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Using board games to teach physics

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"Using Board Games To Teach High School Physics," a master's thesis prepared by Kadia Alfaifi in partial fulfillment of the requirements for the degree Master of Instructional Media and Technology in the Department of Education, has been approved by the members of the examining committee.

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Abstract

This was an exploratory study that examined how board games affect students' motivation and learning of content about science (Physics). Quasi-Experiment research was used to determine the academic effects of the board game as well as an attitudinal survey to evaluate motivation. Participants were selected by a convenience sample from undergraduate courses in the Department of Education at a regional university. Participants were taught by two methods: using a board game and traditional (lecture). Participants in both groups gave a pretest to determine their knowledge of physics followed by posttest to determine their retention after using the board game, or traditional method. An attitudinal survey was given after each setting for participants to evaluate their impression about their motivation to learn, increasing social skills, and enhancing critical thinking about either method. Findings of the study suggested that the board game should be used to help students develop their content knowledge of physics, motivate them to learn, increase their social skills, and enhance critical thinking.

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CHAPTER 1

Introduction

Background

In my country, Saudi Arabia, our system of education requires that all tenth grade students take required science and literature courses. At the eleventh grade, however, students can choose any subjects they are interested in or which will aid their future careers.

I was a physics teacher at a high school in Saudi Arabia. At the end of the tenth grade, I asked my students about their choices between science and literature courses to see if they have a plan for the eleventh grade. One of the students said that she really liked science and wanted to do something new in the future, but found nothing that grabbed her attention in science. Another said, “When you are teaching us the concepts of physics I always ask myself: Why do you like physics?” Another student said, “I love science, but I am afraid physics may be too difficult for me.” In that case, I felt that even though many students liked to learn science, they needed something to encourage them.

A year later, I traveled to the United States to obtain my master’s degree. One class that I took was about games in education. The class was so memorable and enjoyable.

When I was presenting my game, I felt that games would address the concerns raised by my students.

Because of my experience with playing games as a teaching tool, I found that the games were fun, and that was what made me learn and understand different and complex concepts of my class. In addition, I found that games can be used as a motivational tool because they were competitive exercises which the subjects were to win and the players have to master some knowledge to advance in the exercise and win. More importantly, the games can be a facilitative tool that builds social skills such as academic, compliance, and assertive skills when the players interaction with each other. For all above reasons, I have chosen to study using games to motivate students to learn physics.

Significance of this Study

Part of the education process is to generate interest in students and motivate them to complete their education rather than cutting it short. Education should be exciting to students rather than burdensome or boring. It is an integral part of their growth and helps them become good citizens. Educators know that they need to do more than open a book and read its information to students. Teachers should relate the information to their students' world. They should involve students in projects, conversations, and tasks that use all their senses ("Teaching Strategies", 2010).

Science subjects are interactive and, to understand them, students need challenges and more exercises than simply reading books. Reasons for students' difficulty with science subjects include difficult vocabulary and the lack of experiences relating the concepts to the student's real life. Sciences require discovery learning and critical thinking, thus students need visual tools that engage them and help them to understand.

One science subject that usually worries students is high school physics. Physics requires students to employ various methods of learning because of the difficult

vocabulary, tables of numbers, graphs, equations, diagrams, and maps. In addition, it requires the ability to use algebra and geometry and then to translate them to the real life. Over all, teachers need an effective method to address all these aspects of understanding physics.

Technology is a tool that supports teachers when delivering their lessons to their students and helps students to learn and succeed. In fact, games are a good instructional technology that be used in a classroom for two reasons. First, games build students' motivation to learn and succeed because they are a leisure activity which people do for fun and games fulfill motivational elements which are competition, challenge, chance, and curiosity (Prensky, 2001). Second, games support and respect learning and teaching theories such as constructivist theory, problem-based learning theory (Tan & Yam San, 2012), learning by doing instructional theory, and activity theory (Prensky, 2006) that teachers need in their classroom to translate knowledge for students.

Educational games are games that used to teach students many objects about certain subjects. Games include two types, board and video games (Summit on Educational Games, 2005). Because board games have many advantages over video games teachers should use them in the classroom. First, board games are not like video games in that they could be expensive and are usually played by only one individual, which makes it difficult for teachers and students to implement in the classrooms. As well , board games do not need computer or Internet access. Thus, can be played at any time. Second, the cost of video games can be prohibitive for many teachers and students. However a single board game is cheaper than video games. Third, board games cannot be played with less than two players. That means board games improve social skills for

students in the classroom. Fourth, board games ensure the randomness that might require changing in the rules or characters. These changes always provide players with new experiences in similar settings and make the game interesting. Mostly of all, features of board games such as material, cost, socialization, and flexibility would make the board games an easy tool for teachers and students to employ regardless of the time and place (Collins & Griess, 2011).

Board games are a teaching tool that assists students in learning science because they promote logical thinking and problem solving as well as enhance cooperation and social skills. They are also very informative and entertaining, which learning science requires ("Board Games", 2010). Board games are a widely accessible type of game about highly adaptable across cultures. Students learn well from visuals, so anything with great detail and design will keep them entertained and help them learn about the sciences easier.

Historically, board games have impacted students' learning in a positive way. Board games have been used to teach many subjects including, science, politics, communications, and health since the 19th century (Seay, 1997). Board games can accomplish many things that traditional teaching cannot. Students become disheartened when they are faced with complex subjects. However, board games can overcome this feeling by breaking the concepts into smaller learning goals, and they can motivate students to learn by giving them a smaller part to analyze. Students can experiment, make choices, and see the effects of their decisions. As they become better at the board games they improve their understanding of the material. In addition, board games make learning an active and physical process that allows students to interact with their subjects. The

Educational Games Database (2010) pointed out that board games are an important educational tool that makes students excited to learn and changes misconception of many complex subjects. Board games can include competition, progression and customization at the same time, which encourages students to engage in during the learning process. For all these reasons, board games are an important tool that teachers can use to aid their students. Further study of the effectiveness of board games in education will help teachers to use them in the most effective way possible.

Board games are very important for physical, mental, and emotional development. They have been described by many researchers as activities, which use subconscious behaviors and instinctive motivations, and are preparation for life (Iseri, Kirikkaya, & Vurkaya, 2010). Board games improve problem solving skills that science depends on, promoting theorizing, promoting mathematical literacy, and promoting memory recall (Bendixen-Noe, 2010). In addition, Petsche (2011) stated that board games enhance three styles of learning which are learning by listening, watching, and by physically doing. Previous research has shown that board games can improve social skills, cover many subjects, and promote feelings of being more connected in school (Fouche & Visser, 2008).

Even though board games are important tools in education and impact students' achievement in positive ways, the games still have some challenges that concern educators who use them. One of the challenges is that board games take a lot of time to design and customize for a particular curriculum, especially at the secondary or college levels. Also, the time for explaining and playing the game is another challenge that faces teachers in their classrooms. The other challenges of using games are class size and

mixed-ability classes. Many board games require a significant physical setup, so teachers have to consider the classroom's capabilities.

Despite these challenges, board games are very useful tools for teaching many subjects. Board games can influence the teaching process in five major areas. They can impact logistics of play-based teaching, students' reactions, teachers' reactions, pedagogical decisions, and the classroom environment, all in a positive way. Board games can positively affect students' outcomes and help them to reach academic standards (Miller, 2008; Prensky, 2011).

Statement of the Problem

The purpose of this project is to investigate the use of board games while teaching students Physics content.

Research Questions

1. What is the understanding of board games in education? (i.e, is: are board games for teaching or just for fun?)
2. How are board games designed?
3. How can board games be applied in the classroom?
4. What are the benefits of using instructional games for teaching science (e.g. content knowledge, motivation, teaching social skills, and critical thinking).
5. What are the challenges of using board games in the classroom?

Possible Limitations

Finding classrooms in which to research the use of board games is one of the possible limitations. Ideally, a researcher would have one's own classrooms to find problems that teachers and students will face. Also, time is another possible limitation because time will be required to look for a simple board game, and play it, and then evaluate its impacts.

Moreover, because educational games are not used in the Saudi Arabia educational system, it will be difficult to find Saudi sources that support this project. This project will be applied in Saudi's high schools that have different curricula and standards than America's. That will limit the number of subjects which are included in these two systems on which the development of educational board games.

Definition of Terminology

Board Game**:** an application that can be an educational tool which puts a player in the role of decision maker and provides a learner with an engaging and challenging environment in which to solve problems (Summit on Educational Games, 2005).

Critical Thinking**:** a mental activity that puts students through the process of analyzing, observing, and making decisions, evaluating information, communicating, solving problem, and guiding themselves.

Traditional Instruction/ Lecture**:** a method in which teachers provide the information to students including facts and concepts by speech using a white board and PowerPoint. During their approach students usually are taking notes and asking some questions during the lecture.

