Motivation in Intelligent Tutoring Systems and Game Based Learning:

Why Am I Learning This?

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Abstract

This paper discusses how Game Based Learning (GBL) provides a more collaborative learning experience while integrating Intelligent Tutoring Systems (ITS) features. First the paper discussion of the advantages of collaborative learning environment in a middle school environment and how it creates higher motivation in students. Then the paper will discuss the basic structure of ITS systems and how it measures motivation of students. Afterwards, the paper will discuss GBL, and how it motivates students and create a collaborative environment. Examples in this paper pulls from multiple ITS designs such as Andy's Tutor for a physics problem and Lynnette for a math classroom. GBL designs such as The Frequency 1550, a game design around the use of mobile device to learn about the history of Amsterdam. There is a future suggestion of how an English literature class studying the theme of tragedy can be designed using the game Final Fantasy XV as a model to create a GBL experience. The paper wraps up by reiterating the concept that GBL can create an environment where students can receive the educational learning support they need while being motivated to learn the material.

Keywords: Intelligent Tutoring Systems, Game Based Learning, motivation

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Video games are traditionally viewed as a recreational activity to pass the time rather than an educational tool for learning. However, in the past several years it has begun to be slowly incorporated into an educational setting in the form of gamification. Gamification is the idea of taking a learning segment and incorporating gaming elements as incentives to keep students motivated (Basten, 2017). Some examples are daily log-in incentives, rewards for completing levels, and unlockable levels. Educational programs, such as *Lexia Core* (Lexia Learning, 2018), uses gamification features to capture student's interest and motivate them to continue their learning because the students want to obtain star points to move onto the next level. In *Lexia Core*, elementary students play a series of games to learn how to read. Games such as matching falling prefixes that needs to be selected to complete a word and obtaining enough stars to move to the next level of reading are ways that gamification has been integrated into the program. These features motivate students to learn through extrinsic ways such as obtaining points to use to progress to a higher level.

Although games are used in the elementary grades, there is a paradox once a student reaches their middle school years. Students are provided with more electronics such as Chromebooks and iPads; however, they are given reduced e-learning content and applications for their classes. Although there are still online applications, most are individual or personalized one to one environments that are geared towards students who are struggling in specific subjects. *READ 180* (Scholastic Corporation) is a program that uses Intelligent Tutoring Systems (ITS) model to assess, level and track students who are struggling readers. Although one on one interaction with the use of ITS can help middle school students learn with a specialized

curriculum, it does not consider the changing social landscape (peer to peer interaction), and motivation for the students. Therefore, applications with gaming features is not enough to keep students engaged and motivated. Instead, game-based learning (GBL) environments can be integrated and used in middle schools to motivate students to learn the material.

Game based learning is "a type of game play with defined learning outcomes" (Shaffer, Halverson, Squire & Gee, 2005). An example of GBL is *The Frequency 1550* game developed by the Waag Society (Admiraal, Akkerman, ten Dam, 2009). This game is about medieval Amsterdam where students are split into groups and use phones to explore the city of Amsterdam. In this game, the city is divided into six areas with their own theme. Each group starts at different section and once they are done, they can move to another section. When entering a section, the theme is introduced with a video and a text message (Huizenga, et al, 2009). As a group, students have to do assignments in each new section. To conduct assignments, GPS signals track student groups. When they reach a certain location, assignments are sent out for students to do such as take pictures, do a scavenger hunt and write short answers through texts. At the end of the game, students participate in a large group discussion (Huizenga, et al, 2009). To design a successful GBL, the "design process of games for learning involves balancing the need to cover the subject matter with the desire to prioritize game play" (Plass, Perlin, & Nordlinger, 2010).

This design aspect of GBL is where there is a distinct difference between gamification and GBL. As stated above, gamification involves using features of games to keep students engaged; however, if those features were removed then the core application would not change. In a GBL module, all features in the game becomes an integral part in understanding the lesson. I believe that in a middle school setting, a GBL environment is better for motivating middle

students because it can integrate ITS-like features while providing a collaborative learning environment.

In this paper I will discuss the various e-learning environments that middle school students partake in and discuss the pros and cons of them. Then, I will discuss why I believe GBL will provide a more collaborative learning environment to help students stay motivated. I will also speculate on future implications of GBL and how it can be incorporated in a classroom.

