



# EFFECTS OF A SIMULATION BOARD GAME IN ENHANCING COGNITION AND KNOWLEDGE RETENTION IN LEARNING SHIPPING MANAGEMENT AMONG STUDENTS IN TWO HIGHER EDUCATION INSTITUTIONS



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SULTAN IDRIS EDUCATION UNIVERSITY

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KNOWLEDGE RETENTION IN LEARNING SHIPPING MANAGEMENT AMONG  
STUDENTS IN TWO HIGHER EDUCATION INSTITUTIONS

SHANIZAN HERMAN BIN MOHD RADZI



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FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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## ABSTRACT

This research aimed to develop and examine the effects of a simulation board game for learning shipping management in two higher education institutions. A provisional board game design framework was proposed by referring to the game-based learning literature. Based on the framework, an instance of shipping management board game was developed, standing on the discreet event simulation of a realistic shipping process and activity. The framework was converted into game mechanics for constructing the gameplay by applying a transparent process of gameplay, while enforcing face-to-face interaction among players. The design of the board game was validated by 27 experts through a playtesting session; and the effects of the board game usage was examined through a non-equivalent control group pre-test/post-test quasi-experiment. Edumetric tests were administered to measure the effects of the board game in two locations involving 67 participants from Institution A and 74 participants from Institution B. Ten sessions of intervention were given to the experimental group in both institutions within ten weeks. The results of parametric statistical tests indicated that the effect of cognition was statistically significant with  $F(1,65) = 147.13$ ,  $p=.000$  ( $p<.05$ ) for Institution A and  $F(1,72) = 146.85$ ,  $p=.000$  ( $p<.05$ ) for Institution B. In addition, this research showed that the experimental group achieved better knowledge retention than the control group in both institutions. In particular, participants in Institution A were 26% better; and participants in Institution B were approximately 10% better. In conclusion, as an instance of the framework, the board game demonstrated positive effects as a learning tool for learning shipping management. This, in turn, validated the simulation board game. The implication of this research was, the simulation board game developed provided significant effects in learning shipping management.





## KESAN PERMAINAN PAPAN SIMULASI DALAM MENINGKATKAN KOGNISI DAN PENGEKALAN PENGETAHUAN DALAM PEMBELAJARAN PENGURUSAN PERKAPALAN DALAM KALANGAN PELAJAR DI DUA BUAH INSTITUSI PENGAJIAN TINGGI

### ABSTRAK

Tujuan kajian ini adalah untuk membina dan mengkaji kesan permainan papan simulasi ke atas pembelajaran pengurusan perkapalan di dua buah institusi pendidikan tinggi. Satu reka bentuk kerangka permainan papan sementara telah dicadangkan berdasarkan kepada kajian-kajian terdahulu berkaitan pembelajaran berasaskan permainan. Berdasarkan kerangka tersebut, sebuah contoh permainan papan tentang pengurusan perkapalan telah dibina, berasaskan simulasi situasi sebenar dalam aktiviti serta proses penghantaran perkapalan. Kerangka ini diubahsuai kepada mekanik permainan yang membangunkan permainan dengan menerapkan proses permainan yang telus, yang pada masa yang sama menerapkan interaksi bersemuka dalam kalangan pemain. Reka bentuk permainan papan telah disahkan oleh 27 orang pakar melalui satu sesi ujimain; dan kesan permainan papan itu telah dikaji menggunakan kaedah eksperimen-kuasi pra-ujian / pasca-ujian kumpulan kawalan yang tidak setara. Ujian edumetrik juga telah dijalankan untuk menilai kesan permainan papan di dua buah lokasi yang melibatkan 67 orang peserta dari Institusi A dan 74 orang peserta dari Institusi B. Sepuluh sesi intervensi telah dijalankan ke atas kumpulan eksperimen di kedua-dua buah institusi dalam tempoh sepuluh minggu. Hasil ujian statistik parametrik menunjukkan bahawa kesan kognisi adalah signifikan secara statistik dengan  $F(1,65) = 147.13$ ,  $p = .000$  ( $p < .05$ ) untuk Institusi A dan  $F(1,72) = 146.85$ ,  $p = .000$  ( $p < .05$ ) untuk Institusi B. Di samping itu, kajian ini telah membuktikan bahawa kumpulan eksperimen telah mencapai pengekalan pengetahuan yang lebih baik berbanding kumpulan kawalan di kedua-dua buah institusi tersebut. Khususnya, peserta di Institusi A adalah 26% lebih baik; dan peserta di Institusi B adalah lebih kurang 10% lebih baik. Kesimpulan, melalui perwakilan kerangka kerja, permainan papan ini telah menunjukkan kesan positif sebagai alat pembelajaran untuk kursus pengurusan perkapalan. Ini seterusnya mengesahkan kegunaan permainan papan simulasi ini. Implikasi dari penyelidikan ini adalah, permainan papan simulasi yang dibangunkan memberikan kesan yang signifikan dalam pembelajaran pengurusan perkapalan.