CHAPTER 2

Literature Review

Research has shown that games have a unique place in the learning environment. In a survey of eight European countries, volunteer educators at formal and informal adult education institutions were asked questions with the goal of determining how widely games are used in education. The highest rate of game use by adult educators was 64%, observed in Spain, Cyprus, and Bulgaria. Other subjects were asked to identify which game genres they prefer for their education purposes. The results showed that 18 % of trainers prefer puzzles and 16 %, quizzes (Demirbilek, 2010). Games have indeed become common teaching tools, serving a wide array of purposes, and combining work and play.

Board games have generated a great deal of positive recognition with regard to helping students learn fundamental skills. In order to benefit students and teachers, board games must have a specific purpose. Educators design it to help students explore and discover new concepts. Moreover, board games can motivate students to tackle complex topics through play and discovery. Thus, board games can be a teaching tool because, with their use, students can increase their desire to learn, learn social skills and critical thinking, which are all essential for learning to take place. This chapter focuses on five aspects of this topic: 1) games in education; 2) board games design; 3) classroom applications of board games; 4) the benefits of using board games; and 5) the challenges of using board games in classroom.

Games in Education

Kramer, Remmele, Schmette, and Seeber (2009) defined a game as "an artificially constructed, competitive activity with a specific goal, a set of rules and constraints that is located in a specific context" (p. 326). In education, a game is a tool that relates curriculum concepts to real life. Educational games must have a subject, problem solving, interaction, rules, and require critical thinking (Basnet, 1996; Kramer et al., 2009). Moreover, several researchers have examined many types of games and found that games used to teach others require presentation of new knowledge, sequenced strategies, and motivation for learners (Kerr, Koenig, Wainess, & National Center for Research on Evaluation, 2011; Rule et al., 2011). A board game can be defined as an educational tool that puts a player in the role of decision maker and provides a learner with an engaging and challenging environment in which to solve problems (Summit on Educational Games, 2005).

Design Board Games

According to Miller (2008), games are engaging and motivating because they can provide "explicit information both on-demand and just-in-time, when the learner needs it or just at the point where the information can best be understood and used in practice" (p. 25).

Designing a board game requires much more than just accumulation of content (Prensky, 2011). Teachers need to follow certain steps to design a good board game that is engaging and, most importantly, fun to play (Bates, Brown, Cranton & Lewis, 2010). The six steps involved are content analysis, incubation, chunking, aligning, drafting, and incubating (Moseley, 2011).

Step one: content analysis.

First, during content analysis, teachers should decide which topic will be applied in the board game and why the topic has been chosen (Basnet, 1996; Mandran, Mariais, Michau & Pernin, 2012; Kramer et al., 2009). What are the values, skills, facts, principles, and procedures that students must master when they play the game (Kerr et al., 2011; Rule et al., 2011). Then the teacher should write down some words that relate to the topic of the game (Moseley, 2011).

Step two: incubation.

In this step, a teacher needs to let their mind work on problems related to the topic (Bates et al., 2010). They should then leave the application to rest for some time, returning later with new ideas (Moseley, 2011). Many additional connections and relevant information will become clear and can be readily added to the game (Prensky, 2011).

Step three: chunking.

The third step involves listing the content elements that relate to the board game (Bates et al., 2011). Teachers must label pieces, patterns, paths, probabilities, prizes and principles on which their board game depends (Prensky, 2006). Pieces are elements that seem to make sense when viewed as moving through the board game (Moseley, 2011). Patterns are combinations of content elements which seem to go together and have additional meaning (Bates et al., 2010). Paths are a physical place in the content in which one can move around in. Probabilities are things in the content which may happen by chance (Charlier, Fraine, 2010). Prizes are what students strive to gain. Principles are the

statements that describe how the board game works (Bates et al., 2010; Moseley, 2011; Prensky, 2006).

Step four: aligning.

Teachers should determine the patterns, elements and structures that arise from the content (Prensky, 2011). In the alignment step, teachers should remember two things; the structure of the game should mirror the structure of the content, and, the structure of the game should never contradict the structure of the content (Bates et al., 2010).

Step five: drafting.

Educators can use a sheet of paper and any pieces to start playing this board game (Bates et al., 2010; Moseley, 2011). They should keep playing until the game begins to come together. During game play, teachers should consider what their students will learn through playing the game (Kerr et al., 2011; Rule, 2011). Will students gain new knowledge or will students revisit prior knowledge? (Kerr et al., 2011; Rule, 2011).

Step six: incubating.

Teachers should put the application away for some time, then return to it with several new ideas for improving the game (Moseley, 2011). Additionally, teachers should test their game with others and gather feedback for continued development of the game (Kerr et al., 2011; Moseley, 2011; Rule, 2011).

Classroom Applications of Board Games

Building a collection of board games for the classroom means choosing and storing those which are educationally appropriate (The Educational Games Database, 2010). The best board games have requirements for designers as well as for users (Basnet, 1996). The game design should include a clear learning goal, challenges that

motivate students to continue playing, and practice of lesson content (Demirbilek, 2010). Additionally, board games should encourage questions that require the learner to find the answers and seek new information by using a game card, asking their peers, or using other resources (Marjanen, 2010; Teaching Strategies, 2010). Board games should be set in real-world contexts which will help learners to experiment with new skills and retain what they have learned. Designers must also consider the time required for game-play and for collecting new information (Summit on Educational Games, 2005; Trybus, 2012; Wainess, 2011).

Requirements of using board games as educational tools include teacher experience with the game to help students engage in the concepts (Jones, 2007). Teachers should play the game before applying it in class and then be flexible when playing the game with their students (Summit on Educational Games, 2005;The Educational Games Database, 2010). Teachers should allow students to enjoy themselves when playing and learning and teachers should assess their students' achievement (Crews 2001; Williams, 2007).

Kumar's and Lightner (2007) qualitatively studied 112 instructors with the purpose of determining rates of classroom techniques used and influences on teaching styles in a high school. The study showed that five faculty members who used material from skilled instructional designers provided well-developed activities, while 62 college instructors and 45 corporate trainers without these resources did not. Students who had been taught by college instructors and corporate trainers said that they felt they were treated like children and that the teachers had wasted their time with lack of clarity. The students responded that many of the teachers did not incorporate challenges, a clear

underlying structure, and a distinct finishing point. Faculty members' and their students' comments indicated that the actual design and implementation of the games in the classroom also influenced the way games were perceived by students in the classroom (Seay, 1997). Consequently, Prensky (2011) indicated that games should be fun and have rules, objectives, feedback, completion and interaction to engage students learn by them.

The Benefits of Using Board Games for Teaching Science

Student effort is required at every moment and must be maintained over a long period of time for academic success (Teaching Strategies, 2010). Board games help and encourage many learners to sustain their interest. Board games can develop students' content knowledge, increase their desire to learn, improve their social skills, and develop critical thinking. This will have an important connection to developing students' science skills (Board Games as Educational, 2010; Kumar and Lightner, 2007).

Developing content knowledge.

Lester, Meluso, Spires and Zheng (2011) reported that games can be good instruction that supports teachers to transform content information to their students. Jones (2007) indicated that playing games can improve academic learning achievement in students.

Williams (2007) conducted a one year study on using board games to enhance biology students' learning. During this year, the students were interviewed to discuss how the game affected their performance on exams. Students who faithfully availed themselves of the activities consistently improved their test scores and their overall grade throughout the course. Many students who chose not to use the activities in preparing for the first exam realized afterward that they required additional review. When they took

advantage of some of the study items, they found their own understanding as well as test scores improved. The few bonus points assigned upon completion of the study items raised their overall grade as well (Board Games as Educational School Supplies, 2010; Petsche, 2011).

Motivation to learn.

Games can motivate students to learn and achieve higher standards (Crews, 2001; Mayer, 2011; Petsche, 2011). Using games, students are free to experiment because they have opportunities to apply creative solutions and experience successes and failures (Bendixen-Noe, 2010; Kerr et al., 2011). Moreover, students feel themselves improving as they analyze many complex topics during game play, so they feel the immediate effects of their improvement as they become better at the game. Receiving feedback from teachers may take a long time, or at times teacher feedback does not affect students (Crews, 2001). However, games can provide immediate feedback for students, then allow them to try again and correct their strategy for playing the game (Williams, 2007). Games allow students to understand themselves and their identity as they engage in real experiences rather than imaginary scenarios (Demirbilek, 2010; Marjanen, 2010). This helps students to examine the way they make choices, and see the effects of their decisions, turning the abstract concepts that they are learning about into tangible experiences (Iseri, Kirikaya, & Vurkaya, 2010; Klopfer, Osterweil, & Salen, 2009).

