MONOPOLY-BASED BOARD GAME WITH AUGMENTED REALITY INTERVENTION IN ENHANCING UNDERGRADUATE STUDENTS' UNDERSTANDING IN STID1103 COMPUTER APPLICATION IN MANAGEMENT CONCEPTS OF EMERGING TECHNOLOGY REVOLUTION

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RESEARCH TECHNICAL REPORT
S/O CODE: 14757

UNIVERSITI UTARA MALAYSIA
2021

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ACKNOWLEDGMENTS

We would like to thank Universiti Utara Malaysia for awarding us the **Scholarship of Teaching and Learning (SoTL) Research Grant**. In particular, we would like to acknowledge the continuous support of all the staff in University Teaching and Learning Centre (UTLC) and Research and Innovation Management Centre (RIMC), Universiti Utara Malaysia.

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ABSTRACT

The use of technology in education is believed to enhance students' learning experience. Augmented reality (AR) is one of the technologies that is progressively being used in education to enhance the students' learning experience through interactive lessons by combining virtual and real environments. An instance of the technology used in the classroom is an AR board game which is designed to aid in learning through games. This research presents the proposed AR board game, REV-OPOLY, that concentrates on the emerging technology revolution concepts in the STID1103 Computer Application in Management course in Universiti Utara Malaysia. REV-OPOLY consists of a board and cards that contain questions, information, and instructions for the game. AR is implemented into the components on REV-OPOLY to act as the AR marker that can be scanned to reveal AR objects represented in various types of multimedia. The respondents of this research are undergraduate students enrolled in this course. The findings showed that REV-OPOLY received positive feedback from the respondents and impacted the students' learning motivation positively which is supported by significant improvements in the students' scores in the three assessments preceding the use of REV-OPOLY. Based on these findings, REV-OPOLY, an augmented reality board game, shows promising results to be adopted as an alternative and additional tool in higher education.

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CHAPTER 1

INTRODUCTION

1.1 Background

With the emergence of technology, the realm of teaching and learning is constantly evolving. Following the implementation of IR4.0, the teaching and learning of undergraduate students in higher education should be adapted and reflected in the modern age of technology to ensure better learning outcomes in their core subjects. Many instructors are reluctant to include activities in the form of games, be it online or offline (during classes) in undergraduate courses, as it is time-consuming and seems difficult to accustom to new methods of teaching and learning. Sánchez-Mena and Martí-Parreño (2017) mentioned in their study, conducting games in online or offline classrooms is quite challenging as it consumes more time and is difficult to adapt in teaching and learning. However, Glover (2013) stated that in a video game-dominated world, applying video games for educational purposes would inspire new generations of students in learning. Lin et al. (2021) found that using board games' application in teaching enhances students' participation and motivation.

1.1.1 Gamification

Gamification is defined as the process of including game elements or mechanics into a pre-existing experience to improve learners' engagement and enjoyment (Orlig, 2019). Gamification is the process by which services are enhanced utilizing motivational affordances to arouse gameful experiences and advance outcomes in behavior (Hamari et al., 2014). Another way to look at gamification is that it employs

the same aspect of video games but in non-game applications (Su & Cheng, 2015). Gamification uses game-like features including points and various levels in a way that is not meant to entertain (De Byl, 2013). Its main goal is to foster more engagement in people by helping to create more robust experiences by utilizing game mechanics (Kim & Lee, 2015). A study on gamification among Postgraduate students found that gamification-based educational intervention was well accepted among millennial learners (Nevin et al., 2014). It was found that they enjoyed the opportunity to compete for both individuals and teams to progress further on the leaderboard as it motivates them to be competitive.

1.1.2 Augmented Reality Gamification

In line with the Sustainable Development Goal 4: Quality Education, which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, the use of technology in curricula and assessments could be a catalyst in the higher education sector. For instance, Augmented Reality (AR) could make a difference in students' engagement in the classroom. AR technology, when combined with an effective pedagogy, has the potential to promote inclusive education by representing content, expressing knowledge, and engaging students in learning. It could promote innovative and cooperative learning environments, allowing for the achievement of learning outcomes using slightly different but successful methods.

Augmented Reality (AR) is a new element in education research, which helps educators to apply virtual objects to the classroom context. According to the definition of augmented reality, there are three major technological elements: the combination,

alignment, and real-time interaction of real and virtual objects in the real environment and among the objects (Khan et al., 2019). By incorporating augmented reality into any gamification-based intervention, the player is given a more immersive and unique experience than they are accustomed to. It augments traditional games with virtual elements, allowing the virtual portion of the game to remain hidden.

With smartphones being used by the majority of the world's population, AR is regarded as a widely accessible technology. Because most smartphones have a gyroscope and accelerometer, which are required for AR applications, it would be simple to apply AR in any situation. In an overview of augmented reality in education, Yuen et al. (2011) state that one of the primary goals of research in the field is to increase productivity in real-world tasks. AR is regarded to have the power to engage and excite pupils, promote innovation and imagination (Kaliyaperumal et al., 2021), and aid in the teaching of topics that are difficult, if not impossible, to encounter in the actual world. For instance, Dünser et al. (2012) investigated the use of a book in conjunction with a Hand-Held Device (HHD) to improve high school physics comprehension. They conducted a quantitative study with a group of students, with half of the students studying the book with augmentation and the other half studying the book without augmentation. The findings demonstrated that augmented reality has the potential to aid in the teaching of spatial concepts that would benefit from being visualized in 3D form (Enzai et al., 2021).

Similarly, in the classroom, gamification with AR features provides students with a choice of interactive activities – capable of managing a variety of learning paths in

which the main goal can be met based on the students' personality, abilities, and other qualities. Another benefit of gamification is that it emphasizes the visual side of the learning process, particularly progress visualization and the chosen learning path. According to Kaufmann (2018), gamification can help students be more involved just by playing an online app with a short-term reward notion, which can assist students to avoid procrastination on a certain activity. In terms of receiving feedback and advancement, gaming and learning are considered similar. When students are playing, they will receive immediate feedback, as they would in a normal setting, in written (scores or grades, comments) or oral form (remarks).

Thus, the use of games with AR can provide a more engaging and interactive method to study or revise for a rapidly changing technology as the game mechanics are added in the non-game context. It encourages and capitalizes on the technological progression of the learners which can further enhance the educational benefits using gamification-based education.

1.2 Problem Statement

STID1103 Computer Application in Management course offered in Universiti Utara Malaysia broadens students' knowledge in the study of the emerging technology revolution. It covers among others, the IT infrastructure, the Internet, information management, digital markets, and goods, IR4.0, and IT security and ethics. Thus, it can be said that the subjects of Computer Application in Management can be quite a challenge to keep up with the exponential pace of technology change that rolls out in quick succession, impacting all aspects of professional organizations and society.

Knowledge and information technology (IT) skills need to be developed to cope with the growing demand for the latest technology skills. This will allow students to investigate the ways in which technology impacts them professionally and towards organizations. It requires a lot of reading, research, and the ability to predict the technology trends to stay relevant.

Due to these setbacks, the students have shown ineffectiveness in learning, showed very little interest in the course, and lacked motivation. To combat these problems, several researchers have proposed a myriad of solutions to create better engagement for their students in learning, such as mobile learning applications, visualization, web-based learning, game-based learning, and 3D animation (Chang, 2020; Dai et al., 2010; Tan et al., 2009; Tsukamoto et al., 2012).

In line with the researchers, this study which focuses on the STID1103 Computer Application in Management course will attempt to utilize gamification with AR to assist students to better acquire the concepts regarding the evolution of technology. Gamification with AR is a great way to make mundane activities such as understanding the concepts and theories of any subjects and make them more interesting and engaging. It transforms the passive learning environment and regular activities into an interactive game to promote learning and deepen the understanding of the subject matter. Thus, the use of gamification with AR is hoped to bring the game elements into the education context, and simultaneously exert the element of fun in learning.

1.3 Research Question

There are three research questions that this study aims to answer:

1. What is the comprehension level of undergraduate students towards the emerging technology revolution concepts in STID1103 Computer Application in Management?
2. How do board games assist undergraduate students' comprehension level in acquiring the emerging technology revolution concepts in STID1103 Computer Application in Management?
3. How effective are board games in enhancing undergraduate students' comprehension level in acquiring the emerging technology revolution concepts in STID1103 Computer Application in Management?

1.4 Research Objective

This study embarks on the following objectives concentrating in the emerging technology revolution area in STID1103 Computer Application in Management. The three main research objectives are:

1. To perceive undergraduate students' understanding of the emerging technology revolution concepts.
2. To evaluate the effectiveness of board games in enhancing undergraduate students' understanding.
3. To assess the efficacy of the REV-OPOLY board game in enhancing undergraduate students' understanding.

1.5 Significance of the Study

This study proposed REV-OPOLY, which is an interactive board game with AR. Board games have the advantage of promoting valuable social skills for players through interaction and competition. REV-OPOLY opens up a new learning experience for the students as an alternative to the typical learning method. Using the nature of games as an informal medium to learn while play, REV-OPOLY helps the students to focus while enjoying the learning process. In the game, they are required to make explicit references to previous learning by applying knowledge into the game and convert the knowledge gained into formal learning. As REV-OPOLY is expected to be played as a multiplayer game, it acts as a group study in which students who have mastered the topic can assist weak students through the game's rule on technology investment. This has the benefits in refining their understanding through discussion and explanation, sharing abundant information, developing stronger communication skills, and increasing their confidence level as they have to engage to defend their answers.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Gaming has evolved to the point of being used as an approach to learning in various disciplines. By 2020, it is estimated that there are 2.7 billion gamers around the world (Gough, 2020). This high number shows that games can be used as an effective means for learning with great potential as it is more appealing to millennials and generation Z. A survey that was conducted by Adobe Education Creativity Study (2016) found that 93% students consider that it is essential to adopt technology as part of learning as they rely on technology for interconnectivity and access to information which can be more interactive with the correct tools. Games are one of the tools that can be used to attract the interest of the new generation in learning as they can utilize traditional and technological-based learning through the infusion of classic games and technologies. Games are engaging as it modifies the learner's behavior to reach the desired experience such as finishing game levels or achieving higher scores (Powers, 2016). It can capture attention, engage in a target activity, and influence behavior. There are two different methods of utilizing games for education, through gamification such as adapting the concepts from classic board games as part of the learning process or game-based learning such as role play and simulation games.

Students have shown ineffectiveness in learning, showed very little interest in the course, and lacked motivation (Khaleel et al., 2019). To combat these problems, several researchers have proposed a myriad of solutions to create better engagement

for their students in learning programming related courses, such as mobile learning application, visualization, Web-based Java Programming, game-based learning, and 3D animation (Chang, 2020; Dai et al., 2010; Tan et al., 2009; Tsukamoto et al., 2012). It is suggested that the utilization of gamification could assist students to better acquire the concepts of a particular subject. Thus, the use of gamification is hoped to bring the game elements into the education context, and simultaneously exert the element of fun in learning.

2.2 Monopoly-based Game

Many educational sectors and organizations have employed the Monopoly board game as a template reference to build their games. In education, the Monopoly games have been adapted to be applied to different fields, such as psychology (Schoen, 1996), sociology (Jessup, 2001), entrepreneurship (Cruz, et al., 2018), tourism (Ran & Wei, 2020; Tan & Lim, 2018), financial (Kulkarni, 2020), and health (Santoso et al., 2019). Collectively, the findings have shown that incorporating games such as Monopoly, or Monopoly-based games provides positive feedback from both the learners and instructors.

For instance, the use of Monopoly in an introductory course in Financial Accounting is found to increase the competitiveness amongst the students which improves the classroom engagement where students are actively involved in grasping the nature and purpose of the financial accounting system compared to other pedagogical approaches that were previously used (Shanklin & Ehlen, 2017). Similarly, positive results were found by Gazdula and Farr (2019) by incorporating the Monopoly game in teaching

Risk and Probability, in which students can reflect on decision making in a risk environment using both formal and informal approaches prompts for discussions, collaborative learning, and self-analysis among students.

2.3 Augmented Reality Game

Cumulatively, adapting board games have extensively brought positive reactions among students and educators. For example, in a study by Lin et al. (2021) a board game with Augmented Reality is adapted in health education. They found that the students could understand concepts better when playing augmented reality board games associated with human education. It is found in the study that by using this method, students were attracted to certain functions offered. One of the features that drew them in was how simple it was to get into the game. Moreover, students felt more motivated to learn the subjects provided.

Pinto et al. (2017) implemented an Augmented Reality Board Game (ARBG) on concepts and traditions of Nasa indigenous culture. Their main objectives were to determine how active participation in the board game could contribute to teaching and learning and identifying students' motivation. They wanted to connect the concepts in the game to students' daily lives. It is found that the board game could enhance understanding and students felt motivated to learn the concepts. However, they mentioned that it is not fair to generalize the result as it was carried out on a small scale.

In a study using tangible programming with AR, the authors demonstrated the prototype that was created with the goal of merging concrete items and augmented reality virtual features (AR) (Krpan et al., 2018). The prototype was created for touch-based devices (tablets or smartphones) and marks a step forward in the process of making elementary programming ideas more appealing for learners. In a similar study, ARQuest (Gardeli & Vosinakis, 2019), a collaborative mobile augmented reality game for primary school pupils to improve their computational thinking skills were presented. Students use the game's actual board and tactile tokens, as well as animated 3D information, to design and solve tasks in a gamified setting. AR and holographic technology have also been applied to board games to enhance the user experience (Fadzli et al., 2020). Non-players may have another way to see the battleship due to the AR Battleship board game's integration with a pyramid hologram display. However, further work is needed to evaluate the usability of the system.