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## LIST OF ABBREVIATIONS

COTS	Commercial of-the-shelf
DES	Discrete event simulation
GBL	Game-based learning
MET	Maritime education and training
PBL	Problem-based learning
RPG	Role-playing game
TPACK	Technological pedagogical content knowledge

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## CHAPTER 1

### INTRODUCTION



#### 1.1 Overview

This research explores the use of a bespoke board game as a simulation tool for learning shipping management in higher education. This chapter describes in details the research background, problem statement, research objectives, research questions, significance of the research; and a list of operational definition.

#### 1.2 Research Background

Computer games and mobile games have always been highly appointed as the main medium in applying game-based learning (GBL). Consequently, there is also a hope for non-digital games to take its place into this area (Cushman-Roisin, Rice III, & Moldaver,





2000; Huang & Levinson, 2012). One such non-digital game is board game or Euro game. A well-developed thematic board game can be a tool in simulation especially when it tries to replicate the real process in the gameplay. This research intends to use board game as a tool for simulation and implementation of GBL concept in learning shipping management for higher education.

Board game is a game which is played using markers or tokens which are moved on a board that is provided in compliance with the rules written in the manual. Board games that are on the market can be classified into two categories: board games that reflect the realities of life and board games that do not reflect the realities of life (Shapiro, 2004). Some examples of board game that reflects the reality of life include Saidina (Ting, 1978) which simulates the real estate business, Cluedo or Clue (Pratt, 1949) which simulates a murder mystery and Risk (Lamorisse & Levin, 1959), a war game simulation. On the other hand, the examples of board games that do not reflect reality encompass Blokus (Tavitian, 2000) and Chess where the aspect of abstract strategy is emphasized. Sahibba (Ting, 1976) and Upwords (Rudell, 1982) which are word-based games are also classified under the board game that does not reflect the realities of life. There are also a few quiz based board games that are developed such as Wits and Wagers (Crapuchettes, 2005) and Trivial Pursuit (Haney, 1982).

Modern board games have evolved drastically which present a multimodal textual system. These multimodal textual systems exploit the use of text, images, and materials that are easily available as a token or the use of realistic and durable material (Evans, 2013). The key components to identify board games are the surface of the game, number





of players, tokens that are used for games, the arrangement of tokens during the game, the rules of the game, and how to win the game (Woods, 2012).

While the appeals of modern board games exist widely within the community, in the field of education, board games are only developed just for learning within the early education (Treher, 2011). Therefore, the actual value and the impact of board games for learning have not been thoroughly explored (Treher, 2011). The combination of simulation elements in the modern board games was able to provide various advantages in the development of board games for educational purposes. This is due to the simulation elements which are capable of replicating the actual scenario for themes that are represented in the game (Huang & Levinson, 2012; Leemkuil, de Jong, & Ootes, 2000).



Most retail version modern board games are developed based on an actual scenario or tied to a certain theme as to grasp user attention and provide competitive advantage towards marketing (Evans, 2013). Thus, the mechanics of the gameplay evolved and the activity involved during the gameplay have somewhat resembled the actual process in a given theme. Knowing the advantages and prospects of the board game as well as the evolution of the board game mechanic that can be exploited as a stepping stone towards applying a transparent transaction within the gameplay, GBL practice can be implemented to enhance the effects of learning for shipping management course in higher education.

In order to develop a thematic board game, simulation provides a good mechanism to drive the flow of the game (Zapata-Tamayo, Zapata-Jaramillo, & Betin-Montes, 2017). Simulation in games are quite prominent in teaching and learning business courses





(Anderson, 2005). Simulation refers to a collection of methods and applications to mimic the behavior of real systems, usually on a computer with an appropriate software (Kelton, Sadowski, & Swets, 2010). Additionally, simulation is also referred to as a process of designing a model of the actual system and carry out experiments on this model in order to understand the behavior of the system and formulate a strategy to improve the operation of the system (Shannon, 1998). Simulation is a tool to assess the performance of the existing systems or the systems being proposed, under different configurations according to the needs and in the long term (Maria, 1997). In fact, the simulation can be very general as the simulation can be used in various fields, industries, and applications (Ingalls, 2002).



The simulation model is a representation of reality. Therefore, it is important that the model developed should be accurate and authentic so that the understanding of the system behavior can occur. For example, if someone tries to practice driving in a simulator which is unable to accurately simulate the characteristics of driving a car, these individuals will not feel the real driving experience of a car and also the simulator will not be able to reflect on how to respond to the actions of the individuals. Simulation was able to specify process involved in the system, other system, or organizations involved, and the relation of simple to detail interactions within other systems and people.

