances, initial excitement was overtaken by confusion, boredom and eventual loss in interest (especially where technical problems arose).

5.1.4 Perceived barriers

Several teachers suggested barriers as being a potential problem for the uptake of GBL, e.g., technical problems, reluctance to change, time limitations, computer availability, potential role reversal between the more knowledgeable pupil and inexperienced (in terms of games) teacher, and the fact that pupils may expect games in all classes, or that they may not take the subject seriously.

The main source of dissatisfaction arose from the technical difficulties which the teachers experienced with the applications, such as uploading and memory problems. In the focus groups particularly, it was thought that many potential benefits regarding learning outcomes, thinking gains, and motivational appeal were hindered due to the technical difficulties encountered with the technology

Despite technical glitches and perceived barriers, the teachers' reactions to the games were positive, as they acknowledged the potential that games-based learning holds.

5.2 Pupils' views on games – based learning

Responses to the questionnaire item were provided on a 5 point Likert scale, where 1,2 is considered a negative response, and 3,4,5 is considered a neutral/ positive response. The main findings are summarised below.

5.2.1 Frequency of use – in and out of school

Results from the questionnaires revealed that GBL is still quite a novel experience for the pupils. 84% reported that they had never used such games in class before. In contrast, a substantial number of pupils answered that they play video games quite frequently outside of school, with 69% playing games once/ few times a week.

The results revealed that more boys spend their leisure time playing video games than girls, with more boys playing more frequently than girls (90% of boys reported playing once/ few times a week vs. 63% of girls). T-tests on mean ratings revealed a significant difference between males' and females' responses to this question ($p=0.002$).

5.2.2 Enjoyment and involvement with the games

Most of the pupils enjoyed using the games in class with 79% of respondents rating their experience neutrally/ positively. In addition, 81% were neutral/ positive about using such games or others like them, again in the classroom. Slightly higher percentages (88%) rated their involvement neutrally/ positively.

There were very few differences between the boys and the girls in their responses to these questions, with more girls being slightly more neutral/ positive on some questions (enjoyment, 80% girls vs. 72% boys; use games again, 80% girls vs. 82% boys; involvement, 89% girls vs. 81% boys). It is important to note that boys' self-reported enjoyment increased from 72% who rated their enjoyment neutrally/ positively to 86% when they were asked 'compared to other classroom activities how much do you enjoy using these games?'

5.2.3 Learning and thinking

Pupils' ratings with regard to how the games helped their learning were in general lower than their ratings of levels of enjoyment and involvement with the games. 68% reported that the games had helped their learning neutrally/ positively and slightly less than half (47%) considered that the games made them 'think harder' than they would in other classroom activities. There was a substantial gender difference in that many more girls (76%) than boys (42%) felt that the games helped them to learn more. T-tests on mean ratings revealed a significant difference between males' and females' responses to this question ($p=0.007$).

5.2.4 School differences

Differences were recognised between schools in terms of their ratings of enjoyment, involvement, ease of use and learning. Table 1 shows a stark contrast between two schools who used the same game, but pupils' opinions differed quite dramatically on a number of questions.

Table 1: Pupil responses – Contrast between two schools.

	Rating	School 1	School 3
Enjoy	3,4,5	100%	54%
Help learn	3,4,5	90%	15%
Think harder	Yes	75%	36%
Easy to use	3,4,5	90%	39%
Held interest	3,4,5	100%	50%

5.3 Pupils' interactions with the games: Video analyses

5.3.1 Motivation and engagement

Very few instances of off-task dialogue were observed indicating that the games held the pupils' interest and conversation for the duration. Competition, enthusiasm, excitement/ pleasure and exploration were also evident in some cases. However, frustration, boredom/disinterest and confusion were also observed on a few occasions (especially when technical problems arose).

5.3.2 Collaboration

Collaboration was evident both physically (by the shared control of the mouse and keyboard) and also verbally (pupils were seen offering direction to one another, making decisions together and helping each other). Collaboration was evident not only between the pairs/groups but also on a wider network amongst others in the class.

5.3.3 Quality of thinking

All the pupils were inexperienced with the software and so a substantial proportion of the dialogue was procedural ("what's this for…?", "how do I…?" "do you know….?, 'try this…"). Also, a large amount of time was spent reading instructions from the screen. Nevertheless, there were examples where the pupils' dialogue did show that they were engaged with the substantial cognitive demands of the scenario in the game, through expressions of uncertainty (whereby the student's dialogue reflected the recognition of the dilemma in the scenario), deciding a path of action (whereby the pupils negotiated or decided how to proceed) and judgement (whereby the pupils attempted to interpret or defend their understanding of the issues presented in the scenario). All of which were categorised by Herrington and Oliver (1999) as indicators of higher order thinking.

6. Issues arising

Disconnection. Although the teachers in this study revealed that they felt GBL was an appropriate educational tool, the statistical findings revealed that the majority of pupils had never experienced GBL in class before. These results reveal a stark contrast between the amount of time pupils play computer games in their leisure time and the amount of class time dedicated to this type of activity, highlighting a disconnection between young people's preferred activities and those they encounter in school. This gap can be seen as an opportunity to harness preferred informal activities for the purposes of formal classroom learning. However, are schools prepared for this? The perceived barriers anticipated by the school teachers involved in this study (some of which are consistent with Futurelab [2005]), may offer some clues as to the readiness of schools and classrooms in Northern Ireland (and perhaps further afield) to embrace this technology.

