Exploring How Individual Traits Influence Enjoyment in a Mobile Learning Game

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Title Page

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Exploring How Individual Traits Influence Enjoyment in a Mobile Learning Game

Abstract

This study investigated individual traits as predictors of game enjoyment by including learning style, intrinsic motivation, collaboration skills, and computer game attitude as key parts of a model that also included achievement. Results of correlation and regression analyses revealed that intrinsic motivation was the only variable to predict game enjoyment. This supports the conceptualization of enjoyment as need satisfaction of intrinsic needs. Enjoyment was also found to be positively correlated with achievement. Other significant relations emerged, particularly how a player's attitude toward games predicted intrinsic motivation. The present study examined children's enjoyment experiences in the mobile version of the Minecraft game. It also highlights the complexity of game enjoyment as it relates to mobile learning games.

Keywords: Enjoyment; Mobile learning game; Learning styles; Collaboration skills; Computer game attitude; Minecraft

1. Introduction

For many years, the role of play in children's development has been widely recognized by researchers and educators. Children often play either individually or collaboratively for fun and enjoyment. Play provides a means for children to learn and explore in a more meaningful way. In a sense, play is an autotelic and voluntary act that requires intrinsic reasons (Feezell, 2010). However, when placed in the context of work or education, play is often seen as a frivolous activity. Despite such criticism, play was shown to contribute to children's social, cognitive, and emotional development (Fisher, Hirsh-Pasek, Golinkoff, & Gryfe, 2008). Additionally, Brown (2009) contends that the improvisational potential of play makes individuals less rigid in their ways of doing things and more open to change, including displaying new behaviors and thoughts.

Perhaps the most interesting behaviors that an individual displays when engaging in play are devotion and persistence. In video games, for instance, it is common for players to extend their

interactive experiences with the game and persist in accomplishing their goals regardless of failure. In fact, experiencing failure has been shown to be an important element in game enjoyment (Juul, 2009). The importance of the element of enjoyment has been widely stressed in learning and education. Lack of enjoyment and boredom can be linked to disengagement and failure in learning (Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2003).

In video games, engagement is considered a replication of pleasurable associations similar to the ones experienced in childhood play where mistakes are expected and tolerated (Hoffman & Nadelson, 2010). More importantly, while also considering the complexity and multifaceted nature of the concept of engagement, empirical investigations had indicated that engagement can predict enjoyment (Lyons, et al., 2014; Przybylski, Ryan, & Rigby, 2009; Ryan, Rigby, & Przybylski, 2006). Thus, in various situations, notably in the academic context, engagement triggers positive emotional experiences including fun, enthusiasm, and commitment to hard work (Niemi et al., 2014). Taken in sum, learning can only take place if there is a willingness to engage and persist. But, unless the tasks are perceived enjoyable, motivation and persistence are less likely to occur (Lumby, 2011).

Facing the popularity of video games in educational settings and the complexity of player psychology, researchers had begun to investigate various factors that contribute to enjoyment, including interactivity (Klimmt, Hartmann, & Frey, 2007), suspense (Klimmt, Rizzo, Vorderer, Koch, & Fischer, 2009), competition (Vorderer, Hartmann, & Klimmt, 2003), and spatial presence and perceived reality (Shafer, Carbonara, & Popova, 2011). To date, little empirical work has been done to describe the association between individual traits and video game enjoyment, particularly in mobile game settings. In sum, the current study aims to test an integrative model that examines (1) the relationships between enjoyment and certain individual traits, notably learning styles, collaboration skills, intrinsic motivation, and game attitude and (2) the association between enjoyment and achievement. The relationships included in the model are theoretically and empirically supported to provide a more comprehensive understanding of how players' traits can determine the level of game enjoyment rather considering single traits separately.

1.1. Individual traits and enjoyment

Researchers have attempted to define the concept of enjoyment without universal consensus. In the particular context of media enjoyment, past studies have broadly defined enjoyment as a pleasure response but are still short of conceptual clarity (Tamborini, Bowman, Eden, Grizzard, & Organ, 2010). To provide a more comprehensive model to complement the hedonic components and highlight the non-hedonic aspect of the enjoyment concept, Tamborini et al. (2010) proposed and validated a model of enjoyment as need satisfaction by investigating the three basic needs in self-determination theory: autonomy, competence, and relatedness. Their findings also suggested that media enjoyment can potentially be the result of the satisfaction of intrinsic needs. Based on their study, which built on the work of Ryan et al. (2006), Tamborini et al. broadly defined media enjoyment as need satisfaction. Thus, enjoyment may not only be limited to pleasure responses of media use. The tripartite model by Nabi and Krcmar (2004) conceptualized enjoyment as an attitude and suggested cognitive, affective, and behavioral reactions to game enjoyment. That is, the type of attitude shown towards a particular media offering is a strong indicator of the extent to which the media have been enjoyed. Other concepts of video game enjoyment may also reside in control or performance itself (Grodal, 2000), flow states (Sherry, 2004), and social interactions (Gajadhar, de Kort, & Ijsselsteijn, 2008). This complex process of enjoyment goes beyond the assumption that enjoyment is merely a product of positive feelings or inputs, particularly in video games (Shafer, 2012). For instance, Oliver (2009) highlights that even media that produce negative emotions, such as sadness, can be enjoyed to some extent.

There are implications within media enjoyment theories that a player's personality and enjoyment are closely related (Fang & Zhao, 2010). The study by Fang and Zhao (2010) in particular has shown that sensation seeking and self-forgetfulness, as two personality traits, may have a significant impact on computer game enjoyment among university students. To reinforce past video game studies, the present study investigates the combined effect of both attitude and intrinsic motivation on enjoyment, which previous studies have addressed separately. Additionally, this article explores other factors such as learning styles and collaboration skills that have often been overlooked as determinants of enjoyment, particularly in video games used in educational and mobile settings.

1.1.1. Learning style and enjoyment

The concept of learning style, used interchangeably with cognitive style (Simpson & Du, 2004), refers to the idea that individuals are different with respect to what is considered the most effective method of instruction or study (Pashler, McDaniel, Rohrer, & Bjork, 2008). According to Cano-Garcia and Hughes (2000), it is difficult to find consensus on the definition of learning style because researchers tend to focus on one of the dimensions of the learning process. Previous studies suggest that learning performance could be improved when learning style dimensions are adequately addressed in the design of learning systems (Filippidis & Tsoukalas, 2009; Hsieh, Jang, Hwang, & Chen, 2011). For instance, it was shown that fifth graders who learned with personalized educational video games that addressed their learning styles performed better than those who used computer games that did not meet their learning styles (Hwang, Sung, Hung, Huang, & Tsai, 2012). The study by Simpson and Du (2004) explored the relationship between students' learning styles and enjoyment in a distributed learning environment and found that a student's learning style had a significant effect on student's self-reported enjoyment levels. In general, video game research has rarely explored the relationship between learning styles and enjoyment. This leads the present study to investigate the link between players' learning styles and the level of enjoyment they experience. Specifically, it is hypothesized that a student's learning style will predict the level of enjoyment in a mobile learning game.

1.1.2. Collaboration skills and enjoyment

Collaboration is broadly defined as a particular form of interaction that requires participants to engage mutually in a task. Players in shared virtual worlds can work collaboratively to achieve common goals, thus establishing a sense of community through social interactions. Previous studies showed that children who worked together in small groups experienced increased enjoyment (Scott, Mandryk, & Inkpen, 2003) and that flow experiences also occurred when children played video games in a group (Inal & Cagiltay, 2007). In general, collaborative gaming involves cooperation with other players to reach common goals. Some factors, such as competitiveness, allow players to demonstrate their game competence to other players (Kaye & Bryce, 2012), which can also lead to enjoyment of the experience. However, there is always the possibility of a conflict among group members as a result of different visions or strategies. That being said, it seems reasonable to assume that the level of enjoyment players get from a collaborative experience in gaming is dependent on how they perceive their skills to collaborate

with others in the group. Therefore, it is hypothesized in this study that more positive collaboration skills will predict a higher level of enjoyment.