There are three types of simulation which are realistic, virtual, and constructive. Realistic simulation refers to the activities that operate in a real time. The simulation on runways in an airport; looking at the effect if both runways are used for landing and takeoff for aircrafts, as compared to the effect if one runway is used for landing only and the other one is used for takeoff, are some of the examples of realistic simulation. Virtual simulation,







on the other hand, involves human and equipment in an environment that is controlled by the computer. The most obvious example is the simulation of driving a car. In comparison to constructive simulation, it does not involve humans and equipment. Constructive simulation focuses on the sequence of events that occur in a process for a given time, for instance, the simulation to forecast the impact of tsunami on the adjacent areas. This research focuses on realistic simulation where every activity that occurs in operation of shipping management are recorded and modeled.

Apparently, simulations is one of the best tools to replicate a certain scenario (Maria, 1997; Shannon, 1998). However, simulation does not provide greater exposure and experience to the user (Cushman-Roisin et al., 2000; Oblinger, 2006). To utilize the potential of simulation, there is a need for another model or inference engine to be used in simulation which is the game-based model. Game-based model helps to explain the scenario represented in the simulation better than a normal simulation model. This is because, activities involve in game-based model encourage the user to participate in the simulation rather than to observe at the simulation run. Therefore, the user will have a deeper understanding by performing the actions involved in the process such in the application of learning by doing (Aldrich, 2004, 2005). The concept of learning by doing which is stressed by Aldrich (2004, 2005) was triggered when the players played the game which they executed the actions and tasks provided within the game environment.

In fact, learning by doing is better than learning through reading (Chen & Levinson, 2006; Kachaturoff, 1978; Oblinger, 2006). In this perspective, the simulation has a considerable potential for the use in training in various fields, particularly in transportation and healthcare. The experience gained from simulation is equivalent to those experienced





by the user itself (Lunce, 2006; Patterson, Blike, & Nadkarni, 2008). The use of simulation affords students to experience the simulated situation thus apply knowledge obtained from the study material in order to enrich learning experience (Leger, 2006). Conclusively, simulation provides an ideal space for students to gain an immense discipline-specific knowledge that enables them to transfer into professional environment.

Most application of GBL refers to simulation games as a medium for transferring knowledge (Gunther, Kiesling, & Stummer, 2010; Petroski, 2012; Shih, Jheng, & Tseng, 2015). As a matter of fact, simulation games are often associated with fun user experience rather than focusing on the details and behaviors of the system it represents (Prensky, 2007). Obviously, simulation games are governed by rules which makes the players who understand the rules able to achieve the game goals. In addition, simulation games primary activity was action based and might has little attachment of the real system in reality, thus, making it focalizes on a fantasy environment (Gredler, 1996). Furthermore, simulation games back story was light as to make players engaged with the game in a short period of time.

Moreover, simulation games which come in either computer based or manual participation have become an active learning medium which is highly regarded as popular and effective tools in teaching and learning (Zhou, Xie, Wild, & Hunt, 2008). Also, there were also other hands-on exercises that were widely adopted in education such as process flow design exercises, and work flow design exercises especially when educators try to involve real life application with the theory being taught in lectures. Needless to say, the combination of both hands-on exercise and games can greatly improve the





learning experience by students and facilitate their learning as well, concerning practical issues and approaches (McCall, 2012).

Prensky (2007) highly regards the many benefits of playing games towards learning which include cooperation, collaboration and team work, mastering and applying new skills and information, and thinking laterally and strategically to solve problems and achieve game goals. Consequently, simulation games and games generally have been great motivators for learners nowadays which would make a great advantage for educators to include learning through games to encourage and nurture knowledge discovery by the students on its own (Aldrich, 2005; Chen, Wong, & Wang, 2014; Habgood & Ainsworth, 2011). Apart from that, simulation also was highly regarded as a beneficial medium for blending multiple teaching objectives. Hence, the use of simulations in educational setting as a means for implementing GBL is imperative as it also provides a sequential decision making environment where students manage their assigned role given to them as they thrive to fulfill discipline specific task within the setting that portrays realistic events and processes.

This research focuses more towards simulation in the application of GBL. Fundamentally, the scope of the application focuses on tramp and liner services which is included as part of the course structure for higher learning. The characteristics of the research amplify the use of information that governs the play which provides learners with more information leading to them making better decisions in solving the problem. In addition, the primary activity in the game session is scenario-based interaction which includes multiple choice, and branching decisions. Although the board game is used, the core of the game follows the actual scenario which is represented using tangible user





interface and interaction between players as students follow through a series of process in the shipping operation. By doing so, hands-on practice can be done as students take the role of the desired character which mimics the process of apprenticeships.

The simulation board game was used as a means of implementing GBL in higher education, more specifically in the shipping management field of study. It was an effort to engage students actively in the learning activity to maximize their learning experience. It nurtures positive effects of learning environment for students in which may lead to faster learning, better learning in terms of cognition and knowledge retention, or maybe both (Nguyen & Clark, 2005; Zerr et al., 2018). Moreover, positive effects in learning can also be achieved by fulfilling a maximum impact on learning objectives with a minimum wasted effort, expense, or resource (Elyakim & Reyhav, 2015). In other words, it can also be defined as using a minimum resource or effort to achieve a desired objective in learning process.

