Researching Game-Based Learning: A Brief Synthesis Project

Jennifer Jenson[1] and Suzanne de Castell[2]
[1]Department of Language and Literacy Education, Faculty of Education, The University of British Columbia, Canada
[2]Faculty of Education, Simon Fraser University, Canada

jennifer.jenson@ubc.ca
decaste@sfu.ca

Abstract: The purpose of this research synthesis project is to survey existing digital game-based learning (DGBL) research in order to generate preliminary categories that articulate analytically distinguishable cognitive competencies. These include orientations, attitudes, interactions, and dispositions that enable cognitive development through playing games. We compile an initial literature scan, limiting the language to English, then search via keyword "game-based learning" through the following educational research databases: Eric, Education Source, Communication & Mass Media Complete, Education Index Retrospective, and Teach Reference Center. This returned over 1,500 results, which we refined by filtering out papers focused on gamification, those researching populations outside of educational contexts (e.g., private business and healthcare), systematic and scoping reviews, and papers published before 2010. This focused the results closer to 1,300 papers, which we divided into two categories, research focused on learning ecologies, and research using "motivation" in its key words and/or abstract. One clear and unexpected result was the way in which DGBL research inconsistently discusses motivation, and how it mainly seems to be used as a catch-all for measuring GBL outcomes. This brief synthesis reveals that much more attention needs to be paid to whether and how potentially pat constructs like motivation are being deployed in GBL studies.

Keywords: Game-based learning, Learning ecologies, Engagement, Motivation

1. Introduction

The following review of games and learning literature was not approached from the standpoint of "how can games support learning", or even from the standpoint of "how do games support subject matter understandings such as science or math or physics". Instead we interrogated the extant literature through a set of questions: 1) methodologically, what papers (if any) approach game play as part of the larger learning ecology of a classroom or learning 'event' and how do they describe their approach and outcomes?; and 2) definitionally, how do researchers describe and/or define what are largely non-measurable outcomes such as 'engagement' and 'motivation'? For both searches we used a variety of databases—PSYCH Info, ERIC, Communication and Mass Media Complete, and Education Index Retrospective. Search terms for the methodological question included "ecology and video games", "ecology, video games, and learning", "video games and ecology", and "digital games and ecology". For the definitional question we used a primary search category of "digital games and learning", refined by the secondary search terms "engagement" and "motivation". To better manage the scope of the search, we only examined articles and research reports from 2010 to June 2023.

The purpose of this paper is to review the literature related to both questions, with two aims: the first is to better understand how researchers are making use (or not) of an ecological approach to studying video games, and learning how that perspective might yield insight into optimal ways to carry out games and learning studies amidst the messiness that invariably accompanies classroom studies; the second is more prescriptive, attempting to better understand how researchers have defined, understood, and (where so claimed) measured 'motivation'. For the latter, although we had filtered out gamification studies as outside the frame of this review, a large number of gamification studies remained in the sample because their key words related to "game-based learning," and these papers had to be removed or retained on a case-by-case basis, according to their overall relevance to our key search criteria. What was included in the sample were all papers that explicitly addressed GBL, irrespective of methodology. While this yielded a large number of papers, we wanted to take the broadest approach possible in this initial pass at the literature review. In the next two sections, we detail what each separate search yielded, expanding, where relevant, extended summaries of key papers in the areas.

2. Ecologies of Learning With Video Games

It is not the intent of this literature review to rehearse the research on media ecologies or, by extension, learning ecologies, except to point out that an ecological approach to studying learning has been around for quite some time (Klopfer, 2011), and has been used as a methodology to better understand the intricacies of learning environments. Learning ecologies are used to broadly refer to the whole system of teaching and learning: social, cultural, tools, technologies, curriculum, time, space, and their network of inter-relations (c.f. Barron, 2006; Lave

& Wenger, 1991; Lemke, 2000; Jackson, 2013). A learning ecology, then, can incorporate both formal instruction and curriculum and informal learning opportunities outside of classrooms.

In the literature on video games and learning that we reviewed there is limited, if any, engagement with learning ecologies as a theoretical or methodological framework for research on the topic. In general, there were three lines of inquiry that made use of the concept of 'ecology'. The first looks at ecologies within the games, that is games that contain their own ecologies such as plants, animals, and ecological systems, that act on players, just as they are acting and enacted upon by a digital game. For example, Sheu explores a fishing game, *Brass Pro Shops: The Strike*, to explore how the game mimics real world ecologies of bass fishing, and another paper examined player preferences in *World of Warcraft* related to areas in the game, finding that most preferred vegetation-based landscapes (Truong et al., 2018). Another ecologically focused view on video games is made in Alenda Chang's book *Playing Nature* (2019). Chang argues that video games and their depictions of nature and environment, including the ways that players interact with (or largely do not), can challenge players to think differently about the virtual environments they inhabit, reflecting also on 'real life' counterparts. As Chang puts it: "games can offer a compelling way to reconcile a deep connection to nature and the non-human world with an equally important connection to technology and the virtual" (p. 5).