In a related study, AR games are also used in assisting vocabulary acquisition (Lantavou & Fesakis, 2018). Results found that AR games contribute to vocabulary learning, higher motivation, and active participation from students. On the emotional level, students showed higher intrinsic motivation to do well during the activities, which is an important component in encouraging an anxiety-free and supporting learning environment in the classroom.

On the contrary, Jursenaite & Bengtsson (2019) found in their study that board games with or without AR can be used without any significant differences in terms of “competence, immersion, flow, tension/annoyance, challenge, negative and positive

effects, psychological involvement consisting of empathy and negative feelings, behavioral involvement, positive and negative experience, tiredness and return to reality" (p.3). The results indicated that AR board games do not affect the user experience negatively, however, developers should consider whether or not it is needed in the games, which would act as an added value or provide a better experience for the players.

2.4 Monopoly-based Game with AR

Pokémon Go, the smartphone gaming phenomenon, is one of the first popular games to have augmented reality (AR) elements, offering players the sensation of hunting Pokémon in real-life environments. Pokémon Go provides players access to "Pokélayer", a game layer that overlays the real world and incorporates GPS and augmented reality. This ability to transform everyday tasks into gameplay allows players to live out their childhood fantasy of being Pokémon Trainers.

Following the hype, McDonald's has released an AR app that uses the same combination of real-world and technology that made Pokémon GO this summer's hottest game. McDonald's introduced the new Monopoly game for diners in Australia, based on the most downloaded application of 2016, which allows players to use their mobile camera to view cards from the promotion (McCrum, 2016). McDonald's named the app "The Monopoly Game at Macca" which turned promotion into a mobile gaming experience that converges the digital and physical worlds. where it features AR game mechanics. Even though the concept of it is as a promotion in offering prizes, cards, and food offers to those who play and attend the restaurant, it demonstrates how

business can also focus on creating innovative and engaging digital experiences for its customers. Basically, the game serves as a digital wallet (Roper, 2016).

The use of Augmented Reality was also used by a company named Ally financial to teach the public about financial literacy through an interactive method (iDEKO, n.d.). The game was named Ally Monopoly, where this project takes the idea of a common financial board game and applies it to six cities in the United States. Players will obtain clues to identify the virtual reality game squares in their city once they join the game. When they arrive at their destination, Mr. Monopoly AR will appear and assist them in completing tasks and winning prizes (ARPost, 2019).

Lin (2015) developed Monopoly Architect-AR that integrates 3D printing and AR elements to visualize 3D figures and 3D architectures modeling. It translates 2D images into 3D when the game is scanned. This enables architecture players of the game to have a 3D overview of building models to provide design depth, a real view of the finished model, and be able to identify any potential design problems. In addition, using 3D AR objects allows visualization of the design without having a physical model, making it more cost-effective as any changes do not affect the production costs. The AR technology will continue to develop from the traditional board games to mobile applications and perhaps through the use of AR goggles, which are popular in video games. The AR experience could change teaching and learning across the world.

2.5 Conclusion

Based on the studies discussed, it shows that gamification is an interesting aspect to be explored in education. The adaptation of board games with AR has shown and received positive feedback among students and educators as they could understand the concepts better when playing augmented reality board games associated with the education-based content. Students were attracted to the AR functions offered in these games in terms of the AR ability in visualization.

There are several factors that need to be considered when designing the board game such as the game rules, theme, background story, and questions that are suitable which enable students to focus on playing the game. A monopoly-based game with AR intervention is proposed in attempting to utilize gamification into the education context to exert the element of fun in learning. It is expected that this gamification method can assist the students' comprehension level in acquiring important concepts and ideas in any subject in higher education, along with any program, field, or discipline.

CHAPTER 3

REV-OPOLY

3.1 Introduction

When combined with an effective pedagogy, AR technology has the potential to promote inclusive education by presenting content, expressing knowledge, and engaging students in learning. It has the potential to promote innovative and cooperative learning environments, allowing for the achievement of learning outcomes through slightly different but effective methods (Ardiny & Khanmirza, 2018; Nordin et al., 2021; Wu et al. 2013). Gamification with AR elements in the classroom provides learners with a variety of interactive activities and is capable of managing multiple learning paths. It prioritizes the visual aspect of the learning process. Gamification can also help students avoid procrastination as they are more likely to be engaged while playing an educational online app with a built-in short-term reward (Kaufmann, 2018).

This research proposed REV-OPOLY, which is an interactive monopoly-inspired board game with augmented reality (AR). By infusing the board game with AR, it has opened up the possibilities of strengthening the process and experience in learning. REV-OPOLY enables interactive lessons by combining virtual and real environments while promoting valuable social skills for players through interaction and competition among them. REV-OPOLY concentrates on the emerging technology revolution, which is a part of the Computer Application in Management curriculum offered at Universiti Utara Malaysia (UUM). This course is enrolled by students from a variety of backgrounds and programs such as Law, Communication, Business Administration

in Logistics and Transportation, Entrepreneurship, Marketing, Public Management, International Business Management, and Human Resource Management. As a result of their exposure to the evolution of technology and future trends analysis in this course, students will be able to identify, present, and apply relevant technical solutions to various business and management situations.

3.2 Design and Implementation

REV-OPOLY is an interactive board game with web augmented reality, themed around the emerging technology revolution concept (**Figure 3.1**) that is developed using WebAR tools. The objective of this game is to become the wealthiest player through buying, renting, and selling technologies. REV-OPOLY consists of a board, four-player pieces, a pair of dice, seven types of play money, and five types of cards that act as AR markers.

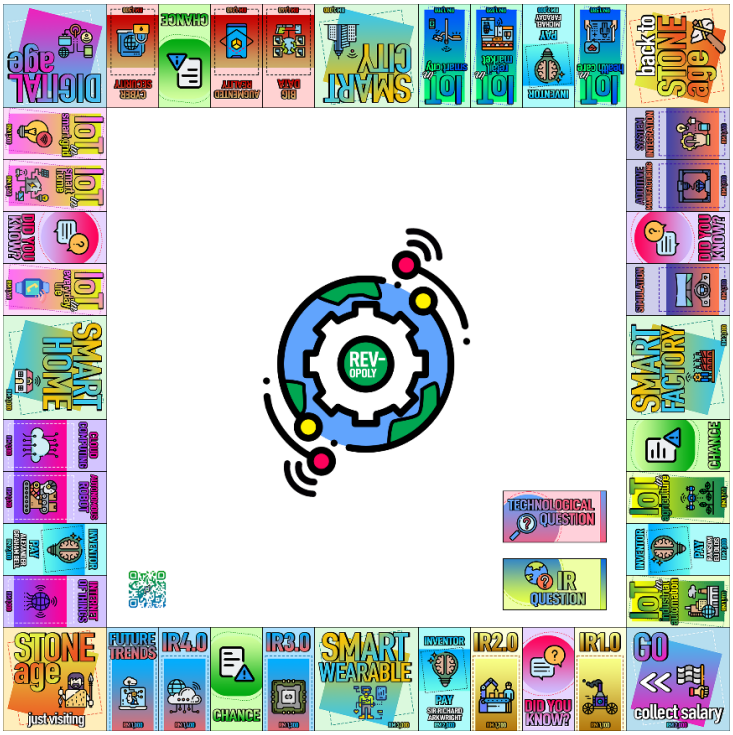

Figure 3.1. REV-OPOLY graphical user interface and the components

To view AR objects, the player can type on their browser rev-opoly.com or scan the QR code provided on the board as shown in **Figure 3.2**. It will direct the player to the website.

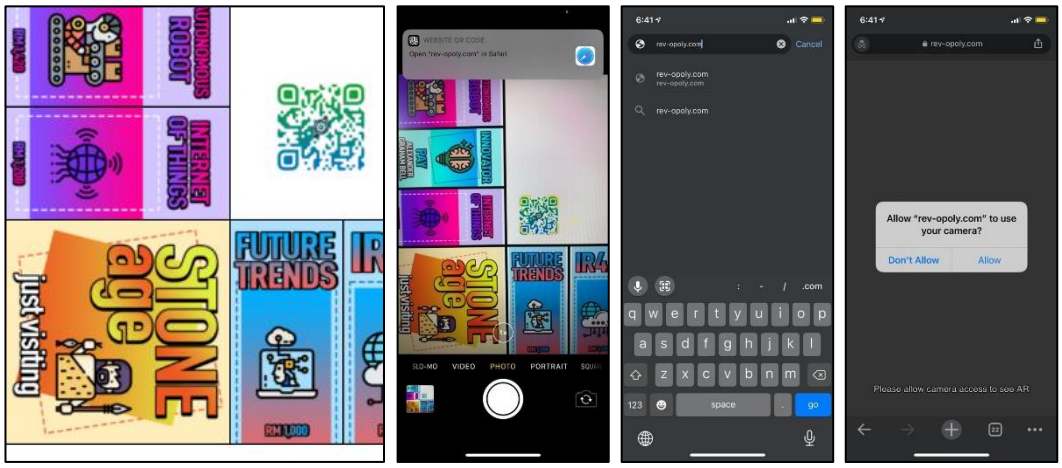

Figure 3.2. QR to enable AR objects scan

The player pieces are represented by images of characters as shown in **Figure 3.3**. These pieces can be configured and personalized to the individual accordingly. When the pieces are scanned, it will display the 3D representation of the characters and their names.

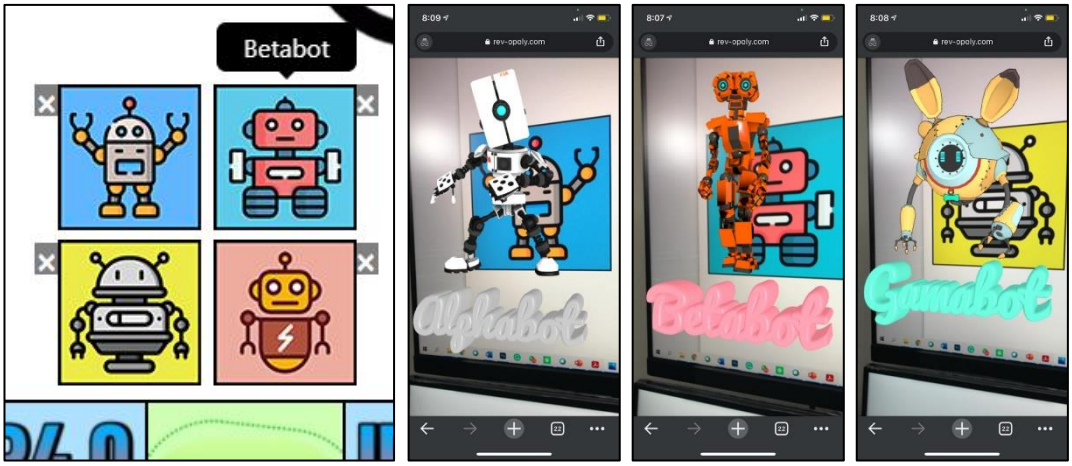

Figure 3.3. Player pieces and the 3D AR characters

The seven types of money are valued at RM 10, RM 50, RM 100, RM 200, RM 500, RM 1,000, and RM 5,000 (**Figure 3.4**). Each player is given RM 15,000 at the beginning of REV-OPOLY. The detail of the pieces to be divided to each player is explained in the REV-OPOLY Manual Book that is provided with the game set and can also be accessed on REV-OPOLY's website.

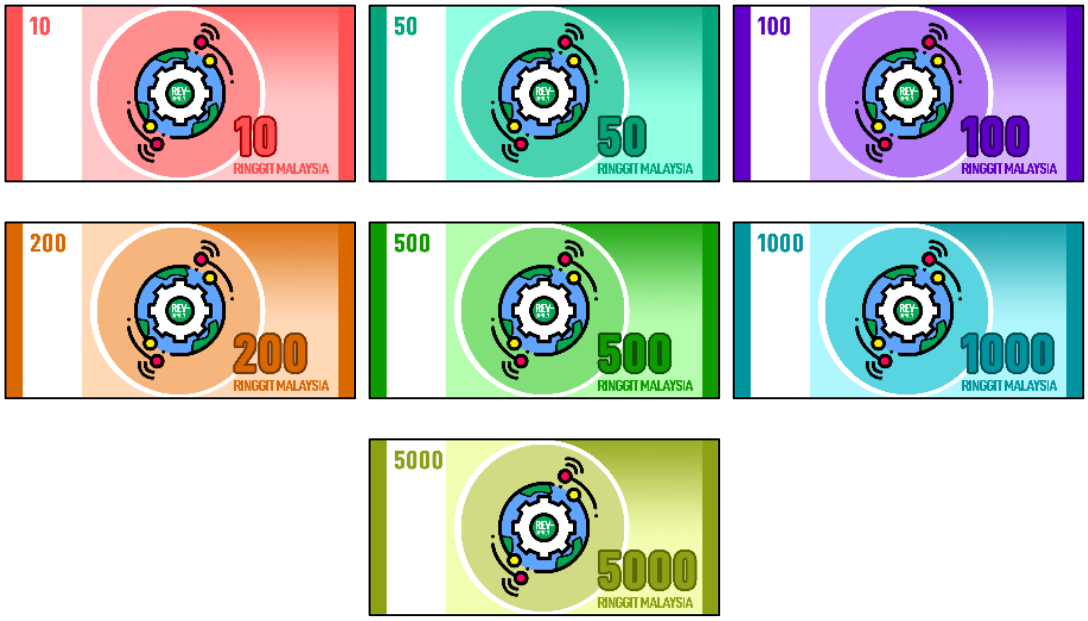

Figure 3.4. Play money

In REV-OPOLY, the five types of cards are the Title Deed cards, IR Question cards, Technological Question cards, Chance cards and Did You Know? cards. Title Deed cards represent the technology on the board that can be purchased by the players. There are 2 sets of 26 Title Deed cards. The Title Deed cards have the same image of the technology on the board. The back of the cards contains the value of the rent that the player can collect when other players land on their space and the technology value if the player decides to sell it (**Figure 3.5**).