Theory

Collaborative learning is "an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together" (Smith & MacGregor, 1992). Students work in groups of two or more to reach a common goal or solution to a problem. Collaborative learning creates a space where students can explore and apply the materials that were learned in the course rather than reciting what the teacher said from lecture. This student-centered teaching style is different from a traditional teacher centered classroom where the teacher stands at the front of the room and lectures. In a collaborative learning environment, learning is an active and constructive process. This constructivist theory stems from cognitive theory where students learn new information, ideas or skills by working with them in an active way. As Smith and MacGregor summarized, "they are creating something new with the information and the ideas. These acts of intellectual processing – of constructing meaning or creating something new – are crucial to learning" (Smith & MacGregor, 1992). Additionally, research suggests that learning is influenced by the context and activity that it is presented in (Brown, Collins & Duguid, 1989). Collaborative learning is also very social which is an important aspect of how students learn. Students learn through discussing ideas with one another (Cazden, 2001).

Collaborative learning is a way for students to be motivated and engaged in what they are doing. To be motived means "to be moved to do something" (Ryan & Deci, 2000). Within the broad term motivation, there are many subcategories such as the level and orientation of that motivation. The level of motivation corresponds to how much motivation a student has in completing work while orientation of the motivation refers to why the student is motivated to do the work. Additionally, there are two types of orientation of motivation that students may have, intrinsic or extrinsic motivation. Intrinsic motivation refers to "doing something because it is inherently interesting or enjoyable" while extrinsic motivation refers to "doing something because it leads to a separable outcome" (Ryan & Deci, 2000). Schools frequently provide extrinsic motivation for students to do their homework or do well in school in general such as providing candy for good marks, high grades for doing well on exams and certain privileges such as honor roll and high honor roll. Students who has "a strong intrinsic motivation to learn will result in high quality learning and creativity" (Ryan & Deci, 2000). What schools and teachers try to encourage into students is intrinsic motivation or the drive to continue learning.

In a collaborative learning environment, students have many additional forms of extrinsic motivation to push them along in their learning if they do not have the intrinsic motivation yet. These forms to push the student to finish their work comes from the teacher assigning the problem, their peers who want to solve the problem as well as the want to fit in and get a good grade. Due to the idea that extrinsic motivation is a force that pulls the student to finishing their work, there are multiple regulatory styles, such as compliance, reluctant compliance or outright refusal to do the work, that come to play. The student may show a range of acceptance from complete compliance to resistance (Ryan and Deci, 2000).

Currently, schools use technology more as responsive learning tool to tutor remedial classes or provide extra work for students who are ahead of the class. Individualize learning, or personalize learning, is as its name suggests. It is a curriculum that takes into consideration the differences between learners and tailors the material around the learner. Situations where individualize learning is most prevalent is in one to one tutoring environments or computer-based systems such as Intelligent Tutoring Systems (ITS).

Intelligent Tutoring System

The rise of computers and artificial intelligence (AI) propelled a wave of interest to integrate AI techniques into education to produce educationally useful computer programs to support student learning. When AI was first introduced to the world of education, Papert believed that computers would "enable us to modify the learning environment outside the classroom so much that, if not all, of knowledge schools presently try to teach with such pain, expense and limited success, will be learned as the child learns to talk, painlessly, successfully and without instruction" (Papert as cited in Nwana, 1980, pp 251). Although Papert's proposal was a radical change to how education would be conducted, researchers believed that AI's ability to collect real time data while tutoring students could help support or replace teachers in classrooms where one on one interaction is needed. From Papert's idea came intelligent tutoring systems (ITS). ITS are "computer programs that are designed to incorporate techniques from the AI community in order to provide [computer] tutors which know what they teach, who they teach and how to teach it" (Nwana, 1980). Since the introduction of ITS, there has been many studies and applications created in order to support student's learning. Some examples of these ITS are Andy's Physics tutor to teach physics to high school students through questions and answers while providing hints for students who are stuck (VanLehn, 2005). Betty's Brain is

another ITS where students creates a web map to teach their avatar about colds and fevers in a biology course (Chase et al., 2009).

