Novices Vs. Experts; Game-Based Learning and the Heterogeneous Classroom Audience

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Abstract: This paper examines how the heterogeneity of K-12 students, as game audiences, affect the way games can be used as educational tools in formal education. When discussing the application of games in educational contexts, the realities of the formal educational environment are seldom brought to the fore. There has been a lot of discourse and studies surrounding the theoretical viability of games as engaging educational tools and their properties as learning environments, but the practicalities of inserting games into classroom environments are comparatively rarely the subject of game-based learning research. This paper presents two five month long studies using participatory observation that details the process of putting a commercial of-the-shelf game to use in two different types of formal educational K-12 environments: a computer lab and a classroom. More specifically, this paper focuses on examining how students receive and work with a well-known commercial off-the-shelf game when it is introduced as a tool in their ordinary curriculum work. The study revealed several challenges that put many of the axiomatic assumptions practitioners and scholars frequently make regarding games' virtues as educational tools into question. The challenges relate to students' perceptions of games and gaming, variations in students' efficacy while playing, and of exclusionary behaviour during collaborations. Commercial of-the-shelf games, while they might be more equipped than educational titles when it comes to living up to player expectations as far as production values are concerned, can instil a certain set of faulty expectations of how the game will actually be used. If the used game is widely recognisable by the classroom audience, the important distinction between gameplay intended for active directed learning rather than unguided leisure activity can be difficult to establish, which can make it difficult for teachers to keep students in a reflexive and analytic mode of play. The classroom as a game audience also puts the educator in a tricky position due to the wide variation of preferences and gaming literacy among students, and creating engaging play-sessions that are inclusive to everyone in classroom environments can be an immense undertaking for teachers. While the study reveals several issues produced by the tension between games and the heterogeneous nature of the classroom as an audience, it also highlights the importance of managing students' expectations, framing the play activity correctly, and fostering collaborative work where subject matter knowledge and gaming literacy are intertwined.

Keywords: classroom gaming, alpha gaming, audience heterogeneity, gaming literacy

1. The classroom as a game audience

Games are often lauded for their unique capacity to model the structures of complex systems, distil them down to their essence and present them to the player for him or her to experience and manipulate first-hand (Annetta, 2008; Gee, 2009). They invite the player to form an understanding of intricate subject matters based on participation and experimentation rather than mere observation, and thus they are argued to have great potential as learning environments (Squire, 2011). With these stated benefits of employing games as educational tools, there has been an increasing interest for including more game-based learning in school curricula. A particularly popular argument supporting this movement is that students are starved for an educational format that makes use of their affinity for new technologies (Linehan et al, 2011; Prensky, 2001; Srinivasan, Butler-Purry & Pedersen, 2008).

However, whenever one attempts to lift a game with content that can be used for educational purposes into a formal educational setting, problems start piling up rather quickly (Berg Marklund, Backlund & Engström, 2014; Egenfeldt-Nielsen, 2008). Not only are there inherent conceptual issues with the assumption that increased skill or knowledge regarding the contents of a game has any bearing on the world outside of the game even when the game content is closely tied to a specific subject matter (Linderoth, 2009; Rick & Weber, 2009). There is also the simple, often glossed over, fact that many components need to be in place for even the most rudimentary play session to be made possible in a school environment. Hardware availability, the teacher's grasp of the game, the students' gaming abilities, and the strict schedule limiting the length of the play sessions are but a few of the practical considerations you face when attempting to insert games in formal educational contexts (Egenfeldt-Nielsen, 2008; Squire, 2005).

This paper focuses on examining one of the many factors that come into play when games are placed in formal educational environments: how the heterogeneity of the audiences in formal educational settings affect classroom gaming. The research is based on the results of two five month long case studies conducted in K-12

classrooms, where the researcher collaborated with teachers to integrate and use educational games into their curricula.