Iseri, Kirikaya, and Vurkaya (2010) used qualitative research to design a game that could be used in the evaluation of interaction during the game time and make inferences about the adaptability of this game by gaining teachers and students' feedback. This research took one year to evaluate 40 students' recognition of celestial objects by

using a board game. The findings from teachers' opinions were: the rules of the game were easy and took little time to explain to the students, the game was a great tool to evaluate an activity, and students' qualifications and quantities were suitable for the game. The findings regarding students' opinions indicated that 50% of the students said they were assessed with the questions in the workbook and with the experiments, 32.5% stated that they did not feel disturbed when asked questions and they were willing to answer the questions, 50% said they did not feel anxious and they wanted their turn to come quickly, and 50% said they did not have difficulty understanding the rules. In addition, 15% suggested increasing the number of traps, 45% stated that they would like to prepare the game as assignment, and 37.5% said it would be noisy while playing the game in class, but it would be enjoyable and they could understand the topics much better. In another qualitative study of elementary teachers who used a board game to teach their students during one year, observations revealed that the students seemed excited and there was much communication, laughter, encouragement and discussion. They were successful and felt proud of themselves for applying the game. Also, many students did not know board game strategies, which allowed teachers to encourage their students to learn something new. Others said the game allowed the students to better meet their needs (Bendixen-Noe, 2010). Board games were very effective in increasing students' motivation, and they could be applied during the lesson and be used for reinforcement.

Yeats (2012) explained why games can be a great way to motivate students and make exercises enjoyable. Games can include competition between students or between students and their teachers (Choosing the Right Game for Your Lesson, 2012). The

feeling of competition increases the desire to play and win, which can be a very strong motivator for students to learn. Being able to progress and grow stronger is one of the most satisfying and motivational aspects of games (Klopfer, Osterweil, & Salen, 2009). This type of mechanism is a powerful motivator for students, especially when engaged in educational content. Games can motivate students to learn because they allow students to customize (Jones, 2007). Customization engages students with their characteristics and with the games. Letting students choose the colors or the names for their characters makes students more excited to play and to learn (Haugan, Ornek, & Robinson, 2008). Games also motivate students to learn by providing rewards as positive feedback for achieving learning goals. These rewards are powerful motivators that make the games more enjoyable and keep them coming back for more. Thus, games can be a good educational tool that motivates students to learn (Jones, 2007; Marjanen, 2010).

Improving social skills.

Another beneficial use of games is to improve students' social skills when they are used in the classroom. All board games are based on rules, so when arguments and squabbling arise, students can point out what the rules allow and settle the debate promptly (Iseri, et al, 2010). Board games facilitate student interaction with each other and exchange of new skills and ideas. Students can improve their empathy and social relationships when they are playing board games (Marjanen, 2010; Petsche, 2011).

In a study by Demirbilek (2010), participants were asked to select the most appropriate list of social subjects that they learned by using puzzle games. The results showed that language learning accounted for 18%, communication skills accounted for 14%, and culture, 12%. In addition, Morrow (2007) studied the development of the social

and communication skills of male offenders through their own reflective practice when being engaged with puzzle games as a teaching resource while in prison. The researcher randomly selected seven participants who did not know one another. This experiment included two parts during one month. In the first part, the researcher asked participants to begin playing a puzzle game. The researcher assigned scores to observations of behavior, where the highest possible score was 4. The score for asking questions was 2 out of 4, for mixing with people and disagreeing with others, and talking about themselves was 1 out of 4, for people looking at one another was 2 out of 4. The second part involved observation during actual game play. The outcomes were taken during game-play and after completion. The score for making decisions affecting others and maintaining conversation was 4 out of 4, and for meeting strangers, talking to people, and talking about themselves was 3 out of 4. In the beginning, the participants expressed negative feelings and were unable to understand the relationship between reflection games and social development. The results showed that the participants improved their social skills and felt the experiment had been beneficial to the development of their confidence and their social skills (Fouche & Visser, 2008).

Increasing critical thinking.

Additionally and in particular, games can increase student's science skills. Science skills do not come from textbooks (Haugan, Ornek, &Robinson, 2008). They are derived from the realm of experience and application. Calhoun, Joyce, and Weil (2009) asserted that learning means acquiring the skills and thought processes needed to respond appropriately under pressure and that learning needs real experience. Haugan, Ornek, and Robinson (2008) investigated what students believed made physics difficult and what

could be done to overcome these difficulties. Survey questions were given to 1400 students. The responses indicated lack of motivation and interest accounted for 59% of difficulties, problems in understanding textbooks and lectures accounted for 53%, and insufficient examples lack of, real life applications, and problem solving accounted for 48%. Many students were unable to place concepts in a physics perspective because they required real application relating their understanding to their experiences. Furthermore, Iseri (2010), when looking at students' opinions found that 37.5% of students wanted a board game to be designed for Physics because they thought a lesson was boring, and also felt it would be good to design similar games for other lessons.

Using games to teach science helps students to employ principles of argument to improve their critical thinking and become more excited to learn. Fouche and Visser (2008) conducted an experimental study to evaluate the integration of a board game to make the teaching of introductory accounting more effective. The board game dealt with both technical skills and soft skills required of accountants, roles of accountants, the course content of introductory accounting and perceived good teaching methodologies. Questions for evaluating the board game were posted for the learners. The responses indicated that 68% of the learners felt that the project enhanced their interest in financial accounting, 72% felt it enhanced their technical competencies, 77% felt that it broadened their view of the roles of accountants, 73% felt that it enhanced their soft skills. In addition, 73% felt it was an effective learning experience, 72% felt it helped them to acquire knowledge and skills that would stay with them in the long run, and 77% felt it increased their insight into the relationship between theory and practice. This study

demonstrates that board games can enhance technical and other skills required of subjects in a practical and effective manner.

Many board games include the exciting challenge of deduction and drawing conclusions from limited information. Mayer (2011) listed some examples of board games that can be played in the classroom for science subjects. Number Chase is a board game applicable to mathematics subjects to improve problem solving skills. The Suitcase Detectives and Tobago are blending of science and math that enhance the discovery learning skills of students. Moreover, students can analyze many complex topics and develop their self-discovery while playing the Uitiniate Werewolf board game. Finally, the board game Zendo promotes the creation of new structures with students' own rules. This game helps develop students' creative thinking. Science teachers can improve their students' mental prowess and critical thinking skills by regularly engaging their minds in solving puzzles or difficult questions, and engaging in activities that employ strategy (Haugan et al., 2008; Morrow, 2008).

The Challenges of Using Board Games in The Classroom

The benefits of using games in the classroom are clear, but there are still some challenges which concern educators. The primary challenges are time, class size, and mixed-ability classes (Carmmer, Groff & Howells, 2010; Jones, 2007).

Time.

Time is one of the challenges of playing games in the classroom for both students and teachers (Crews, 2011). For the teacher, implementing a game in the classroom requires time to distribute the game and to arrange students in groups if required. Teachers need more time to explain the rules of games and to see how students apply

concepts, as well as assess their ability to use the game (Jones, 2007; Seay, 1997; Williams, 2007). Teachers need time to lecture on a topic, engage their students in discussion prior to plying the game (Carmmer et al., 2010). In Kumar and Lightner's study (2007), the five faculty members who had used educationally designed games reported that the greatest changes they faced when implementing practiced the board game with their students was finding more time to complete the game. Moreover, Students may need to play more than one time to understand the main concepts of the game. It is usually difficult for students to realize the focus of a game with all the distractions available during games, which also subtracts from limited time available for classroom activities such as playing, discussion, and taking notes (Jones, 2007; Summit on Educational Games, 2005).

Class size.

The class size is another challenge for using games as educational tool. The class sizes, whether large or small, can create obstacles for the application of the game (Carmmer et al., 2010). A large number of students can make it difficult for teacher to teach all students and can also make a lot of noise when they are playing a game (Mayer, 2011). On the other hand, a very small number of students can limit the students' opportunity to interact with their classmates (Jones, 2007).

Mixed-ability classes.

Another challenge of using games in education is mixed-ability classes. Teachers do not want the students who are already comfortable playing games to be held back by those who are inexperienced, or those who are inexperienced to be intimidated by those who are already comfortably (Basnet, 1996; Fouche & Visser, 2008; Jones, 2007).

Inexperienced students may not be able to keep up with the game while the more confident students may get bored (Mayer, 2011). Teachers face some difficulties in arranging pairs and groups differently for different kinds of games (Carmmer et al., 2010).

Summary

In summary, many researchers have indicated that games are an instructional tool in education, have requirements to be applied in classroom, have many advantages that support students to learn, and some obstacles that teachers may face when using them in classroom.

Board games have special definition in education (Basnet, 1996; Kramer et al., 2009; Remmele et al., 2009). They should relate curricular concepts, new knowledge, roles, and challenging environments (Kerr et al., 2011; Rule, 2011). In addition, board games have some requirements for designers and teachers (Summit on Educational Games, 2005; Wainess, 2011).

Board games should be designed with a clear learning goal, encourage questions, and be set in real world situation for greater student understanding (Basnet, 1996). Teachers also should have experience with the board game before presenting it in class and be flexible when applying it with their students (Kumar & Lightner, 2007). Teachers also must assess their students when they are playing (Haugan et al., 2008; Yeats 2012).

