Examining upper elementary students’ gameplay experience: A flow theory perspective

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Game players’ subjective playing experience, especially a sense of playfulness, has been claimed to be an important factor that motivates continuous learning engagement. Using flow theory as an analytical lens, we reported two pilot studies that investigated the game-based learning experience of upper elementary students in America and China. Results from both studies revealed that the game (called CRYSTAL ISLAND), which focuses on upper elementary science content, supported students’ enjoyable flow experience in the virtual environment. Game design factors that impacted students’ game flow experiences were identified. Additionally, implications for educational game design and future research were discussed.

Keywords: digital game-based learning; flow theory; game flow experience

1. Introduction

Increasing popularity of computer games among contemporary students, who are often referred to as the “N” generation, has contributed to an interest in the educational potential of computer games [1-3]. In recent years, digital game-based learning as an innovative approach to teaching and learning in the 21st century, especially in the STEM areas, has received much attention from the research community. Well-designed educational games have been found to positively impact students’ learning by providing a learning environment that is both intrinsically motivating and engaging, and that is different from what is provided in traditional schooling contexts [4-6].

The rising popularity in digital game-based learning has also prompted increased attention to the subjective experiences of student gameplay. The importance of game players’ subjective playing experience, especially a sense of playfulness, on the impact of gameplay has been empirically supported by past research. Previous research has revealed that players’ experience of enjoyment and playfulness is one of the most important factors that motivate players to continuously engage in learning, and it might also result in other positive outcomes such as learning gains (e.g. [7]). More recently, researchers have begun to examine students’ game-based learning experience using flow theory proposed by Csikszentmihaly [8]. Flow theory has been suggested as a useful construct to study people’s emotions and experiences of playfulness in general, and especially in human and computer interactions, which includes virtual game environments [9]. When applied in a game-based learning context, flow theory focuses on the context of playing and examines how various game design features (e.g., flow antecedents) impact students’ flow experience. From this sense, one advantage of studying game flow is that it helps to address important questions about how students perceive their interactions with game environments and how the game environment should be best designed to support positive playing and learning experiences. Examining flow theory in the context of game environments is especially valuable considering the fact that educational game design and evaluation is still in its infancy. A body of empirical literature has yet to be fully developed in terms of how to devise game environments that are both engaging and effective for students. As a result, examining students’ playing experiences and perceptions using flow theory may contribute to the design and evaluation process of educational games. Specifically, examining students’ gameplay from a flow theory perspective will allow researchers to capture more information related to gameplay, including the strengths and limitations of the game environment.

The purpose of this chapter, therefore, is to report two pilot studies which examine the gameplay experiences of upper elementary students in America and China, both of which are based on Kiili’s [10] game flow model. Both studies are part of a larger National Science Foundation (NSF) funded game-based learning research project, called CRYSTAL ISLAND. CRYSTAL ISLAND is a 3-D virtual game environment designed for students to learn science. The content of the game was developed based on 5th grade science curriculum (i.e., landforms) in America. In the chapter, we focus on how the CRYSTAL ISLAND game can support students’ game flow experience and how various game-design features impact students’ game flow experience.
2. Literature review

2.1 Gameplay and general learning outcomes

Research regarding the use of mainstream games in various content areas has been conducted extensively over the past 20 years. While most existing studies have demonstrated that computer games provide motivating and engaging learning environments for students that are capable of enhancing learning outcomes in comparison to traditional methods of classroom-based instruction, results have sometimes revealed contradictory and mixed effects as well [11, 12]. In one literature review, VanSickle [13] reported that students demonstrated a slight improvement in learning and increasingly positive attitudes toward learning certain subjects as a result of using instructional games in the classrooms in comparison to learning via traditional teaching methods. Similarly, in a literature review based on 32 empirical studies, Vogel et al. [12] reported that interactive games were more effective than traditional classroom instruction on learners’ academic learning gains and cognitive skill development. In contrast, some other literature reviews have reported negative results. For example, following a review of 48 empirical studies, Hays [11] found no evidence to support the claim that instructional games were a more effective method of teaching than traditional methods of instruction in terms of positive outcomes on student learning. In other reviews of the existing game-based learning literature, both O’Neil, Wainess and Baker [14] and Wrzesien and Raya [15] failed to find a clear causal relationship between academic performance and the use of computer games.