1.1.3. Intrinsic motivation and enjoyment

There are many reasons to expect that intrinsic motivation might increase game enjoyment. First, players who are intrinsically motivated engage in a game task to seek enjoyment or challenge while external reward may play a little to no role in the process. In fact, Ryan and Deci (2000) suggest that individuals who are intrinsically motivated enjoy an activity more when compared to those who are extrinsically motivated. More importantly, these principles of self-determination theory have been argued to be relevant in the context of video games (Przybylski, Rigby, & Ryan, 2010). For the present study, it is predicted that players who are more intrinsically motivated will experience higher levels of enjoyment.

1.1.4. Computer game attitude and enjoyment

Previous attitude studies have measured computer users' attitudes using enjoyment as a variable (Christensen & Knezek, 2001; Knezek, Christensen, & Tyler-Wood, 2011). Other empirical work supported a positive relationship between perceived enjoyment and attitude towards the use of technology (Lee, 2009; Wu & Liu, 2007). Specifically, the study by Wu and Liu (2007) showed that online gaming enjoyment was a significant predictor of attitude. In the context of mobile games, Chinomona (2013) found that mobile gaming perceived enjoyment had a direct positive effect on attitude towards mobile gaming intention. Based on these findings, the present study extends on past research to investigate whether one's attitude towards video games is related to game enjoyment in the context of a mobile learning game.

1.1.5. Enjoyment and achievement

Gaming achievements such as in-game stars or badges are often considered part of the primary reward system inside the game (Hamari & Eranti, 2011). Aabom (2014) argues that accomplishing challenging tasks and goals inside the game is considered an achievement that is player defined in nature and goes beyond the graphical representations of rewards inside the game. In other words, a task achievement brings its reward. In the context of academic achievement, Shernoff, Knauth, and Makris (2000) contend that flow experiences help students

learn to enjoy the challenges that can help them achieve their goals. In a sense, enjoyment, as a learning behavior, triggers other positive behaviors such as motivation and persistence in learning. When considering a reciprocal effect, Low achievement is considered a risk factor for the enjoyment of learning (Hagenauer & Hascher, 2014). In fact, students with poor academic achievements are at risk of losing interest and motivation to learn over time because learning activities are no longer perceived enjoyable. Empirically, it was shown that a student's performance and effort were correlated with enjoyment (Schukajlow & Krug, 2014). Enjoyment was also shown to predict academic achievements (Ahmed, Van der Werf, Kuyper, & Minnaert, 2013). Assuming similar relationships in video game contexts, the present study assumes that game enjoyment is associated with achievement.

1.2. Minecraft as a mobile learning game

1.2.1. Introduction to Minecraft

Minecraft is a multiple award-winning sandbox game that has become popular in recent years. Similar to other sandbox games, Minecraft players do not have to follow a strict linear story found in other game genres (Ocio & Brugos, 2008) and are free to roam and explore the virtual worlds they build out of blocks with almost no constraints (Bebbington & Vellino, 2015). In addition to the endless possibilities offered by creative play within the virtual worlds of Minecraft, the gameplay also revolves around collaboration, exploration, and adventure (Zorn, Wingrave, Charbonneau, & LaViola, 2013). Players can either play individually or collaboratively with other players in two game modes: creative and survival. In creative mode, players face no threats and can use their creativity to build and design different structures ranging from simple building to more complex structures and cities using the unlimited resources at their disposal. In survival mode, on the other hand, a player must survive hostile environments and the life-threatening creatures or "mobs" at night by creating structures for shelter and crafting items to battle the mobs while managing health and hunger to survive the game. However, since Minecraft does not include a manual of how to play the game, players are often required to search and locate online resources for information (Thompson, 2014). YouTube, for instance, has proven to be a popular social platform for Minecraft players to share their work on replicated real world environments and to receive feedback (Morelli, 2015). The importance of peer feedback in a Minecraft community, according to Morelli (2015), may play a role in the

popularity of the game since feedback, not score, is what motivates good players to perform at a high level.

1.2.2. Minecraft's characteristics as an educational tool

At its core, Minecraft is an open-ended game that offers its users a great deal of freedom and flexibility in how to play the game. When used as a learning tool, it can be accessible and appealing to almost everyone including technology laggards because of the simplistic lego-like concept of play that requires minimum instructions to play. In addition to allowing students to express their curiosity through investigation, research, and creation (Wernholm & Vigmo, 2015), Minecraft incorporates certain characteristics of game-based learning environments that give players a sense of ownership and provides tools to express creativity (Duncan, 2011). Similar to many educational video games, Minecraft allows students to play a more active role and to be part of the learning environment rather than passively listening to more experienced individuals (Sáez-López, Miller, Vázquez-Cano, & Domínguez-Garrido, 2015).

Brand and Kinash (2013) highlight two potential learning objectives when Minecraft is used as an educational tool: an affinity space and a simulation environment. An affinity space, according to Gee (2004), is an informal learning environment where participants are engaged through shared interests and goals and where both newbies and experts can share a single space. Participants in affinity spaces learn based on their purposes and identities while bridging gaps around participants' age and technology levels, unlike in traditional classroom settings where students are often segregated by grades or skills (Gee, 2004). The second potential learning objective when using Minecraft as a learning and teaching tool is the creation of a simulation environment. At the present time, educators are using Minecraft as a virtual environment in STEM subjects to provide visual illustrations of different scientific concepts such as the features of body cells (Brand & Kinash, 2013). Minecraft is also used in other subjects such as art, geography, and history where students can design and build structures and buildings of different historical eras while advancing their artistic skills.

Another positive educational feature of Minecraft is promoting an information-seeking behavior among students. In fact, to play the game more efficiently, players are encouraged to seek information not only within the game environment but also through external resources such as

discussion forums, video tutorials, and blogs (Bebbington & Vellino, 2015). Moreover, because of the open-ended nature and the sandbox design of the game, Minecraft can also be modified to address core academic standards (List & Bryant, 2014).

1.2.3. The various educational usages of Minecraft

Video games can potentially change the existing educational landscape as we know it (Williamson, Squire, Halverson, & Gee, 2005). The virtual worlds provide a possibility to develop situated understanding through which learners can experience more concrete realities and draw connections between abstract concepts and real-world problems (Williamson et al., 2005). In video games, like Minecraft, there is more emphasis on playful exploration than on mastery since players can learn the game basics in less time then proceed immediately to match purpose with scale (Brand & Kinash, 2013). In addition to fostering a collaborative behavior, video games can promote higher-order thinking and social skills (Dondlinger, 2007; Steinkuehler & Duncan, 2008). More importantly, using Minecraft as an environment for game-based learning provides opportunities to create an immersive and interactive curriculum (Sáez-López et al., 2015).

There are many modifications (also known as mods) that are available and shared in the Minecraft gaming community that players can use to change game environments and playing experience (Morelli, 2015). Both educators and learners alike have a variety of virtual environments they can use as a learning contexts to design learning activities without having to create and build virtual environments from scratch, especially if building and designing environments is not the intended outcome. Regarding classroom use, Minecraft can be utilized as a cross-curricular learning tool. Morelli (2015) reports how Minecraft was used to promote active learning including teaching students about online behavior and how to design buildings from the Roman Empire era. Minecraft, according to Short (2012), is also used in other disciplines such as biology, ecology, math, physics, chemistry, and geology and geography. In biology, for example, players can create custom textures to help visualize and investigate different functions within the human body including cellular activity. In Chemistry, MineChem is an example of a modification that is available for free. This 3-dimensional representation of the periodic table of elements provides information on important uses and properties of the

elements using sign posts (Short, 2012). While it is evident that Minecraft can be a useful teaching tool in different subjects and disciplines, the open-ended concept provides a tool for educators to express their creativity equally while designing various instructional activities.