Nonetheless, there are very few researcher that incorporate the effectiveness in knowledge retention as compared to effectiveness in cognition for learning. In fact, the criteria to measure the effectiveness in knowledge retention has not been specified clearly in most research. Without doubt, GBL is proven effective in the teaching and learning by most researchers; however GBL cannot exceed the effectiveness of a mainstream module or as a material for teaching and learning. On the other hand, the positive effect of learning using GBL can exceed the effect of learning in the mainstream module by offering the minimum usage of resources in order to deliver the same content; in which provides a longer knowledge retention for a specific content.





Generally, the criterion for the positive effects for both the management and the field of decision science is to minimize or maximize resources. In terms of shipping management, to gain a positive effects in operations, managers should try to minimize the cost for shipment of a particular delivery and they also must maximize the load for such ship in order to make a delivery. Consequently, in education, it can be achieved if and only if the resource used in education can be minimized. Thus, these two criteria; cognition which refers to the achievement score, and knowledge retention have been selected to measure the positive effects in learning. .

Most higher education establishments in Malaysia adopt the 14 weeks study system which is also based on credit hour system. The Shipping Management course in Institution A was credited for three credit hours which makes the lecture time 42 hours. Based on the course syllabus, 14 chapters must be covered to fulfill the full course content. Hence, one week or three lecture hours is allocated for each chapter to be covered. This scenario proved to be hard for educators to cater the lecture hour as to deliver the content without understanding the level of learners' prior knowledge (Yusof, Radzi, Khalid, & Din, 2016).

On that account, GBL was used in the post learning session after the first lecture session to enable students construct their knowledge based on the learnt theories from the lecture with the practice that they undertook during the gaming session. Although the content of the board game only focuses on a particular chapter, the simulation of a process represented within the game illustrates the actual comprehensive operation of a shipping industry. Hence, the board game does provide a good exposure for the students to reconnect the past and future lecture contents.





Other than that, using the board game in learning activity minimizes the time for students to learn the content of a specified chapter. As a result, accelerated learning will be achieved as students should be able progress through the chapter relatively in a shorter time (de Freitas & Jarvis, 2007). Conclusively, the board game is able to promote cognitive acceleration (Tan, Lin, Chu, & Liu, 2012), increase self-management of learning time and facilitate data collection using a realistic scenario while solving problems within the game environment.

The first criteria for the effects of learning in this research is cognition. In general, cognition is defined as information processing (Cunningham & Kirkland, 2012). Cognition must be maintained during the learning process as to provide a meaningful learning experience for students. A well maintained learning activity provides a balance of cognitive load to maximize the effectiveness of learning efficiency. A balanced cognitive load should consider optimizing the intrinsic load and germane load with very minimum extraneous load (Nguyen & Clark, 2005).

Using the board game as a medium for learning provides a clear intrinsic load with various germane loads as the students delve into the game environment. The content of the game was aligned with the course syllabus, observation from the realistic application in shipping industry, as well as key items and characteristics from the domain experts. In addition, the game includes the replication of realistic scenarios and events in the gameplay which add the realism towards gaming experience. Hence, the experience that students undergo during the game session mimics the application of the shipping industry in reality. This, thus, enables students to conduct information processing using tangible user interface in a non-threatening environment within their own pace.





This research only focuses on two topics from the fourteen chapters' course. The topics which are in focus are tramp shipping, and liner shipping. Although only two courses were selected, the scenario represented in the game does reflect the entire shipping operation in mild detail. Therefore, students should be able to construct the knowledge from the theory that they have learned earlier with the game session that they undergo during post learning. As to maintain the cognition of the board game, content experts were selected which include lecturers who teach the subject and an expert in shipping operations. Alpha test will be conducted to verify the correct framework of operation represented in the board game.



The second criterion that was used in this research to measure the effects in learning is knowledge retention. Educators are always keen on finding new learning approaches that could increase students' knowledge retention (Chow, Woodford, & Maes, 2011; Phuong & Nguyen, 2017). In this research, the knowledge retention was measured based on the prior knowledge from the students which used the result from the pre-test. It was then compared to the time-series test and the post-test as to determine the change of effect in learning in knowledge retention (Ebrahimzadeh & Alavi, 2017). The instruments used for the time series test were the same test items as the instruments in the post-test but the order of the question is reshuffle; which was administered after the fifth session of the field testing session.

The outcome for this criterion is used to determine whether there is a change in knowledge retention from students as they play the simulation board game for their learning activity. The outcome would be either:





- i) Positive with retention.
- ii) Positive but no retention.
- iii) No impact.
- iv) No retention – guessing.
- v) Negative with retention.

In point of fact, GBL contributes in maintaining the interest of students to prolong their engagement in the activity involved through a game environment (Plass, Homer, & Kinzer, 2015). Henceforth, exploiting this advantage would be significant in making students become motivated in learning especially in higher education. No doubt, GBL has proven to increase the affection of learning even though the content is complicated, yet it is more challenging for players to master (Cicchino, 2015; Silva, Macedo, Teixeira, Lanzer, & Graziani, 2017). In addition, the elements of game provide exposure of challenges and problem solving towards the theme. Thus, students are deeply engaged throughout the gaming session as they are trying to solve the problem and delve into the scenario as to feel the experience.