How ITS supports its learners

ITS supports learners when they are using their problem-solving skills to work out complex problems (Long & Aleven). They also enhance students' "learning outcomes in domains such as mathematics, programming, sciences and language learning (Graesser et al. 2008; Koedinger and Aleven 2007; Mitrovic and Ohlsson 1999; VanLehn 2011). The way that ITS supports students is through two key features. The first feature is the step-by-step guidance in a complex problem-solving activity with feedback and hints to push students along in their learning. The second feature is the ability to customize learning by providing problems at the level of the child based on detailed individual tracking of the student's knowledge (Corbett et al 2000). For example, an ITS program name *Lynnette* is a cognitive tutor that provides supplemental instruction to students in a math classroom (Long & Aleven). In this tutoring system, there are five levels of increasingly difficult math problems to which students would work through step by step with the help of guidance from the program. Every time the student provides an answer, *Lynnette* will provide feedback by turning red or green. Depending on the answer of the student, there will be different feedback from the tutor. Students can also request hints on how to solve the problem. The way students can pass a level is through answering enough questions correctly to be deemed as masters of the content (Long & Aleven).

ITS that are used in the classroom "reveal more about conceptions of learning than they do about what computers can or cannot do" (Bruce, 1990). They can represent the student's growing knowledge to catch misconceptions and address them before the misunderstanding grow (Bruce, 1990). To do this, ITS consists of two models, the domain, or pedagogical knowledge,

model and the student model. The domain model consists of knowledge from experts which is then used as a standard for comparing and evaluating student's performance. An example of the domain model from Ande's physics tutor are the kinematic equations needed to answer the problem. The student model consists of "all the aspects of the student's behavior and the knowledge that have repercussions for his performance and learning" (Wenger, 1987). Essentially, the student model should be a data collection of all possible misconceptions that students may have of the subject. This student model is what makes ITS a personalize tutoring tool to help students learn. Using the student model to track and evaluate student's answers to the domain model will place students at levels where it is challenging but not too difficult. This is a way to personalize the program to student. These programs are used in standardized tests in middle schools where students answer questions and with every question that they answer, the program provides harder problems to move them to a higher level or provide them the same question to confirm that they are at that level. Through the usage of ITS's knowledge and student model function, ITS became a popular tool used in the classroom and, specifically, for students who are behind in learning a certain subject or topic because it accommodates to individual student's learning styles.

Motivation in ITS

Motivation in an ITS environment is commonly understood through cognitive theory, such that students can learn to be motivated if associated with the attributes of a motivated student (Anderson, Boyle, Corbett & Lewis, 1990). ITS environments determine student attributes that support motivation through computational models such as the ARCS Model of Motivational Design. These models analyze the attributes that may contribute to student's motivation through usage of educational data mining (looking and organizing data) such as

randomization trees (quantify data) to categorize the different behavioral skills that students do while working towards their goal. (Naghizadeh & Moradi, 2015; Chase, Chin, Oppezzo & Schwartz, 2009). According to the ARCS model, motivation can be categorized into four categories: attention, relevance, confidence and satisfaction (Keller, 1987). Breaking it down even further there are seven features that can call between one or multiple categories that affects student's motivation in ITS. These features are: task time, grade, task difficulty, student interest in subject, accordance between content and student's learning style, skill level and previous motivational state (Naghizadeh & Moradi, 2015). It has been difficult to measure motivation in ITS programs because of the limitations in what metric to use to measure. If using a self-reported metric question, the data will have a certain level of error. If researchers place points on the metric, then it could be bias towards what the researcher views is being motivated and unmotivated.

Recent research around motivation in ITS consists of the integration of affective learning into ITS. Integration of affectivity means "providing computers the ability of recognize emotional states of students" (Jimenez, Juarez-Ramirez, Castillo, Ramirez-Noriega, 2017). In Jimenez et al's research on researching motivation in ITS, inclusion of dialogue between the computer and student creates a more positive motivation to students who are facing learning difficulties and is neutral to students who are not facing learning difficulties (2017). This falls in line with the idea that ITS is typically used in remedial cases where students need extra help to learn the subject material.