MinecraftEdu is the educational version of the game that was developed specifically to bring the Minecraft experience to the classroom. This release provides new and enhanced features that allow teachers to supervise students while in play and to freeze or mute students to redirect their attention to the teacher when giving instructions. According to MinecraftEdu website, more than 5,500 educators in over 40 countries have used this educational version of Minecraft for different subjects ranging from STEM to history and art.

Some studies have explored the potential of teaching programming in Minecraft environments (Wilkinson, Williams, & Armstrong, 2013; Zorn et al., 2013). For example, a robot control programming language in Minecraft called CodeBlocks was shown to improve non-programmers and Minecraft players' perceptions of programming in general (Zorn et al., 2013). A similar study by Wilkinson et al. (2013) found that 69% of Minecraft workshop participants (primarily female) who previously indicated no desire to pursue a career in computer science changed their mind in a post-survey as a result of exploring the "fun" side of programming. Wilkinson et al. (2013) also maintained that the increasing number of modifications in Minecraft has provided an array of possibilities, particularly when teaching and learning programming.

2. Material and methods

The purpose of this study was twofold: a) to investigate whether individual traits- e.g., learning styles, collaboration skills, intrinsic motivation, and computer game attitude- could predict the levels of enjoyment, and b) to explore the relationship between enjoyment and achievement.

The hypothesized model was constructed based on six hypotheses. First, this study sought to explore learning styles as a predictor of game enjoyment and collaboration skills. Since learning styles represent the differences in how students prefer to learn, the study assumed that participants with certain learning styles would experience higher levels of game enjoyment. These differences in learning preferences were also predicted to be linked to a player's perceived

collaboration skills. Additionally, collaboration skills, intrinsic motivation, and computer game attitude were considered as independent variables that predicted game enjoyment. Lastly, researchers introduced game enjoyment as a predictor of achievement in an attempt to explore whether there was a direct association between these two variables.

2.1. The Proposed model
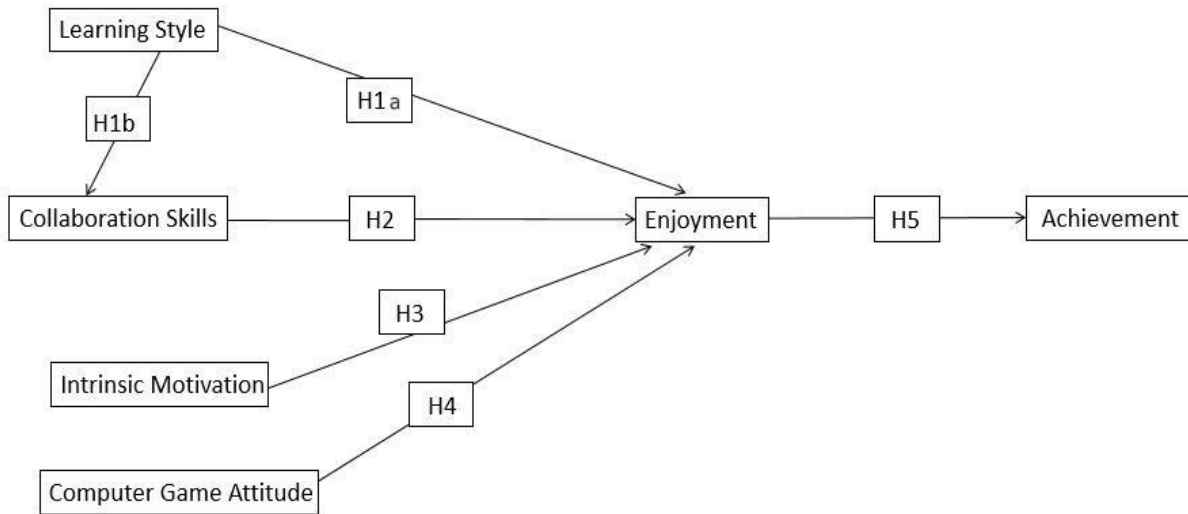
Fig 1. Proposed Model

H1: a) Student's learning style will predict the level of enjoyment

b) Student's learning style will be positively linked to the level of perceived collaboration skills.

H2: More positive collaboration skills will predict higher levels of enjoyment.

H3: Students who are more intrinsically motivated will experience higher levels of enjoyment.

H4: More positive computer attitude game will predict higher levels of enjoyment.

**H5:** Game enjoyment is positively related to gaming achievement.

2.2. Participants

One hundred sixty-four, eleven and twelve-year-old students (97 boys and 67 girls) from two mid-size elementary schools in South Korea participated voluntarily in this study. Participants were recruited via in-person announcements in classrooms. Sixty-six students were from the

same school while ninety-eight students were from a different school. These two schools are located in the same city, and participants from both locations followed the exact same research procedure. On average, students spent one and half hour a day playing the mobile version of Minecraft. Students also indicated that they had known about Minecraft game for about three years. In terms of gaming levels, 75 students rated their Minecraft skill levels as high, 86 students rated their skills as moderate, while 3 students rated themselves as beginners.

2.3. Procedure and data collection

Participants played the mobile version of Minecraft for one and a half hours every day after school for three weeks on their own initiative. The mobile devices participants used were the Samsung Galaxy S5 running Android OS and with 16 G memory. Participants were briefed on the nature of the activity in that it was not real and that it differed from real world experiences to avoid alterations in thoughts and perceptions as a result of transfer of experiences for virtual to real world, and vice versa. They were then given two tasks for their game play: one was to replicate a maze of their choice in Minecraft from three levels of difficulty (Fig. 2), and the other was to build their school's main building with a playground.
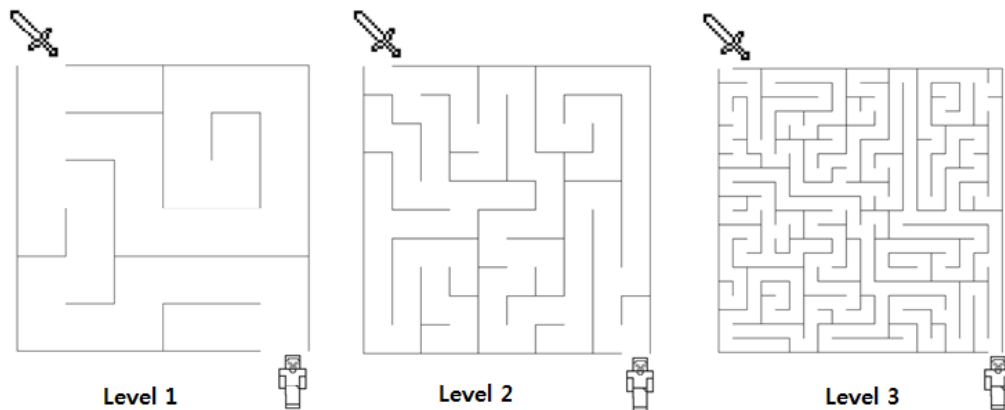

Fig.2 Difficulty levels of Maze

Three students were assigned in a group, resulting in twenty-two groups in the first school and thirty-three groups in the second school (only one group had two members). For about twenty

minutes every day before their individual game play, students engaged in discussions about game strategies to improve their skills and to solve any problems as a group.