Comparisons with other games and classroom activities. It is true that many educational games are inferior, both in terms of graphics and action, when compared to commercially available games, which can then influence pupils' attitudes. The findings from this study highlight how children may criticise educational technology when they compare it to commercially available games but, when they shift their frame of reference towards textbooks and the classroom, then educational games are rated more favourably. This is evident in how boys' self-reported enjoyment increased from 72% to 86% when asked 'compared to other classroom activities how much do you enjoy using these games'?

Design implications. The study also has implications for design. For example, it is important that technically the games run smoothly. As this study evaluated a 'trial' run of the games, it was recognised that they were not yet in their most 'developed' state and so technical difficulties were encountered. At times this did hinder both motivation and learning outcomes. It is important that the playability of the game does not become so demanding that the cognitive challenges are overlooked. Research suggests that technology interfaces should be transparent so learners can focus their cognitive resources on the learning that is to be achieved (Shin 2006; Finneran & Zhang 2003).

School differences. A very important finding was the differences between schools. School 1 and 3 stood out, School 1 pupils were extremely positive and School 3 were very negative (note that both these schools used the same game with a similar age group). One reason for this difference may be the manner with which the teachers implemented the games. School 1 integrated the games well into

their ongoing lesson plans and School 3 used a less guided approach, fitting it into their teaching in a less integrated manner. The results would suggest that this then had a direct impact upon how the pupils enjoyed the games, how involved they felt, how easy they found the games and how much they felt the games helped them learn (see Table 1 for comparisons).

This finding supports Sandford et al. (2006), as it challenges the idea that a teacher's role will become redundant in a GBL classroom. In this study the teachers' management of the GBL process may have had an impact not only on pupils' enjoyment and motivation, but also on the learning benefits that they perceived.

Did the games live up to the motivational promise of GBL? From the many sources of information – from teachers, pupils themselves and from video observations, it was clear that many of the pupils were motivated by the games, enjoyed them, were involved in the play and stayed on task. Although, this was in certain cases hindered by technical difficulties experienced during play. However, there was also a minority (21%) who rated enjoyment negatively. Other research also highlights that not all pupils want to see computer games in lessons (Futurelab 2006). It is important to highlight that regardless of the educational resource, it will probably not suit every pupil.

Do they have potential classroom/ learning benefits? The teachers mentioned several gains from the games, for example, several teachers commented particularly on the benefits the games had for the weaker pupils. This result is consistent with previous findings which suggests that it is poor performing/ undisciplined pupils who benefit the most from technology (Banyard, Underwood, & Twiner 2006; Henderson et al. 2000; Virvou et al. 2005).

The lack of off-task dialogue between the pupils and their high levels of self-reported engagement reveals the focussed attention that was evident in the classrooms. In addition, the level of collaboration witnessed between the pupils demonstrates a productive and collaborative classroom dynamic, whilst also showing that the pupils became less dependent upon the teacher, as they participated in more a self regulatory work style.

In terms of thinking and learning gains, several teachers did comment on learning benefits and differences in quality of thinking. From the pupil questionnaires however it was clear that on the whole learning/ thinking benefits were rated slightly lower than ratings of levels of enjoyment and involvement with the games. This points to some concerns within the literature with regards GBL. For example, authors have asked if pupils are motivated to learn or simply to play with the computer (Okan 2003)? For example, Lim et al. (2006) found that engagement does not necessarily lead to improved learning, as they recognised how students became so immersed in the 3D world that they lost focus on their learning tasks.

This finding is therefore important, as although engagement and enjoyment was witnessed and reported by both teachers and pupils, the pupils themselves did not rate perceived learning outcomes as highly. This finding suggests a need for future research in this particular area of GBL.

In addition to this, there was a substantial gender difference in that many more girls than boys felt that the games helped them to learn more. It is not suggested that the games used were more effective at encouraging girls to learn more so than boys, rather it is more likely a limitation of the self-report measure employed in the study, in that perhaps the girls were more willing to admit to learning outcomes in comparison to the boys. This may be because the girls in this sample were more honest, or perhaps more susceptible to social desirability.

Finally, from the dialogue it is clear that certain conditions need to be in place for the predicted 'thinking' benefits to be realised. The games need to be well embedded in an ongoing series of lessons or unit of work; the software needs to run smoothly with a feeling of flow and the pupils need to become practiced with the navigational tools. Only then are the cognitive benefits of the curriculum-based games likely to emerge.

7. Conclusions

Overall, the benefits and potential of games-based learning was recognised by both the teachers and pupils in this study. In terms of the two main promises of GBL, they were partially recognised. Several

teachers commented on the learning gains achieved, and motivation was also recognised by both the participants in this study and in the analysis of pupil observations. It is however suggested that proper implementation and teacher management, and technical/ design improvements could improve and maximise the learning and motivational potential that educational 3D games hold for the classroom.

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