Student motivation and engagement are ongoing challenges for instructors and are the basis of various research endeavors (Petsche, 2011). The argument for using active learning, such as games in the classroom is clear. A student passively sitting through a lecture does not reach the level of stimulation required to promote effort

(Mayer, 2011). Moving around a room, participating in a contest, or simply talking to other students can raise the level of activity to a point where a student is more alert and attentive to the activities of the class. Students must be actively involved in their learning, they have to get feedback, and they should practice sharing, reflecting, and generalizing in small group activities (Iseri et al., 2010; Mayer, 2011). Board games can motivate students to learn and achieve the higher standards (Crews, 2001; Mayer, 2011; Petsche, 2011). Competition, customization and rewards, which board games include, are powerful motivators for students to learn. Also, board games give students opportunities to share their ideas, discuss, and communicate, which improves social skills (Morrow, 2008; Petsche, 2011). Board games helps students to employ principles of argument to improve their critical thinking, problem solving, and discovery learning, which supports students in their science skills (Marjanen, 2010).

Even though there are some benefits for using games as an educational tool in classroom, there are some challenges that face teachers and their students when applying board games in the classroom (Cranmer et al., 2010; Jones, 2007; Mayer, 2011) Time, class size, and mixed-ability classes are some challenges of using board games as an educational tool (Basnet, 1996; Fouche & Visser, 2008; Jones, 2007).

CHAPTER 3

Method

Teachers need to involve their students with lesson topics. They should have methods that motivate students to engage in the learning processes. Science teachers often face obstacles when attempting to use a method that makes their students excited to learn science concepts. On the other hand, educational board games are a tool that support teacher to encourage their students to learn science. By using board games in classrooms students will be motivated to learn, develop their content knowledge, improve their social skills, and increase their critical thinking skills. This chapter includes the following: (a) type of design used for this study and the assumptions that underlie it, (b) the role of the researcher including qualifications and assumptions, (c) selection and description of the site and participants, (d) data collection strategies; and, (e) data analysis strategies.

Type of Design and Underlying Assumptions

This was an exploratory study that examined how board games affect students' motivation when learning science (Physics). Quasi-Experimental research was used to determine the effects of the board game on learning and survey questions to evaluate students' perceptions of motivation to learn physics, improving content knowledge, increasing social skills, and enhancing critical thinking. Clark and Creswell (2010) indicated that Quasi-Experimental design is used when "researchers want to determine whether a treatment causes the desired effect. Researchers also choose this design when

they plan to compare groups" (p. 170). The participants were taught by two methods: using a board game and the traditional (lecture). Participants were given a pretest to determine their knowledge about Physics (especially the concept of light) followed by a posttest to determine their retention after using the traditional method, or the board game. All the tests were essay questions. Then the survey questions (rating scale questions) were given for participants to evaluate their motivation about each method.

Board game.

The researcher explained how the participants play the board game then she let them play and learn the light concept by themselves. According to Bates, Brown, Cranton and Lewis (2010) the researcher followed the six steps which are content analysis, incubation, chunking, aligning, drafting, and incubating to design the board game for light concept.

Step one: content analysis.

The concept was about natural light. Albrakaty and Ammar (1984) summarized that light has two distinctive theories which are Physical theory and Wave theory. Based on Saudi Arabia education standards, Alerany, Almsarwh, Hadad, Hemeady, and Rafea (2009) decided that it is important that high school students understand what is the composition of light to be able to explain some cosmic phenomena (2011). After playing the game, students should be able to know the main and the secondary colors of light. They also should be able to know the wavelengths of all the colors and how the colors affect on nature.

Step two: incubation.

The goal of this game is first player who reached the finish square of the path and

collected all the color pieces will be the winner. This goal makes a great competition between players. Moreover, the board game has colors that grab students' attention to play as well as to learn. At white squares, the player must say the word (light) and then he/she can take any pieces that he wants from the other players. This rule makes the player to be in more control and make the game more enjoyable.

Step three: chunking.

The board game defined Light Game. It was a board game that divided a path which was the letters of the word (LIGHT). The path was coloring by the main colors of light. Also, it had stop, problem, and white squares for giving players more opportunities to learn about the light concept and collect the pieces to win. The materials of the board game were: one especial dice that had the numbers of the wavelengths for the main colors of light. Widgets were the characters that the players choose and collect all the color pieces in them. A color box that had 32 multiple questions cards about light. The answers were clear on the board. A problem box that had 32 multiple problem cards about light. The cards had the answers of all the questions. There were six pieces of red, green, blue, indigo, and violet colors, which were the main and secondary colors of light.

Step four: aligning.

The board game required more than one player. First player who reached the finish square of the path and collected all the color pieces would be the winner. Each player chooses a widget, and then moves on the board as well as the number that he/she got of the dice. On any color square the player stopped on, he takes a card of the box colors and the other player asks the question. If the main player answered the question, he can have a piece that has the same color of the square. If he cannot answer the question,

he cannot have any piece and the player who asked the question has to read the answer of the card. At stop squares, the player must stop one round. If he has a white card, he has to return it to the bank and return to play normally. At problem squares, the player chooses a card of the problem box and the other player asks the question. If the main player found the solutions, he can win the color piece that the problem card decides. If he could not find the solution, he has to move back depending on the number of the dice that he already had got.

Step five: drafting.

The researcher made a paper and used some color cards to exam how the game can relate to the light concept.

Step six: incubating.

The last step is incubating. The researcher collected all the game materials and played it with her three friends who did not have background about the light concepts (see Appendixes A and B for the picture of the board game and its rules).

Lecture.

The researcher speech and used PowerPoint tool to explain the light concept. There were twelve slides that had information and pictures that explained how the colors of light can effect in universal. The participants could see and hear the light concept information as well as they took some notes during the lecture.

Qualifications and Assumptions of the Researcher

The education process has many important aims that depend on individual perspective of core values. There are many educational philosophies that identify different goals of education. An overarching goal or purpose of education is to prepare

students to be well-educated and individuals who contribute to society and their future lives. That is, students need to be prepared to participate and contribute to the successful functioning of society.

Being an educator means applying the above beliefs of education, which will assist in accomplishing this researcher's goal of education. This research is an attempt to investigate how teachers' methods could affect on student learning. This researcher was a physics teacher in Saudi Arabia for one year. During this experience, she developed the belief that all students have certain needs that must be met if they are to grow and learn. In addition, students should feel they are important and they are the most valuable participants in classroom. As a physics teacher, it was important to understand that all students do not learn at the same level; therefore, a variety of methods are needed to reach all students. Moreover, effective methods that enhance students' motivation to learn are extremely important. As a teacher, this research felt that even though students liked to learn science, they needed something more to motivate them.

For all the above reasons, this researcher had a desire to study how a board game can increase students' knowledge of physics, increase their desire to learn, improve their social skills, and develop critical thinking versus traditional lecture.

The study hypothesis was that using board game as a teaching tool in physics content would improves students' motivation, knowledge, social skills, and critical thinking. If this hypothesis is not accurate, there would be no difference in improving students' motivation, knowledge, social skills, and critical thinking who learned by the board game versus students who learned by traditional lecture.

Participants and Site

The participants were selected by convenience sample because they were easily accessible and the researcher could not travel extensively to gain the information. Convenience sample can be used when the subjects are accessibility and proximity to the researcher (Clark & Creswell, 2010; Trochim, 2006).

An Institutional Review Board (IRB) application was submitted and approved prior to the start of the study (see Appendix C). Each student was given a consent form in the beginning of the study which explained the researcher's plan of her project and informed the participants of the study and their rights as participants (see Appendix D)

The sample consisted of two groups college-age students who were undergraduate elementary education students at a small regional university in eastern Washington State (N = 48). Both courses are required of elementary candidates and are only one quarter apart in the sequence of courses students take. The first group was enrolled in a Science and Social Studies Methods, Management and Assessment course (n=24). The size of the classroom was large and it had big tables. In addition, the classroom was amenable for teaching the students concepts of physics by using the board game because it was easy to divide the students into groups and it was easy for students to play the game. This class was chosen to be the experimental group.

The second group was enrolled in a Reading Methods, Management and Assessment course (n=24). This classroom was not as big as the classroom for the experimental group. However, it had a computer and a screen which made lecturing using the traditional method and using PowerPoint easy for the researcher to teach the students concepts of physics. This class was chosen to be the control group.

Data Collection

Demographic information was gathered from the participants (e.g., gender, age, year in school, number of science courses taken). See Appendix E for demographic data gathered.

Performance measures were used to assess individual achievement. The same pretest and posttest was given to both the experimental and control groups. Also, the pretest and posttest contained the same questions so that growth could be measured. These tests consisted of seven essay questions, which were about natural light. See Appendices F and G for examples of the pretests and posttests. Each question was worth only one point, for a total of seven points.

Students then were administered a questionnaire which evaluated their perceptions about motivation, higher level thinking, social skills, etc. This attitudinal survey consisted of five questions that ranged from "strongly disagree" to "strongly agree" (see appendices H and I for examples of the board game survey and the lecture survey).

Data Analysis

Data were analyzed by using Excel by Microsoft Office tool because there were not many independent variables. Analysis included the mean. There were pretest and posttest made for all the groups (experimental and control). Those tests were to see if there were any differences between both groups' achievements. Additionally, there were attitudinal survey that analyzed by explanation the participants' respective bout the method that they taught the light concept by it.