On the first day, the Computer Game Attitude Scale was administered as a pre-test. Minecraft tasks and the evaluation criteria were explained to the participants.
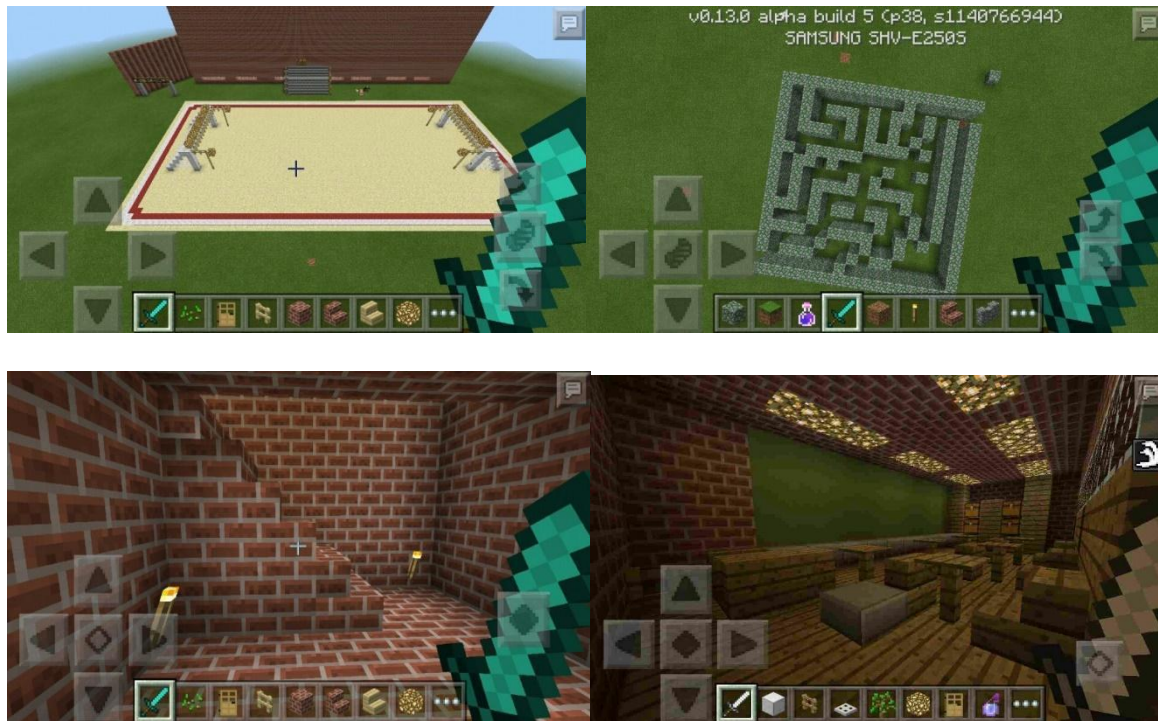
Fig.3 Maze, Playground, and school

After three weeks of gameplay, students were given the Enjoyment Test, the Learning Style Inventory of Felder-Silverman's, the Computer Game Attitude Scale (CGAS), the Intrinsic Motivation Inventory, and the Collaboration Attitude Test (Collaboration Multiple Group Model).

2.4. Psychometric properties of measures

2.4.1 Enjoyment

Enjoyment was measured using the instrument developed by Fang, Chan, Brzezinski, and Nair (2010). The scale is based on the tripartite model of media enjoyment (Nabi & Krcmar, 2004) and measures the affective, cognitive, and behavioral reactions of enjoyment of computer game.

This 11-item instrument also comprises three scales with acceptable level of reliability on all three dimensions. Cronbach alpha for affect, behavior, and cognition were 0.73, 0.83, and 0.77 respectively (Fang et al.,2010).

The affect dimension of the instrument contains five items of which four are items are reversed that focus on negative affect during gameplay (I feel unhappy/I feel exhausted/ I feel worried/I feel miserable then playing this game). The three items on behavior are aimed to assess the player's viewing intent and behaviors while the three items on cognition focus on judgments of characters' actions during the gameplay (Fang et al., 2010).

2.4.2. Learning Style-Felder-Silverman's

The Index of Learning Styles (ILS) was created by Felder and Solomon (1991) to assess preferences on four dimensions of the Felder-Silverman learning style model (1988): sensing-intuitive, visual-verbal, active-reflective, and sequential-global (Felder & Spurlin, 2005). The ILS is a 44-item questionnaire with 11 forced-choice items representing each learning style dimension. Each item on the questionnaire is answered with either 'a' (value of +1) or 'b' (value of -1). Answer 'a' corresponds to the preferences of the first pole of each dimension (i.e. sensing, visual, active, and sequential) while answer b highlights the preferences of the second pole (intuitive, verbal, reflective, and global) (Graf, Viola, Leo, & Kinshuk, 2007).

Felder and Spurlin (2005) highlight three studies that were performed to test-retest reliability measurements of the ILS (Livesay, Dee, Nauman, & Hites, 2002; Seery, Gaughran, & Waldmann, 2003; Zywno, 2003). A Cronbach alpha of 0.75 or greater is acceptable to measure achievement and 0.5 or greater is acceptable to assess attitude (Tuckman, 1999). Accordingly, Livesay et al., Seery et al., and Zywno all reported an alpha value that exceeds the criterion value of 0.5 in the four dimensions of the model. Thus, Livesay et al. and Zywno, in particular, concluded that the ILS is a suitable instrument to assess learning styles based on their reliability and validity data (Felder & Spurlin, 2005). For the purpose of the present study, authors recoded the scale to make it four continuous scores using a 5 point- Likert- scale. For example, on the active and reflective scale, 5 and 4 mean Active, 2 and 1 mean Reflective, while 3 implies a balanced preference. In other words, a higher score on this scale means the respondent is more active and a lower score means the respondent is more reflective.

2.4.3. Computer Game Attitude Scale (CGAS)

We measured students' computer game attitude using the Computer Game Attitude scale (CGAS) by Liu, Kuo, and Chang (2014). This scale is a revised version of the New Computer Game Attitude Scale (NCGAS) previously developed by Liu, Lee, and Chen (2013). The CGAS was designed for early adolescents and is suitable for use by 2nd-grade elementary school children (Liu et al., 2014). It also contains 17 five-point-Likert scale items (5= Strongly Agree; 1= Strongly Disagree) within three subscales: cognition, affection, and behavior.

The cognition subscale includes two factors- confidence and learning-, and each factor contains four items to measure users' confidence and positive impact when playing a computer game in learning. The affection subscale of CGAS contains four items to examine the liking factor or perceived enjoyment for playing computer games. The third subscale, behavior, includes five items that aim to measure the leisure factor or how players perceive computer games as leisure activities. Principal Component Analysis with Varimax rotation was used to examine the validity of items within each factor. Liu et al. (2014) reported valid and reliable Cronbach's alpha values in all three subscales- cognition (Cronbach's alpha value =0.882); affection (Cronbach's alpha = 0.748); and behavior (Cronbach's alpha = 0.754).

2.4.4. Intrinsic motivation

The Intrinsic Motivation Inventory (IMI) can be used to assess users' subjective experience with computer games and was used in previous studies related to intrinsic motivation (Ryan, 1982; Ryan, Mims, & Koestner, 1983; Ryan, Koestner, & Deci, 1991). The IMI instrument contains 45 items and assesses users' experiences on seven dimensions: interest/enjoyment, perceived/competence, effort/importance, pressure/tension, perceived choice, value/usefulness, and relatedness. McAuley, Duncan, and Tammen (1987) conducted a study to test the validity of IMI and concluded that as many or as few of the items of the items can be used without having a significant impact on the psychometric aspects of the instrument. Hanus and Fox (2015) also reported a Cronbach alpha value of 0.86 on the 22- item scale used in Ryan et al. (1991). The scale used in the current study comprises 25 items within four subscales: interest/enjoyment, perceived choice, perceived competence, and pressure/tension. Items in IMI are measured on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Additionally, a total of 10

negative or reversed items are present in all four subcategories: interest/enjoyment (2 reversed items), perceived choice (5 reversed items), perceived competence (1 reversed item), and pressure/tension (2 reversed items).

2.4.5 Collaboration Attitude Test (Collaboration Multiple Group Model)

The Collaboration Multiple Group Model was developed by The National Center for Research on Evaluation, Standards, and Student Testing (CRESST) and used as a subscale of a survey which aimed to examine three dimensions of students' 21st-century skills: self-efficacy, oral communication skills, and collaboration skills (Huang, Leon, Hodson, La Torre, Obregon, & Rivera, 2010). The scale items were selected or adapted from scales established in previous studies (Bandura, 2006; Bruten, 1985; Kouros & Abrami, 2006) for students in both 4th and 5th grades who participated in the CRESST study (Huang et al., 2010). The 22-item collaboration test addresses three dimensions: peer interaction (15 items), process of collaboration (5 items), and product of collaboration (2 items). These items are measured using a four-item Likert scale (True, Mostly True, Mostly False, and False).