2. Fundamental concepts in game design and engagement

To examine how and why the heterogeneity of the classroom audience affects educational games and game-based learning initiatives, a brief review of some key concepts of game design is necessary. The reason why games engage their players, and which designs manage to do so consistently, has been dissected for several decades by many scholars and practitioners (Cowley et al, 2008). Literature discussing serious games and educational games often use the outcomes of this type of game studies to describe why games are a good idea to implement into schools and how different subject matters can be conveyed through different types of designs methods (Annetta, 2010; Franzwa, Tang & Johnson, 2013). The primary design challenge of serious games and educational games tend to be described as a balancing act between maintaining the integrity of a subject matter while simultaneously providing engaging game scenarios (Annetta, 2010; Bellotti et al, 2009). However, good game design is not an objective metric and game designers' intentions mean little if the game is not 'good' in the eyes of the people playing it. This is where formal education becomes troublesome as a setting for gaming; as an audience, the classroom is exceedingly heterogeneous, and a game *needs* to be accessible and engaging to all of its members.

2.1 What makes games 'engaging'?

Csikszentmihalyi's (1990) theory of 'flow' and optimal experience is often used to describe well-designed gaming experiences (Cowley et al, 2008; Sweetser & Wyeth, 2005). Just like rock climbing, ballroom dancing, or the playing of an instrument, or any other activity that has the ability to instil a sense of flow, an engaging game needed to adequately challenge its player while not being imposingly difficult (Chen, 2007; Sweetser & Wyeth, 2005). According to subscribers of Csikszentmihalyi's concepts, an activity that pushes the right psychological buttons can fully absorb its participant, and this realization has been widely applied to game design, both as an object of academic study and as a craft (Cowley et al, 2008; Sweetser & Wyeth, 2005). The 'flow' model that visualises the balance between skill and challenge is one of the more commonly referenced concepts from Csikszentmihalyi's work (see Figure 1).

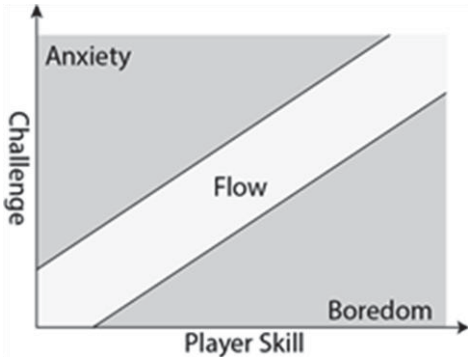

Figure 1: The relationship between challenge and player skill, here a merger of the diagrams presented by Chen (2007) and Csikszentmihalyi (1990).

Since its inauguration, flow has both been used as a template to design good game experiences, but also as a tool for evaluating games and why they do or do not engage their players (Sweetser & Wyeth, 2005).

2.2 The formal and the informal

The central dichotomies between formal and informal application settings are characterized by the circumstance of player participation. A formal setting is characterized by its structure, the obligatory nature of audience participation, and the constraints it places on time and space for the play sessions. A game played in formal settings is often played under supervision of some type of tutor, that it has specific requirements of learning objectives that need to be fulfilled, and that it has a structured time and space allotment in which to do so. More importantly for this paper, however, is that the formal application means that the game has a captive audience rather than an opt-in one. In informal settings these conditions and parameters are not present to the same extent, if at all. This significantly alters the requirements on the games, and puts constraints on what they are allowed to do.

In the case of entertainment games, or educational games that are not bound to a specific educational context (e.g. games with educational elements purchased for home use), the audience are opt-in consumers and the developer has the creative license to focus their game aesthetics to resonate with a certain type of individual. In these cases, developers are not obligated to cater to everyone, and the consequences of focusing their product only means that the consumers that are not attracted to the game concept and engaged by its contents simply will not purchase the game. Games that are to be used in formal education however, have far more intense requirements of audience appeasement – and a more heterogeneous audience they need to appeal to. The outcomes of the studies presented here highlights why this can be problematic, and what the implications are for educational game design.

3. Method

This section briefly covers the methods of data gathering, and the different premises of the classrooms and game-based learning projects in which the studies were conducted.