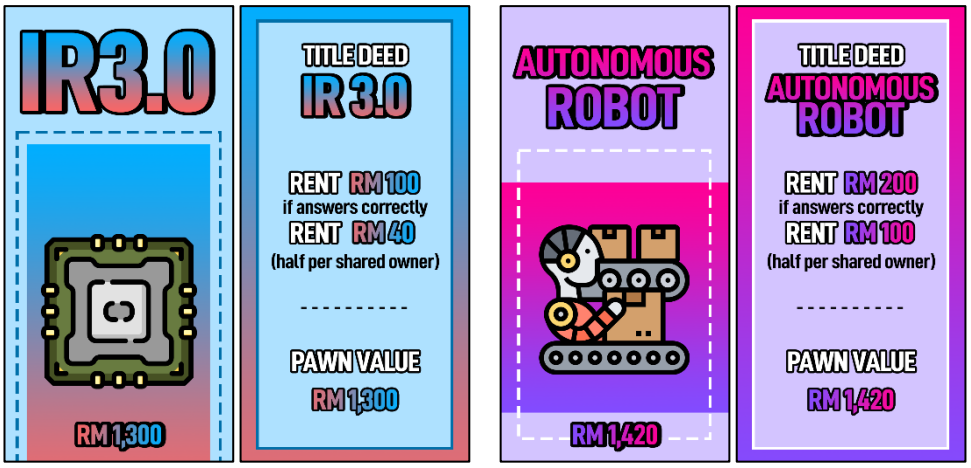

Figure 3.5. REV-OPOLY Title Deed cards

The two types of questions cards in REV-OPOLY are the IR Question cards and Technological Question cards. These cards are used to test the player's knowledge of the technologies. In REV-OPOLY, it is suggested that the IR Question cards are used when the player lands on IR1.0, IR2.0, IR3.0, IR4.0, or Future Trends spaces. An example of the IR Question card is shown in **Figure 3.6**.

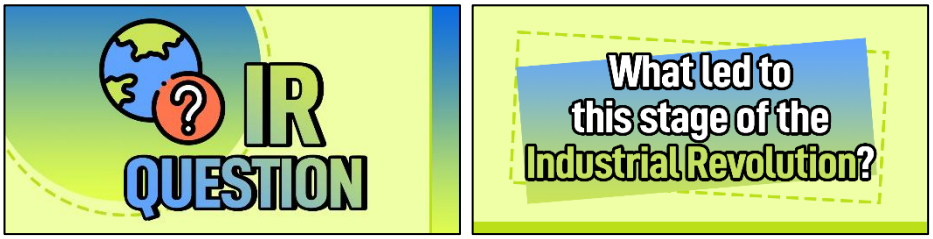

Figure 3.6. Example of IR Question card

When the player lands on the other spaces on the board, it is suggested to draw the Technological Question card (**Figure 3.7**). There are 25 different questions each for IR Question and Technological Question cards to ensure players could get a different question during their turn. This is considered a good number of questions as the question on the card refers to the space that the player lands on the board. For example,

the Technological Question as shown in the example is, *"Give an example of this technology"*. If the player lands on *"Autonomous Robot"*, the question would refer to giving an example of an autonomous robot. Even if the player draws the same card in the next round, the player is more likely to land on a different space. Thus, the question will refer to a different technology.

Figure 3.7. Example of Technological Question card

Similarly for the IR Question, if the player lands on *"IR3.0"* and draws the question card of *"What led to this stage of the Industrial Revolution?"*, the phrase *"this stage"* refers to IR3.0. Thus, as there are 26 technologies on the board, the cumulative number of questions is 650 questions. The questions on the cards are written in the general form so that they can be related to any space that the player lands on.

Figure 3.8. Example of Chance card

Chance cards are cards with various types of advantages that the player can use while playing the game such as *"Skip the question"* and *"Ask ONE other player to assist with the current question"* (**Figure 3.8**). There are 25 different Chance cards.

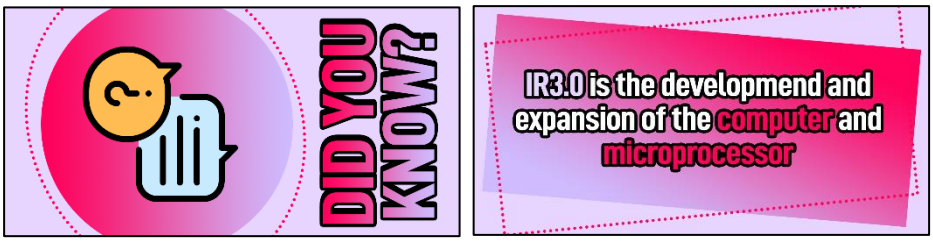

Figure 3.9. Example of Did You Know? card

As a way of retaining the distinctive learning while playing, the Did You Know? cards contain brief facts and statements that are related to the spaces on the board such as the meaning of the terms, examples, and impact of the technology towards various sectors (**Figure 3.9**). There are 25 different Did You Know? cards that provide information on various technologies on the board. More cards can be added if required. Did You Know? cards can be used as flashcards for a quick revision with or without playing REV-OPOLY.

Most of the components on the board act as AR markers that can be scanned to reveal 3D characters or information in the form of 3D texts, images, animations, audio, and videos. The player pieces can be scanned, and it will reveal a 3D representation of the character. Title Deed cards will show the information about the specific space that can be clicked to reveal texts, audios, or videos. The IR Question, Technological Question, Chance and Did You Know? cards show a 3D image of a question box that the player can click from the device screen. It will generate a randomized question or information for the player. The sample answers for all questions can be viewed by scanning the AR image of the technology or space on the board. All AR objects and information can be customized and edited without the need to modify the board itself. REV-

OPOLY's AR only requires an Internet connection, and it works with any web browser and does not require the installation of any software or applications.

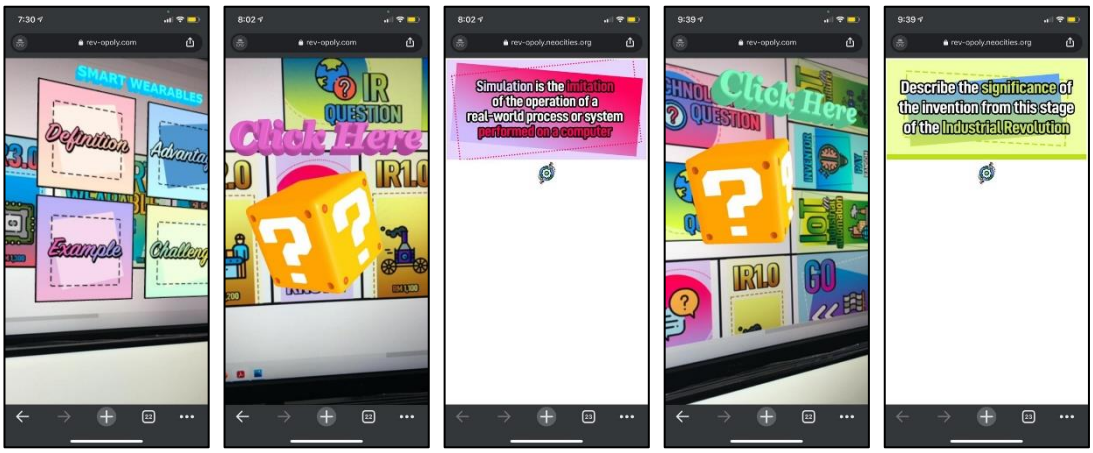

Figure 3.10. AR objects when the components on REV-OPOLY are scanned

There are two distinctive outputs from this research, namely a physical board and an online board game. Depending on the players' preferences, they can choose the medium to play the game, either using the physical board or the web-based online board, REV-OPOLY.COM.

The web-based REV-OPOLY (**Figure 3.11**) is developed using HTML, CSS, and JavaScript. It can be accessed at **https://board.rev-opoly.com**. REV-OPOLY can be viewed and played on any type of device that has an Internet connection. As REV-OPOLY is a web-based game, it is played through the web browser. The board is fully functional even without the AR part as some devices might not be able to support it. Similar to the physical board, the web-based REV-OPOLY also consists of a board, four moveable player pieces, two animated dice, and cards that act as AR markers.

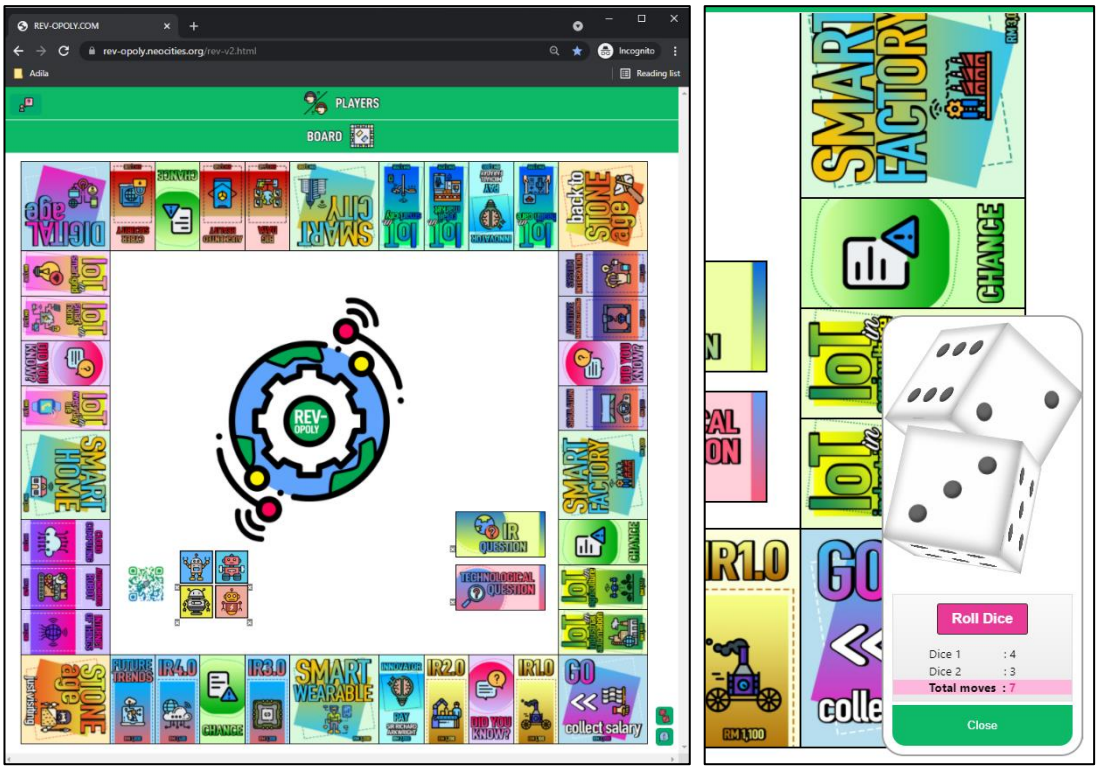

Figure 3.11. Web-based REV-OPOLY

The pair of dice represent the number of moves the player has after rolling the dice. The player pieces can be moved on the board using the keys on the keyboard. This is done to imitate the traditional board game and to ensure that players are engaged rather than passively watching the game. As there are four player pieces on the board, the first player piece can be moved by pressing 1 (left), 2 (right), 3 (up), 4 (down), the second player piece using the key Q (left), W (right), E (up), R (down), the third player using the key A (left), S (right), D (up), F (down) and the fourth player using the key Z (left), X (right), C (up) and V (down). The movements can also be coded to move automatically based on the dice values.

The web-based REV-OPOLY has two main tabs labelled as Players and Board. In the Players tab, there are four buttons for each player represented by the character image.

As part of the game, the player can claim the Title Deed by dragging the card on the board into the Players tab as shown in **Figure 3.12**.

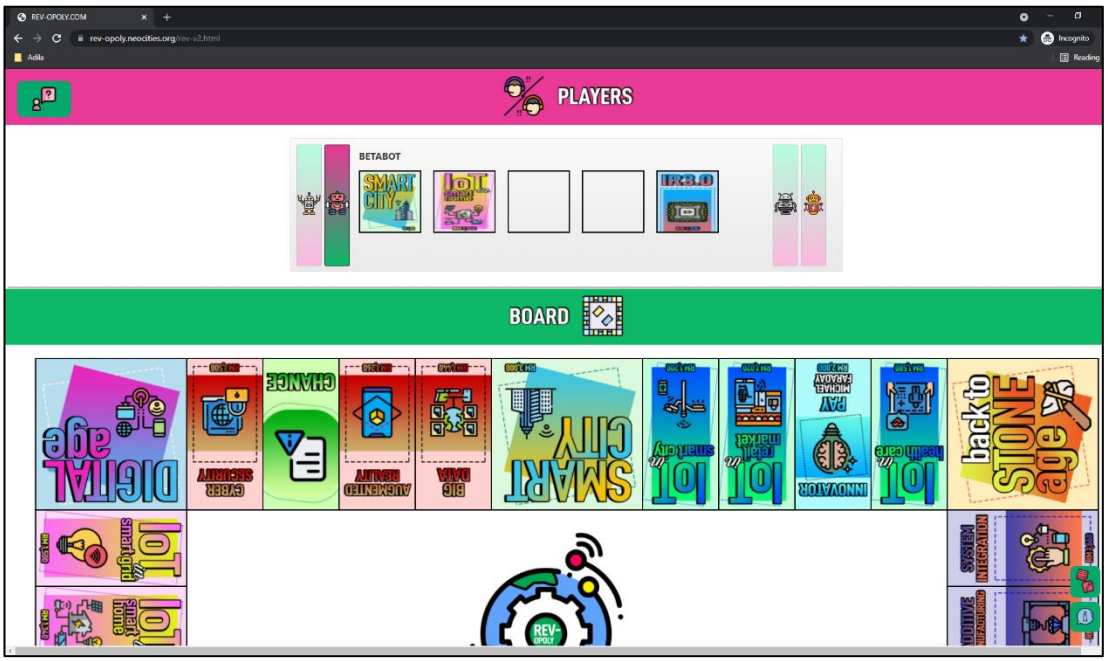

Figure 3.12. Player's Title Deed cards at the Players tab

REV-OPOLY provides a new learning experience for learners as an alternative to the traditional learning method. By utilizing the nature of games as a casual medium for learning while playing, REV-OPOLY helps to assist and enhance learners' comprehension level while enjoying the learning process.