Though conflicting findings have been reported regarding the effectiveness of gameplay on enhancing learning in educational contexts, it is important to note that several individual studies have in fact reported that gameplay can result in improved academic learning achievement in students (e.g. [16-20]). For instance, Stevens [17] studied 33 students from 7 to 14 years old. These students played games for one hour each morning, for 30 visits. The researcher reported that parents of the students who played the games not only reported improvements in school work, but also in other areas such as increased interest in literature and an increased patience with daily tasks in comparison to students in a control group. Spires and colleagues [18] also reported game-based learning gains, specifically that middle school students who selected a higher proportion of appropriate hypotheses demonstrated greater learning gains and completed more in-game goals as they solved a science mystery based on microbiology content. Similarly, in two game-based science (microbiology) learning studies by Rowe and his colleagues [19, 20], the authors reported significant learning gains, indicating that middle school students learned by playing the 3-D narrative-centered game. In another study by Gillispie et al. [16], the authors used a pre-and-posttest experimental design with students in a rural middle school to examine how 3-D digital games impacted students’ math learning attitudes and achievement. Gillispie and colleagues [16] found that there was a positive change in students’ learning attitudes and learning outcomes for both boys and girls.

Another important finding derived from game-based learning research is that games serve as motivators for students, especially in content areas that many students find to be particularly difficult, such as science and math. For example, in a study that examined the impact of educational games on middle school students’ motivation to learn science, Foster [4] found that educational games could arouse students’ interest and motivation in learning science by connecting the learning process with students’ personal life experiences. Foster [4] explained that “hard fun” is the mechanism by which educational games motivate students, in that game playing provides students with a challenging but meaningful learning experience that is both frustrating and also life enhancing. According to Foster and other researchers, this kind of enjoyment (i.e., “hard fun”) derived from gameplay helps to improve students’ intrinsic motivation for learning (e.g. [5, 6, 21]). Besides motivating students to play and learn, researchers have found that educational games also serve several additional positive functions, such as engaging students more deeply in learning, improving concentration, and increasing interest, satisfaction, and communication skills (e.g. [16, 19, 22, 23]). At the same time, it is important to note that some researchers (e.g. [20]) have found that even though educational games can provide an engaged learning environment for students, games may also elicit students’ off-task behaviors, which may have a negative impact on students’ content area learning gains.

More empirical studies are needed not only to further explore and potentially validate the impact of educational gameplay in certain contexts, but also to identify specific factors that most directly impact the effectiveness of learning in a gaming environment on students’ educational outcomes, including learning gains and also engagement and motivation for learning.

2.2 Game play and students’ flow experience

If students can become deeply engaged in learning in an enjoyable and meaningful way, it is possible that games that afford such an experience may better enhance the impact on learning outcomes above and beyond those that are less engaging. “Flow state” has been explained as a state of consciousness that is sometimes experienced by individuals who are deeply involved in an enjoyable activity, also referred to as the “optimal experience” or being “in the zone” [24]. During optimal experience, a person is in a psychological state where he or she is so involved with the goal driven activity that nothing else seems to matter. According to flow theory, Csikszentmihaly [24] defined the phenomena of...
flow state as having eight dimensions: (a) clear goals, (b) immediate and unambiguous feedback, (c) a balance between the challenges of an activity and the skills required to meet those challenges; (d) merging of action and awareness, (e) concentration on the task at hand, (f) sense of potential control, (g) a loss of self-consciousness, and (h) a distorted sense of time. Jackson and Marsh [25] proposed that the concept of autotelic experience that describes the rewardfulness of the activity be added as the 9th dimension.