Limitations of ITS

Although providing one on one instruction with feedback and hints helps students learn subject materials, ITS has its limitations. First, some ITS programs, such as Ande's tutor, are

equip with bottom-out hints which explicitly tells the student how to solve the problem if they worked through the three-hint sequence imbedded into the program. Once students realize this trend, students can quickly pass through the program by consistently asking for hints and solving the problem with the bottom-out method (VanLehn, 2005). If students do this, they are not learning the material; instead they outsmarted the system. Secondly, the programs are created with one student interaction in mind, therefore not taking into account social relations happening around them. It also does not create a collaborative environment where students can discuss with other students to solve a common problem. Although teachers can encourage discussion with each other, ITS are typically used at times of assessment such as the middle school state tests in Wisconsin, writing an essay or being assessed to move up a level in remedial education such as *Read 180*. If every student has their own ITS system on their computer, students would want to finish their own problems first rather than discussing the problem with each other. As mentioned, there is learning that happens through discussing with each other. Game Based Learning environment can provide the collaborative space for learning while also providing an ITS-like system with feedback and hints.

Game Based Learning

There are many elements that comes to play when designing a GBL environment. Design elements from behaviorists, cognitivists and constructivists theory are combined to create a game. Behaviorist theory in gaming is to show an object, announce the object then question the player about the object. From there, the game would show how the object is made or done and evaluates the performance of the player by how well they recreate the object. Cognitive theory in gaming believes that players learn through the five senses and recognition through memory. Therefore, if the game is teaching with a cognitive view, they would start with small chunks of

information for students to learn then slowly add more chunks. The game would also activate long term memory experiences from players by asking to return to a place that they have not gone to in a while. If a game is created from a constructivist theory viewpoint, then the game would have multiple angles of one scenario, so players are able to construct their own understanding of the situation. Discussing with different non-playable characters in game, discussing and working with peers are examples of constructivist theory ideals (Driscoll, 2004; St-Pierre, 2011).

How GBL support learners

No matter which design element the game was pulled from all have the same common characteristic: playfulness (Plass, Homer & Kinzer, 2015). Playfulness means there is some form of engagement with the game such as competition between teams, exploration of an area, or a goal to reach. These engagements are cognitive (mental thinking), affective (emotional), behavioral (gesture) and sociocultural engagement (social interactions in a culture content) (Plass et al., 2015). Additionally, other characteristics include space and territory, rules and instructions, and competition or cooperation. According to Rene St-Pierre (2011), all these characteristics support students in the following (pp. 84-85):

- Competence and skill development
    - Ability to communicate and work collaboratively
    - Ability to resolve problems
    - Ability to use numbers
- Ability to Equip Oneself Effectively
    - Mastery of content
    - Mastery of structures, systems and procedures

- Ability to interact with the world
    - Development of attitudes, communication and cooperation
    - Comprehension of sender-receiver roles
    - Knowledge of how to evaluate different types of discourse
    - Decision-making
    - Ability to analyze a context, anticipate results, design strategies for carrying out/managing a project

The way game-based design can support these developments in students can be seen in figure 1 from Plass et all showcasing a design of the learning theory embedded in a game. In this Magic Circle, the three prongs are challenge, feedback and. Within that are the game design features such as learning and assessment mechanics (feedback), narrative design (story) and aesthetic design (overall feel). Figure 2 shows an integrated design framework of game based of playful learning (Plass et al). Both figures show that the design of GBL pulls from multiple learning theories with the core being content knowledge and assessment as well as core features from games to keep students engage. Due to the vagueness of what consists of GBL, designers can be flexible in their creation and adapt the game to best fit their students. Some games adapt to player's emotions (Hudlicka, 2011), others provide rigid rules, and some have no rules.

Motivation in GBL

GBL motivates students through its accommodating and adaptive design by providing students with the autonomy to play the game in their own style. According to Deen and Schouten, there are four types of playing and learning styles: theoretical, pragmatic, interpersonal and self-expressive (2007). Taking *Final Fantasy XV* (Square Enix, 2016) as an example. Players who falls into the theoretical playing and learning style would like the bestiary

(information about enemies such as their weaknesses), ingredients for new cooking recipes and magic flask creations. In contrast, pragmatic players enjoy repetitive trial and error gameplay. They would enjoy *Final Fantasy XV*'s monster hunter missions because of the repetitiveness of defeating the same monster over and over to obtain materials and rewards. Deen and Schouten states that interpersonal playing and learning styles are players who enjoys discussing their problems or game play with other members of the same gaming community (2007). These players enjoy talking to others on forums, participating in online events and watching YouTube videos who play the game. The fourth learning and playing style is self-expressive which are the players who enjoys exploring the game to find loopholes. These players would also enjoy setting goals for themselves such as finishing the game as efficient as possible (speed running).