This research highlights the effects of learning using GBL especially based on the two criteria which are cognition, and knowledge retention. The use of GBL in learning shipping management should be set as a new paradigm in which critical constructs of learning could be re-organized so that learning could be transformed from information and knowledge to learning from hands-on experience and apprenticeships for any shipping related contents and maritime education and training (MET). The approach will enable the students to personalize and specify the requirement of learning on their own pace within a non-threatening environment.







Looking at another aspect, maritime education plays an imperative role in training specialized personnel. The shipping industry, which is one of the fast growing industries, consists of three main aspects which are internationalization, standardization, and specialization (Chen, Bai, & Xiao, 2017). In order to maintain these three aspects, shipping management personnel need to be well-trained as they delve through the challenges on daily basis. Hence, an effective medium of learning is needed as to fulfill the needs of mastering the domain. Such medium should provide a better cognition and knowledge retention. Accordingly GBL which employs a simulation based experience would be best suited for MET.

### 1.3 Problem Statement



Shipping management course is offered to all bachelor degree programmes in logistics as managing imports and exports through ports is an integral part of the trade. Although there are alternatives of other medium of trades, it is still cheaper to move trade goods around the globe using ships compared to any other logistics medium. Maritime transport (ships) contributes to over 80 per cent of the volume for global trade (UNCTAD, 2014, 2015). Therefore, as long as shipping is still one of the top logistic medium of trades, the shipping management course is still significant for those who undergo the study in logistic management. However, there were issues regarding the current learning practice for maritime education in Malaysia; which are measuring the level of cognition, and knowledge retention.





Commonly, traditional learning methods that feature lecture in shipping management class is abstract and passive and has been used in the teaching and learning in higher education for years (Kunieda & Murai, 2017). Such teaching methods needs an integration of other learning tools to support the teaching and learning process because students prefer more active and inductive learning (Felder & Silverman, 2002). Furthermore, lectures do not adequately prepare graduates with the learning process and more novel approaches are required to highlight the shortcomings of traditional approach (Ludi & Collofello, 2001; Navarro & Hoek, 2009). This also applies on the learning process for shipping management course especially when cognition and knowledge retention become visible as the specific measures that are needed to be achieved. Students who attend the course possess no experience on the operation of ships in the global trading business. Thus, students were facing difficulties to visualize processes that occur during the operation of ships hence creating a bridge between theory and knowledge making the application to real situation quite difficult. The effect also provides the students to have problems during any session of problem-based learning (PBL). Although PBL could highlight the application towards the theory, students are unable to solve the questions provided in the case study from PBL due to the lack of experience and basic background knowledge (Abdelkarim, Schween, & Ford, 2018).

Kolb (1984) defines the experiential learning theory as the process where knowledge is created through the transformation of an experience. He categorized the learning modes into four; concrete experience, abstract conceptualization, reflective observation, and active experimentation emphasizing on learning by experiencing, reflecting, thinking and acting again to enhance cognition and knowledge retention (Sato & Haan, 2016). Henceforth, it can be described as one of the most effective instruments





for enhancing cognition and knowledge retention in management development (Holman & Mumford, 2001). Some examples of the experiential learning in management includes lean management (De Zan, Toni, & Fornasier, 2015) and disaster management (Rijumol, Thangarajathi, & Ananthasayanam, 2010). However, it has been argued that management education must include an experiential learning component as to enhance cognition and knowledge retention in learning (Clark & White, 2010). What is more, the positive effect in cognition and knowledge retention can be achieved since management education requires wisdom that can be obtained through experience, in which the experiential learning theory emphasized (Gruver & Miller, 2011). Therefore, experiential learning is obviously essential to be used in college curricula (Cline & Kroth, 2008; Radford, Hunt, & Andrus, 2015).



Narrowing down to GBL, it has been proven that there is an alternative environment which students are able to delve in terms of exploring knowledge (Huizenga, Admiraal, Akkerman, & Dam, 2007; Ofen-Noy, Dudai, & Karni, 2003; Yusof et al., 2016). The ability to create an engaging yet fun learning environment enhances the students' intrinsic motivation towards such learning strategy. Furthermore, the variation of problem space available for each activity maintains the students' interest towards learning a specific subject or domain.

In this case, board game is one of non-digital games that shows a stable growth of market share each year (ECSIP Consortium, 2013). Board games emphasize more towards a social activity which gathers players together and nurtures a shared entertaining and engaging experience. The physical interaction of the board game forces a face-to-face interaction in which players should be able to look at each other and see how they





react physically towards any challenges in the game setting. There are various proves that playing against human opponent is much more preferable than playing against an artificial intelligence opponent (Mandryk & Inkpen, 2004). Players show greater enjoyment and tends to be more aroused when playing against human opponent (Mandryk & Inkpen, 2004; Szentgyorgyi, Terry, & Lank, 2008; Voids & Greenberg, 2009).