In studies of flow theory, the above nine dimensions are usually categorized into three stages: flow antecedents, flow state, and flow consequences [9, 26-29]. For example, Kiili [27] developed a three-stage game flow model/scale, which the author later tested and validated in another study examining undergraduate students’ game flow experience in the content area of computer science. In this game flow model, the author examined six important game flow antecedents, including a balance of perceived skills and challenges, clear goals, unambiguous feedback, playability, gamefulness, and frame story. Though the first three antecedents (i.e., balance of perceived skills and challenges, clear goals, and unambiguous feedback) are relatively simple to interpret, the remaining three antecedents require a bit of explanation. Specifically, playability describes the ease by which the game can be played. Good playability means that the user interface of the game is easy and it is easy for the player to find necessary functionalities and information. It also means there are not too many distracting factors which will add to the cognitive load of the players. Gamefulness refers to things such as how many opportunities/ways there are for players to earn in-game rewards, or to what extent the players can employ different playing strategies. Finally, the frame story is a narrative technique that is employed by game designers to create an introductory main game story. It provides the framework for connecting a series of otherwise unrelated stories/plots in the game. Based on this flow model, the dimensions expressing flow experience in the game environment have been described as including concentration, loss of self-consciousness, a sense of control, time distortion and autotelic experience. In essence, flow experience refers to a mental state when the player plays the game out of pure intrinsic motivation and great enjoyment derived from playing, instead of playing for any external reasons. The pilot studies described in the chapter were based upon this validated game flow model.

The game flow scale proposed by Kiili in 2005 has generated increasing interest in recent years (e.g. [21]), though the literature is still short on documented empirical studies of flow experience and game-based learning. Nevertheless, flow theory provides an important lens to examine digital game-based learning [10]. One of the most important contributions of existing game flow studies is that researchers have identified some common factors that players believe to have contributed to their flow experience. These common factors include perceived balance of challenge and skills, clear goals, immediate and unambiguous feedback, good playability and gamefulness [10, 21, 30]. For example, Inal and Cagiltay [21] used Kiili’s [27] flow scale in their game flow study with 32 third graders. The authors administrated the flow scale through structured interviews, revealing that a balance of challenge and perceived skill, useful feedback, and a user interface which required less cognitive process (e.g., good playability) were important factors that impacted students’ game flow experience. These results were consistent with Kiili’s [27] findings that students’ perceived challenge and skill balance contributed to their game flow experience, but bad playability and low gamefulness impeded game flow experience. Inal and Cagiltay’s [21] study also revealed that individual and group differences may be present in flow experiences. For example, boys emphasized the challenge provided by the game more than girls, while girls emphasized the game frame story more than boys. Also, the authors reported that in terms of flow state, all students experienced flow in the gameplay but flow experience was found to occur more frequently among playing groups formed by boys than playing groups formed by girls and boys also concentrated more than girls during gameplay. In addition, the authors also found that completion among different playing groups might also increase students’ game flow experience.

Another area of increasing interest among researchers is the relationship between game flow experience and learning outcomes, such as content learning achievement, change in attitude towards the content area, and exploratory behaviors. Unfortunately, existing studies have reported mixed results. Some researchers have reported that students’ game flow experience could lead to positive outcomes. For example, Kiili [27] found that undergraduate students who played the game experienced flow, which was in turn highly related to their content learning gains. A similar positive correlation was also found in another study by Hsu and Lu [30], in which the authors applied a technology acceptance model (TAM) that incorporates social influences and flow experience as a construct to predict acceptance of online games. The survey data indicated that social norms, attitude and flow experience explained 80% of the acceptance of online game playing. In contrast, some other studies have instead reported negative findings in terms of learning gains as a result of educational game play. In a study by Kiili and Lainema [10], the author constructed and empirically tested the usefulness of a game flow scale with a group of college students who played an experimental game. Contrary to the findings in the same author’s previous flow study in 2005, this later study only found a loose connection between students’ game flow experience and their learning achievement. Lee and Kwon [31] also studied the effect of how flow connected to success in a computer-based simulation game in an experiment in which 100 university students played the simulation for a total of 30 minutes. The flow survey data indicated that flow was not a significant predictor in game achievement.
2.3 Summary

Studies that have empirically investigated the effectiveness of game-based learning, especially students’ positive gameplay experience (e.g., game flow experience) have been slow to emerge and have often times presented conflicting findings, therefore leaving an area that has yet to be fully understood. Furthermore, it appears as though the few existing game flow studies have been conducted exclusively with older players, such as middle school and college students. More empirical studies should be conducted to understand students’ flow experience in the game environment across age groups, with an additional focus of game flow experience in younger children, such as those that are of elementary school age.