GBL allows students to play in their own style which gives them the autonomy to take ownership in their own learning. Unlike ITS, which is not as adaptive to player's learning style, GBL's strong point is the flexibility of the design. This flexibility motivates students to continue their learning. Recent educational games "are grounded in social constructivist learning theory" which are "concerned with the individual's interaction with others in a context…in which an activity occurs." (Toprac, 2011). Social constructivists believe that motivation is the "engagement to maintain interpersonal relationships and identity in a person's community" (Greeno, et al., 1996 in Toprac, 2011). GBL provides the collaborative space where students can discuss with one another when playing a game such as in *The Frequency 1550*. As research suggests, peer to peer dialogue and interaction creates a sense of relatedness which can be achieved in a social environment (Cazden, 2001; Deen & Schouten, 2011). This sense of relatedness in a social environment provides the opportunity for students to discuss with one another what is happening in the game and to question unknown situations that they are

unfamiliar with. This help students situate their identity and background to the context of the game. To fully understand motivation in a context where games respond and adapt to their players, it is important to examine the interaction between an individual's identity and their contexts (Nolen, Horn, & Ward, 2015). Questions such as, 'are the contents of this game familiar to students?' Or 'are students not understanding this because they do not know the context that this game is situated in?' are questions to ask when assessing motivation in GBL.

Relationships between middle school peers have an influence in student's well-being at school as well as their motivation (Kathryn, 1998). Therefore, creating an environment where students are allowed and encouraged to work together and discuss problems together would help support students in their learning. Assessing motivation in GBL is still very vague. The ARCS model used to assess motivation in ITS can be used to measure motivation in GBL. Another way is through dialog-based interactions where observation of students interacts with each other. Game-play based interaction can also be used to track student's movement through the game to see if they are moving towards the end goal of the game. One clear indication of motivated behavior is when teachers do not have to remind students to return to their seats during break time (Toprac, 2011).

In addition to the collaborative aspect to GBL, ITS functions can be incorporated into GBL. Scaffolding, or hints, can help students connect the contents of the game and the contents they are learning in class (Chansky & Mims, 2008; Neulight, Kafai, Kao, Foley, & Galas, 2007 from Chen & Law, 2015). Chen and Law's (2015) research on scaffolding in GBL showed that scaffolding was positive in relation to learning performance. Scaffolding that explicitly tells students what to do such as an instruction in the game telling students to talk to a person,

positively increases student's motivation to discuss and collaborate with their peers and to continue the game.

Limitations of GBL

Although GBL provides a collaborative space where students have the autonomy to learn in their own way as well as discuss their ideas with one another, there are also limitations. Designing GBL for teachers may be difficult because teachers need to identify what in the curriculum is relevant and the core aspect that students need to learn. There is also a lack of time and resources for teachers to become familiar with GBL to design the highly specific scenario that they want to use in their classroom. Additionally, there are many technical and software problems with technology which adds another stress to teachers (St-Pierre, 2011). In addition to helping students work through a problem and monitor the class, teachers must also worry about technical problems that may or may not be in their control. For example, if wifi is required to start the game but is down for the day then teachers cannot do anything about it.

Summary

Collaborative learning between peers is important in motivating middle school students to learn the topic at hand. Although computers provide a space to collaborate, the structure of ITS is better in a one to one setting whereas the structure of GBL is geared to a space where students interact with each other. By interacting with one another, students work together to sort their new learning to themselves and stay motivated to continue the game through their internal motivation as well as usage of external motivation. If the student gains an interest of the topic then their intrinsic motivation also propels them to learn the topic.

The integration of technology into schools paved a path for ITS and GBL to put their food in the door of classrooms. Although both are adaptive to student's learning, ITS follows a tutoring system structure where the main goal is to assess whether students learned the material through answering several questions correctly. ITS provides a certain number of hints before providing the answer with the bottom out method. An ITS can be a series of questions, short responses and breaks down the overarching question into steps. Limitations to ITS is the loophole of hints that students may find. If a student realizes that after asking for a certain amount of hints the ITS provides the answer, then the student may not actually be learning the material. There is also a possibility that students would become frustrated at the program because they do not have their peers as resources if each student has their own work on their own computer.