In essence, traditional approaches including lectures, coursework, live-through case studies, and paper-based case study are often used to educate and demonstrate the highly important process to graduates (Dack, 2018; Yadav & Beckerman, 2009). Therefore, there are few evidences that support the use of modern board games that incorporates the concept of GBL in teaching and learning management course (Evans, 2013). Thence the potential of GBL were not fully utilized even though there were evidence of the success of using such material for learning effectiveness (Liu, Rosenblum, Horton, & Kang, 2014; Shih et al., 2015; Yien, Hung, Hwang, & Lin, 2011). Thus, the application of mechanics in board game as a simulation tool for implementing GBL has been proposed.

Nowadays, the teaching and learning process were lacking to attract and provide enthusiasm for students to explore the lesson that has been taught (Sharp, 2012). This is because students still have to refer to the lecture notes after the learning session to understand the theories and then to be able to link the theory with the actual application. In other words, students have to imagine within their mind just to be able to combine the concepts and theories learned without having a clear learning medium. Naturally, not all students have the ability to visualize the application of any given concept, therefore, obviously a certain medium is needed to assist them to understand the concept as they





are easily disengaged with traditional instruction (Van Eck, 2006). As a result, knowledge discovery towards the lessons and concepts can be done by students at their own pace and environment. In the end, the outcome of the result showed that the students achieved towards the theory being taught were not as expected (Bennis & O'Toole, 2005; Sequeira & Martins, 2013).

This is so as during lectures, lecturers always try to engage students in the learning sessions by trying to get responses from students which includes asking simple questions. On the other end, students are less responsive and try not to react to lecturers during lectures. In fact, there are also some students who choose to remain silent when questions are directed to them. Due to the lack of student engagement in lectures, learning has become passive in which communication happens in the lecture hall is only one way (Berryman, 1991; Michel, Cater, & Varela, 2009). Hence, it complicates lecturers in measuring the knowledge retention and cognition of students when they are less responsive or refuse to give feedback.

In relation to this, post-learning session occasionally happens within groups of students. However, more often than not, the course materials prepared by lecturers are more likely cater towards individual revision. The course materials that are commonly used are lecture notes and e-learning content which was prepared by the lecturers. The main drawback of this post-learning session is the lack of involvement of students during their post-learning session. Students are more likely to listen as to try to understand the content of e-learning material and the transcribed notes. Truth is, active respond during learning session is proven as an effective learning activity as it helps students digest the knowledge presented in order to put into practice (Taylor, 2010). As a result, it drives them towards





active learning which could benefit them with applications of the theory. In addition, course materials and teaching tools that are able to challenge and arouse students' curiosity would be crucial in maintaining the interest of students when exploring knowledge in any given context. The impact of cognition and knowledge retention of self-learning from this activity varies depending on the ability of students. The issue leads to debates on how to stabilize the level of cognition and knowledge retention for all students with different ability.

The answer to the argument comprises the main issue which is to combine an engaging game design with learning outcomes. This GBL must meet certain learning outcomes highlighted in the course in order for it to be useful in education. Additionally, adapting the game to those outcomes requires various challenge, array of steps or levels, numerous quests with various difficulty levels to run the game. The second issue is that most board games in the market provide fictional gameplay that does not align with the educational structure for learning shipping management; moreover it also does not reflect reality in shipping operations (Auerochs, 2013; D'Orey, Sentieiro, & Soledade, 2014; Delonge, Ewert, & Nesbitt, 2018; Suchý, 2009). In addition, it is difficult to expose students to the shipping operation and process with the authentic scenario within the industry itself. Therefore, the board game developed from this study is proposed as a medium of learning in shipping management course. As to proof the learning effects, this research provides empirical evidence to support the use of board games which implement simulations that occur within the board game developed in learning shipping management.

Despite the endless efforts by the lecturer in revamping active learning during lectures and post-learning, it has been less successful without proper learning tools. These constraints were also felt by lecturers in delivering lessons due to the lack of an





appropriate innovative teaching medium to represent the applications in reality that would require the involvement of students (Viera, 2008). In spite of focusing on what to be taught and how to deliver the knowledge meaningfully to the students, the question of how to improve the cognition and knowledge retention still lingers among lecturers. Multiple streams of information, besides quick and frequent interaction with content and implementation of inductive reasoning, are required to successfully deliver information in lectures (Oblinger & Oblinger, 2008; Prensky, 2005). In this case, the implementation of GBL by using board game as a learning medium matches all the criteria listed.

#### 1.4 Research Objectives



The main objective of this research is to examine the learning effect of simulation board game that provides the learning experience of realistic process of shipping operation. In other words, this research aims to develop a board game framework for learning shipping management course in higher education through a quasi-experimental analysis. This research intends to provide a structured and empirical evidence in exploiting the potential use of board game as a medium for practicing GBL. More specifically, the objectives of this research can be derived as follows:

- i. Design and develop a board game framework for shipping management course.
- ii. Measure the effectiveness of board game in enhancing cognition of students in learning shipping management.