Regarding the reliability of the Collaboration Multiple Group Model, Huang et al. (2010) report a good internal consistency of the 21 items ($\alpha = 0.831$) when the negative item "I get upset when kids in my group say bad things about my work" was removed.

2.4.6. Gaming achievement

As noted earlier, two game tasks were given to participants. One was to build a maze and the other was to create a Minecraft replica of the school building where students were located.

The first task consisted of creating an avatar, creating a sword at the destination point, building two layers of the wall, and allowing the avatar to successfully navigate through the maze to reach the destination. The task had three levels of difficulty based on complexity of the maze, as shown in Figure 1. Participants' final mazes were assigned a total score of 100 points using the following criteria: a) 10 points for creating two layers of the wall, b) 10 points for accuracy of replicating the model mazes, c) 30 points for the overall structure, d) 30 points for choice of a difficulty level (i.e., 10 points for level 1 maze, 20 points for level 2 maze, and 30 points for

level 3 maze), e) 10 points for having a mobile avatar that successfully navigated to the end point, and f) 10 points for simply having an avatar in the game environment.

The second task consisted of creating a game replica of the main school building which had two stories and a playground with one track. The main building also had windows and a stairway leading upstairs. Similar to task one, the second task was assigned a 100 points, distributed as follows: a) 15 points for the balance between school building and playground, b) 15 points for building the playground and its track, c) 25 points for accuracy or closeness to reality, d) 10 points for including windows, e) 10 points for replicating the objects in both floors, and f) 25 points for including the stairway to the upstairs level.

Each student's final game product was evaluated and scored by two peers using rubrics created by study researchers. The average score from both task 1 and 2 was used as a final score to reflect student's accomplishment of game tasks.

3. Results

The predicted model hypothesized learning style, collaboration skills, intrinsic motivation, and computer game attitude as predictors of game enjoyment. The model also hypothesized a possible correlation between learning styles and collaboration skills, while game enjoyment was assumed to predict achievement (Fig. 4).

3.1. The Predicted model
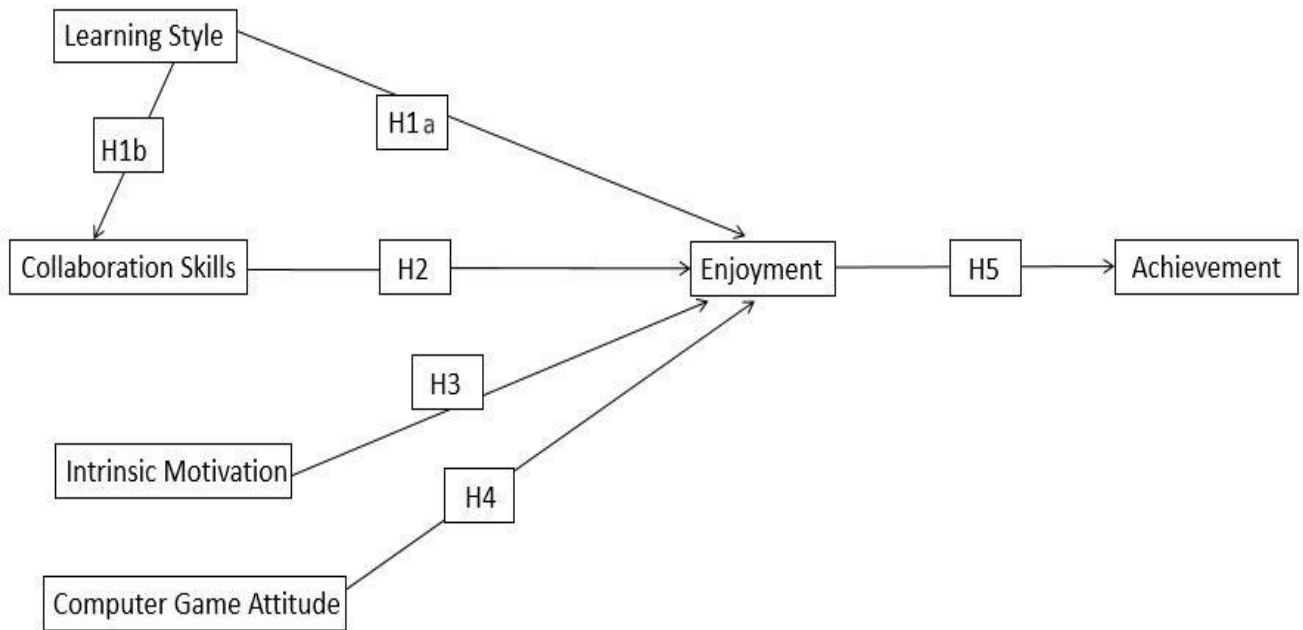
Fig. 4 Predicted model

3.2. Correlation matrix

A Pearson Correlation analysis was conducted to investigate the relationships between the variables in the hypothesized model (see Table 1). Results revealed that learning style was not significantly correlated with collaboration skills (correlation coefficient = -0.036, p-value = 0.645), thus H1b is not supported. However, learning style was found to have a weak but significant relationship with game enjoyment (correlation coefficient = 0.210, p-value < 0.01). Furthermore, correlation analysis results revealed that collaboration skills was not significantly correlated with game enjoyment (correlation coefficient = 0.141, p-value = 0.072), thus H2 is not supported. As predicted, correlation results showed a significant relationship between intrinsic motivation and enjoyment (correlation coefficient = 0.692, p-value < 0.01). Lastly, analysis results showed a significant relationship between computer game attitude and enjoyment (correlation coefficient = 0.335, p-value < 0.01) while a significant link was also found between enjoyment and achievement (correlation coefficient = 0.441, p-value < 0.01).

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Table 1

Correlation matrix

	1	2	3	4	5	6
1. Learning Style	-	.225**	-.036	.177*	.210**	.072
2. Computer Game attitude	.225**	-	.113	.329**	.335**	.159*
3. Collaboration Skills	-.036	.113	-	.047	.141	.202**
4. Intrinsic Motivation	.177*	.329**	.047	-	.692**	.319**
5. Enjoyment	.210**	.335**	.141	.692**	-	.441**
6. Achievement	.072	.159*	.202**	.319**	.441**	-

Note: *$p < .05$, two-tailed. **$p < 0.01$, two-tailed. N=164

3.3. Multiple regression

A follow-up linear regression analysis was conducted to test whether learning styles, computer game attitude, collaboration skills, and intrinsic motivation can significantly predict participants' game enjoyment (see Table 2). The results of the regression indicated the four predictors explained 49.4% of the variance ($R^2 = .507$, $F_{(4,159)} = 40.842$, $p < .01$). It was found that Learning style ($\beta = .361$, $p = .173$) and collaboration skills ($\beta = .049$, $p = .069$), and game attitude ($\beta = .061$, $p = .120$) were not significant predictors of game enjoyment in the hypothesized model. Therefore, H1a, H2, and H4 are not supported. Conversely, intrinsic motivation was shown to be a significant predictor of game enjoyment ($\beta = .569$, $p < .01$). As such, H3, which predicted that more intrinsically motivated students will experience more game enjoyment, is supported.