3.1 Data gathering methods

This research focuses on understanding how games actually work within their intended real-life context of use. To that end, this research has employed a case study methodology during two game-based learning projects spanning from November 2014 to March 2015. The reasons for choosing to conduct case studies is that they afford an opportunity to examine a contemporary, perhaps not fully detailed previously, phenomenon in its real-life context (Robson, 2002; Yin, 1984). In order to create the "full body of evidence" (Yin, 1984 p.24) needed to build a comprehensive understanding of the studied context, the research employs a mixed-method approach employed on multiple cases. The primary methods used during the case studies conducted for this research have been participatory observation protocols, transcriptions of classroom gaming sessions, and interviews with teachers.

The classroom gaming sessions were documented through the use of a written observation protocol that were formalized to keep track of teacher and researcher interventions, student discussions, and technical difficulties that arose throughout the gaming sessions. Furthermore, and perhaps more importantly for this paper, audio recordings were made during classroom gaming sessions, and the audio was then transcribed to either provide context to events that were mentioned in the protocols and to find interesting events that the researcher missed during their field work.

3.2 Classroom setups and game-based learning project designs

The two studied game-based learning processes consisted of two quite different setups. One case involved students in the 7th grade (ages 13-14) who were all part of a national program that supplied them with one laptop per individual. The other case involved 5th graders (ages 11-12), who had a smaller amount of communal computers to share within their class. The classroom sessions were thus structured differently, as the older students had enough hardware to play games as a whole class (all 24 students could play simultaneously), and the younger students played in smaller groups (dividing 24 students into two groups of 12, that shared six computers). However, even though the high-school class had enough computers to play individually, the teacher often opted to have them work in groups of two, sharing one of their laptops. Figure 1 shows the different classroom setups.

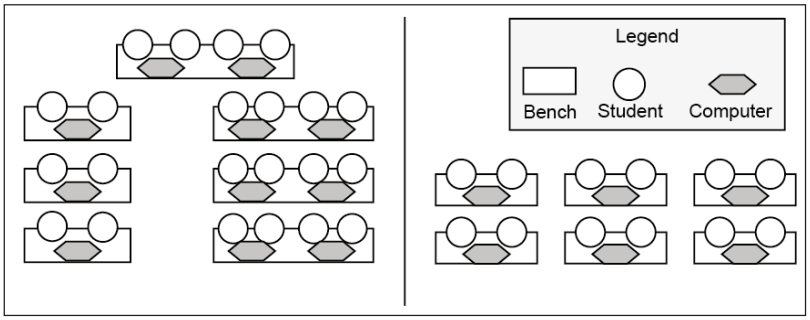

Figure 1: Though the 7th grade students (left) had individual laptops, they were divided into groups of two and shared one laptop. The 5th grade students (right) worked in groups of two on communal laptops.

The two different classes also worked with different subject matters: the 7th grade class worked with mathematics and geometry, and the 5th grade class worked with medieval history. The game used in both subjects was *MinecraftEdu* (TeacherGaming LLC, 2012), which is a version of the game *Minecraft* (Mojang, 2011) that has been modified for use in educational environments. The 7th grade students worked in smaller groups and collaborated on a series of different geometry exercises. The 5th grade students worked with history, and had a longer continuous collaborative project where the class was divided into two groups of 12 to build medieval structures and societies. Examples of what types of gaming activities the two curriculums resulted in can be seen in Figure 2.

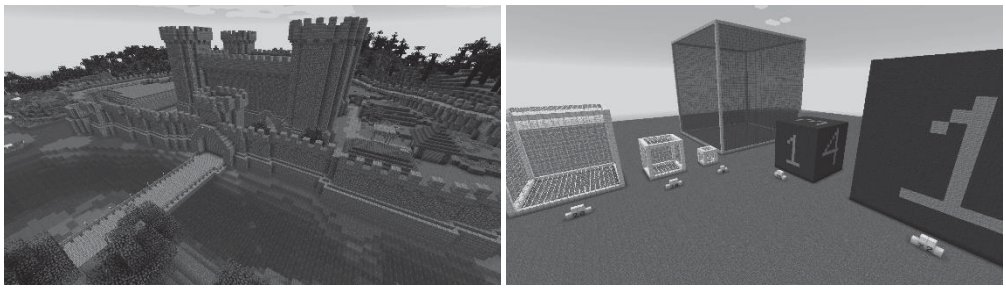

Figure 2: During the history curriculum, students collaboratively built medieval structures and societies (left). During the mathematics curriculum (right), students made calculations, drew blueprints, and built geometric objects and models of real-world objects (e.g. a scale model of a numbered dice)