The current state of the game-based learning and flow theory research provided a rationale for the research questions that guided two pilot studies that will be reported here. In study one we asked the question: What was students’ general playing experience in the CRYSTAL ISLAND game environment and what factors impacted the playing experience? In study two, we asked two more specific questions: 1) To what extent did students experience game flow? and 2) What and how did different game design features impact students’ game flow experience? The following section explains the research methodology that we employed to answer these questions.

3. Methodology

CRYSTAL ISLAND (see Figure 1) is 3-D narrative-centered learning environment with a cast of characters situated on an island within a story world. It is in its third year of development as a NSF-funded project. Throughout gameplay, students interact with characters (e.g., town mayor, citizens of the island) to learn about science-related concepts and to obtain advice and guidance pertaining to game scenario completion. The content of the game was generated based on the North Carolina State standard course of study on landforms for fifth graders.

3.1 Study 1

3.1.1. Participants

Study one was conducted as a pilot study that will be incorporated in a larger research program. The pilot data collection was undertaken in 2010, with a group of 19 sixth graders from an international school in Beijing, China. The majority of the participants in the study were originally from Korea; two were from Singapore and one was from Canada.

3.1.2. Instruments

The pilot study reported here is part of a larger NSF funded game-based learning study examining the effects of CRYSTAL ISLAND on several outcome variables, measured through a pretest-posttest research design. Of the outcome variables examined, this study focused only on students’ subjective gameplay experience and feelings. This qualitative data was collected through three open-ended questions in the post-test, which required students to write about how they thought about CRYSTAL ISLAND, what they remembered from the game, and what their favorite features of the game were.

Figure 1 Screenshot images from CRYSTAL ISLAND.
3.1.3. Data collection
Students first took the pre-test individually on Survey Monkey, which is a web-based survey system. After the pre-test, students went through a 10 minute tutorial gameplay which familiarized them with the game environment, including how to drive the game characters using different hot keys in the keyboard. Students then proceeded to play the game individually for about one hour. The post-test was administered through Survey Monkey immediately after the gameplay.

3.1.4. Data analysis and findings
Qualitative data from the post-test was coded using a priori coding in the first pass and open coding in the 2nd pass. The a priori coding was guided by Kiili’s [10] game flow framework, which was discussed earlier in the chapter. The purpose of the priori coding was to examine students’ general playing experience in the CRYSTAL ISLAND game environment and to identify factors/dimensions in Kiili’s [10] game flow framework that were mentioned and emphasized by the participants. The open coding was conducted to see what additional factors, if any, were mentioned by students. Two graduate students coded all the data individually. Coding results were compared, with disagreements resolved through discussion. The inter-rater reliability was calculated at 88%.

Overall, results revealed that the CRYSTAL ISLAND game was able to arouse students’ playing interest, in that most of the students found the game to be both “interesting” and “fun.” More specifically, three of the six game flow antecedents in Kiili’s [10] game flow model were mentioned by the students and identified during the first pass of data coding. These three game flow antecedents (e.g., game design related factors) were a balance between task challenge level and students’ perceived skills, playability, and gamefulness. Specifically, three students mentioned the challenge level of the playing tasks, with one student stating, for example, that “CRYSTAL ISLAND is awesome! I like it very much and sometimes it is challenging, sometimes it’s really easy.” Two other students reported that they had thought that the game was “fun but the mission is so hard.” In terms of playability, one student explained in his own words that it was easy for him to understand how to play the game because the explanation given in the game tutorial was very clear. Two other students, however, thought that the game environment was too big to navigate and it was difficult to find different game characters because they were not “nearby.” The dimension of gamefulness was identified in the responses of two students. One of them mentioned this game design feature by saying that “Each time I completed the quest, they gave me sand dollars. But I am not sure what I could have done with them.” The other student remembered he had to collect sand dollars that he would be able to use to make purchases (i.e., films for the camera to take pictures).