3.3 Game Play

REV-OPOLY is suggested to be played within a group of two to four players. By default, REV-OPOLY is suggested to be played similar to the classic Monopoly game. In REV-OPOLY, the way that it is played can be modified and adapted based on the players' agreement to increase the difficulty levels by introducing various rules, goals, strategies, interactivities, and rewards. The manual of the game is provided on the

board and web-based REV-OPOLY by clicking on the icon or scanning REV-OPOLY's logo (**Figure 3.13**).

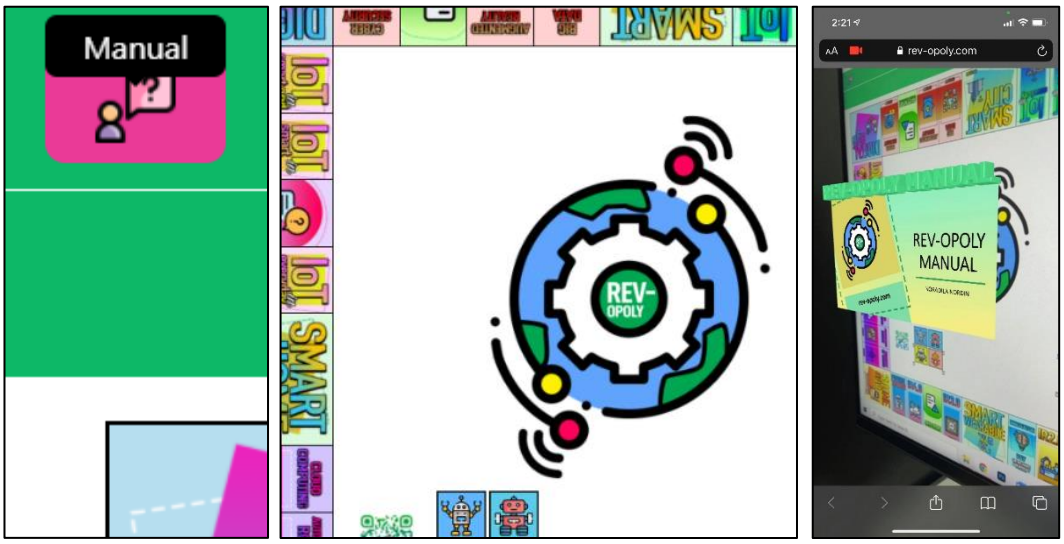

Figure 3.13. REV-OPOLY's manual

To play the game, the players must choose one player piece to represent them. Each player in turn throws the dice. The player with the highest total starts the play. All players will start at the corner marked Go, throw the dice, and move the player piece to the number of spaces indicated by the dice. In the next round, each time the player piece lands or passes over Go, the player will receive RM 2,000 salary.

Figure 3.14. Go space on REV-OPOLY

After the player has completed the play, the turn passes to the player on the left. The player pieces remain on the spaces occupied and proceed from that point on the player's next turn. Two or more player pieces may rest on the same space at the same time.

According to the space the player piece reaches, the player may be entitled to buy the technology or obliged to pay rent, pay inventor, draw a Chance, or Did You Know? card, Back to Stone Age, and other instructions stated on the board.

3.3.1 Stone Age

If the player throws doubles, the player should move the player piece as usual. However, if the player throws doubles three times in succession, the player will immediately be sent to the space marked Stone Age. The player can also be sent to Stone Age if the player lands on the space marked Back to Stone Age. The player gets out of Stone Age by using the *"Out of Stone Age pass"* card from the Chance card or paying a fine of RM 500 after skipping at least one turn. The player then gets out of Stone Age and immediately moves forward the number of spaces shown by the dices. If the player is not sent to Stone Age but in the ordinary course of play lands on that space, the player is *"Just visiting"*, no penalty incurs, and the player can move ahead in the usual manner on the next turn.

Figure 3.15. Stone Age space on REV-OPOLY

3.3.2 Buying Technology

Whenever the player lands on an unowned technology, the player may buy that technology at its printed price. The player will receive the Title Deed card showing ownership. In the online version of REV-OPOLY, the players can claim ownership of the card on the board by dragging the card into one of the boxes to the Players tab (**Figure 3.12**). At the Players tab, the player can click on the button that represents different players based on the character image before dragging the card into the boxes. The card can be removed by double-clicking on the card in the box.

To buy the technology, the player needs to answer the question card correctly. At the Industrial Revolution row, the player has to answer the question from the IR Question card (**Figure 3.6**). For other rows, the questions are based on the Technological Question card (**Figure 3.7**). The player must answer the question verbally. Other players may agree with the given answer or share their responses and thoughts on the same question as a means of sharing knowledge. Sample answers for all the questions are provided as guidelines which can be viewed through the AR marker.

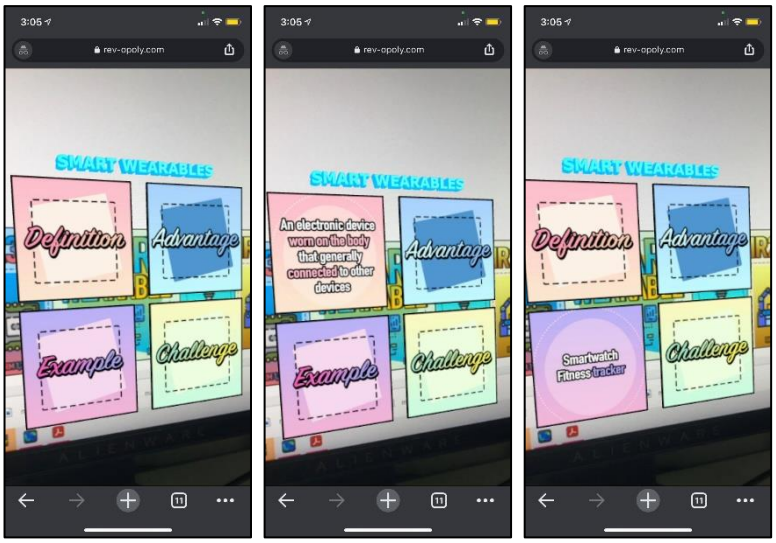

Figure 3.16. Sample answers on REV-OPOLY

If the player answers wrongly or does not know the answer, the player needs to pay a fine of RM 100. The player can choose to share the ownership of the technology with another player if the other player can help to answer the question correctly during the current player's turn. Otherwise, both players have to pay a fine of RM 200.

If none of the players wish to buy the technology, it will be sold at auction to the highest bidder who can answer the question correctly. Each bidder needs to answer the question which is of different question cards. Each bidder will draw a new question card. There will be no fine if the player answers wrongly. Any player including the one who declined the option to buy it at the printed price can bid. Bidding may start at any price.

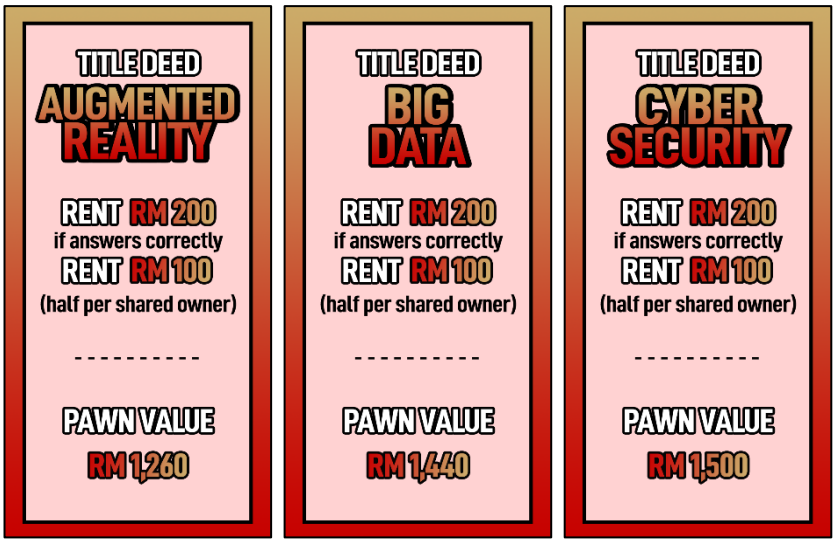

Figure 3.17. Rent printed on the back of the Title Deed cards

3.3.3 Paying Rent

When the player lands on technology owned by another player, the owner can collect rent from the player following the list printed on its Title Deed card as shown in **Figure 3.17**. The player can pay a lower rent if the player manages to answer the question from the question card correctly.

It is an advantage to hold all the Title Deed cards in a color group because the owner may then charge more. The owner may charge double rent for that color group, 3 or 4 times if the owner owns 3 or 4 Title Deed cards of the same color group. This rule applies to unpawned properties even if another technology in that color group is pawned.

For shared technology, the rent will be divided equally based on the listed rent. If the first owner holds another Title Deed card in the same color group, the owner can

collect double the half rent. If the owner holds 3 or 4 Title Deed cards of the same color group, the owner can collect 3 or 4 times the half rent. The shared owner will not benefit from this if the shared owner does not own another Title Deed in the same color group. If the technology is pawned, no rent can be collected. The owner may not collect the rent if the owner fails to ask for it before the next player throws the dice.

3.3.4 Did You Know? and Chance

When the player lands on the Did You Know? or Chance spaces, they select the card and follow the instructions. Several Chance cards can be held until used. If the player who draws it does not wish to use it, the player may sell it at any time to another player at a price agreeable to both. Examples of these Chance cards are shown in **Figure 3.18**.

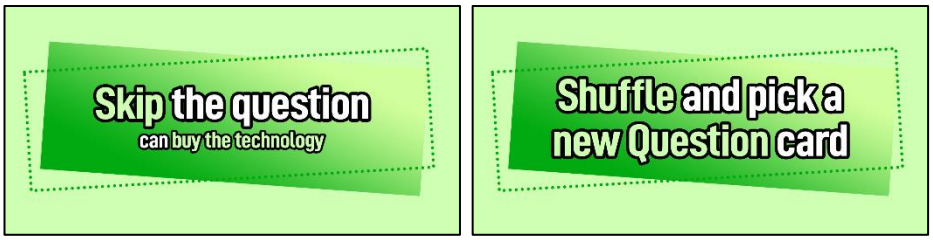

Figure 3.18. Example of Chance cards that can be held

3.3.5 Inventor

If the player lands on the Inventor space, the player needs to pay the amount written to the game. The player can scan the image where an image and audio that contain information about the inventor will be displayed and played.

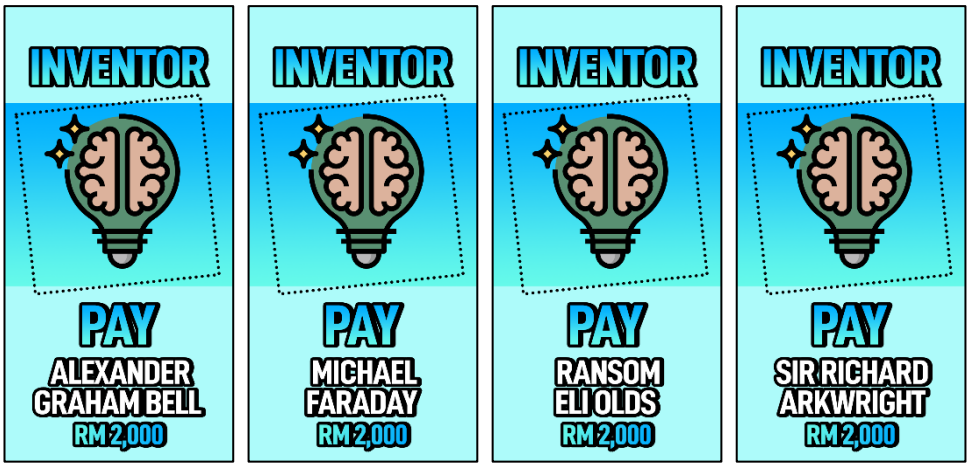

Figure 3.19. Inventor spaces on the board

3.3.6 Digital Age

A player that lands on the Digital Age space do not receive any money, technology, or reward of any kind (**Figure 3.20**). Digital Age space is a free resting place.

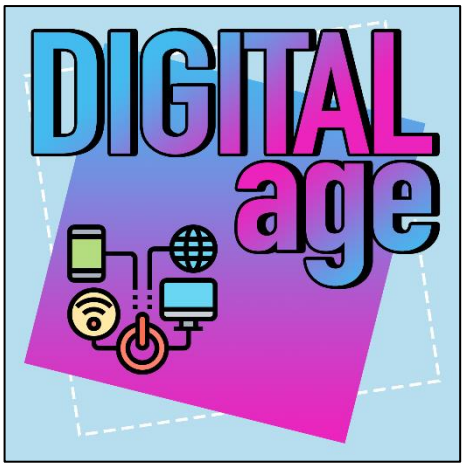

Figure 3.20. REV-OPOLY's Digital Age space

3.3.7 Bankruptcy

The player is declared bankrupt if the player owes more than the player can pay either to another player or to the game. A bankrupt player must immediately retire from the game. The last player left or the player with the most money and deeds values wins.