Table 2

Regression analysis: Predictors of enjoyment

	B	SE B	β	t
Learning Style	.361	.264	.079	1.368
Computer Game Attitude	.061	.039	.094	1.565
Collaboration Skills	.049	.027	.103	1.829
Intrinsic Motivation	.569	.053	.642**	10.815
R^2		.507		
F		6.824**		

Dependent variable: Enjoyment. **$p < .01$. N=164

A further multiple regression analysis was conducted to investigate the relationships between the variables that were shown to be significantly correlated (see Table 3). First, we used learning style and computer game attitude as predictors of intrinsic motivation. The model explained 10.8% of the variance. The model was also significant ($R^2 = 0.119$, $F(2, 161) = 10.918$, $p < 0.01$). Results revealed that intrinsic motivation was significantly predicted by game attitude ($β = 0.221$, $p < 0.01$) but not learning style ($β = 0.559$, $p = 0.156$). Second, we conducted a multiple regression test to explore how achievement can be predicted by the variables that emerged to have positive correlations with achievement in the model. As such, collaboration skills, intrinsic motivation, computer game attitude, and enjoyment were entered as predictors of achievement. This overall model was significant ($R^2 = 0.215$, $F(4, 161) = 10.918$, $p < 0.01$). Results showed that achievement was significantly predicted by collaboration skills ($β = 0.232$, $p < 0.05$) and enjoyment ($β = 1.335$, $p < 0.01$) (see Table 4). The latter finding supports H5, which predicted a positive link between enjoyment and achievement.

Table 3

Multiple regression analysis: Learning Style and game attitude as predictors of intrinsic motivation

	B	SE B	β	t
Learning Style	.559	.392	.108	1.425
Game Attitude	.221	.055	.305**	4.016
R^2		0.119		
F		10.918**		

Dependent variable: Intrinsic motivation. $p < .01$. N= 164

Table 4

Multiple regression analysis: collaboration skills, game attitude, intrinsic motivation, and enjoyment as predictors of achievement

	B	SE B	β	t
Collaboration Skills	.232	.114	.145*	2.027
Computer Game Attitude	-.006	.165	-.003	-0.038
Intrinsic Motivation	.122	.296	.041	.412
Enjoyment	1.335	.337	.394**	3.961
R^2		.215		
F		10.918**		

Dependent variable: Achievement. *p<.05. **p < .01. N=164

3.4. Revised model

Based on data analysis of the predicted relationships, we have constructed a revised model that also includes the un-hypothesized relationships supported by both correlation and regression analysis results. The revised model excludes learning style since analysis results showed no significant relationships between learning style and other variables in the model.
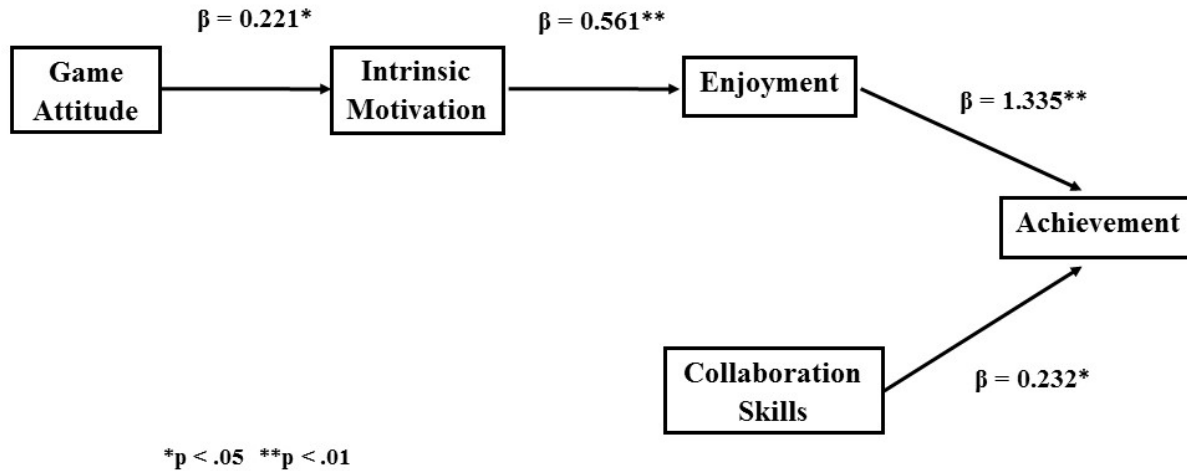
Fig. 5 Revised Model

4. Discussion

This study investigated game enjoyment in the context of a mobile learning game. A hypothesized model considered the effects of learning styles, collaboration skills, intrinsic motivation, and computer game attitude on enjoyment and how enjoyment, in turn, can predict gaming achievement. The hypothesized relationships were largely not supported. Enjoyment was not significantly predicted by learning styles, collaboration skills, or game attitude. However, the relationship between intrinsic motivation and enjoyment was evident. In fact, results showed that players who were more intrinsically motivated to play experienced higher levels of enjoyment in the game. Concerning the possible link between enjoyment and achievement, our findings suggest a direct relationship between these two variables. These findings offer some evidence on the conceptualization of enjoyment as need satisfaction of intrinsic needs put forward by Tamborini et al. (2006). This definition suggests that enjoyment results from the satisfaction of autonomy, competence, and relatedness.

Findings from this study do not provide enough evidence to suggest that learning style is a good predictor of game enjoyment. This could be explained by the mild variation in participants' preferences for particular learning styles. The small variation in learning styles preference is particularly of interest because a prior study (Chao, 2006) found that age was a significant factor

that influenced the difference in individual learning styles in a heterogeneous group of student mobile users. In our case, however, age was not a factor since only students of closely similar age (12- 13 years of age) participated in this study. This age similarity may explain the small differences in learning style preferences. But, in order to better capture the complex relationships between age, learning styles, and enjoyment, future work could focus on larger samples with different age groups.

Another relation this study intended to explore was between learning styles and collaboration skills. It was predicted that students' preferences of particular dimensions on the four learning styles proposed by Felder and Solomon (1991)- e.g. sensing-intuitive, visual-verbal, active-reflective, and sequential-global- and found no relationship between these preferences and perceived collaboration skills. This is consistent with the preliminary results from a previous research (Falvo & Pastore, 2005), which also found no significant relationship between learning styles and perceived collaboration skills through the use of technology. Overall, empirical research that explores the link between learning styles and collaboration attitude is scarce. Future work should clearly pay more attention to the effect of learning styles on collaboration attitude, particularly in the context of game-based learning.

Furthermore, the results demonstrated no relation between collaboration skills and game enjoyment, meaning that enjoyment was not determined by how students perceived their collaborative skills. As pointed out earlier, students played Minecraft individually and interactions between group members were limited to discussions of tasks for a short period of time rather than engaging in collaborative tasks within the virtual world of Minecraft. While we acknowledge this aspect as a limitation in the research design, a replication of the present study where students can perform game tasks collaboratively in the virtual world is therefore needed in order to test the reliability of the link between perceived collaboration skills and game enjoyment.

In the case of the association between intrinsic motivation and game enjoyment, results were consistent with literature. Self-determination theory (SDT) suggests that intrinsic motivation results in greater enjoyment of tasks or activities (Ryan & Deci, 2000). This implies that individuals who are more intrinsically motivated will enjoy an activity more than those who are

less intrinsically motivated. More importantly, this finding is also in line with the conceptualization of enjoyment as need satisfaction (Tamborini et al., 2010) in that there is a link between satisfying basic intrinsic needs and enjoyment. Another important aspect to highlight in this study is the role of extrinsic motivation in mobile gameplay. As mentioned earlier, given the open-ended nature of Minecraft, researchers used grading rubrics to assess gaming outcomes, thus introducing extrinsic goal in the form of grade points as representations of the level of quality achievement. Although the significance level of extrinsic reward was not investigated in the present study, we posit that introducing an extrinsic reward in Minecraft had a minimal impact on diminishing the level of pleasure that participants would normally experience from a purely intrinsic interest in a gaming experience. This finding and interpretation may have implications for future use of Minecraft as an educational game. That is, using Minecraft as an educational mobile game can be an intrinsically motivating experience regardless of what role extrinsic goals play in driving students' behaviors. However, we are careful to point out that participants in this study did not come in with only educational intentions nor to attain certain instructional and academic expectations. In other words, playing for entertainment may still have been a dominant motive for participation. As such, it is unclear whether students can still exhibit the same level of motivation when using this game in a curriculum-driven context with explicit curricular goals and learning objectives. This could be an interesting research direction with important implications for the integration of Minecraft and similar games in the educational practice.