In terms of game flow experience, the sub-dimensions of a sense of potential control and autotelic experience were identified in students’ responses during the first pass of data coding. Three of the four students who mentioned the dimension of a sense of control noted that the game was not very easy to be controlled although they found that it was interesting. For example, one student said that sometimes she felt “frustrated with the controls.” Students’ responses therefore indicated that they valued the importance of a sense of control in the gameplay experience, most directly apparent in one student’s statement that his favorite part of his gameplay experience was when he “controlled the characters.” Findings also revealed the game flow sub-dimension of autotelic experience received much attention from the students. Out of the 19 participants, 11 of them stated that they really enjoyed the feeling of playing the CRYSTAL ISLAND game and that they felt good in the game environment. Students’ responses also indicated that the playing tasks that they enjoyed most were taking photos of different characters in the game using a camera and collecting sand dollars (external rewards received when playing the game).

During the second pass of data coding, additional factors that impacted students’ game play experience were further identified. Specifically, two students mentioned that they enjoyed playing the game because it was 3-D (e.g., “CRYSTAL ISLAND is pretty cool because it is 3-D”). Students also pointed out other factors (not related to game design) that they thought may have impeded their enjoyable playing experience. One such factor mentioned by students was the slow internet speed in the computer lab where they played the game. Two students explicitly pointed out that the game would have been much more fun if the computers running the game had been faster.

3.2 Study 2

3.2.1. Participants
Study two was a pilot study that will be incorporated into a larger research program examining game flow that was conducted in early 2011 in the United States. The participants were 19 fifth graders from an urban elementary school in a southeastern state in the United States.
3.2.2. Instrument

Students’ game flow experience was measured by using a game flow scale adapted from Kiili [10]. The original Game Flow questionnaire, consisting of 33 items in the 5-point (from 5 = strongly agree, to 1 = strongly disagree) Likert-type response format, measured 6 game-design related flow antecedents and 5 sub-dimensions of game flow experience (see discussion earlier). Each dimension was measured with 3 items. Students were asked to rate the extent to which they agreed or disagreed with the statements about the flow antecedents and flow experience. A higher score indicated higher levels of flow experience. The reliability of flow experience as a single construct was found to be acceptable ($r = 0.81$). The overall reliability of flow antecedents as a single construct ($r = 0.83$) was also found to be acceptable.

Since the original flow scale was developed for use with undergraduate students, some of the statements were reworded in an effort to make the questionnaire age-appropriate for fifth grade students. Due to the small number of participants, a meaningful factor analysis was not possible. However, an initial reliability analysis was conducted to calculate the revised/reworded survey. Results indicated that the reliability of the flow antecedents as a whole construct was reasonably high ($r = 0.89$). The overall reliability of the flow experience as a whole construct was also found to be acceptable ($r = 0.83$).

3.2.3. Data collection

Students played the CRYSTAL ISLAND game during a time after which they had been exposed to landform content related to the state curriculum for fifth graders. They first were presented with a 3-minute game background story that familiarized them with the context of the game. Following this, they went through the game tutorial (see study one). Students then played the game individually for approximately one hour, after which the adapted game flow scale was administered through Survey Monkey.

3.2.4. Data analysis and findings

This pilot study aimed to address two questions: (1) To what extent did students experience game flow?; and (2) What and how did different game design features impact students’ game flow experience? To answer the first research question, basic statistical descriptive data such as means and standard deviations for each subscale of flow experience were calculated. An overall flow experience score was also calculated. The overall flow experience was divided into three categories of high (4.0-5.0), medium (3.0-4.0), and low (below 3.0). To answer the second research question, basic statistical descriptive data such as mean and standard deviation for each of the six flow antecedents were calculated. Multiple regression was also conducted to see how each of the flow antecedents impacted students’ overall flow experience.

The descriptive data for each sub-scale of the flow experience as well as the overall flow experience as a single construct are presented in Table 1. The overall flow experience ranged from 2.80 to 4.87, with a mean for all students of 3.73. Five students had an overall flow score of over 4.0, and two students had an overall flow score of below 3.0.