Throughout the game, players are required to make explicit references to previous learning by applying knowledge and converting the knowledge gained into formal learning. REV-OPOLY encourages the players to engage, interact and have constructive discussions among them through the question cards. Even though REV-OPOLY focuses on the emerging technology revolution in the Computer Application in Management curriculum, the generality of this topic allows REV-OPOLY to be played by individuals who are interested in this topic.

3.4 Conclusion

REV-OPOLY's online board game with AR provides a new learning experience for students in acquiring knowledge. REV-OPOLY can be played as a stand-alone board game. It provides students the opportunity to have an informal and more casual learning process on the same syllabus with the additional element of fun and interest with various rules, goals, strategies, interactivities, and rewards, in addition to the AR objects provided by the board in various types of multimedia, images, texts, audios, and videos.

CHAPTER 4

PRELIMINARY STUDY

4.1 Background

Students were invited to participate in a questionnaire on their experience and preference on the way the course should be conducted using a board game learning approach. Among a total of 100 students in the course, 86 responded to the survey with a response rate of 86%. The questionnaire is separated into four parts, Section A is on demographics which is to understand the relationship of age, participants' current semester, and the department that they belong to. Section B is on participants' board game experience and the relevance of board games compared to other types of games. Section C is on board game features and designs that attract participants especially on Monopoly and AR-based games. The last section, Section D is on the participants' impression of REV-OPOLY. A video of REV-OPOLY was provided to show the participants how REV-OPOLY works. Due to the pandemic, all participants were off campus. Therefore, they were unable to test REV-OPOLY themselves. The questionnaire contains measurement scales on the importance of game features and reasons to adopt REV-OPOLY as the learning approach rather than other typical learning pedagogy which uses a five-point Likert scale to understand and focus on the aspects that participants defined as most related and important to them.

4.2 Data Collection and Sampling

The respondents' demographics were 55 (64.0%) females and 31 (36.0%) males. 26 respondents (30.2%) aged below 20 and the majority of them, 60 (69.8%) were

between 21 to 25 years old. The respondents were in semester 1 (17, 19.8%), 62 (72.1%) in semester 2, 3 (3.5%) in semester 3 and 4 (4.7%) in semester 4. Due to the pandemic, the respondents who were in semester 1 to semester 3 had not been to the campus since they began their studies. Thus, REV-OPOLY is a multiplayer game that enforces interactions and discussions amongst the players, which is appealing to the respondents as a way to constitute the lack of face-to-face interactions in lessons into informal learning. This is supported by the result of this questionnaire where 82 respondents (95.3%) like the idea of multiplayer REV-OPOLY and 77 (89.5%) responded to try REV-OPOLY as it allows them to share knowledge through discussion.

The distribution of the respondents was mainly from various schools and programs in UUM. 61 respondents (70.9%) were from School of Business Management, 11 (12.8%) from School of International Studies, 8 (9.3%) School of Technology Management & Logistics, 5 (5.8%) from School of Government, and 1 (1.2%) from Islamic Business School. Even though their degrees were not directly game and technological-related, 74 respondents (86.1%) said that they like playing games in general. In 2021, it is estimated that there are currently 2.8 billion gamers around the world, and it is expected to increase each year, reaching 3 billion by 2023 (Clement, 2021a). According to another survey published by Clement (2021b) on the age of gamers in 2020, out of the 4000 respondents involved, 21% of them were aged below 18 years old and 38% were between 18 to 34 years old. This shows that students are more likely to be interested in games based on the average age of gamers.

In terms of the distribution of gamers by gender in 2020, as demonstrated in a study conducted with a sample size of 4000 respondents, females accounted for 41% whereas 59% were males (Clement, 2021c). This shows that games are usually preferred by males over females even though the percentage increases each year since 2006. This proves to be true as 85.5% of females liked games while males accounted for 87.1% based on the 86 respondents in this study (see **Table 4.1**). The respondents were also asked if they preferred to have the aspects of games into their learning such as the use of Kahoot, Quizizz, and Quizlet, and it shows an overall increase of 95.4% (82 respondents) where 51 (92%) were females and 31 (100%) males. All of the respondents were familiar and had tried at least one of these game-based learning platforms during their lessons. Therefore, they were able to relate their experience in playing education-based games with their preferences.

Table 4.1. Respondents' game preference distribution by gender

Gender	**Games**		**Education-based Games**	
	N	***P***	***N***	***P***
Male	47	85.5	51	92.7
Female	27	87.1	31	100.0

N number of respondents, *P* percentage of respondents (%)

4.3 Result and Discussion

4.3.1 Relevance of Board Game

Board games have been around for quite a while. One of the oldest board games known to have existed, called Senet, was dated back to the First Dynasty of ancient (Crist, 2019). Board games have been played in most cultures and societies where they can be categorized into three main genres which are competitive board games such as Monopoly, educational board games such as Scrabble, and simple board games such as Snakes and Ladders. In these genres, they can have different types of gameplay

structures to make them enjoyable. Out of these genres, 61 respondents (70.1%) agreed that they are more likely to play competitive board games, where 43 (50.0%) prefer simple board games. 20 (23.3%) are open to play educational board games, where 42 (48.8%) have experience in this genre. Based on this information, the initial assumption that physical board games are still relevant proved to be true despite the advancements of technology in video games and mobile games. According to Arizton (2020), their global board games market report analyzed in-depth the board games market revenue which is expected to grow during the period 2021-2026.

When the respondents were asked specifically about the Monopoly board game, 14 of them (16.3%) said that they had never played it, 53 (61.6%) used the physical board game, 13 (15.1%) played both the physical and online Monopoly and only 6 (7.0%) had only played the online version of the Monopoly. Monopoly has been around for a long time where the first Monopoly published by Hasbro started back in 1935. In terms of the enjoyment of playing Monopoly, 71 respondents (82.6%) responded positively while 3 (3.5%) strongly objected.

Additionally, more than half of the respondents selected Monopoly as their favorite board game (23 respondents, 26.7%), whereas 14 (16.3%) and 8 (9.3%) chose familiar board games that have the same concept as Monopoly produced by different brands such as SAIDINA and Jutaria (also known as Millionaire or Billionaire) respectively, where the properties on the boards are based on the local attractions and places in Malaysia. Nevertheless, many of the respondents chose these board games because they could learn about money management, buying, and trading properties, and

developing properties with houses and hotels. They also preferred Monopoly as it has different versions, editions, and variations of games such as Monopoly: Star Wars Complete Saga Edition, Monopoly: Pokémon, and Monopoly: Here & Now The World Edition where in this version, an electronic banking unit device is provided.

4.3.2 Perception towards REV-OPOLY

Based on a three-minute short video that shows the gameplay of REV-OPOLY, 40 respondents (46.5%) rated REV-OPOLY as very good, 34 (39.5%) good and 12 (14.0%) were neutral about the board game. Referring to **Table 4.2**, 85 respondents (98.8%) out of the 86 respondents were interested in using REV-OPOLY as a learning approach. This relates to the respondents interested in having games as part of the learning process where 82 (95.4%) preferred it while a small number of 4 (4.7%) preferred traditional methods in learning and assessments.

Table 4.2. Respondents' acceptance towards games in learning

Statements	*N*	*P*
I like playing games	74	86.1
I like games to be included as part of the learning	82	95.4
I like REV-OPOLY	74	86.1
I am interested in using REV-OPOLY as a learning approach	85	98.8

N number of respondents, *P* percentage of respondents (%)

There were mixed responses in terms of the use of AR as part of the game. 31 respondents (36.0%) strongly agree that REV-OPOLY and the AR components of it can help them have a better learning experience, 41 (47.7%) agree, 13 (15.1%) neutral and 1 (2.4%) strongly disagree with the use of AR. This could be due to the lack of AR-related games available; thus, it can be unclear on the effectiveness of AR-based

games. To support this finding, the questionnaire showed that 65 respondents (75.6%) stated that they had never played any AR game while 21 respondents (24.4%) had, stating Pokémon Go and Minecraft Earth as the AR-based games that they had played.

Table 4.3. Respondents' agreement on the current features of REV-OPOLY

Features	***N***	***P***
Design and gameplay	75	87.2
Learn while play experience	83	96.5
Easy to learn through the game	80	93.0
Group learning	82	95.4
Group interaction	77	89.5
AR playing cards	64	74.4

N number of respondents, *P* percentage of respondents (%)

The respondents were asked about the features of REV-OPOLY that attracts them to use it as part of the learning approach in terms of the design and gameplay, learning while playing experience, the effectiveness of it, as an alternative to typical learning method, enforcing group learning and engaging in discussion (see **Table 4.3**). 52 respondents (60.5%) and 31 (36.0%) strongly agree and agree that REV-OPOLY opens up a new experience in learning for them as the majority of the respondents feel that through this game, they can learn better (80 respondents, 93.0%) due to the nature of the game as an informal medium which helps to keep them focus while enjoying the learning process.

39 respondents (45.3%) pointed out that the ideal time to spend on a board game is around an hour or more and 33 (38.4%) 30 to 40 minutes, which suggests that they are able to stay focused for a long period during gameplay. Only 13 (15.1%) prefer games that can be completed within 10 to 20 minutes. This strongly supports the way that

REV-OPOLY is constructed, as the game revolves around the theme where it depends on the ability of the players to solve the questions to end the game. There is no time limit in REV-OPOLY. However, REV-OPOLY is expected to be played for more than 30 minutes.

64 respondents (74.4%) prefer to try REV-OPOLY as an alternative to reading slides or books to understand the subject while 20 (23.3%) neutral and 2 (2.3%) are not convinced of the effectiveness that REV-OPOLY has to replace those resources. This is understandable as games are typically used to complement lessons or as assessments rather than as the main method in acquiring information. 82 respondents (95.3%) like the idea of REV-OPOLY which involves the game to be played with several players and the interaction that is enforced through discussions (77, 89.5%). The questions related to the game theme are provided to lead the players towards constructive discussion where sample answers are also provided as the guidelines.

Table 4.4. Respondents' perspective on the importance of the features

Important Features	***N***	***P***
Gameplay	73	84.9
Game tutorial	72	83.7
Passive information transfer	70	81.4
Multiplayer	79	91.9
Reward system	71	82.6

N number of respondents, *P* percentage of respondents (%)

Other than multiplayer REV-OPOLY, the 15 respondents (17.4%) suggested including an option for the game to also support single-player. Nevertheless, the majority of respondents, 61 (70.9%) and 46 (53.5%) said that they normally play board games with their friends and families. In order to support a single player, this can be done by

modifying the rules and instructions without affecting the physical parts of the game. They also suggested that REV-OPOLY could provide a more direct reward system to record the players' improvement in acquiring knowledge through the game in the form of scores or bonuses. 71 (82.6%) feel that the reward system such as high scores or marks is one of the important features in a game (see **Table 4.4**).

4.4 Conclusion

Gamification is believed to be able to enhance students' learning. Findings from the questionnaire conducted among the students undergoing the Computer Application in Management subject show that the majority of the students commented that they are interested in using REV-OPOLY in their learning. However, the limitation of this research is that the students were not able to experience playing REV-OPOLY in person as they are off-campus. Further research will be done on identifying students' actual learning outcomes and experiences after they are able to return to campus and play REV-OPOLY. Moreover, further research is required to see whether this game can increase students' performances or grades.

CHAPTER 5

ASSESSMENT

5.1 Background

This study employs a quantitative method of quasi-experimental design using pre-test and post-test, and test assessment. It was conducted in one semester to 100 undergraduate students enrolled in the Computer Application in Management subject at Universiti Utara Malaysia. The pre-test and post-test were used to measure the students' knowledge gained from REV-OPOLY. To ensure the validity of this study, students were asked to complete the pre-test before REV-OPOLY was demonstrated. Students were not informed about the study before it began in order to test the effectiveness of REV-OPOLY on their understanding based on their prior knowledge of the topic as the baseline. However, the topic was covered in previous lectures. The students were then given an explanation and demonstration of REV-OPOLY. Their interactions during the game were observed and recorded in order to be analyzed. After the game, students had to complete a post-test to evaluate the REV-OPOLY intervention.

5.2 Pre-test and Post-test Design

The pre-test and post-test contained 15 multiple-choice (MCQ) questions about the emerging technology revolution such as the definition, causes, examples, benefits, and impacts of the technology. The questions were written in a straightforward and simple format that students could understand. Furthermore, distinct answers to the questions were based on the content covered in lessons and lecture notes. For example, the first

question in the test is about the definition of the Industrial Revolution 1.0. The question and choices are:

What does it mean by Industrial Revolution 1.0?

A. Transition from manual to machine production
B. Development of electrical machines
C. Expansion of computer and microprocessor
D. Expansion to allow automated communication amongst machines

Each option in this example refers to a different stage of the industrial revolution and is therefore implausible. Therefore, it could be assured that the questions and list of possible answers in the pre-test and post-test were well-developed in order to assess the students' knowledge on the subject matter.

The questions in pre-test and post-test were divided into three main categories which are industrial revolution, smart concept and Internet of Things, and pillars of Industrial Revolution 4.0. These categories were also used in REV-OPOLY. Thus, the questions and game were related and supported the knowledge required in the Computer Application in Management subject on the fundamentals of the emerging technology revolution. After playing REV-OPOLY, it was expected that the students would be able to correctly answer the majority of the post-test questions.