4. Results

In this section, the differences in the types of players one encounters in a classroom audience will be presented. The section covers a few overarching 'archetypes' of students as gamers, and couples them with examples from the observation protocols and audio transcripts. The implications of these results are later discussed in the conclusion and discussion.

4.1 The spectrum of students as gamers

During classroom sessions, it was evident that students had severely different backgrounds when it came to technological- and gaming proficiency. Some students professed to not only playing *Minecraft* on their own at home, but that they also paid for dedicated servers and created gameplay videos and guides that they put up on YouTube. Simultaneously, the same classrooms also contained students that had never tried *Minecraft*, or any computer game with a similarly advanced interface. For example, during one of the early classroom sessions with the 7th grade students, the observation protocol states that "*A lot of students (around a fourth of the class) still don't know how to start the game or how to play, how to interpret "blocks" as units of measurement, how to choose and place blocks in the game interface, or even how to steer their avatar (the combination of WASD steering and mouse movement is difficult for many), I spend a lot of time running around and managing those issues*." Conversely, transcripts from the same class show that some students are highly proficient:

Excerpt from a 7th grade classroom gaming exercise on February 20th
[Aaron and Sarah are playing together. Aaron is a proficient player, and is showing off his grasp of the game to his classmate]
Aaron: Take this one. And then you use them on the pigs here. Check it! They're making babies!.. And then they fall off.
Sarah: Awh, those pigs are adorable! You're not going to kill them are you?
Aaron: time set one thousand [reading aloud a console command (/time set 1000) he is executing]
Sarah: What do you mean… "set"?
Aaron: Now you'll see something even cuter.
Long pause with mouse clicks
Aaron: Mushroom cows! You know, take 'em, take 'em, take 'em!

Here, Aaron clearly demonstrates that he is a proficient player as he knows console commands for the game, and knows how to access relatively obscure objects in the game. Simultaneously, Sarah has some trouble with the game, and is not familiar with the language Aaron employs, showing the breadth of students' game proficiency. Furthermore, the excerpt also exemplifies a common issue encountered during the classroom

gaming sessions – the game proficient students focusing more on showing off and experimenting with game mechanics rather than remaining in an educational frame of play.

4.2 The proficient gamers

While proficient gamers need less supervision in terms of game tutoring, they often require other types of attention and are also prone to display gaming behaviours that can be disruptive in the classroom environment. The proficient gamers are both difficult to engage with educational goals, but they also place much higher demands on the conditions for their gaming.

Excerpt from a 7th grade classroom exercise on February 20th
[Aaron has just started up the game for the class exercise]
Aaron: Oh my god, my latency is super high. Check out my ping!
Aaron: Can you have a look at my latency? [directed towards the researcher]
Aaron: My ping is over a thousand!
[…]
Aaron: But like… I have 1600… my ping is one thousand one hundred and sixty two.
Another excerpt from the same session
Jonas: Minecraft on the highest settings – that's what I'm running at my gaming computer at home. Desktop rig. No lag.
Jonas: Here it lags on the lowest settings.