<table>
<thead>
<tr>
<th>Flow experience</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration</td>
<td>3.9123</td>
<td>.75230</td>
</tr>
<tr>
<td>Sense of control</td>
<td>3.2456</td>
<td>1.00518</td>
</tr>
<tr>
<td>Time distortion</td>
<td>3.8947</td>
<td>.72053</td>
</tr>
<tr>
<td>Lose of self-consciousness</td>
<td>3.4035</td>
<td>.70780</td>
</tr>
<tr>
<td>Autotelic experience</td>
<td>4.1930</td>
<td>.93172</td>
</tr>
<tr>
<td>Overall flow experience</td>
<td>3.7298</td>
<td>.54273</td>
</tr>
</tbody>
</table>

Descriptive statistical data that pertain to the second research question are presented in Table 2. Multiple regression analysis was used to test if these game design factors significantly predicted students’ overall game flow experience. The results of the regression indicated that the six factors explained 84.1% of the variance ($R^2 = .841, F(6, 12) = 10.557, p < .01$). It was found that three of the six factors significantly predicted students’ overall game flow experience. These three factors were challenge and skill balance ($\beta = .406, t = 4.042, p = 0.02$), clear and immediate feedback ($\beta = .632, t = 3.874, p = 0.002$), and gamefulness ($\beta = -.293, t = -2.360, p = 0.036$).
1. Introduction

The results of the two studies presented in this chapter indicate that CRYSTAL ISLAND afforded the students an enjoyable game flow experience, supported both by qualitative data derived directly from student dialogue, as well as from statistical data using the game flow questionnaire. Qualitative data extracted from students’ statements after playing the game in Study 1 made it possible to identify several of the features of Kiili’s [10] game flow model. To reiterate, some of the most important features that students mentioned were the balance between the challenge of the game and their own personal skill level, the playability of the game, as well as their perception of the gamefulness that they experienced while they played. In addition, students provided statements indicating that their sense of control while playing the game contributed to their playing experience, as did statements made referring to their autotelic experience while playing CRYSTAL ISLAND. In Study 2, however, international students had difficulty interpreting the English dialogue in the game, this would undoubtedly affect their game flow experience in ways dissimilar to the students in Study 2. If the international participants studying in China) may have experienced language proficiency limitations while playing CRYSTAL ISLAND that affected their game flow experience in ways dissimilar to the students in Study 2. If the international students had difficulty interpreting the English dialogue in the game, this would undoubtedly affect their perceptions of skill while playing the game.

A comparison of the two studies also revealed that there are some apparent similarities and differences among the qualitative data in Study 1 and the quantitative game flow data in Study 2. In terms of antecedents, for example, the dimensions of gamefulness and playability in the Game Flow Scale administered to students in Study 2 were also emphasized by the students in Study 1 through statements revealing that they did in fact experience a certain degree of gamefulness and playability. Similarly, in Study 2, gamefulness and playability were also found to have means within the upper level of the medium range, indicating that students in this study also thought that the game provided reasonably high levels of gamefulness and playability, both desirable features of a well-designed game.

Despite these similarities, students in the two studies also demonstrated different perceptions of other game design features (e.g., game flow antecedents). For instance, the game flow antecedent of having a clear goal had the highest mean out of all of the game flow antecedents in Study 2 but was not often mentioned by students in Study 1. This difference does not necessarily indicate that clear goals were not of great relevance to students in the first study, but that perhaps this was not one of the first things that came to mind when providing statements about their gameplay experience. Also, students in Study 1 often reported that the game was too challenging for them, whereas students in Study 2 received the highest overall mean score for the dimension of “challenge and perceived skill balance” among all of the flow antecedents, indicating that the game was in fact challenging for them but these students thought that their skill would allow for them to meet the challenge. It is possible that variations in participant demographics across both studies may shed light on the reason behind the above-mentioned difference, namely that the students in Study 1 (e.g., international participants studying in China) may have experienced language proficiency limitations while playing CRYSTAL ISLAND that affected their game flow experience in ways dissimilar to the students in Study 2. If the international students had difficulty interpreting the English dialogue in the game, this would undoubtedly affect their perceptions of skill while playing the game.