Students were briefed on the study and stages involved before proceeding with pre-test, testing REV-OPOLY, and completing post-test at the end of the session. Informed consent was obtained from the students which they could opt out at any step throughout

the study. REV-OPOLY was played for 30 minutes in groups of at least four players via Webex breakout sessions, followed by a post-test consisting of the same set of questions as the pre-test. The pre-test and post-test were administered through the UUM Online Learning Portal, which had a 15-minute countdown timer, and the results were synchronized and linked to the students' profiles for analysis.

5.3 Other Assessment

Relying solely on the pre-test and post-test results might be insufficient to prove REV-OPOLY's effectiveness. Therefore, the post-test results were compared to the results of the course assessment, Test 2, on the same topic. The assessment was carried out for several days after the students were introduced and used REV-OPOLY. For validity, the questions in Test 2 were developed and moderated by at least four different experts in the Computer Application in Management subject. Test 2 covered five different topics in the syllabus (60 MCQ questions) and ten of the questions were on the emerging technology revolution topic. The assessment questions were securely protected and could only be viewed on a specific date. Even though the questions used in the post-test and Test 2 were different, they had similar difficulty levels and covered the same categories which were industrial revolution and pillars of Industrial Revolution 4.0. Whereas Test 2 did not contain questions on smart concepts and Internet of Things category.

5.4 Data Collection and Sampling

Out of 100 students, 88 completed the pre-test and only 58 completed the post-test. The results of students who took both tests were chosen for analysis (**Table 5.1**). In

total, 55 students completed pre-test and post-test. In Test 2, all 100 students sat for the assessment. The results of Test 2 were used to further analyze the 55 students who had previously completed the pre-test and post-test. Within the 55 students, 38 (69.09%) were female and 17 (30.91%) were male, with 10 (18.18%) in their first semester, 43 (78.18%) in their second semester (the majority), and 2 (3.64%) in their fourth semester.

Table 5.1. Demographic distribution

Profile Factors	**Particulars**	***N***	***P***
Gender	Female	38	69.09
	Male	17	30.91
Semester	1	10	18.18
	2	43	78.18
	3	0	0.00
	4	2	3.64
Department	School of Business Management	35	63.64
	School of International Studies	8	14.55
	School of Technology Management & Logistics	8	14.55
	School of Government	3	5.45
	Islamic Business School	1	1.82

N number of respondents, *P* percentage of respondents (%)

The respondents came from a variety of backgrounds and studied non-technological programs. 35 (63.64%) respondents enrolled in the School of Business Management pursuing Bachelor in Business Administration, Bachelor in Entrepreneurship, Bachelor in Human Resource Management, and Bachelor in Marketing. Eight (14.55%) respondents were from the School of International Studies, pursuing Bachelor in International Business Management, eight (14.55%) were from the School of Technology Management & Logistic, pursuing a Bachelor in Logistic & Transportation Business Administration, three (5.45%) were from the School of

Government pursuing Bachelor of Public Management and one (1.82%) from the Islamic Business School, pursuing a Bachelor in Islamic Finance and Banking.

5.5 Result and Discussion

The correct responses for each question (15 questions in total) in the pre-test and post-test were tabulated as shown in **Table 5.2**. Questions 1–5 (Q1–Q5) are about the industrial revolution, questions 6–10 (Q6–Q10) are about the smart concept and the Internet of Things, and questions 11–15 (Q11–Q15) are about the pillars of the Industrial Revolution 4.0. After the students finished answering the pre-test, they were not informed of the results. Therefore, they were not aware of the answers to all the questions. However, by playing REV-OPOLY, similar information and knowledge could be gained in order to see improvements in their answers during the post-test, as the post-test contained the same questions as the pre-test.

According to the results in **Table 5.2**, the first category showed an improvement (gain) in all questions, with the obvious improvement in Q5, a 23.64 % increase. In the second and third categories, even though the majority of the questions showed improvement, two questions (Q8 and Q10) and one question (Q11) showed decreases in the number of students who answered them correctly. Even though the percentage was small (3.64%, 5.45%, and 1.82%), these three questions needed to be analyzed to find the reasons for these negative values while Q9 showed no changes.

Table 5.2. Students' pre-test and post-test responses

Questions	Pre-test		Post-test		Gain
	N	***P***	***N***	***P***	***P***
Q1	38	69.09	43	78.18	9.09
Q2	24	43.64	28	50.91	7.27
Q3	24	43.64	25	45.45	1.82
Q4	14	25.45	19	34.55	9.09
Q5	19	34.55	32	58.18	23.64
Q6	41	74.55	45	81.82	7.27
Q7	39	70.91	44	80.00	9.09
Q8	29	52.73	27	49.09	-3.64
Q9	20	36.36	20	36.36	0.00
Q10	29	52.73	26	47.27	-5.45
Q11	28	50.91	27	49.09	-1.82
Q12	38	69.09	47	85.45	16.36
Q13	21	38.18	24	43.64	5.45
Q14	30	54.55	36	65.45	10.91
Q15	31	56.36	35	63.64	7.27

N number of respondents, *P* percentage of respondents (%)

For Q8, *"Which of these is NOT the benefit of IoT in smart city?"*, and the answers are *"A. Able to have smart air quality control of the city"*, *"B. Able to use smart traffic control in the city"*, *"C. Able to implement smart parking system in the city"*, *"D. Able to control individual smart devices within the city"*. However, students were confused with smart air quality and smart traffic control. Supposedly, it should be clear that individual smart devices should not be controlled by unauthorized personnel. Therefore, to avoid misleading the students, the question could be rephrased as a positive statement. Moreover, for Q10, *"What is the use of smart grid?"*, and the choices are *"A. To remotely control connected home appliances"*, *"B. To automate the connected machinery"*, *"C. To control the changes in electricity usage and issues"*, *"D. To virtually control and monitor field operations"*. In this question, students had a misconception of the smart grid. In REV-OPOLY, the definition of the

smart grid is provided. Students might overlook it when they were using REV-OPOLY.

Similarly, for Q11, *"What is the purpose of system integration?"*, *"A. To access the system over the Internet"*, *"B. To link different systems to act as a single system"*, *"C. To join process that builds the system parts layer by layer"*, *"D. To overlay virtual objects to the real-life"*. Students had misunderstood the concept of system integration as additive manufacturing or cloud computing. Based on these findings, a clear comparison of the different types of technologies should be included in REV-OPOLY in the form of texts, videos, or images to avoid misconceptions from happening, especially in the definition of the terms which is crucial in understanding the emerging technology revolution topic.

In terms of the overall gain in the three categories, based on the responses results in **Table 5.2**, in the first category, the total percentage gained was 10.18% (correct pre-test 43.27%, post-test 53.45%), in the second category was 1.45% (correct pre-test 57.46%, post-test 58.91%) and in the third category was 7.63% (correct pre-test 53.82%, post-test 61.45%). This shows that most students improved greatly when answering questions in the first and third categories, while in the second category, 57.46% answered the questions correctly in the pre-test which was the highest value compared to the other categories. This demonstrates that the baseline was set higher than the other categories, resulting in the lowest total gain. Overall, students improved in all categories, particularly their understanding of the Industrial Revolution (first category).

Table 5.3. Students' pre-test and post-test scores

Scores	Pre-test			Post-test		
	N	***P***	***t***	***N***	***P***	***t***
<=5 (low performers)	8	14.55	12.99	6	10.91	11.68
6-10 (moderate performers)	39	70.91	10.77	33	60.00	7.70
>10 (high performers)	8	14.55	13.57	16	29.09	9.68

N number of respondents, *P* percentage of respondents (%), *t* average time taken by respondents to complete the test (minutes)

Table 5.3 categorizes the students' pre-test and post-test scores based on their performances, low (at most with 5, inclusive, correct answers or 33.33%), moderate (6 to 10 correct answers or 40% to 66.67%), and high (more than 10, exclusive, correct answers, 66.67% to 100%). Even though the number of moderate performers decreased (39 to 33), this was a positive result because the number of high performers increased by doubling compared to the pre-test (from 8 to 16) and the number of low performers decreased slightly (8 to 6). In terms of time spent during the pre-test and post-test, students spent an average of 13.11 minutes during the pre-test and decreased by 3.42 minutes to 9.69 minutes during the post-test. This suggests that students might have known the answers to the questions better than they did during the pre-test, allowing them to complete their answers faster.

In terms of the scores, 16 students showed an improvement of 13.33% and 6.67% each, compared to their initial pre-test score. Three students improved significantly, with their post-test scores increasing by 46.67 percent. One student's score dropped by 46.67 percent. Further investigation revealed that the student was unable to complete the post-test due to an Internet connection issue. The system used for the pre-test and

post-test automatically submitted the students' answers when the timer ran out, regardless of whether or not the students completed them.

Table 5.4. Students' post-test performance scores and results

Scores	**Post-test**			
	N	***P***	***mode*$_{score}$ *(N)***	***max*$_{score}$ *(N)***
Less score	10	18.18	6.67 (7)	46.67 (1)
No changes	16	29.09	-	-
Improvement	29	52.73	13.33 (8) 6.67 (8)	46.67 (3)

N number of respondents, *P* percentage of respondents (%), *mode*$_{score}$ highest frequency of scores, *max*$_{score}$ maximum score achieved (%)

To further support this result, **Table 5.4** shows that 29 students (52.73%) improved their number of correct answers when compared to the pre-test. However, 16 students (29.09%) received the same scores in both tests, while 10 students (18.18%) received lower scores than before. Pre-test scores that did not change during the post-test should be investigated further because they could indicate a variety of issues, such as students having difficulty understanding the questions and the suitability of the game, which may need to be altered and modified to meet the diverse needs and interests of all types of students. This information could be gained through the feedback provided by the students.

Results of the post-test were then compared to another assessment, Test 2. Test 2 covers similar types of questions and information that could be obtained in REV-OPOLY. The main distinction is in the structure of the assessment questions. In the pre-test and post-test, simpler words are used, while in Test 2, the questions are more descriptive. For example, one of the questions in Test 2 is as follows:

Refer to the statement below:

"A cluster of technologies that produce objects by adding material in sequential layer which can be from metals, plastics, and composite materials."

From the above statement, this is one of eleven enabling technologies that is highlighted by the National Policy on Industry 4.0 – Industry4WRD. This enabling technology is referring to _____.

A. Artificial technology *B. Cybersecurity*

C. Advance materials *D. Additive manufacturing*

Table 5.5 shows the students' scores compared to the post-test. As mentioned in the previous section, the questions are categories into industrial revolution (5 questions), and technology (5 questions) which gave a cumulative value of 275 (55 students * 5 questions) in each category. Test 2 showed an improvement with a gain of 3.65% in the first category (from 53.45% to 57.09%) and 5.45% in the second category (from 61.45% to 66.91%), as 10 and 15 students performed better in Test 2 than in the post-test.

Table 5.5. Comparison of Test 2 and post-test responses based on categories

Question Categories	**Post-test**		**Assessment (Test 2)**		**Gain**
	ΣN	***P***	***ΣN***	***P***	***P***
Industrial Revolution	147	53.45	157	57.09	3.64
Technology	169	61.45	184	66.91	5.46

ΣN number of cumulative respondents in all questions within the category, *P* percentage of respondents (%)

Table 5.6 shows students' performances which can also be compared to Table 3. The number of low performers decreased from 6 to only 1 in Test 2. The majority of the students were within moderate to high categories (a total of 98.18%) compared to a total of 89.09% in the post-test and 85.46% in the pre-test. Based on the results of the

pre-test, post-test, and Test 2 tests, it is possible to conclude that the students improved at each test as they gained a better understanding of the topic.

Table 5.6. Students' post-test and Test 2 scores

Scores	Post-test		Assessment (Test 2)	
	N	***P***	***N***	***P***
<=50% (low performers)	6	10.91	1	1.82
50-75% (moderate performers)	33	60.00	22	40.00
>75 (high performers)	16	29.09	32	58.18

N number of respondents, *P* percentage of respondents (%)

5.6 Conclusion

The use of augmented reality board games in the classroom is undeniably exciting and encourages students to become more involved in the learning process. Although learning the rules and features of the board game takes time, once the students are accustomed to the gameplay, it is a fun and interactive way for them to learn and review a topic in their studies. The attractive 3D features of the AR board game allow the students to become immersed in the game. The disadvantage is that it requires good internet connections, as these features may be too heavy to support multiple devices and users at the same time.

By incorporating AR into board games, the important component of REV-OPOLY is retained alongside digitization. Students in augmented reality games have a vast and perhaps a limitless number of interaction options. Therefore, the addition of augmented reality to the game adds value which may improve the game by merging the greatest aspects of traditional and online board games. Additionally, by

incorporating the emerging technology revolution subject to the game, students were able to grasp important concepts from the IR1.0 to IR4.0 era.

According to the post-test and Test 2 scores, students were able to identify the basic concepts, definitions, causes, examples, benefits, and impacts of technology. However, a clear comparison of the various types of technologies should be included in REV-OPOLY in the form of texts, videos, or images to avoid misinterpretations, particularly in the definition of the terms which is critical in understanding the emerging technology revolution topic.

CHAPTER 6

STUDENTS LEARNING MOTIVATION

6.1 ARCS Model

The ARCS Motivational Model is a student-centered approach that has been widely used to measure the effects of instructional materials on the student's motivation in learning (Keller, 1987). The ARCS model can be used in both face-to-face and computer web-based instructional settings (Keller, 1999). There are four dimensions in the ARCS model that measure a student's motivational levels, which are attention (A), relevance (R), confidence (C), and satisfaction (S). In this study, these components are used to evaluate motivation measurement in terms of impact and the use of AR technology in REV-OPOLY, as the learning tool.