Excerpt from a 5th grade classroom exercise on February 17th
[Felicia and Miley are playing together; Felicia is an inexperienced player while Miley is an expert. Felicia is commenting on the stacking of chests on top of each other – realistically, the bottom chest *should* be impossible to open.]
Felicia: I don't think they had… um. Chests like that.
Pause
Felicia: I don't think they had the technology to do things like that.
Miley: Whaaat?
Felicia: I don't quite think that they had that technology – like, how are you going to open them?
Felicia: *laughs* … the one that's on the bottom?
Miley: *silly voice* Felicia you can build like that *unintelligible* in minecraaaaaft.
Felicia: *giggles* But if you put a thing down, super close to the other thing that can be opened. why... [Miley interrupts]
Miley: Oh come on, it- it- it- it's lagging! [Miley gets frustrated with the computer's performance]
Felicia: … can you open it? [Felicia finishes her sentence]
Miley: Like it- it- it double-clicks when you only click once…
Felicia: Shouldn't we also put in a monastery citizen?
Miley: … sometimes.

The above transcript excerpts exemplify the demands that game proficient students place on the tools they are given to work with, and if either the provided hardware or software hinders their ability to play the game to their full capabilities their engagement in the educational gaming task often diminishes rapidly. In the example of Miley and Felicia, Felicia kept contextualizing the gameplay in reality (by mentioning how the chests in the game were used illogically). But, as a more proficient player, Miley pays more attention to what the game allows rather than what might correspond better with the life-like environment they are trying to create in the game. Miley's attention to the task is also interrupted as a result of non-satisfactory performance of the hardware.

The proficient players were also often generally displeased with the constraints that the educational goals of the gaming activities placed on their gameplay. The observation protocols note several instances of game proficient students shouting objections like "*this sucks*" when they are informed of what the goals of the gaming activities are, and teachers also frequently noted that the game proficient students were the ones who were most difficult to engage with when it came to discussing details of the taught subject matter. A note in the observation protocol from an exercise with the 5th graders exemplifies this clearly: *"One group of boys, seasoned players, had a tendency to just veer of track and start using the bow and other game elements to pass the time, and show off their skills […] One person in this group was also fairly negative about the process, and I got the feeling that*

the student felt very restrained or constricted by having to work with his peers, and that their plans didn't really mesh with what he had envisioned."

4.3 The less experienced players

Novice players present a totally different set of challenges during gaming activities. As previously mentioned, a non-trivial amount of students in the classrooms had difficulties grasping fundamental aspects of the game, or even had trouble launching it. Interfaces that some might consider self-explanatory can be hard to decipher for newcomers. The following transcript excerpt is an example of a commonly recurring intervention the researcher had to make during gaming exercises:

Excerpt from 5th grade exercise on February 24th
Juliet: [Talking to the researcher] Ok so… Alright, how do I. Like, how do I find. Like, how do you set out fences like, like *that*
Juliet gestures towards a fence and a fence gate in the game
Researcher: How do you mean?
Juliet: You know, kind of like. A fence that can do like this.
Researcher: Oh, ok! That's actually not a piece of fence, it's a gate.
Juliet: Oh!
Researcher: So you have to go in here, and pick this. [The researcher shows the item in the inventory menu]
Juliet: Ah.
Researcher: And there we go, there it is.
Juliet: Where is it?
Researcher: There we go. And then you put it down like that.
Juliet: Ok.

It should also be noted that this example is not taken from an exercise early on in the game-based learning project, the students had at this point spent four sessions playing the game (totalling around six hours of game time). It was also not an isolated case, and other groups of students frequently needed help navigating the interface of the game. Another common issue is that the less proficient player finds the gaming activity boring or pointless, either because the game proficient student 'takes over' the activity, or because they feel frustrated by the difficulty of the task:

Excerpt from 7th grade exercise on February 27th:
Anne: But like… this is boring as sh*t.
James: Not… not for me, because I know how I'm going to build. Check this out. [James then proceeds to invent a lava-based animal-murdering machine]
Excerpt from 7th grade exercise, 20th of February:
[The students are working with the scaling of area and volume]
Researcher: Are you building a cube each?
Sarah: No! I'm going around killing pigs.
Researcher: Alright, have something happened?
Sarah: Not really. First we started working on mine, but then he wanted to, um… do things his way.
Researcher: Oh, but this pink shape you have, is that one of your versions at least?
Sarah: Mhmmm. I worked on that one.
Researcher: So that's your Area-version?
Sarah: Yes, that was mine.
Aaron: Nooo, I need to get one that has Strike [Strike is an enhancement for weapons that increase their damage]

5. Conclusion and discussion

From studying two five month projects of game-based classroom gaming, severe differences in students' proficiencies, preferences, and approaches to gaming could be seen. The heterogeneity of the average classroom constitutes a fundamental problem for educational games. Both proficient and novice students presented their own set of specific challenges, and it is difficult to construct exercises that will engage proficient students while still being inclusive to the novices.