In terms of game flow experience, the participants in Study 2 had the highest mean for the dimension of autotelic experience, which was also found to be important to the students as reported in Study 1. This indicates that students in both studies experienced a good deal of enjoyment from playing the CRYSTAL ISLAND game and that this enjoyment was driven by intrinsic motivation derived from playing the game as opposed to being driven primarily by external rewards afforded by playing the game. On the other hand, students across the studies felt that they experienced different degrees of control (another important dimension of flow experience) while playing CRYSTAL ISLAND. Specifically, in Study 1, many stated that they had experienced difficulty in controlling the game characters (see discussion earlier). In Study 2, however, sense of control was found to have a mean in the medium (e.g., 3-4) range in Study 2. A mean in this range indicates that students did feel in control of their playing actions, although this dimension was found to have the lowest mean in comparison to all of the dimensions of flow experience.

Finally, in terms of predicting game flow experience, challenge and skill balance, clear and immediate feedback, and also gamefulness were all found to be important predictors of game flow experience in Study 2, as indicated by the regression analyses. This was consistent with previous game flow studies by other authors (e.g. [9, 10, 21]). The dimensions of challenge and perceived skill balance, as well as gamefulness, were also emphasized by students in Study 1. However, immediate feedback was not mentioned as frequently by the students in Study 1. This difference may have

<table>
<thead>
<tr>
<th>Flow antecedents</th>
<th>Mean</th>
<th>Std. Deviation</th>
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<tbody>
<tr>
<td>Challenge/skill balance</td>
<td>3.9298</td>
<td>.79021</td>
</tr>
<tr>
<td>Clear goal</td>
<td>3.9825</td>
<td>.79717</td>
</tr>
<tr>
<td>Immediate / useful feedback</td>
<td>3.5789</td>
<td>.80770</td>
</tr>
<tr>
<td>Playability</td>
<td>3.8947</td>
<td>.77022</td>
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<tr>
<td>Gamefulness</td>
<td>3.6491</td>
<td>.89906</td>
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<tr>
<td>Frame story</td>
<td>3.2</td>
<td>1.26789</td>
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</tbody>
</table>

4. Discussion

The results of the two studies presented in this chapter indicate that CRYSTAL ISLAND afforded the students an enjoyable game flow experience, supported both by qualitative data derived directly from student dialogue, as well as from statistical data using the game flow questionnaire. Qualitative data extracted from students’ statements after playing the game in Study 1 made it possible to identify several of the features of Kiili’s [10] game flow model. To reiterate, some of the most important features that students mentioned were the balance between the challenge of the game and their own personal skill level, the playability of the game, as well as their perception of the gamefulness that they experienced while they played. In addition, students provided statements indicating that their sense of control while playing the game contributed to their playing experience, as did statements made referring to their autotelic experience while playing CRYSTAL ISLAND. Quantitative data from the game flow questionnaire in Study 2 provided a more direct measurement of students’ game flow experiences and supported the qualitative data described in Study 1 by indicating that students did in fact find the same game flow antecedents to be important while playing the game.

A comparison of the two studies also revealed that there are some apparent similarities and differences among the qualitative data in Study 1 and the quantitative game flow data in Study 2. In terms of antecedents, for example, the dimensions of gamefulness and playability in the Game Flow Scale administered to students in Study 2 were also emphasized by the students in Study 1 through statements revealing that they did in fact experience a certain degree of gamefulness and playability. Similarly, in Study 2, gamefulness and playability were also found to have means within the upper level of the medium range, indicating that students in this study also thought that the game provided reasonably high levels of gamefulness and playability, both desirable features of a well-designed game.