The attention dimension refers to the ability of REV-OPOLY to attract and maintain students' focus and interest in the learning process. The relevance dimension is closely related to the instructional material, REV-OPOLY, which is designed to align with the course's content and objectives, making it relevant and perceived compatible with the students' learning experience in achieving the learning outcomes. Based on the learning experience, students' confidence, and attitude to learn and use REV-OPOLY are measured within the confidence dimension. The final dimension is satisfaction, in which the process or results of using REV-OPOLY fulfilled the expected learning outcomes and positively influenced the students' learning experience in terms of achievements and meaningful knowledge exchange through the use of REV-OPOLY. Several factors influence student's satisfaction such as the ease of use and consistency

of the instructional materials in reinforcing learning by providing appropriate opportunities and challenges to retain students' interest.

The Reduced Instructional Materials Motivation Survey (RIMMS) is used to measure students' motivational ARCS model by scoring on the dimensions of attention, relevance, confidence, and satisfaction, which add up to an overall motivation score.

6.2 Reduced Instructional Materials Motivation Survey

The Reduced Instructional Materials Motivation Survey (RIMMS) is a 12-item scale consisting of three items that measure each of the four dimensions in the ARCS model. RIMMS is a reduced version of the Instructional Materials Motivation Survey (IMMS), a 36-item questionnaire that corresponds to the ARCS model and is used to assess student motivation (Keller, 2010). Previous studies by Huang et al. (2006), Houze & Marshall (2020) and Loorbach et al. (2015) validated RIMMS and found that RIMMS fits the dimensions of the ARCS model better. In addition, by reducing the number of items on IMMS, the measurement's psychometric property is strengthened, as 12-item RIMMS reduces the possibility of response biases. Similar to IMMS, the scoring in RIMMS can be done independently or cumulatively for attention, relevance, confidence, and satisfaction dimensions.

In this study, RIMMS is adapted and modified to measure students' motivation of REV-OPOLY. 3-item in the RIMMS are directed to each dimension of the ARCS model using a five-point Likert scale, measured from the scale of 1 (strongly disagree) to 5 (strongly agree).

6.3 Questionnaire Design

The questionnaire was adapted and modified based on several research studies that used RIMMS (Hauze & Marshall, 2020; Loorbach et al., 2015; Khan et al. (2019); Wang et al., 2020). The questionnaire was made available to respondents through Google Form. It uses 12-item RIMMS that fits the ARCS model. The questionnaire is divided into five sections, beginning with the demographics of the respondents to understand the relationship between age, the current semester of the participants, and the department of their enrolled program. Section A is on REV-OPOLY's features in terms of the layout, design, and usability of the board and AR properties. It measures students' attention to REV-OPOLY. Section B focuses on the learning aspects of using REV-OPOLY versus traditional learning methods. It measures the relevance of REV-OPOLY and its contents. Section C focuses on the participants' confidence in using REV-OPOLY as an alternative tool for learning and understanding how it works. Finally, Section D emphasizes on how satisfaction leads to motivation to use and play REV-OPOLY again, as well as the participants' acceptance of using the game in general as part of their learning process. In addition, players also shared their comments, feedback, and suggestions that they had on REV-OPOLY for further refinement. In all sections, a five-point Likert scale is used, measured from the scale of 1 (strongly disagree) to 5 (strongly agree).

6.4 Data Collection and Sampling

This study was conducted for one semester on two groups of students consisting of 100 undergraduate students enrolled in the Computer Application in Management subject at Universiti Utara Malaysia, Malaysia. All of the students were briefed and then showed a demonstration of REV-OPOLY. Students had learnt about the emerging

technology revolution in prior lectures, so they were prepared for the study. They were then divided into groups of at least four players each via Webex breakout sessions to play REV-OPOLY. This is done to allow students who had Internet connection and bandwidth limitations, as well as unsupported devices, to participate in REV-OPOLY. Players in groups of more than four were partnered accordingly. For example, a group of six players is paired to form and use only three player pieces. Each pair can take turns and discuss among themselves before deciding on their moves.

Table 6.1. Demographic distribution

Profile Factors	**Particulars**	***N***	***P***
Gender	Female	36	70.58
	Male	15	29.41
Age	Below 18	2	3.92
	19 - 20	40	78.43
	22 - 24	9	17.65
Semester	1	9	17.65
	2	39	76.47
	3	1	1.96
	4	2	3.92
Department	School of Business Management	35	68.63
	School of International Studies	7	13.73
	School of Technology Management & Logistics	6	11.77
	School of Government	2	3.92
	Islamic Business School	1	1.96

N number of respondents, *P* percentage of respondents (%)

Their interactions when playing REV-OPOLY were observed and recorded to be analyzed and reflected. Students were asked to complete a questionnaire after the game had ended. In total, 52 questionnaires were filled by respondents but only 51 (51%) questionnaires were valid because 1 participant responded twice due to the Internet problem. The latest response was recorded. The demographic distribution was tabulated in **Table 6.1**.

From the 51 respondents, 36 (70.58%) were female and 15 (29.41%) were male. 2 (3.92%) respondents were aged below 18, 40 (78.43%) respondents were between the ages of 19 and 20, and 9 (17.65%) were between the ages of 22 and 24 years old. Furthermore, the Computer Application in Management course is an optional that students from all semesters can take. In this study, 9 (17.65%) students were from the first semester, 39 (76.47%) students from the second semester, 1 (1.96%) from the third semester, and 2 (3.92%) were from the fourth semester. The students came from a variety of disciplines of study, with 35 (68.63%) studying Bachelor in Business Administration, Bachelor in Entrepreneurship, Bachelor in Human Resource Management, and Bachelor in Marketing at the School of Business Management. 7 (13.73%) students from School of International Studies doing Bachelor in International Business Management, 6 (11.77%) from School of Technology Management & Logistic, Bachelor in Logistic & Transportation Business Administration, 2 (3.92%) from School of Government, Bachelor of Public Management and 1 (1.96%) from Islamic Business School, Bachelor in Islamic Finance and Banking. This shows that the respondents did not come from technological related backgrounds based on their field of study. However, their range of age and semesters indicated their familiarity and adaptability to use game-based AR as part of their learning process (Clement, 2021).

6.5 Result and Discussion

The questionnaire contains 12-item RIMMS of the ARCS model and was analyzed and discussed separately into four dimensions; attention, relevance, confidence, and satisfaction.

6.5.1 Scale Reliability

The validity of RIMMS was measured using Cronbach's alpha, a coefficient of reliability. Cronbach's alpha was used to examine the reliability of the Likert scale RIMMS by measuring the internal consistency of the items in the dimensions as well as the overall value of the ARCS model. A validation study by Cook et al. (2009) reported that Cronbach's alpha for all ARCS dimensions is valid for $\alpha \geq 0.75$, with an interdimensional correlation of 0.40-0.80. Becerra & Almendra (2020), Linser & Kurtz (2018), Nel & Nel (2019), and Wang et al. (2020) in their studies have reported the acceptable reliability values of Cronbach's alpha for the dimensions are: attention α is 0.73-0.90, relevance α is 0.69-0.82, confidence α is 0.59-0.89 and satisfaction α is 0.82-0.88.

Table 6.2. RIMMS reliability

Dimension	**α**	$\bar{x}$	***s***
Attention	0.8191	4.47	0.65
Relevance	0.8904	4.44	0.67
Confidence	0.9285	4.54	0.61
Satisfaction	0.8533	4.48	0.68

α Cronbach alpha, $\bar{x}$ sample mean, *s* sample standard deviation

In this study, the overall reliability of Cronbach's alpha α was 0.9501 (n = 51 and 12 items). This coefficient was assumed as high reliability as each dimension also showed reliability values of α in the range of 0.82-0.93 which was in the scales larger than 0.75

(Cook et al., 2009) as shown in **Table 6.2**. The relevance and confidence dimensions were higher reliability ($\alpha = 0.89$ and $\alpha = 0.93$) compared to attention and satisfaction dimensions.

The mean values were calculated for each dimension of the ARCS model which showed the value of $\bar{x}$ of 4.44 to 4.54 with the standard deviation between 0.61-0.68, which was acceptable. This shows that the data were slightly more spread out in terms of the respondents' measured Likert scale in each dimension. The items in each dimension will be analyzed in the next section.

6.5.2 REV-OPOLY Features: Attention

The 3-item in attention dimension of the ARCS model is as shown in **Table 6.3**. In this dimension, the students' attention to REV-OPOLY was measured to understand the factors that contributed to their ability to focus and stimulate their interest and curiosity to learn.

Table 6.3. Attention dimension

Attention	**Scale *P(N)***					$\bar{x}$	***s***
	5	**4**	**3**	**2**	**1**		
The quality of REV-OPOLY helped to hold my attention	47.06 (24)	35.29 (18)	17.65 (9)	0.00 (0)	0.00 (0)	4.29	0.76
The way the information is arranged on REV-OPOLY helped keep my attention	49.02 (25)	45.10 (23)	5.88 (3)	0.00 (0)	0.00 (0)	4.43	0.61
The variety of 3D and 2D images, texts, audios, and videos, helped keep my attention on REV-OPOLY	70.59 (36)	27.45 (14)	1.96 (1)	0.00 (0)	0.00 (0)	4.69	0.51

P percentage of respondents (%), *N* number of respondents, $\bar{x}$ sample mean, *s* sample standard deviation

In terms of the features of REV-OPOLY, 36 (70.59%) of the respondents strongly agreed that augmenting the objects in REV-OPOLY as 3D and 2D images, texts, audios, and videos, helped them to focus better. This is because using various types of multimedia to relay information allows students to better retain information based on their learning styles, such as visual or spatial learners (through images), kinesthetic, interpersonal, and linguistic learners (through gameplay and the use of cards), and auditory learners (through audios and videos). It can also be seen that this item received the lowest standard deviation of 0.51 which supported their acceptance of REV-OPOLY features.

In addition, REV-OPOLY attracted students' interest to learn through a game that was tailored to their learning style where 24 (47.06%) respondents strongly agreed for the quality and 25 respondents (49.02%) strongly agreed in the helpfulness of REV-OPOLY. 9 (17.65%) respondents were neutral on the quality and 3 (5.88%) in the way that the information was arranged in REV-OPOLY. Further feedback from the respondents, it was suggested that perhaps REV-OPOLY can be a serious game instead of a gamification type of learning where it falls into the formal learning strategy. However, one of the main purposes of REV-OPOLY is to serve as an alternative tool in an informal setting, as an addition to the lectures to provide a more holistic learning experience.

6.5.3 Learning Aspects: Relevance

The relevance of the materials used in REV-OPOLY was measured to ensure that students could relate the knowledge gained through REV-OPOLY to the previous

lectures on the same topic of the emerging technology revolution. **Table 6.4** shows the 3-item on the relevance dimension. 27 (52.94%) of the respondents strongly agreed that the content in REV-OPOLY, which was presented as images, texts, audios, and videos, was related to what they had previously learned. This shows that REV-OPOLY was successful in providing respondents an alternative revision tool, as more than half of the respondents strongly agreed (32, 62.75%) with the statement.

Table 6.4. Relevance dimension

Relevance	**Scale *P(N)***					$\bar{x}$	***s***
	5	**4**	**3**	**2**	**1**		
It is clear to me how the content of REV-OPOLY is related to things I already know	52.94 (27)	39.22 (20)	7.84 (4)	0.00 (0)	0.00 (0)	4.45	0.64
The content and style of REV-OPOLY convey the impression that being able to work with the game is worth it	45.10 (23)	41.18 (21)	13.73 (7)	0.00 (0)	0.00 (0)	4.31	0.71
The content of REV-OPOLY will be useful to me	62.75 (32)	29.41 (15)	7.84 (4)	0.00 (0)	0.00 (0)	4.55	0.64

Majority of the respondents strongly agreed and agreed that REV-OPOLY made a good impression on them in terms of its value in their learning (23, 45.10% and 21, 41.18%). However, seven (13.73%) respondents answered neutral, thus giving this item a higher standard deviation value of 0.71. Based on their feedback, some respondents were unable to view the augmented videos as it was not supported by their devices. REV-OPOLY will add lightweight images or texts as alternatives to overcome this problem and accommodate students' limitations on their devices or the internet. As a result, they can utilize and play REV-OPOLY as intended across a variety of media.

6.5.4 Learning Tool: Confidence

REV-OPOLY is a custom-built game for the emerging technology revolution topic in the Computer Application in Management course. Students' confidence level in using REV-OPOLY and completing the game were assessed in the confidence dimension (**Table 6.5**). 31 (60.78%) of the respondents were confident that they could learn to work with REV-OPOLY and finish the game. Respondents were shown how to play the game before they started playing, so they knew what to expect. In addition, they were given access to an e-book instruction and video on the REV-OPOLY website that explained the recommended way to play the game.

Table 6.5. Confidence dimension

Confidence	**Scale *P(N)***					$\bar{x}$	***s***
	5	**4**	**3**	**2**	**1**		
As I worked with REV-OPOLY, I was confident that I could learn how to work well with it	60.78 (31)	37.25 (19)	1.96 (1)	0.00 (0)	0.00 (0)	4.59	0.54
After working with REV-OPOLY for a while, I was confident that I would be able to complete the game	60.78 (31)	33.33 (17)	5.88 (3)	0.00 (0)	0.00 (0)	4.55	0.61
The good organization of the content helped me be confident that I would learn the emerging technology revolution from REV-OPOLY	56.86 (29)	33.33 (17)	9.80 (5)	0.00 (0)	0.00 (0)	4.47	0.67

29 respondents (56.86 %) highly agreed that the organization of the board and cards that contained the content and augmented reality elements helped them feel confidence in studying the topic through REV-OPOLY. Images on the board and cards served as AR markers that could be scanned to display information that they were expected to know and that had been presented during lectures, in order to improve students'

confidence and nurture their curiosity about the topic. Thus, it is expected that after playing the game, students would have a better understanding of the emerging technology revolution due to these features of REV-OPOLY.