CHAPTER 4

Results

Many researchers have indicated that games have advantages that support students to learn (Basnet, 1996; Kramer et al, 2009; Remmele et al. 2009). Board games are instructional tools that can be used in science classrooms to enhance students in learning process. Board games can motivate students to learn, develop their content knowledge, improve their social skills, and increase their critical thinking skills. This chapter consists of the following: (a) description of the project and what actually happened, (b) what changes were made and factors that caused such changes, (c) data collection, (d) data analysis, and (e) challenges the researcher experienced while implementing the project.

Description of the Project

This was an exploratory study that examined how board games affect students' motivation while learning physics. The concept was about natural light. Albrakaty and Ammar summarized that light has two distinctive theories which are Physical theory and Wave theory (1984). Based on Saudi Arabia education standards, Alerany, Almsarwh, Hadad, Hemeady, and Rafea decided that it is important that high school students understand what is the composition of light to be able to explain some cosmic phenomena (2011). Quasi-Experimental research was used to study the effects of the board game on learning about natural light. Survey questions were used to evaluate participants'

perspectives on their motivation to learn physics, develop their content knowledge, improve their social skills, and increase their critical thinking skills.

The Sample consisted of two groups, the experimental group (n = 24) and the control group (n = 24). The experimental group was taught natural of light by using the board game. The control group was taught about natural light by using the traditional method (lecture) and using PowerPoint. Both groups were college-age students who were undergraduate elementary education students at a regional university in eastern Washington State (N = 48).

Changes Made

In the beginning of the study, the researcher did not make survey questions to evaluate the students' motivation while participating in the lecture to learning physics content, developing their content knowledge, improving their social skills, and increasing their critical thinking for the control group. However, when the researcher analyzed the data, the researcher realized that surveying the control group was very necessary to make a clear comparison between the effects of both traditional lecture and the board game in students' experiences. Four weeks later, the researcher met with the control group students to administer the survey questions. Only 20 out of 24 students participated.

Data Collection

Demographic.

The researcher gathered information about all the participants in both groups. In the experimental group, the participants were 24 (n=24, 100%) female and (n= 0, 0%) male). The participants ranged in age from 20 to 41 years old (20 years old (n=1, 4%), 21 years old (n=4, 16%), 22 years old (n= 7, 29%), 23 years old (n= 5, 20%), 24 years old

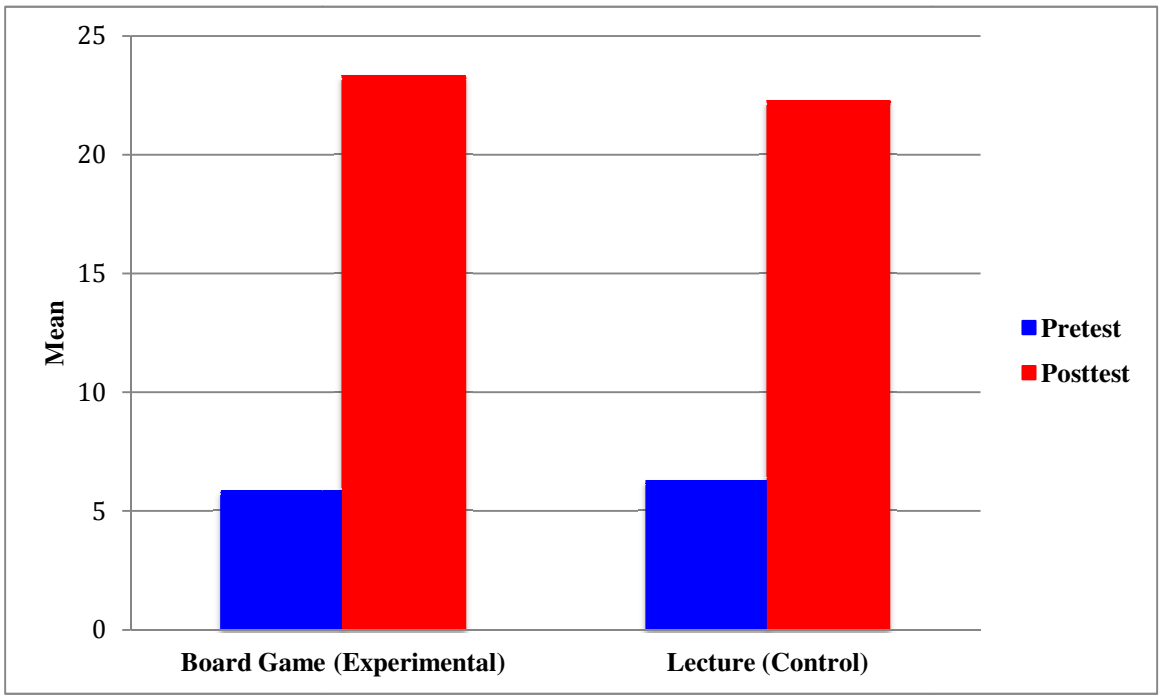
(n= 2, 8%), 30, 36, and 41 years old (n= 1, 4%). The participants took some science courses while in high school and college (4% of the participants took 3 courses, 20% took 4 courses, 29% took 5 courses, 20% took 6 courses, 4% took 7 and 9 courses respectively, 8% took 10 courses, 4% took 11 and 13 courses respectively). Included in the courses were chemistry, biology, and physics.

In the control group, there were 24 participants (n=20, 83%) female and (n=4, 16%) male). The participants ranged in age from 21 to 40 years old (21 years old (n=21, 25%), 22 years old (n=5, 20%), 23, 25, and 26 years old (n=3, 12%), 27 years old (n=2, 8%), 38 years old (n=1, 4%) and 40 years old (n=1, 4%). When asked how many science courses, the range of science courses participants reported as taking was quite large (range=2-14). Included in the courses were chemistry, biology, and physics.

Performance measures for content knowledge.

Both groups were administered the same pretest and posttest. As well both tests included the same questions to note the growth of individual achievement. The questions were seven questions about natural light. There were worthy differences in participants' achievements in their pretest and posttest in both groups. Both groups showed improvement in their posttest (see Figure 1). However, the experimental group (board game) mean difference between the pretest and posttest was 17.5 and the control group (lecture) mean difference was 16. When comparing the posttests in all both experimental and control group, the difference between the means was 1.06 for the experimental group (see Table 1).

Figure 1. *Comparison between Pretest and Posttest in the both Groups.*



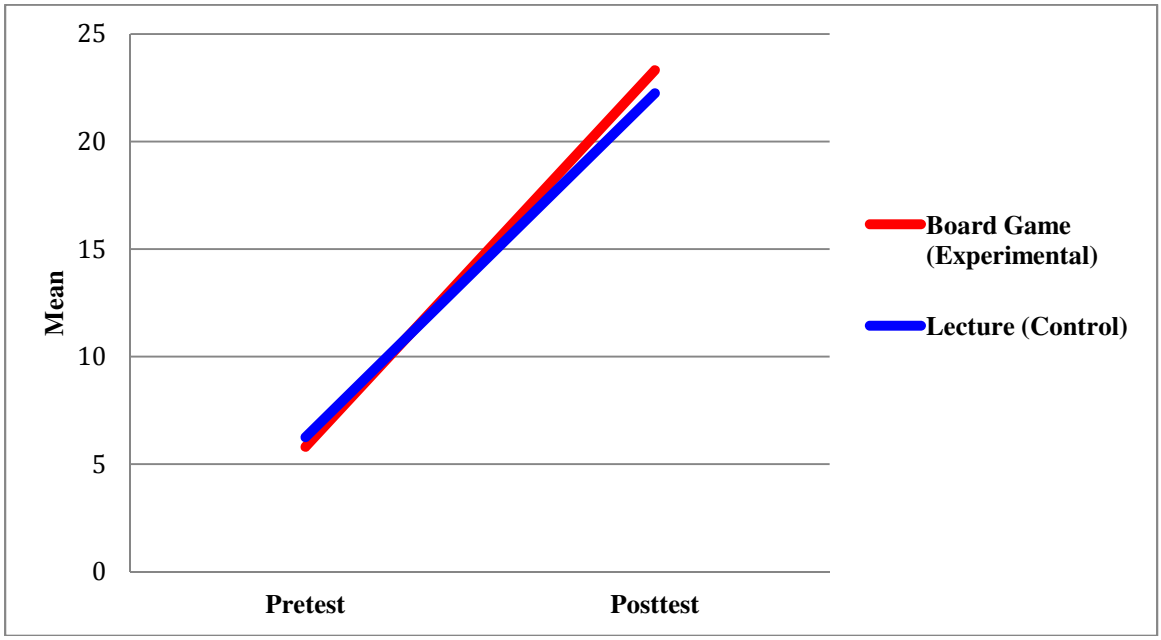
The experimental group mean was 23.31 for posttest and 5.81 for pretest. The control group mean was 22.25 for posttest and 6.52 for pretest (see Table 1).