The second line of inquiry, like the first, looks specifically at what ecologies are present or enacted by the game system, environment, rule structures, and actions. This asks what 'ecologies' are present (real or imagined) in the game, and a few papers go so far as to ask questions about what might be learned by interacting with those in-game ecologies. For example, *Red Dead Redemption* (RDR) and its follow-up title *Read Dead Redemption 2* (RDR2) are commercial video games set in the colonizing period of the American West. The game features flora, fauna, and wildlife endemic to the region during the time the game is set (roughly late 1800s) that can be interacted with and that interact with the player as they explore this open-world game. Crowley et al. (2021) set out to study whether players who had and players who had not previously played RDR2 were able to correctly identify species depicted in the game. Overall, they found that playing RDR2 supported correct visual species identification, and that interaction, even simulated with the overall ecology of the game world, resulted in player observation of programmed animal behaviours most players would not have had access to in the real world. In a similar virtual world to the real world identification study, Coroller and Flinois (2023), examined whether players of *Animal Crossing* were better at species identification from the game than non-players. Overall, they found that playing *Animal Crossing* (AC) contributed to players obtaining higher scores on identification quizzes than non-players, suggesting that players "learned the name of the organisms and became able to recognize them, despite having likely never encountered them in real life" (p. 12). And in another study of *Animal Crossing*, Ho et al. (2022) surveyed over 600 players, and found that playing AC contributed to greater understandings of limited resources, such as trees and water.

The third application 'ecology' to video games is more centrally about digital games as and through a learning ecologies framework. While outside the scope of the search parameters for this review, it is important to acknowledge an edited collection by Katie Salen Tekinbas (2008) entitled *The Ecology of Games: Connecting Youth, Games, and Learning*. Interestingly, the concept of ecology in this text is taken loosely to refer to the ways in which games might contribute to new literacies, new practices, and new socio-cultural forms for young people. While the concept of ecology (beyond the introduction) is under-interrogated in the edited collection, it does at least serve as a touch point for entering into thinking about playing and interacting with digital games as learning ecologies.

More recent literature that mentions digital games as potential learning ecologies is still scant, and our rather exhaustive searching only produced 5 papers that directly address the topic. The first paper has learning ecologies in its title and directly addresses how digital games are increasingly a part of learning ecologies (Persico et al., 2019). The authors claim (as we do) that there is a paucity of research on digital games as part of larger learning ecologies, suggesting that this omission in part results from a focus on a single game and/or single learning environment (formal or informal), rather than adopting the wider perspective afforded by a learning ecology lens. Data for the study was collected through interviews and focus groups with key stakeholders: teachers, parents, players, game developers, and GBL researchers. Analysis of the focus group and interviews is broken out into recommendations for each of those stakeholder groups, binarized into "positive and negative aspects" of using digital games for learning. In the end, the possibilities for understanding digital games as part of formal or informal learning ecologies is left behind, as there is no 'ecological' focus present in either the data collection or the analysis. In the end, Persico, et al. (2019) argue:

> *Our study has investigated some positive and negative aspects of digital gaming for learning from the point of view of the main actors who play a role in the LE [learning environment]. The results demonstrate how important it is that all actors in the landscape are fully aware of the salient characteristics of this ecology component to harness its promise for learning in all contexts. (p. 1700)*

Klopfer (2011) takes a similar stance, which is to rather under-define what learning ecologies look like when playing digital games. This is all well and good when your research does not necessitate a more detailed description of the ecologies in question, but just what are those ecologies? What do they look and feel like? How do we identify, understand them and study them?

A second paper examines the home gameplay practices of one adult individual (Vazquez-Calvo, 2018) over a six-month period. The paper is mainly concerned with documenting the variety of literacies the individual practices through his gameplay and fan-related engagements online, including translation from English to Spanish. The author does spend some time documenting the ecology of their informant's literacy practices as a fan and game player, but this examination is not followed through into the conclusion, leaving the paper more as a literacies mapping exercise than a specific focus on learning ecologies.