The findings of this study fall well in line with a similar study conducted in 2008 by Egenfeldt-Nielsen (Egenfeldt-Nielsen, 2008). In an attempt to use the complex historical strategy game *Europa Universalis II* (Paradox Development Studios, 2001), his study revealed severe differences in how quickly students were able to learn the game, some spending several weeks trying to grasp the basics of the game's interface. For these students, just getting to the level of expertise needed to interact with the content meant to teach the subject matter consumed several valuable classroom-hours (Egenfeldt-Nielsen, 2008). Instead of being able to discuss the subject matter, teachers also had to spend a significant amount of their student-teacher time teaching the students how to play instead. Granted, *Europa Universalis II* is a complex game, but it is unlikely that reduced complexity and difficulty in educational games is a solution to the problem. For example, *Minecraft* is arguably a much more accessible game than *Europa Universalis II*, but the gaming activities in this study was still beset with the same issues that Egenfeldt-Nielsen encountered. This shows that games do not have to be overly advanced in order to make classroom gaming problematic.

This has some implications on the concept of 'digital natives' that is still prevalent in the game-based learning community. While some scholars and practitioners maintain that everyone born after technology and connectivity had become ubiquitous have an innate ability to grasp technological interfaces and a desire to engage with them (Annetta, 2008; Prensky, 2003), placing a game in front of a classroom of students quickly reveals the spuriousness of those claims. From the participatory observations, and analysis of transcripts from classroom gaming sessions, the students were not found to share an innate affinity or desire for interacting with technology interfaces. The proficient students often found gaming activities too trivial and constraining, while the novice students often found it intimidating or frustratingly difficult. This often complicated the game-based learning process, as creating assignments that simultaneously cater to the students who have trouble controlling their avatar and the students who are very game proficient (and get bored by too trivial gameplay) is a very difficult task.

These problems are further ratified by the principle of 'flow' in games. If player engagement depends on the relationship between the intensity of game challenges and player skill, and if player skill varies greatly in your intended audience, creating an engaging game becomes difficult. Fundamentally, a classroom audience is spread all across the X-axis of the 'flow' model (see Figure 1). But, there are also several parameters other than player skill that dictate game enjoyment and that varies greatly between individuals in a classroom as well (Kickmeier-Rust et al., 2011; Squire, 2003). For these reasons, creating an engaging learning game for classroom environments is difficult, and unless the classroom is homogenous (e.g. private schools, specific summer schools, or schools focused on training specific skills) or if the game is highly adaptive, a significant amount of students may rapidly become disinterested in the educational game experience. But, as noted by Egenfeldt-Nielsen (2008) and Squire (2005) in their studies on the implementation of educational games in classrooms, failing to motivate is not the only challenge of catering to these environments. Time spent on mastering game mechanics, for instance, is time taken away from learning the subject matter (Macklin & Sharp, 2012; McClarty et al., 2012; Squire, 2005).

This paper shows that the integration of a game into a classroom – even one as popular as *Minecraft* – is difficult, and no guarantee for student engagement. By close supervision and guidance from the researcher and the teachers, the gaps between the students could be smoothed out over time. But, it is important to recognise that access to an extra set of game-proficient hands and eyes is not a common occurrence in classrooms, and is mostly a privilege exclusive to schools that engage in research initiatives or special programs. The implications of this research are that games might not be the golden tickets to student engagement that some scholars and practitioners claim. Games, just as any other educational tool, requires a great deal of investment and hands-on guidance from teachers, who needs to continuously anchor gameplay in an educational framework and tutor novice students in how to work with a game's interface.

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