On the other hand, GBL is design with the learning outcome of the subject in mind while keeping its playfulness. Students will be able to play the game in accordance to their own learning and playing style however the environment created in GBL is a collaborative environment. If a student does not understand the content of the game, he or she is encouraged to ask their peers or partners. This collaborative environment while providing the support for student learning motivates students to continue learning. However, there are also limitations to GBL such as the cost and resources needed to support this type of learning environment, extra responsibility on teachers to learn how to integrate GBL into their classroom as well as the technology aspect they must also learn.

Future Implications and Conclusion

For future research or applications of GBL I can imagine it changing the way students learn about certain literature. Rather than reading classic books such as McBeth in old English,

teachers or students can use GBL to create their own tragic story. Teachers can also use existing games as a basis to generate ideas. For example, if teachers want to use GBL to teach about tragedy, *Final Fantasy XV* can be used as a model to create a GBL experience. The story line of the game is a tragedy and as students play through there could be points where students must collect certain materials or watch certain scenes and write about it in a journal while they pretend to be the main protagonist Noctis. During scenes where it is a clear indication that a character has a flaw, questions or short answers can appear in the form of a journal asking students to reflect upon the characteristic of the character. At the end of the game, they can write their own persuasive essay arguing who they believe had the most tragic story. Students can argue that Noctis did due to his unfavorable circumstances of losing his father and home in a quick amount of time. Others can argue that Ardyn had the most tragic story because he was too trusting and therefore got tricked by his brother. Multiple character in *Final Fantasy XV* ends in a tragic story, allowing students to argue for their character. Although the game itself may not fit in a GBL classroom experience, teachers can use gaming elements from *Final Fantasy XV* to create a comprehensive GBL experience around the theme of tragedy.

ITS such as Ande's physics are programs that schools use to provide support for their student's learning. GBL is a fairly new concept that integrates games and curriculum into one cohesive lesson plan. Although both have their strong points, GBL provides an opportunity that ITS does not: creating a collaborative learning experience. GBL creates a safe space where students can discuss what they are learning with one another, work on problems or understand concepts in different aspects and create a more didactic environment. Although there are additional resources that needs to be in place for a GBL environment to work smoothly, GBL can be both an ITS and more if designed carefully.

Appendix

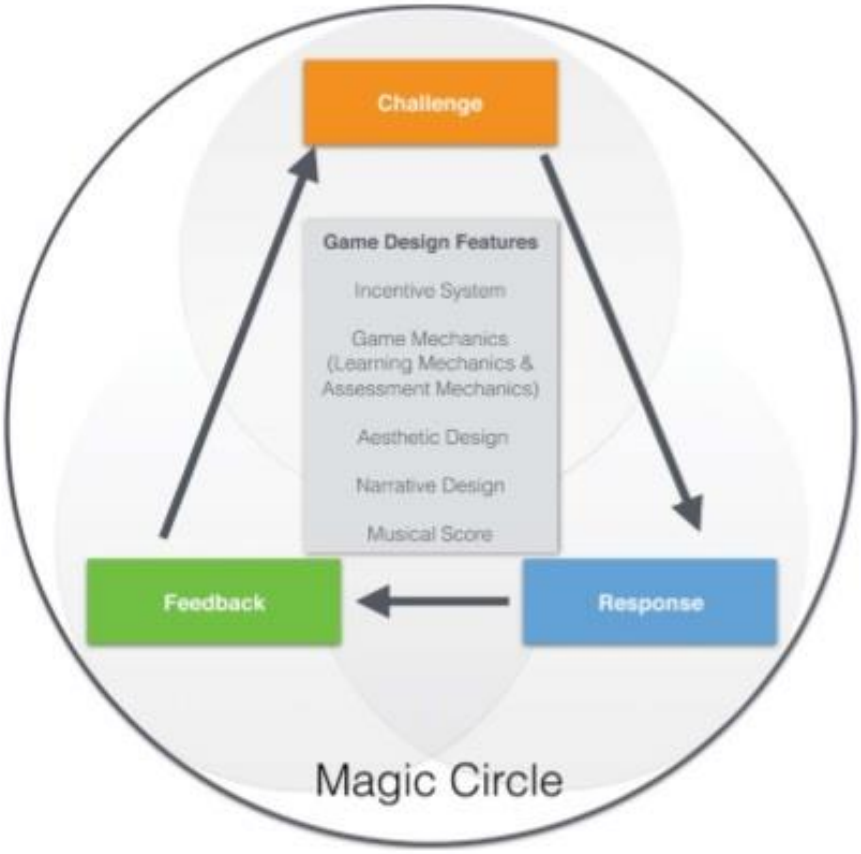

FIGURE 1 Model of game-based learning.