A third paper focuses on GBL and second language learning through an ecological approach to 'gaming' (Ibrahim, 2017). The author defines an ecological approach to L2 learning by focusing on the "actions, processes, and relations" (Ibrahim, 2017, p. 535) of the learner in a given setting. The paper reports on 6 English speakers interested in learning Egyptian Arabic, who are asked to play a resource management game, *Baalty*. Data collection included a think-aloud protocol that participants used to document their gameplay as well as a pre-study questionnaire to collect data about previous gameplay experience, screencasts of video gameplay that recorded both their gameplay and the think-aloud activities, game logs, game journals, fieldnotes, and semi-structured interviews. It seems an enormous amount of data was generated from these 6 L2 language students, which contributed to the primary finding that those participants with either a higher L2 proficiency or previous gameplay experience tended to "make limited use of the opportunities for practicing new L2 discourse" (Ibrahim, 2017, p. 543). However, those more limited in L2 or gameplay experience were challenged by and interacted more with the linguistic affordances of the game. While the author claims to have taken an ecological approach to both study design and analysis, it is not made clear how the ecology of the game (or "gaming ecology") actually figured in the study's conclusions.

A final study flips the attention from the students to the teachers, asking how teachers implement an educationally focused math game across 4 different classroom ecologies. Data collection included video recordings of teachers and students during the implementation of the game as well as pre- and post-tests, and informal interviews with teachers after the game implementation days. The authors analyze and report on the study through 4 cases involving 4 different teachers. While they do cursorily describe the ecology of the classroom, this does not figure largely in their cases. Rather, the authors argue that "teachers are a central part of the overall learning ecology that develops around the game" and that "students learn better and have more opportunities to engage with the mathematics content of digital games if teachers interact with students and talk about the math during gameplay" (Bell & Gresalfi, 2017, p. 86). In other words, if teachers understand and are involved in talking about the game and its play, students tended to do better on the post-test in this study.

Overall, the literature on GBL and learning ecologies is sparse and under-developed, which is interesting considering that an ecological approach to studying GBL might well help to move the literature out of the realm of "it depends" onto firmer ground. It is the case that there is a growing area of work that examines the particular ecologies in video games as having possible implications for understanding 'real world' ecologies, however there really is not much written to date on that. Taking a broader ecological approach to GPL might document "just playing" within the context of a classroom, including both how things stay the same and how the simple act of playing might change the classroom's learning environment.

3. A "Motivation" Industry?

It shouldn't be surprising that 'motivation' figures largely in outcomes related to game-based learning. However, the sheer number of papers with claims related to motivation, and the massive variation within the literature on how 'motivation' is understood and reported became a surprising outcome of this review. The full sample of game-based learning articles was over 1,400 papers, and of those a search within abstracts and keywords yielded 537 papers that had 'motivation' as part of their titles, keywords, or abstracts. Each was individually assessed by the first author, first at the level of abstract, and then, where the relevance proved high enough, the full paper was reviewed. Overall, 120 papers were reviewed in full. Papers potentially relevant that turned out to be

gamification studies were, as previously indicated, left out of this analysis. Also removed from the analysis were health and exercise game studies, studies focused solely on flow theory (Csikszentmihalyi, 1975), and largely generic GBL studies that might for example mention "motivation" once in the paper in a literature review, but without interrogating the concept further, nor reporting on results related to that construct.

We found that "motivation" is a construct that is surprisingly widely used, yet not necessarily well defined or even understood in many of the GBL articles we reviewed. For example, are games motivating learning or are the researchers reporting on being motivated to continue to play the game? What are the boundaries for motivation (i.e., how do you see it, measure it, and report on it (some studies do this, others do not), and how is motivation different from engagement and attention? Overall, we noticed a pattern in these papers that could be characterized as falling into three broad categories: 1) papers that used motivation as a kind of 'straw' construct invoked in title, keywords, abstract, and maybe a literature section, but that then does not figure in the analysis, results or conclusion of the paper; 2) papers that go some way towards trying to say what they mean by motivation (most often taken to mean intrinsic motivation see section 3.2) attempt through a self-report (survey or questionnaire) to collect data on the construct, and report some results and conclusions on any motivation indicated therein; and 3) papers that were all quantitative, were careful to define what they meant by attention, and then reported on those results. These studies often referenced large data sets, created their own instruments, and reported both positive and null outcomes related to GBL and motivation. As these latter cases exceed the scope of this brief review we will concentrate on cases 1 and 2.

3.1 Vaguely, Motivation

While it is not possible to review each and every paper that was included in this first category of using an ill-defined construct in relation to motivation, here we will endeavour to present some explicit examples of this issue through a closer look at three representative papers. First, though, it is important to know that much of the GBL literature begins in a very similar place, attributing the "motivational" properties of video games to the likes of Prensky (2001) and Gee (2007). Neither of these two oft-cited books are empirical; written a significant time ago relative to the rapidly-evolving landscape of videogames, they are simply waxing poetic about the learning possibilities for digital games. That the current crop of literature reviewed here still chooses to harken back to those early days, especially in relation to the motivation inspired through playing games, is somewhat suspect, given how much games have evolved since the early-mid 2000s.