The results of the present study showed no direct link between intrinsic motivation gaming achievement. This is inconsistent with previous studies (author; Juriševič, Glažar, & Devetak, 2008; Unrau, & Schlackman, 2006), which found a direct link between intrinsic motivation and game achievement. Our findings suggest that a player's intrinsic motivation level did not determine how well they achieved in the game. One possible explanation is that other considerations may have impacted players' motivation to perform in the game. Such considerations may include the lack of competitiveness in Minecraft. We suggest that future investigations should focus on the element of competitiveness in educational video games and whether it is linked to players' motivations and achievements.

An important finding in this study was how game attitude significantly predicted intrinsic motivation. In other words, players who had more positive attitudes toward a game were more intrinsically motivated to play. Based on this finding, it is suggested that educators who use video games for educational purposes to continuously monitor and assess students' attitudes prior to implementing a specific type of game. As demonstrated by our findings, a student's game attitude might determine the level of motivation to play, which in turn predict the level of enjoyment.

As mentioned earlier, computer game attitude was not associated with game enjoyment. This is inconsistent with earlier findings (Lee, 2009; Wu & Liu, 2007), which indicated a relationship between enjoyment and attitude towards the use of technology. More importantly, findings provide no evidence to support the conceptualization of enjoyment as an attitude previously proposed by Nabi and Krcmar (2004). Further, no association was found between computer game attitude and achievement, which is inconsistent with previous research. For instance, in the context of computer research, Liu and Johnson (1998) suggested a linear relationship between computer attitude and computer achievement. Another study (Liu, Maddux, & Johnson, 2004) highlighted time spent on learning and using technology as an intermediate variable between computer attitude and computer achievement. Exploring time, however, as a mediating variable between game attitude and achievement in a game- based environment is beyond the scope of the present study. Future video game research should focus on exploring time as well as other possible mediating factors.

Another interesting result was the positive correlation between collaboration skills and achievement. This implied that students with more positive collaboration skills were able to achieve better in a game-based setting. In the context of social games, players who are skilled collaborators are willing to accept and provide assistance to other players. Displaying such behaviors may increase the level of engagement, persistence to achieve objectives, and eventually the levels of achievement. In the academic context, a previous study (Ladd et al., 2013) found a positive relationship between different types of collaboration skills and achievement. Among the collaborative skills investigated in their study was student's ability to stay on task, cooperation, support and concern, and conscientiousness. Interestingly, when Ladd et al. made a comparison between high-skilled groups and low-skilled groups, they found that

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students with low collaboration skills had significantly lower achievements. While the relationship between collaboration skills and achievement is an area that remains under investigated in video game research, our findings suggest that improving achievement outcomes may depend on whether players have positive collaborative skills and not necessarily on the experience of working collaboratively with others.

Finally, one aim of this study was to explore how enjoyment was associated with achievement. As noted earlier, results showed a direct relationship between these two variables. It might seem obvious that game enjoyment would influence game achievement because enjoyment of a gaming activity would normally lead the player to make more efforts to learn and master the game, which could eventually result in better achievements. Nonetheless, our results highlight the importance of the element enjoyment in games used in the educational practice. In other words, a learning game must be enjoyable to be effective, considering the importance of achievement in the academic context. This link between enjoyment and achievement also echoes previous findings in closely related contexts. A study by Liu and Johnson (1998) found that enjoyment contributed to computer achievement even more than motivation. In our case, a relationship between enjoyment and achievement was evident; however, results showed no link between motivation and achievement. We recommend that further studies be conducted to determine the differences of these cause-effect relationships with considerations of platforms used. Lastly, at least from one perspective, it is worth investigating certain factors, such as control and value, as mediators between enjoyment and achievement in video games, a concept that was proposed by earlier work (Hagenauer & Hascher, 2014; Pekrun, 2009).

5. Conclusion

This study allows some insight into the system of multiple factors that influence game enjoyment. The authors believe that the findings indicate important avenues for future research regarding the use of mobile learning games. This study is one of the first to investigate the role of individual traits in predicting enjoyment and achievement in mobile games. The authors have proposed a model based on the supported relationships. Overall, the hypothesized relationships between enjoyment and certain individual traits, which included learning styles, game attitude, and

collaboration skills were not supported. However, a link between intrinsic motivation and enjoyment was evident in the present study. More importantly, this significant correlation is consistent with the broad conceptualization of enjoyment as need satisfaction, which suggests a positive link between enjoyment and the satisfaction of autonomy, competence, and relatedness. Further, a player's game attitude was found to be a strong predictor of intrinsic motivation while collaboration skills were shown to account for achievement in a mobile gameplay.

This study presents a number of potential implications to video game researchers and educators who intend to use mobile games for educational purposes. The current findings suggest that motivation to play is determined by the attitude the player holds toward that particular game. As such, considering the growing popularity of mobile learning games, this study emphasizes the need for a continuous assessment of students' attitudes towards commercially available games prior to their implementation in learning activities. As shown in this study, a player who has positive game attitude may be more intrinsically motivated to play, which can potentially lead to an enjoyable gaming experience. As implied by the data presented in this study, achievement, as the ultimate goal of gaming and learning activities, is directly related to enjoyment. A second important takeaway from this research is the importance of the social context of video games in promoting achievement. That is, positive collaboration skills can potentially lead players to achieve better. Overall, the authors suggest that collaboration skills are a promising area of study for future video game research that aim to explore the complex psychology of play.

In light of this study findings, a number of limitations should be considered. First, the small number of participants raises some issues of statistical power. The nature of the sample also puts some limitations on the generalization and significance of these findings. Specifically, students who participated in this research came from two elementary schools in South Korea; that is to say the findings may solely represent perceptions and impressions of this specific population.

Another important limitation is the fact that participants' nationality and cultural characteristics may have influenced their level of competitiveness and collaboration in this research study. As such, it is possible that certain aspects such as collaboration and motivation may change according to participants' nationalities and cultural backgrounds. Since the gaming experience involved group collaborations on a daily basis, peer pressure may have influenced certain

behavioral aspects such as motivation to play and willingness to collaborate. Lastly, from a cultural perspective, the potential influence of researchers on students' motivation or performance should also be noted.

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Table 1

Table 1

Correlation matrix

	1	2	3	4	5	6
1. Learning Style	-	.225**	-.036	.177*	.210**	.072
2. Computer Game attitude	.225**	-	.113	.329**	.335**	.159*
3. Collaboration Skills	-.036	.113	-	.047	.141	.202**
4. Intrinsic Motivation	.177*	.329**	.047	-	.692**	.319**
5. Enjoyment	.210**	.335**	.141	.692**	-	.441**
6. Achievement	.072	.159*	.202**	.319**	.441**	-

Note: *p < .05, two-tailed. **p <0.01, two-tailed. N=164

Table 2

Table 2

Regression analysis: Predictors of enjoyment

	B	SE B	β	t
Learning Style	.361	.264	.079	1.368
Computer Game Attitude	.061	.039	.094	1.565
Collaboration Skills	.049	.027	.103	1.829
Intrinsic Motivation	.569	.053	.642**	10.815
R^2		.507		
F		6.824**		

Dependent variable: Enjoyment. **$p < .01$. N=164

Table 3

Table 3

Multiple regression analysis: Learning Style and game attitude as predictors of intrinsic motivation

	B	SE B	β	t
Learning Style	.559	.392	.108	1.425
Game Attitude	.221	.055	.305**	4.016
R^2		0.119		
F		10.918**		

Dependent variable: Intrinsic motivation. $p < .01$. N= 164

Table 4

Table 4

Multiple regression analysis: collaboration skills, game attitude, intrinsic motivation, and enjoyment as predictors of achievement

	B	SE B	β	t
Collaboration Skills	.232	.114	.145*	2.027
Computer Game Attitude	-.006	.165	-.003	-0.038
Intrinsic Motivation	.122	.296	.041	.412
Enjoyment	1.335	.337	.394**	3.961
R^2		.215		
F		10.918**		