Despite these similarities, students in the two studies also demonstrated different perceptions of other game design features (e.g., game flow antecedents). For instance, the game flow antecedent of having a clear goal had the highest mean out of all of the game flow antecedents in Study 2 but was not often mentioned by students in Study 1. This difference does not necessarily indicate that clear goals were not of great relevance to students in the first study, but that perhaps this was not one of the first things that came to mind when providing statements about their gameplay experience. Also, students in Study 1 often reported that the game was too challenging for them, whereas students in Study 2 received the highest overall mean score for the dimension of “challenge and perceived skill balance” among all of the flow antecedents, indicating that the game was in fact challenging for them but these students thought that their skill would allow for them to meet the challenge. It is possible that variations in participant demographics across both studies may shed light on the reason behind the above-mentioned difference, namely that the students in Study 1 (e.g., international participants studying in China) may have experienced language proficiency limitations while playing CRYSTAL ISLAND that affected their game flow experience in ways dissimilar to the students in Study 2. If the international students had difficulty interpreting the English dialogue in the game, this would undoubtedly affect their perceptions of skill while playing the game.

In terms of game flow experience, the participants in Study 2 had the highest mean for the dimension of autotelic experience, which was also found to be important to the students as reported in Study 1. This indicates that students in both studies experienced a good deal of enjoyment from playing the CRYSTAL ISLAND game and that this enjoyment was driven by intrinsic motivation derived from playing the game as opposed to being driven primarily by external rewards afforded by playing the game. On the other hand, students across the studies felt that they experienced different degrees of control (another important dimension of flow experience) while playing CRYSTAL ISLAND. Specifically, in Study 1, many stated that they had experienced difficulty in controlling the game characters (see discussion earlier). In Study 2, however, sense of control was found to have a mean in the medium (e.g., 3-4) range in Study 2. A mean in this range indicates that students did feel in control of their playing actions, although this dimension was found to have the lowest mean in comparison to all of the dimensions of flow experience.

Finally, in terms of predicting game flow experience, challenge and skill balance, clear and immediate feedback, and also gamefulness were all found to be important predictors of game flow experience in Study 2, as indicated by the regression analyses. This was consistent with previous game flow studies by other authors (e.g. [9, 10, 21]). The dimensions of challenge and perceived skill balance, as well as gamefulness, were also emphasized by students in Study 1. However, immediate feedback was not mentioned as frequently by the students in Study 1. This difference may have
been driven by a limitation in the effectiveness of the feedback received in the game for the international students in comparison to those that were native English speakers.

It is also important to note that while not supported by the studies reported here, other game flow antecedents, including clear goals and playability, have also been found to be important predictors of students’ game flow experience in previous research (e.g., [10][27]). Clear goals and playability may not have been significant predictors in Study 2 due to the development stage of the CRYSTAL ISLAND game at the time of data collection. The goals and tasks throughout the game have since been updated and refined, as has the playability of the game (e.g., sophistication of character movements, etc.), yet at the time of data collection may have presented inherent limitations to student abilities to understand the goals of the game at some point and also to move within the game as well. Thus, the lack of support for clear goals and playability in terms of predicting game flow experience in Study 2 may have been driven by limitations in the design of the game as opposed to actual weaknesses of those dimensions in predicting game flow. Also, the frame story dimension was not found to be predictive of students’ game flow experience in Study 2 and may also be supported by the above-mentioned limitation in game design. Kiili’ [25] study also failed to find game frame story as directly correlated with undergraduate students’ game flow experience because the game used in the study did not have a very clear background story. In our Study 2, however, another possible reason behind this phenomenon might be that the background story video was loaded very slowly on the computers running the CRYSTAL ISLAND game, thus some students were not able to watch the entire frame story video. This might also explain why the dimension of game frame story had the lowest mean score (around 3.2) out of all flow antecedents.

5. Conclusion

The two studies examined upper elementary students’ game flow experience and its impacting factors. The results have important implications for educational game design, in that they revealed game design features that impacted students’ game flow experience. It is important to note that the studies reported here are based on a relatively small sample size; future studies should be conducted with a larger sample size to better understand the phenomenon. Additionally, future studies that examine game flow experience based on students’ individual differences may contribute to the field since previous studies (e.g. [21]) have found game flow experience differences based on students’ gender. Moreover, empirical studies should also be conducted to examine game flow experience and potential learning outcomes. Research in this area is very important because previous research has found that flow experience may lead to positive learning outcomes such as increased content area learning and positive learning attitudes. Finally, future research may empirically validate the similarities and differences in students’ game flow experiences by administrating the game flow scale to students from different countries.

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