The papers detailed next were chosen randomly from a larger sample of 25 papers categorized as loosely defining (if at all) "motivation". The first is a paper that looks at GBL and Chinese poetry learning (Chen & Lin, 2015). The authors argue that playing a game "increase motivation" and (citing Prensky, 2001) can create entertainment and pleasure. Motivation in the paper is described as "learning motivation", which was measured via a scale from a questionnaire about the willingness to play the game based on Chinese language poetry. Results from the study indicated that the students who were in the experimental group (i.e., game playing) were more motivated to learn Chinese poetry than those in the control group (non-game playing). It is not made clear what 'learning motivation' is per se, nor how a self-reported questionnaire could capture that construct.

Paper 2, "Narrative categorization in digital game-based learning: Engagement, motivation and learning" (Breien & Wasson, 2021) examines those three constructs, "engagement, motivation and learning", through a review of 14 papers that discuss 15 digital GBL games, or "systems" as the authors refer to them. These authors also start with citing Prensky (2001), before moving on to argue that games have been found to be both motivating and engaging in well cited literature reviews (e.g., Clark et al., 2016; Connolley et al., 2012; Novack, 2015). While the term "motivation" comes up 44 times via a key word search, it is never explicitly defined, but the paper makes clear that it refers to being motivated to keep playing the games being reviewed. It also often appeared alongside 'engagement' and 'learning', terms we found frequently being used interchangeably with 'motivation'.

Paper 3 takes another kind of—equally vague—approach to the concept of motivation (Tsai et al., 2012), once again citing Prensky (2001) and Gee (2003) to shore up its argument that the study of games and learning is a relevant to education. In this paper, the term "learning motivation" surfaces once more. While it is also not concretely defined, its use in this instance appears to be related to motivation to learn about the subject area (energy saving). There is an important distinction made in the paper between "learning motivation" "to seriously learn new knowledge" and "playing motivation" which is just the motivation to stay in the game or keep playing. Overall, this study of 8 players found that being more motivated by playing the game than by the desire to learn more about the subject the game was built around (energy saving) meant there was less overall understanding of how to save energy. It is not clear how precisely this motivation (either playing or learning) was measured, what the researchers meant by that concept, or how it connects to other similar research.

In another example of a paper that uses the term motivation (albeit in a very limited manner), Cîrnu et al. (2012) argue for the potential of commercial games for learning. One small part of that argument is that games are universally (or so it seems) motivating. They too, inevitably, cite Prensky (2005) whom they quote as arguing that games "have goals that give motivation" (p. 322). That is really the extent of their argument, and the rest of the paper contends in favour of using a few different commercial games in learning contexts.

Finally, Dickey's (2011) work explores how a narratively driven, adventure style game, *Murder on Grimm Isle,* might impact "intrinsic motivation", "curiosity", "plausibility" and "transference of game-based experiences" (p. 456). Unlike Cirnu et al., Dickey never defines what "intrinsic motivation" is, although it's claimed there is a form of it within the game design, whereby players are able to choose which way to go at the start of the game, and the authors argue in their discussion that preconceived notions of what a 'game' is might impact different players, making them more or less motivated to play. Unsurprisingly, this study too cites both Prensky (2001) and Gee (2003) as part of the argument for why and how games are useful as learning tools.

Overall, and with of course some variation, the papers in this category were using motivation as a taken-for-granted construct that is linked (almost always positively) to playing games irrespective of game type, duration, or design. What these papers make clear is that there is quite a lot of work to do in becoming clear about what motivation entails in relation to learning and games.

3.2 Motivation as a Central Construct

Papers that centred motivation in a GBL study were also quite common, varied in their approaches and outcomes, and took few steps towards even superficially unpacking what they mean by motivation. This was the second largest group of papers (66) in this review. Again, we have chosen to describe 3 papers that are representative of those papers that, despite having 'motivation' as a central construct, do not necessarily interrogate or clearly define it.