Table 1. *Scores by Individual Questions by Group.*

Questions	Board Game (Experimental) (n=24)				Lecture (Control) (n=24)			
	Pretest		Posttest		Pretest		Posttest	
	Number of Correct Answer	%	Number of Correct Answer	%	Number of Correct Answer	%	Number of Correct Answer	%
Source of Light	24	100	24	100	24	100	24	100
Primary Colors	4	16.67	23	95.83	6	25	24	100
One Color	24	100	24	100	24	100	24	100
Two Colors	22	91.67	24	100	23	95.83	24	100
Three Colors	4	16.67	23	95.83	6	25	24	100
Secondary Colors	0	0	23	95.83	0	0	22	91.67
One Color	5	20.83	23	95.83	2	8.33	24	100
Two Colors	1	4.17	23	95.83	0	0	24	100
Three Colors	0	0	23	95.83	0	0	22	91.67
Longest Wavelength	7	29.17	24	100	10	41.67	24	100
Shortest Wavelength	1	4.17	24	100	2	8.33	24	100
Wavelength	0	0	24	100	0	0	16	66.67
One Color	0	0	24	100	0	0	24	100
Two Colors	0	0	24	100	0	0	16	66.67
Three Colors	0	0	24	100	0	0	16	66.67
Color Presented	1	4.17	19	79.17	3	12.50	24	100
Mean	5.81		23.31		6.25		22.25	

The graph below explains the scores of the board group and lecture group during pretest and posttest (see Graph 1).

Graph 1. *Comparison of Group Performances in the Pretest and the Posttest.*



The background questionnaire provided interesting insights about students' performance on learning physics by using the board game or the lecture.

Courses in science.

There was no big statistical difference between pretests in both groups because they already had some background about natural light. Interestingly the control group (which did not show as much gain on the posttest) took more science courses than the experimental group. Moreover, it was not surprising to find that both groups improved in the immediate time because the participants' learning could have been due to the participants' reading of the introduction about the light subject.

Ages of the participants.

The ages of the participants in the experimental group (board game) range from 20 to 41 years of age. This largest percentage of participants was in the range of 21 to 23 years of age. Furthermore, some participants of the experimental group may have been

more negative toward the board game approach because more of those participants were older.

The pretest and posttest also provided interesting insights about students' performance on learning physics by using the board game or the lecture.

Main source of natural light question.

The question about the main source of natural light was easy and a very general question, which may have been why all the participants in both groups score correctly on both the pre- and posttest. This question may have helped all the participants score higher on the overall total of their pre- and posttests.

The wavelengths of the colors question.

It was difficult which method was more effective when examining the question regarding the colors of the wavelength. There was 16 participants in the control group (lecture) who answered correctly on the posttest while all participants in the experimental group (board game) answered it correctly. In the control group, the researcher presented the wavelength of light's colors by the longest wavelength to the shortest wavelength. However, during the lecture, the order in which colors were presented was different from the order on the pre-and posttest. In this case, many participants wrote the answer of the question exactly as presented during the lecture. Some participants noted the change in the order on the posttest and changed the arrangement to be correct in their answer. Eight participants of 24 in the control group did not change their arrangement, which resulted in an incorrect answer. In the experimental group, when the participants were playing the board game, they could memorize all wavelengths of the colors with no attention to the order of the wavelengths. In order to win the game, participants had to master respond

correctly the color to the length. Therefore, all the participants in the experimental group scored correctly on this question on the posttest All the participants were confident of their answer because there was no changing or crossing out of answers on this question.

At sunrise and sunset question.

On the posttests of both groups, 19 participants of the board game group got the correct answer while all the participants of the lecture group got the correct answer. This could be due to a lack of clarity in the board game. There was a card question with the answer of why do we see the red color at sunrise and sunset, but many participants asked the researcher for more explanation of the answer because it was not clear. Some participants did not ask the questions. On the other hand, in the control group, this section of natural light may have been explained more clearly in the lecture.

Attitudinal Survey.

In the end of the study the participants were administered a questionnaire to evaluate their motivation while learning physics, developing their content knowledge, improving their social skills, and increasing their critical thinking skills. The survey consisted of five questions that ranged from “strongly disagree” to “strongly agree”. The experimental group’s rating about the effects of the board game in their learning ranged between agree to strongly agree. On the other hand, the control group’s rating about the effects of the lecture in their learning ranged between neutral and agree (see Table 2). The total participant rating for the experimental group was 62 for strongly agree and the total participant rating for the control group was 50 for neutral.

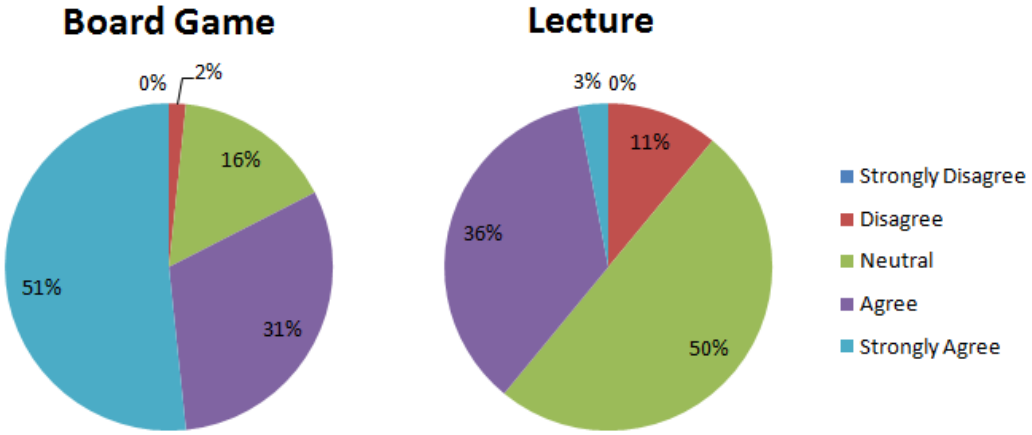
Table 2. *Comparison of Survey of Both Groups.*

Question	Board Game (n=24)					Lecture (n=20)				
	1*	2*	3*	4*	5*	1*	2*	3*	4*	5*
Motivation		1	5	6	12		3	14	3	
Social Skills			5	10	9		7	13		
Critical Thinking		1	6	7	10		1	13	6	
Main Subject			2	5	17			4	13	3
Broadened			1	9	14			6	14	
Total	0	2	19	37	62	0	11	50	36	3

*1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

The chart below explains the difference of the total of the participants who rated for the effects of the lecture and the board game both groups (see Graph 2).

Graph 2. *Comparison of the total of the Participants and their Rating in the both Groups.*



Data Analysis

Performance measures for content knowledge.

For the pretest and posttests, the experimental group mean difference between the pretest and posttest was 17.5 and the control mean difference was 16 (see Table 1). In the experimental group, all the participants correctly answered the first question both the pre-

and posttest. Four participants correctly answered the second questions in the pretest and 23 participants in the posttest. No participants answered question three correctly in the pretest while 23 answered it correctly on the posttest. Seven participants correctly answered the four question in the pretest and 24 participants in the posttest. One participant answered question five correctly in the pretest while all the participants answered it correctly on the posttest. No participants answered question six correctly in the pretest while 24 answered it correctly on the posttest. One participant correctly answered the seven question in the pretest and 19 participants in the posttest (see Appendices F and G for examples of the pretests and posttests). Comparing between the pretest and posttest in the experimental group, the participants had improved their knowledge of natural light. That meant board game could be a great method that use to explain physics topic for students (see Table 1 and Figure 1).

In the control group, all the participants correctly answered the first question both the pretest and posttest. Six participants correctly answered the second questions in the pretest and 24 participants in the posttest. No participants answered question three correctly in the pretest while 22 answered it correctly on the posttest. Ten participants correctly answered the four question in the pretest and 24 participants in the posttest. Two participants answered question five correctly in the pretest while all the participants answered it correctly on the posttest. No participants answered question six correctly in the pretest while 16 answered it correctly on the posttest. Three participants correctly answered the seven question in the pretest and 24 participants in the posttest (see Appendices F and G for examples of the pretests and posttests). Comparing the pretest and posttest in the control group, the participants improved their knowledge of natural

light. That meant traditional lecture could be a great method that use to explain physics topic for students (see Table 1 and Figure 1).

When the pretest was compared between the experimental group and the control group, the control group's mean was higher than the experimental group. However participants in the control group reported taking more science courses in high school and college (see Figure 1 and Graph 1).

Again when the posttest means scores were compared for the experimental group and control group, the mean posttest score of the experimental group was higher than the control group. This could mean the board game developed participants' knowledge of physics more than the lecture method, even though the control group had the higher mean in the pretest (see Figure 1 and Graph 1).

Attitudinal survey.