Figure 1: Model of Game-Based Learning

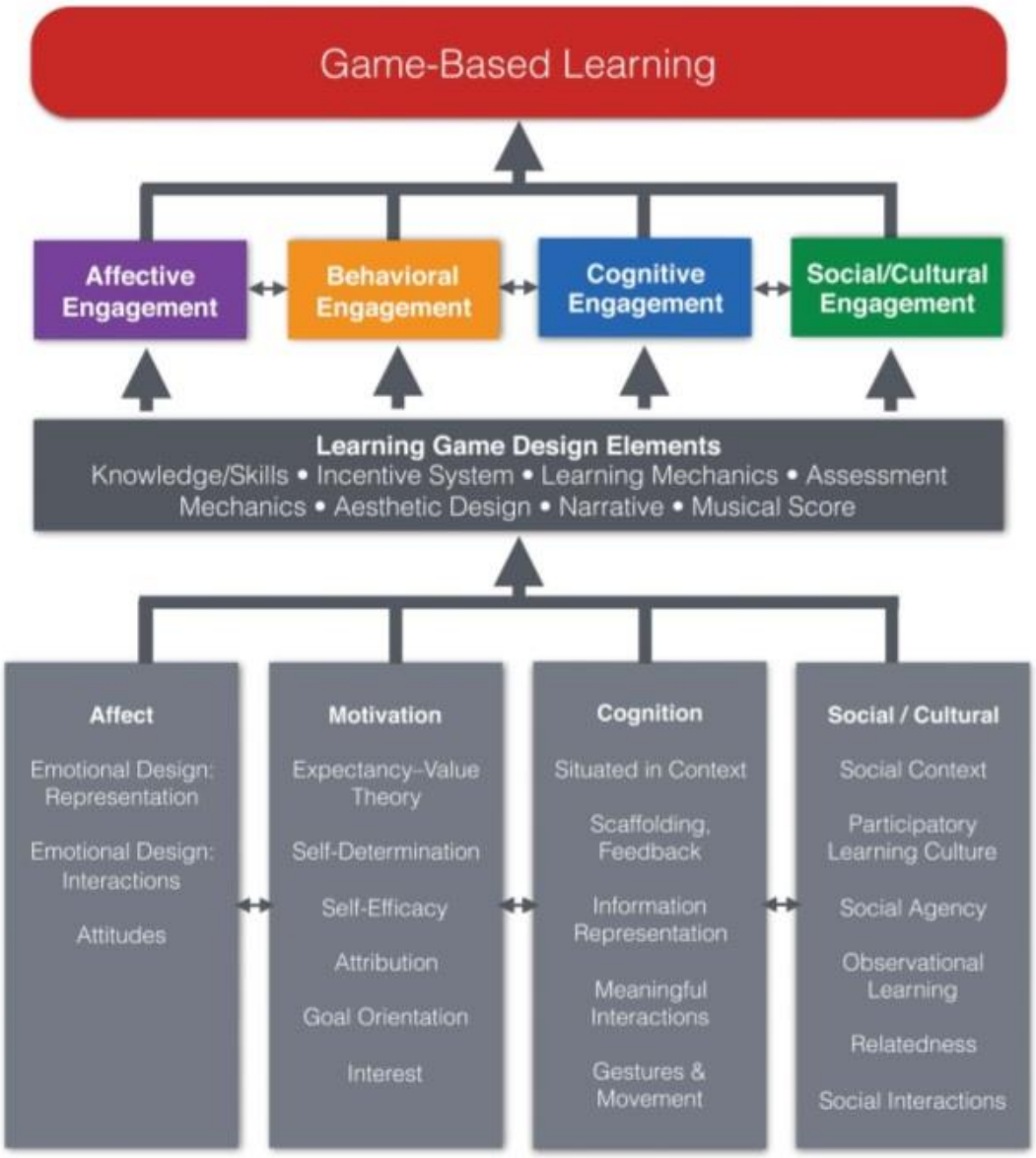

FIGURE 2 Integrated design framework of game-based and playful learning.

Figure 2: Integrated design framework of game-based and playful learning

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