- iii. Measure the effectiveness of board game in enhancing knowledge retention of students in learning shipping management.

The development of the prototype board game has been an ongoing process and when the prototype is at a stage which all the necessary components have been specified and implemented then a user evaluation would be performed. The evaluation for the prototype has been done by experts in their dedicated fields to suggest possible areas of improvement that can be incorporated into the prototype.

## 1.5 Research Questions



The research is intended to examine the learning effect of a simulation board game in learning shipping management course in higher education. More specifically, three research questions were generated based on issues discussed in problem statement. The research questions are as follows:

- i. How to design and develop a simulation board game for use in learning shipping management among students in higher education?
- ii. Is the board game effective in enhancing students' cognition in learning tramp and liner shipping?
- iii. Is the board game effective in enhancing students' knowledge retention in learning tramp and liner shipping?





## 1.6 Research Hypotheses

The hypotheses made from the research questions listed as Figure 1.1.

H<sub>0</sub>1: There is no significant effect of the board game in enhancing students' cognition.  
H<sub>0</sub>2: There is no significant effect of the board game in enhancing students' knowledge retention.

*Figure 1.1.* Research Hypotheses for Testing the Effectiveness of Learning in Using the Board Game for Learning Shipping Management

## 1.7 Significance of Research

This research is conducted to contribute to the knowledge on experiential learning using the board game. This research highlights the development of a simulation board game where the element of how experience in realistic process is able to be represented in the game session. Consequently, it triggers the four concepts of experiential learning which are concrete experience, abstract conceptualization, reflective observation, and active experimentation. A framework with an algorithm for developing a game-based learning practice using simulation board game has been developed. Simultaneously, a simulation using computer is viewed as the main simulation tool because of its potential sophistication and realism while simulation using game-based model offers unique advantages that cumulatively make such simulation appropriate in certain settings (Crahmaliuc, 2018). Using game-based model, the process represented within the certain areas may be experienced by user (Zapata-Tamayo et al., 2017). Although the experience undergone by the user during gameplay was not the exact experience of what it is in reality, the process represented by the game were in line of what really happened in the



subject that it represents (Domínguez, Saenz-de-navarrete, Fernández-sanz, Pagés, & Martinez-Herraiz, 2013). Hence, it gives a clear direction of what really happens. As a result, it gives a deeper understanding on the behavior of the system (Cushman-Roisin et al., 2000; Huang & Levinson, 2012).

The proposed framework from the simulation board game ensures simulation fidelity of a domain it represents, noting that incorrect feedback was likely to promote misunderstanding and to adversely affect decision making. Within the framework, the method for collecting and analyzing users' interaction data which comprises of choices made, actions taken, results and feedback obtained were specified systematically. Thence, it provides evidence that a simulation's underlying game-based model has accurately represented the conceptual model of the real-world phenomenon of interest.



Meanwhile, the game-based element which was represented using board game was used to apply the practice of a certain process being represented; therefore it engaged the implementation of learning by doing. The combination of simulation elements in the board games provide various advantages in the development of the board game. This is because the simulation elements which are capable of replicating the actual scenario for themes are represented in the game. The simulation represented using games may as well be utilized to assist trainings which allow decision making and have a potential to be used in the learning environment to diversify the learning experience to various type of students. Thus, the first objective can be addressed by designing and developing the framework as it contributes well to keep the fidelity of the simulation represented in the game in line with the practice in real life.





This research is also an important step to highlight the idea that the use of games-based model as a tool for training via simulation can promote active learning among students because they are actively involved indirectly in the process of learning in the classroom and this encourages the proliferation and procurement of ideas and sharing of knowledge through group activities in a safe environment. Thus, it is clear that games and simulations have the potential to generate interest and bring a deep impression on the students. Board games can also arise curiosity and interest among students in which lecturers should take advantage of its potential to generate enthusiasm, encourage a healthy competition and collaboration between students and increase student participation in lectures (Marzano, 2007).



In addition, the use of board games in lectures can promote knowledge discovery among students without involving lecturers or teachers (Aldrich, 2004, 2005; Garris, Ahlers, & Driskell, 2002; Ritterfeld, Cody, & Vorderer, 2009). This is so as the development of the board game is based on a simulation framework developed from the content of the problem domain integrated with various elements of realistic observation of actual operations. It also utilizes the tangible user interface via the use of tokens, miniatures and other realistic item to represent the real item in reality. Hence, learning by doing can be implemented because students are able to experience the role of a decision maker during gameplay.