Twelve participants from the experimental group rated their motivation to learn physics as "strongly agree" by using the board game whereas 14 participants rated their motivation as "neutral" in the control group by using the lecture. Ten participants from the experimental group rated that the board game increased their social skills as " agree" whereas 13 participants rated that the lecture increased their social skills as "neutral" in the control group. Ten participants from the experimental group rated that the board game enhanced their critical thinking as "strongly agree" whereas 13 participants rated that the lecture enhanced their critical thinking as "neutral" and " agree" in the control group. Seventeen participants from the experimental group rated that the board game covered the main subject as "strongly agree" whereas 13 participants rated that the lecture covered the main subject as "agree" in the control group. Fourteen participants from the

experimental group rated that the board game broadened participant's view in physics as " strongly agree" whereas 14 participants rated that the lecture broadened participant's view in physics as "neutral" in the control group (see Appendices H and I or the surveys, and see Table 2). In the experimental group, the "strongly agree" category had the highest rating; that is 51 percent of participants responded to all the questions in this category. However, the "neutral" column had the highest rating by 50 percent in the control group. (see Graph 2).

This study examined the effectiveness of board game method to teach physics. A comparison between groups, experimental and control, in the pretest and posttest was done and showed the differences between the groups. Additionally, comparisons between the two surveys for the board game and lecture also were done and showed the differences between the groups. The board game group showed more improvement than the control group in motivation participants to learn physics, improving their social skills, and increasing their critical thinking as well as increasing content knowledge around physics.

Chapter 5

Discussion and Conclusions

The purpose of this study was to examine the effectiveness of using board game on teaching high school physics concept. Forty-eight college-age students were taught with using the board game or by the method of traditional lecture and then were compared. The hypothesis of the study was that using a board game would help high school age students be more motivated to learn, develop their content knowledge, improve their social skills, and increase their critical thinking skills, and this hypothesis was supported even the project was applied on college age students.

The findings of the present study were the board game worked better than the traditional lecture for motivating students to learn physics, developing their content knowledge, improving their social skills, and increasing their critical thinking skills. The mean difference in the pretest and the posttest for the experimental group was 17.5, and for the control group it was 16; both groups improved. However, when comparing the posttests in all both experimental and control group, the difference between the means was 1.06 for the experimental group. This means that the board game worked more in developing participants' content knowledge comparing to the traditional method.

Moreover, when the finding of the survey questions (participants' motivation to learn physics, developing their content knowledge, improving their social skills, and increasing their critical thinking skills) were evaluated the board game scores were higher than the traditional method. The "strongly agree" column had the highest rating for the

experimental group (62 participants), the “neutral” column had the highest rating for the control group (50 participants). This could mean that using a board game to teach the concept of natural light motivated participants to learn physics, improved their social skill, and increased their critical thinking. The purpose of this study was to examine the effectiveness of using board game on teaching high school physics concepts. The study results show that the board game works well for this purpose.

The background questionnaire provided interesting insights about students’ performance on learning physics by using the board game or the lecture, which requires further discussion in the subsequent sections.

Kliman (2006) indicated that some older people may not be interested in using games for their learning because they might think they are just playing and have fun and not actually learning. Furthermore, some participants of the experimental group may have been more negative toward the board game approach because more of those participants were older. Two participants rated “disagree” on the question of motivation to learning physics and for enhancing critical thinking by using the board game even though those same participants scored 100% on their posttest.

Marjanen (2010) and Petsche (2011) responded that games could increase social skills because a team of players should talk and share their ideas with each other to win. In the experimental group, the researcher informally observed that the participants were excited to play the board game and how it could relate to physics concept. During they were playing, they were speaking, thinking, laughing, and moving. The researcher just defended how the participants can play the board game with no explanation of the light content because they will discover everything about the light by themselves when they

are playing. This seemed to make the participants more excited to see what new knowledge was coming next and, also, the participants had to share information with each other.

Yeats (2012) explained that competition is a reason that makes students motivate to learn. Further, when the time was over with playing the board game, many participants asked the researcher to have more time even they already had some background of the light concept, but they just wanted to complete and win the game. In addition, when the researcher distributed the posttests, the participants were excited to assess their knowledge about the light by just playing the board game. Moreover, some participants wrote comments on their posttest and survey question papers even the researcher did not ask them. One of them said, “This was fun, thank you.”. Other one said, “I loved this activity. I will definitely remember what I have learned today. I will use this idea in my classroom, thank you”. One of them said “did you create this game by yourself? If you did, just sell it. It is an amazing educational game.”

On the other hand, in the control group, some participants did not seem excited to listen to the lecture because or they already had background of the light concept. Some of the participants were yawning or working on their computer. The class was so quiet and the researcher was the only one talking, Three times the researcher tried to ask question of the participants to engage them to the content. Each time the researcher was repeating the question more than one time because the participants did not seem to be engaged in the lecture. Moreover, some participants used their notes to complete their posttest even though they were instructed not to do so. It would be interesting to see if the posttest scores would have been even lower if the participants had not used their notes.

Future Research

This study showed differences between groups, however the participants were not of high-school age. Therefore, research with high-school-aged students might be beneficial and might help to generalize the study's finding. Having background information about the concept of light could make some participants not interested in either method and the findings may not help when attempting to determine which method is best.

Moreover, future research should be done in three groups. One group taught by the traditional method. The second group taught by a board game. The third taught by the both the traditional and board game methods. This way, the researcher could examine all the strengths and weaknesses of all the methods when they compare all findings.

In addition, future research should include three tests for this study, which will be pretest, posttest, and retention test to examine which method is most effective over time. The differences between the pre-and posttests will help determine which methods are most effective. As well, the researcher should compare between the posttest and retention tests to see the differences of the two methods and which method will be effective over time.

Challenges Experienced

There were some challenges encountered while conducting her research project. Finding a high school class, translating some physics idioms from Arabic to English, and collecting the board game's pieces were the difficulties faced. First, the project was created for high school students who are studying physics, but the researcher did not have her own high school class. It was difficult for the researcher to find a sample that could

be treated like high school students and do not have much knowledge about the concept of natural light. Second, transitioning the light idioms from Arabic, which is the researcher's first language, to English was hard for matching meaning. The specific idioms that needed to translate were Diffraction and Polarization of light. Third, the number of board games that the researcher created was ten. Each board game needed 33 pieces to cover the content. As a result, it took long time for to find 330 pieces for all the board games and use them in the project.

Conclusion

By conducting this research, the researcher learned that teachers need to have different methods to transfer knowledge to their students. Teachers could create a method that helps their students enjoy learning and increase their desire to learn. Moreover, the researcher learned how teachers could take advantage of games that many students spend time playing to be a great educational method. Many students spend time playing game for just fun with have no idea about how they can learn by playing. On the other way, by this project, the researcher could find the best strategies of game design to create an educational game.

This study investigated the usefulness of board games while teaching students physics content. In this case, students in the experimental group improved their content knowledge, motivate to learn physic, develop social skills, and increase their critical thinking compared to the control group, as was expected. The use of board game as a tool to teach high school physics worked for almost all participants from different ages, different gender, and different science courses. Even though this study was done through a convenience sample and with a limited of physics contents, it provided useful insights

about the possibility of the board game method and how well it worked. The results of this study can now be added to the literature and, combined with other results.

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APPENDICES

Appendix A−Picture of the Board Game


λ = 700
λ = 400 nm
Problem
Start
Stop
Problem
Stop
Problem
Stop
Problem
Stop
Problem
End
What is the wavelength of the red color of visible spectrum?
700 nm.
What are the secondary colors of visible spectrum?
CONGRATULATION
Indigo Piece

Appendix B−The Rules of the Board Game

Light Game

Object of the Game.

The object of this game is to collect all of the color pieces in your widget. First player who reached the last square of the path and collected all the color pieces will be the winner.

Game Materials:

The game named Light Game. It is a board game that is divided to a path, which is the letters of the word (LIGHT). The path is coloring by the main colors of light (red, green, blue). Also, it has stop, problem, and white squares for giving players more opportunities to collect the pieces and have fun.

The box of the game has:

- 1 board. (It has a big (LIGHT) word divided into squares).
- 1 especial dice. (It has the wavelengths' numbers of the light's main colors).
- 3 widgets.
- 1 color box that has 32 multiple questions cards about light with the answers.
- 1 problem box that has 32 multiple problem cards about light with the answers.
- 6 red pieces.
- 6 green pieces.
- 6 blue pieces.
- 6 indigo pieces.
- 6 violet pieces.
- 3 white cards.

Time Required.

5 minutes to set up the game. The approximate time for playing, completing, and reaching the last square of the game is about 20 minutes.

The Rules.

1- 2 - 3 player.

2- First player who reached the last square of the path and collected all the color pieces will be the winner.

3- A player chooses a widget.

4- All players roll the arrow of the dice and who got the big number will be the first player.

5- First player roll the arrow again.

6- Then first player moves on the board as same as the number on the dice.

7- Any colored square the player stopped on, other player takes a card from the colors box similar to the colored square and asks the question. If the player answered the question, s/he owns a piece that has the same color of the square. If s/he cannot answer the question, s/he cannot have any piece and the player who asked the question has to read the answer of the card.