Dependent variable: Achievement. *p<.05. **p < .01. N=164

Figure 1
Click here to download high resolution image
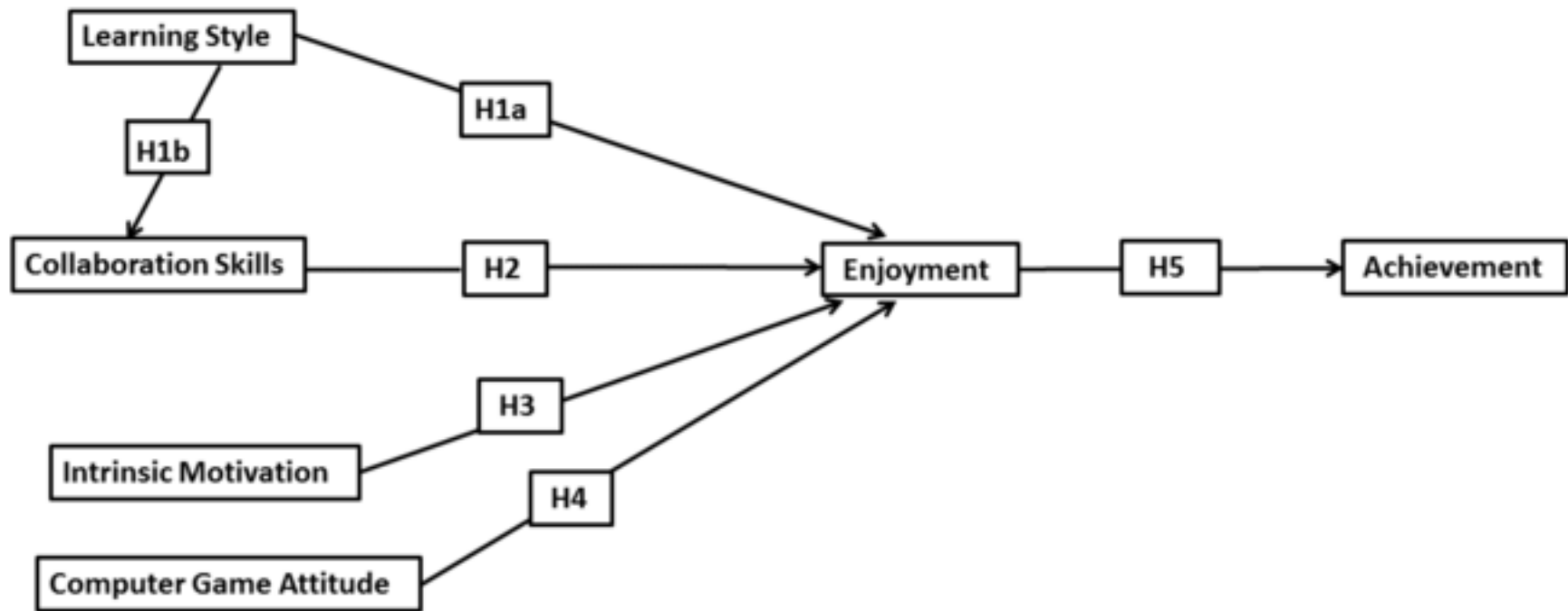
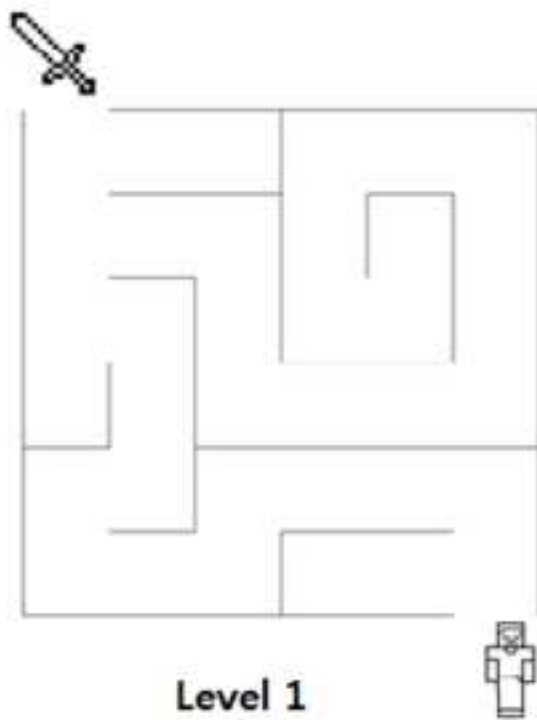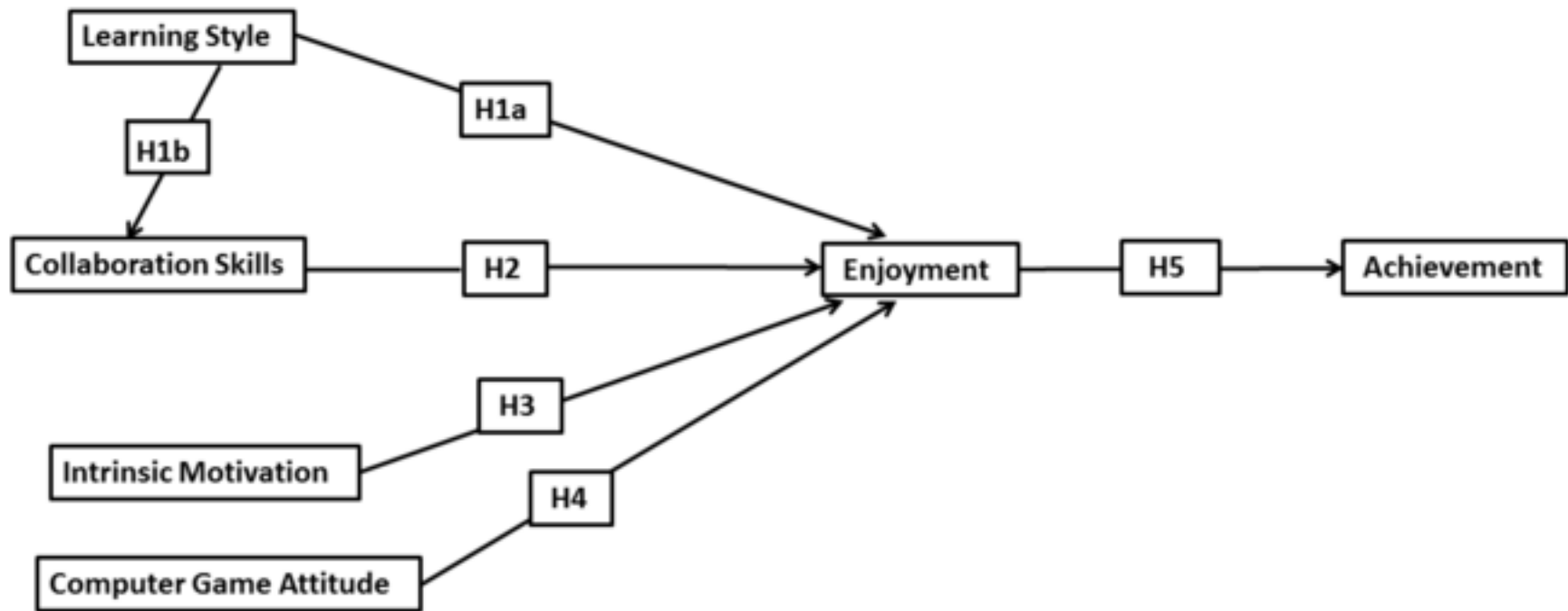**Figure 2**

Level 1

Level 2

Level 3

Figure 3

Figure 4

Figure 5
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$\beta = 0.221^*$ $\beta = 0.561^{**}$

Game Attitude → Intrinsic Motivation → Enjoyment

$\beta = 1.335^{**}$

Achievement

Collaboration Skills

$\beta = 0.232^*$

*p < .05 **p < .01