Apart from those, board games can also generate simulations for events that occur in various activities because these events can provide a useful exposure in real time thus bestow students with experience and challenges in the actual situation (Sato & Haan, 2016; Taspinar, Schmidt, & Schuhbauer, 2016). Players are able to respond by





analyzing the challenges or opportunities, react actively to find the ideal solution, and explore these challenges as they see the effects of the decisions that they have made. With this, students can create a what-if-analysis of their actions and learn on how each decision affects the success of the role they represents. Consequently, students are able to learn from the mistakes that they have made during the game session and reflect within themselves on how to strategize and plan properly as to win the game. The board game developed does not only act as the vehicle by which education is delivered but it also acts as a practice environment to internalize and augment lessons learned.

## 1.8 Operational Definitions



### 1.8.1 Cognition

Cognition refers to the level of mastery and understanding which is measured using the scores for students to achieve during the test given throughout this research. Effectiveness for cognition in this research was done by comparing the difference of cognition gained in the post-test and cognition gained in pre-test. The comparison was done using inferential statistics.

### 1.8.2 Knowledge retention

Knowledge retention refers to maintaining knowledge that had been learnt in any learning environment. It involves the development of short term memory into long term memory so





that it can be used later. The effectiveness of knowledge retention was measured by the percentage of A, B, C, D, E or F. Where as:

- i) A : Positive with retention =  $\text{count of attempts} \div \text{sum of attempts}$
- ii) B : Positive but no retention =  $\text{count of attempts} \div \text{sum of attempts}$
- iii) C : No impact (all correct) =  $\text{count of attempts} \div \text{sum of attempts}$
- iv) D : No impact (all wrong) =  $\text{count of attempts} \div \text{sum of attempts}$
- v) E : No retention, guessing =  $\text{count of attempts} \div \text{sum of attempts}$
- vi) F : Negative with retention =  $\text{count of attempts} \div \text{sum of attempts}$

## 1.9 Definitions of Terms



### 1.9.1 Simulation

Simulation is a field in which one realistic environment is represented in a smaller scale as to replicate its operations and processes. The purpose of this activity is to study the behavior or characteristics of one such environment as maybe there are ways to improve the environment or learn its weakness and try to countermeasure it.





### 1.9.2 Board Game

A board game is a non-digital game which takes advantage of the use of either boards, tokens, cards or any other tangible materials with different kinds of creative mechanics with a dedicated theme.

### 1.9.3 Simulation Board Game

A simulation board game is a board game which attempts to simulate an actual event or situation of a domain for players to experience while playing.



### 1.9.4 Shipping

Shipping is the process of transporting goods or merchandise using ships by sea.

### 1.9.5 Shipping Management

Shipping management is the course selected for the theme of the board game. Shipping management focuses on the management side of the shipping operation.





### 1.9.6 Higher Education

Higher education comprises of students who complete their secondary school and further their study at college, polytechnics or university level.

### 1.9.7 Effectiveness

Effectiveness in this research is measured based on main variables which are cognitive and knowledge retention.



### 1.9.8 Game-based Learning (GBL)

It refers to the creative use of games either digital or non-digital to support teaching and learning. Games that were used are either commercial of-the-shelf (COTS) or purposely designed as to support teaching and learning for specific topic, course, or subject. The key principle for the introduction of GBL is to raise the intrinsic motivation of learners towards voluntary learning or self-driven learning.

### 1.9.9 Commercial of-the-shelf (COTS)

It refers to any product that is made and ready for sale to the public. An example of COTS board game is Agricola, Puerto Rico, and Power Grid.





### 1.9.10 Game play

Game play is how the challenges in the game presented to the player and the actions or rules that the player is permitted to take in in order to overcome the challenges.

### 1.9.11 Short-term Memory

Short-term memory is the capacity of holding a small amount of information for a short period of time and located at the second stage of the multi-store memory model (Atkinson & Shiffrin, 1968). Based on the study from Atkinson & Shiffrin (1968) the duration of short term memory is between 15 to 30 seconds and the capacity is about seven items.



### 1.9.12 Long-term Memory

Long-term memory is the final stage of the multi-store memory model which is the capacity of storing the information over an extended period (Atkinson & Shiffrin, 1968). Based on Atkinson & Shiffrin (1968) the duration of long-term memory is possibly lifelong. In terms of testing in the study, 10 weeks were used as a threshold for testing the retention in long-term memory which was align with few studies regarding on knowledge retention (Emke, Butler, & Larsen, 2016; Rohrer, Taylor, Pashler, Wixted, & Cepeda, 2005; Rondon, Sassi, Regina, & Andrade, 2013).







#### T.4 Research Outline

This research consists of six chapters, each chapter serves a specific function for this thesis:

Chapter 1 is the introduction where the context of this research is documented. Chapter 2 discusses the current practice of teaching and learning in education as well as the use of GBL concept in education. Chapter 3 describes the methodologies used to complete each component of this research. It details the design, development, and validation of the framework, procedure, experimental design, and statistical analysis techniques for the pilot and main evaluation study performed. Chapter 4 discusses the design, development, and validation for the board game Shipping Management Game which has been proposed to be delivered in the learning sessions. Chapter 5 features the findings of this research which are the board game framework, the prototype, and data analysis. Chapter 6 concludes the research which covers the contributions and limitations of the research and implications for further research or study.