8- At stop squares, the player must stop one round. If s/he has a white card, s/he can trade it with the bank to return to play normally.

10- At problem squares, the player chooses a card of the problem box and the other player asks the question. If the player found the solutions, s/he can win the color piece that the problem card decides. If s/he could not find the solution, s/he has to move back number of squares similar to the dice number.
11- At white squares, the player must say the word (light) and then s/he can takes a piece that s/he wants form the other players. But if s/he did not say (light) s/he cannot take any pieces.

NOTE.

- If you reached the last square without having all the color pieces, you have to start over with keeping the pieces that you already had collected.
- You can just have 2 pieces with same color.
- You cannot have 2 white cards at the same time.

Appendix C−IRB Documents

Eastern Washington University

at Cheney and Spokane

MEMORANDUM

To: Kadia Alfaifi, Department of Education, 312 WLM

From: Sarah Keller, Chair, Institutional Review Board for Human Subjects Research

Date: February 4, 2013

Subject: Review of HS-4137 *Using Board Games to Teach Physics in a High School*

Human subjects protocol HS-4137 *Using Board Games to Teach Physics in a High School* has been determined to be exempt from further review according to federal regulations for the Protection of Human Subjects under CFR Title 45, Part 46.101(b)(1-6). Research qualifying for an exemption is valid for a period of one year, to February 4, 2014. If you wish to continue gathering data for the study after that date you must file a Renewal of Approval application *prior to its expiration*, otherwise the project will be closed and you would need to submit a new application for IRB review if you wish to continue the research.

A signed, approved copy of your application is enclosed.

Please note: Although your study involves children it is curricular so does not need to go to Full Board. It is Exempt from further review.

If subsequent to initial approval the research protocol requires minor changes, the Office of Grant and Research Development should be notified of those changes. Any major departures from the original proposal must be approved by the appropriate IRB review process before the protocol may be altered. A Change of Protocol application must be submitted to the IRB for any substantial change in protocol.

If you have additional questions please contact me at 359-7039; fax 359-2474: email: skeller@ewu.edu. It would be helpful if you would refer to HS-4137 if there were further correspondence as we file everything under this number. Thank you.

cc: R.Galm
T.Haskins
C.Valeo
Graduate Office

Department of Geography and Anthropology
MS–52, 103 Isle Hall • Cheney, Washington 99004 • (509) 359-2433 • Spokane – (509) 458-6213

H54137

OFFICE OF GRANT AND RESEARCH DEVELOPMENT

JAN 22 2013

Institutional Review Board for Human Subjects Research

Application for IRB Review

Return Original + 2 copies for Expedited & 14 copies for Full Reviews to Grants-210 SHW

Principal Investigator/Department	Responsible Project Investigator/
Kadia M. Alfaifi/Education. 620 W 7 th St. Apt# 5G, Cheney, WA 99004 (509) 270-2039 kalfaifi@eagles.ewu.edu	Name: Dr. Tara Haskins Williamson Hall 318B,Cheney, WA 99004 (509) 359-6953 tebey@ewu.edu

Status: Undergraduate Graduate Student Faculty Administrator Staff

For students only: Is this research being done to meet a course, thesis or other academic requirement? Yes, this research is being meet thesis.
If **not**, why is it being done?

Request for: Expedited review Full IRB review XX

Title of Project
Using Board Games to Teach Physics in a High School

Project anticipated starting date 2/19/2013 Anticipated termination date 7/6/2013

Funding:
XX Non-Funded Internal Funding External Funding
Funding status: proposal in preparation pending agency decision funded
Funding Agency (if applicable): _____ Grant or Contract Number: _____

Abstract
This is an exploratory study that will examine how board games affect students' motivation on learning science (Physics). Quasi-Experiment research will be used to determine the affect of the board game and survey questions to evaluate it. Participants will be selected by convenience sample. They will be taught by two methods: the traditional (lecture) and using a board game. Participants will be given a pretest to determine their knowledge in Physics followed by posttest to determine their retention after using the traditional method, or the board game. All the tests will be essay questions. Then the survey questions (rating scale questions) will be given for participants to evaluate their motivation about either method and to discern which method was more effective over time.

The information provided above is accurate and the project will be conducted in accordance with applicable Federal, State and University regulations.

Signature, Principal Investigator _____ Date 1/22/13

Recommendations and Action		Date	Approve/Disapprove
Responsible Principal Investigator	Tara Haskins	1/22/13	Approve
Dept IRB representative or Dept Chair	Christina A Waller	1/22/13	Approve
Institutional Review Board	Sarah A Keller	2-4-13	Approve

Subject to the following conditions: _____

Period of Approval 2-4-13 to 2-4-14

Rev 6/08

Appendix D−Consent Form

RATER ID 00640812

Consent Form
Using Board games to Teach High School's Physics

Tara Haskins, Ph.D.
Assistant Professor
Education
509-359-6953

Kadia Alfaifi
Education
509-270-2039

We are seeking your consent to use the results of this study to examine if board games have an effect on increasing students' knowledge about physics, increasing students' desire to learn, improving their social skills, developing critical thinking, as well as evaluating the design of a board game.

Purpose and Benefits

The purpose of this project is to study using board games to motivate high school students while learning physics. Some students avoid learning physics because they think it is hard, so they need instructional methods that motivate them to learn the sciences. Teachers and students will be benefit from this activity in that teachers will be able to obtain students' attention to learn physics and students will enjoy learning the subject of physics.

Procedures

This is an exploratory study that will examine how board games affect students' motivation on learning science (Physics). Quasi-Experiment research will be used to determine the effect of the board game and survey questions to evaluate it. Participants will be selected by a convenience sample from undergraduate courses in the Education Department. They will be taught by two methods: the traditional (lecture) and using a board game. Participants in both groups will be given a pretest to determine their knowledge of physics followed by posttest to determine their retention after using the traditional method, or the board game. The pre- and posttests will be comprised of essay questions. A survey (rating scale questions) will be given after instruction for participants to evaluate their motivation about either method and to help discern which method was more effective.

Risk, Stress or Discomfort

Risk, stress or discomfort will be minimal. However, students who have previous negative experiences with the topic of science may experience some feelings of anxiety. As well the competitive nature of the game may cause some stress, especially if students lose the game.

Other Information

Your identity will remain confidential. At no time will your name be associated with the files. All participants will be assigned an identification number. Again, you can choose to withdraw from the research project at any time without penalty.

_____ _____
Responsible Project Investigator Date

_____ _____
Signature of Principal Investigator Date

This study has been explained to me, and I voluntarily give consent to include my responses as part of the research project.
I have had an opportunity to ask questions. I understand that I will receive a signed copy of this form.

_____ _____
Signature of Participant Date

If you have any concerns about your rights as a participant in this research or any complaints you wish to make, you may contact Ruth Galm, Human Protections Administrator (509-359-6567); email: rgalm@ewu.edu.

Appendix E−Demographic Data Gathered

Participate Number_____

Are you a male or female?

What is your age?

1- Are you considered a freshman, sophomore, junior or senior?

2- How many years has it been since you graduated from high school?

3- How many science courses did you have in high school?

4- What science courses did you take in high school?

5- How many science courses have you taken in college?

6- What science courses were they?

7- Is English your primary language?

8- Are you an International Student?

9- If so, which country is your home country?

Appendix F−Pretest

Participant Number_____

1- What is the main source of natural light?

2- What are the primary colors of natural light?

3- What are the secondary colors of natural light?

4- What is the longer wavelength in the visible spectrum?

5- What is the shorter wavelength in the visible spectrum?

6- What are the wavelengths of all the following colors:

Red is ---------- nm.
Blue is ---------- nm.
Green is ---------- nm.

7- At sunrise and sunset, red color is present. Why?

Appendix G−Posttest

Participant Number_____

1- What is the main source of natural light?

2- What are the primary colors of natural light?

3- What are the secondary colors of natural light?

4- What is the longer wavelength in the visible spectrum?

5- What is the shorter wavelength in the visible spectrum?

6- What are the wavelengths of all the following colors:

Red is ---------- nm.
Blue is ---------- nm.
Green is ---------- nm.

7- At sunrise and sunset, red color is present. Why?

Appendix H−The Board Game Survey

Please range from “strongly disagree” to “strongly agree,” the following statements:

Statement	1*	2*	3*	4*	5*
My motivation in learning physics concept has been enhanced by the board game.					
Participating in the board game increased my social skills.					
Participating in the board game enhanced my critical thinking.					
The design of the board game covered the main subject.					
Participating in the board game broadened my view on physics.					

*1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Appendix I−The Lecture Survey

Please range from “strongly disagree” to “strongly agree,” the following statements:

Statement	1*	2*	3*	4*	5*
My motivation in learning physics concepts has been enhanced by the lecture.					
Participating in the lecture increased my social skills.					
Participating in the lecture enhanced my critical thinking.					
The lecture covered the main subject.					
Participating in the lecture broadened my view on physics.					

*1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

VITA

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2006 Teacher, Asanable High School (private school), Riyadh, Saudi Arabia