Cornille et al. (2012) describe a study on corrective feedback through a game for English language learners. They choose to use a game to support language learners through a Computer-Assisted Language Learning (CALL) framework, which, simply put, means that they are using language learning games on computers to support second language acquisition. They too rely on Prensky (2001) to make the case for learning through playing games and propose that the immediate feedback loop of a game makes it naturally suited and useful for language learning. They loosely define motivation in game design terms, that is the push-pull between positive reinforcement and negative reinforcement, such that the player isn't deterred from "successfully completing an action or a task" (Cornillie et al., 2012, p. 260). They then go on to discuss how motivation (intrinsic and extrinsic, neither construct being unpacked or well-defined) is impacted by corrective feedback and vice versa in the literature on second language acquisition and CALL. Motivation is linked directly to corrective feedback and its potential impacts on L2 language learners, and that carries through their study of 83 language learners playing a role-playing game in English. The researchers created a series of questionnaires pre- and post-play and in-game to measure motivation, supplemented by interviews with participants. They argue that in the end, "intrinsic motivation" is contributed to by positive and adaptive feedback in the game. While they do define intrinsic motivation as "an individual's subjective experience that is the combined result of enjoyable immersive gameplay with his or her positive perception of competence as the result of play" (p. 273), it isn't clear precisely how that subjective experience is accounted for directly by the data collected. Moreover, construing 'intrinsic motivation' as contributed to by 'positive feedback' is a dubious move conceptually, since intrinsic motivation is 'endogenous', it comes by definition from 'within' the subject and cannot therefore be the result of external ('exogenous') factors like reward, punishment or any other goal "extrinsic" to the activity.

Next, Zhang et al. (2021) study a role-playing game they designed to support university students' understandings of information literacy. Motivation in their study was reviewed in relation to GBL as one part of a kind of "learning" package that included engagement, persistence, and flow. Motivation is never defined, nor is there a distinction made between intrinsic or extrinsic motivation, except Insofar as the instrumentused was adapted from Wang and Chen (2010) and assigned 3 questions to each type of motivation in the pre- and post-surveys. As a central construct that was evaluated in the study through a pre- and post-survey of 90 participants, it was found that they were more motivated when playing the collaborative and competitive versions of the game versus solo play, and in their discussion it becomes a little clearer that the authors mean 'motivation to learn' when writing about 'learning motivation' (Zhang et al., 2021, p. 164). While this paper never defines motivation, authors are approaching that construct through a limited range of prior literature on the topic.

Finally, Chen and colleagues (2015) looked at solitary versus collaborative gameplay with 50 seventh grade students who played a science-focused game, which was designed by the researchers to reinforce key science concepts such as force and equilibrium. The authors go to some lengths to review the related literature on GBL, including its treatment of motivation, and they quasi-define motivation as motivation to learn, i.e. to learn about the science concepts, not to keep playing the game. They also make use of an instrument that has measures for both intrinsic and extrinsic motivation, which they administered both prior to and after gameplay. Unlike the Zhang et al. (2021) study, this paper did not report any difference between collaborative and solo play in relation to the motivation measures. They did, however, show improvements from pre- to post-test after playing the game.

What is difficult to really apprehend in any of the three above studies is what exactly is being identified and assessed in terms of motivation—most importantly, are we looking at motivation to play games generally, or to play just the game being studied, to explore that game's environment, to persist in playing it, or to learn about the academically relevant subject it encapsulates? And how is that motivation to play being identified and measured? Or are we looking at motivation as either an observed or a self-reported interest in learning something, or as an observed engagement in persisting with further learning? In either case what is the relationship between self-reports of being 'motivated' and observations of playing behaviours? Of no less importance, where engagement, attention, persistence and motivation are all used seemingly interchangeably, how are these and cognate terms to be distinguished conceptually, as surely they must be, and then operationally, within the studies themselves? All of this really does need to be unpacked, and yet these and the vast majority of studies we reviewed both rely upon the concept of motivation and invoke it is as a black box, even as they attempt to measure and report on it.

4. Next Steps and Conclusions

What is primarily clear from this partial and ongoing review is what GBL research does *not* do: important theoretical and methodological ideas and practices that inform recent and current scholarship in other fields and forms of inquiry— new materialism for example— have made almost no inroads into the field of GLB research and scholarship, which thereby risks becoming stagnant. There is a lot more care and attention that can be taken in GBL research and practice to attend to the wider learning ecologies in which GBL studies take place, through careful qualitative inquiry capable of engaging with current and emerging theories and research practices. It is paramount that GBL studies begin to take a serious look at 'motivation' as a construct that has been and continues to be among its most frequently invoked concepts, and yet remains inadequately—if at all—elucidated, and with rare exceptions (ref) almost completely undertheorized. The idea of motivation in GBL studies is instead rehearsed in a pop-psychology rendition that conflates it with a host of other cognate 'good things', such as engagement and 'flow', interest and attention, and despite decades of careful critical analysis of the concept to draw upon from the fields of philosophy, psychology, and more recently neuroscience.

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