6.5.5 Students' Motivation: Satisfaction

Students' satisfaction in terms of their enjoyment, accomplishment, and contentment in using REV-OPOLY were also measured. In the first three dimensions (attention, relevance, and confidence), the majority of respondents showed high motivation in learning with REV-OPOLY. Understanding students' satisfaction with REV-OPOLY is critical in order to continue utilizing REV-OPOLY. **Table 6.6** shows that 33 respondents (64.71%) strongly agreed, and 32 (62.75%) respondents agreed that they enjoyed using REV-OPOLY and considered the game was well-designed. 25 respondents (49.02%) and 20 respondents (39.22%) strongly agreed and agreed that they felt stimulated to keep on playing the game. In the study, students were given 30 minutes to play, however the time was not enough. Therefore, an additional 5 minutes were given to them. This indicates that they were engaged and focused on the game. Furthermore, because REV-OPOLY is an online game, students can play it at any time.

Table 6.6. Satisfaction dimension

Satisfaction	**Scale *P(N)***					$\bar{x}$	***s***
	5	**4**	**3**	**2**	**1**		
I enjoyed working with REV-OPOLY so much that I was stimulated to keep on working	49.02 (25)	39.22 (20)	11.76 (6)	0.00 (0)	0.00 (0)	4.37	0.69
I really enjoyed working with REV-OPOLY	64.71 (33)	23.53 (12)	11.76 (6)	0.00 (0)	0.00 (0)	4.53	0.70
It was a pleasure to work with such well-designed game	62.75 (32)	29.41 (15)	7.84 (4)	0.00 (0)	0.00 (0)	4.55	0.64

Based on the RIMMS analysis, it can be determined that REV-OPOLY has met its primary goal of providing a tool for students to learn about the emerging technology revolution in a more casual and informal setting. The tool can also be utilized as part of a lecture activity, and it is available at all times. The students demonstrated an interest in REV-OPOLY, the augmented reality board game, and the majority of them were satisfied with and appreciated the learning experience.

6.6 Conclusion

This paper evaluated REV-OPOLY, an online board game with augmented reality that was proposed and implemented as an instructional medium in the emerging technology revolution area in an online environment. REV-OPOLY can be accessed through a web browser on any device with an Internet connection. REV-OPOLY was tested by 100 undergraduate students enrolled in the Computer Application in Management course in Universiti Utara Malaysia. The impact of using REV-OPOLY on students' learning motivation was measured using RIMMS from students' scores on the ARCS model's dimensions of attention, relevance, confidence, and satisfaction.

According to the findings, REV-OPOLY had a positive impact on students' motivation (92.16 %), as well as assisting and improving their comprehension level through the AR features (98.04 %) and raising their confidence and self-efficacy (90.19 %) due to the game setting compared to the rigid, traditional lectures. The results of the RIMMS proved that students were satisfied with REV-OPOLY and enjoyed playing it as an alternative and additional tool for learning and revising the emerging technology revolution topic at their own pace in the game setting.

CHAPTER 7

CONCLUSION

Advances in digital technology have opened up a plethora of options for incorporating various sorts of technologies into the teaching and learning process in higher education. Augmented reality (AR) is a technology that is increasingly being used in education for interactive lessons that combine virtual and real environments.

This research proposed REV-OPOLY, an interactive board game with AR in the area of the emerging technology revolution, which is a part of the STID1103 Computer Application in Management curriculum offered in UUM. As an alternative to traditional learning methods, REV-OPOLY provides students with a new learning experience. By utilizing the informal nature of games as a medium for learning while playing, REV-OPOLY supports students in maintaining attention while enjoying the learning process by mixing virtual and real settings through a variety of forms of multimedia; 3D and 2D graphics, texts, audios, and videos. By experiencing this, students can enjoy a new method of learning through the web-based augmented reality board game.

The performance of REV-OPOLY was investigated and analyzed in terms of the perception towards REV-OPOLY, comprehension level through assessments on the effectiveness of REV-OPOLY, and the impact and efficacy of REV-OPOLY concerning the learning motivation.

The findings indicated that the majority of students were interested in and satisfied with the use of REV-OPOLY for educational purposes. They agreed that using the game as an informal learning medium would help them learn more effectively. There were significant improvements in students' scores in all tests prior to use REV-OPOLY, indicating that students successfully made explicit references to prior learning by applying knowledge into the game and converting the knowledge gained into formal learning. In addition, based on the students' scores on the attention, relevance, confidence, and satisfaction dimensions in the ARCS model, it was demonstrated that REV-OPOLY has a positive impact on students' motivation.

It can be concluded that in this research, REV-OPOLY has been shown to have It can be concluded that in this research, REV-OPOLY received positive feedback from students in all aspects. The students showed improvement at each assessment as they had a better understanding of the topic. Thus, REV-OPOLY, a board game with augmented reality intervention, can improve students' learning, provide valuable social skills, and motivation that can be applied to any program, field, or discipline in higher education.

LIST OF PUBLICATIONS

Nordin, N., Nordin, N. R. M., & Omar, W. (2021). The Efficacy of REV-OPOLY Augmented Reality Board Game in Higher Education. International Journal of Emerging Technologies in Learning (iJET). (revision submitted).

Nordin, N., Nordin, N. R. M., & Omar, W. (2021). REV-OPOLY: A Preliminary Study on Educational Board Game with Web-based Augmented Reality. Asian Journal of University Education (AJUE). (submitted).

Nordin, N., Nordin, N. R. M., & Omar, W. (2021). REV-OPOLY: An insight into Augmented Reality Board Game in Higher Education. Knowledge Management International Conference (KMICe). (submitted).

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LIST OF AWARDS

- **Gold Award** - REV-OPOLY: Interactive Board Game with Mobile Augmented Reality. International University Carnival on E-Learning (IUCEL) 2021.

- **Gold Prize Winner** - REV-OPOLY: Emerging Technology Revolution Augmented Reality Board Game. Sintok International Games & Gamification (SIGG) 2021.

- **Bronze Medalist** - REV-OPOLY: An Immersive Augmented Reality Board Game Experience. Innovative Research, Invention and Application Exhibition (I-RIA) 2021.

- **Bronze Medalist** - ETR-AR: Augmented Reality Intervention in a Web-based Card Game of the Emerging Technology Revolution Concepts, Innovative Research. Invention and Application Exhibition (I-RIA) 2021.

- **Silver Medalist** - Hello Snake: An Online Game-based Approach in Learning Java Programming Language. Innovative Research, Invention and Application Exhibition (I-RIA) 2021.

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APPENDICES

Appendix A Preliminary Questionnaire

Appendix B Pre-Test and Post-Test

Appendix C Students Learning Motivation Questionnaire

Appendix A Preliminary Questionnaire

REV-OPOLY: Preliminary Study Questionnaire

*Required

SECTION A: DEMOGRAPHIC

1. Gender *

   Mark only one oval.

   - ◯ Female
   - ◯ Male

2. Age *

   _____

3. Semester *

   _____

4. School *

   _____

SECTION B: BOARD GAME EXPERIENCE

5. How often do you play board games in a week? *

Mark only one oval.

- 1 - 2 times
- 3 - 4 times
- 5+
- Never
- Rarely (a few times a month)
- Rarely (a few times a year)

6. Where do you play board games at? *

Tick all that apply.

- Online
- Mobile app
- Buying the physical board game
- I don't play board game
- Other: _____

7. If you answered ONLINE, any website link where you play the board game?

_____

8. Who do you often play board games with? *

Tick all that apply.

- Family
- Friends
- Alone
- I don't play board game
- Other: _____

9. What is your favourite board game? Why? *

10. What is the ideal amount of time you would like to spend while playing a board game? *

Mark only one oval.

- ◯ 10 - 20 minutes
- ◯ 30 - 40 minutes
- ◯ Around 1 hour
- ◯ More than 1 hour
- ◯ Other: _____

11. Which genre of board game would you most likely play? *

Tick all that apply.

- ☐ Competitive board games (example: Monopoly, LIFE, Risk)
- ☐ Educational board games (example: Scrabble, trivial pursuit, Operation)
- ☐ Simple board games (example: snakes and ladders, draughts, aeroplane chess/Ludo)
- Other: ☐ _____

12. Have you ever downloaded any learning game apps? Or bought educational board game? *

Mark only one oval.

- ◯ Yes
- ◯ No

13. Are you interested in using a board game as a learning approach? For example, a board game themed around Chapter 9: Emerging Technology Revolution? *

Mark only one oval.

- ◯ Yes
- ◯ No

14. Do you think that learning while playing games (or board game) is effective for you? Why? *

SECTION C: BOARD GAME FEATURES AND DESIGN

15. Do you like playing Monopoly board game? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Never played it

16. Have you played Monopoly board game and/or online Monopoly? *

Mark only one oval.

- ◯ Board game
- ◯ Online
- ◯ Both
- ◯ Never

17. Have you played any Augmented Reality (AR) game before? (for example, Pokemon Go) *

Mark only one oval.

- ◯ Yes
- ◯ No

18. If you've answered YES, what devices do you use to play AR game? (otherwise, select None) *

Tick all that apply.

- [ ] Desktop
- [ ] Laptop
- [ ] Smartphone
- [ ] Tablet
- [ ] None
- [ ] Other: _____

19. What AR games have you played? (or write none) *

_____

20. What do you think about Monopoly with AR? *

_____

21. Rate the importance of learning game features below *

Mark only one oval per row.

	Very important	Important	Neutral	Slightly important	Not at all important
Fun gameplay	◯	◯	◯	◯	◯
Revision section (short notes / slides)	◯	◯	◯	◯	◯
Game tutorial	◯	◯	◯	◯	◯
Reward system (high score or marks)	◯	◯	◯	◯	◯
Connect to friends / Allow discussions	◯	◯	◯	◯	◯

SECTION D: REV-OPOLY IMPRESSION

Please watch this short video on REV-OPOLY

http://youtube.com/watch?v=S9dT2YzhrhY

22. Rate your impression of REV-OPOLY *

Mark only one oval.

	1	2	3	4	5	
Very poor	◯	◯	◯	◯	◯	Very good

23. REV-OPOLY and the cards with AR can help me have better experience during learning *

Mark only one oval.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

24. Are you interested in using REV-OPOLY as a learning approach? *

Mark only one oval.

- ◯ Yes
- ◯ No

25. Why do you want to use REV-OPOLY as your learning approach? *

Mark only one oval per row.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Fun and attractive					
New experience					
Improve effectiveness / Easy to learn					
Can play with friends					
To avoid reading slides or books					
To share knowledge / discuss with friends while playing					

26. Do you think that students can learn something from this game? Briefly explain why *

27. Do you have other comments or suggestions to share? *

Appendix B Pre-Test and Post-Test


You can preview this quiz, but if this were a real attempt, you would be blocked because:

This quiz is not currently available

Question 1 Not yet answered Marked out of 1.00

Which of these is an example of the invention from the Industrial Revolution 3.0.?

Select one:

- A. Software systems
- B. Cloud technology
- C. Spinning jenny
- D. Combustion engine

Question 2 Not yet answered Marked out of 1.00

Which of these is an example of additive manufacturing?

Select one:

- A. Autonomous robot
- B. Online software
- C. Smart assistance
- D. 3D printing

Question 3 Not yet answered Marked out of 1.00

Which of these is **NOT** the benefit of IoT in smart city?

Select one:

- A. Able to implement smart parking system in the city
- B. Able to use smart traffic control in the city
- C. Able to control individual smart devices within the city
- D. Able to have smart air quality control of the city

Question 4 Not yet answered Marked out of 1.00

What is the use of smart grid?

Select one:

- A. To control the changes in electricity usage and issues
- B. To remotely control connected home appliances
- C. To virtually control and monitor field operations
- D. To automate the connected machinery

Question 5 Not yet answered Marked out of 1.00

Why do you think it is important to use simulation?

Select one:

- A. It allows different scenarios to be experimented
- B. It can analyze massive data
- C. It allows prototype to be created easily
- D. It creates unique blend of digital and physical worlds

Question 6 Not yet answered Marked out of 1.00

Why is the Industrial Revolution 4.0 invention an important development?

Select one:

- A. Computers can automate the entire production process
- B. Interconnected machines can be monitored virtually
- C. Steam engines increase productivity and scale in goods mass production
- D. Electrical machines are more efficient in cost, effort and maintenance

Question 7 Not yet answered Marked out of 1.00

What does it mean by Industrial Revolution 1.0?

Select one:

- A. Transition from manual to machine production
- B. Development of electrical machines
- C. Expansion of computer and microprocessor
- D. Expansion to allow automated communication amongst machines

Question 8 Not yet answered Marked out of 1.00

Which of these are the challenges of IoT in health care?

I. Privacy

II. Security

III. Data accuracy

IV. Device configuration

Select one:

- A. I, III, IV
- B. I, II, III, IV
- C. I, II, III
- D. I, II

Question 9 Not yet answered Marked out of 1.00

What is the purpose of system integration?

Select one:

- A. To access the system over the Internet
- B. To link different systems to act as a single system
- C. To join process that builds the system parts layer by layer
- D. To overlay virtual objects to the real-life environment

Question 10 Not yet answered Marked out of 1.00

What does it mean by smart wearable?

Select one:

- A. Connected machinery that can self-optimized
- B. Connected devices to address urban issues
- C. Connected devices to automate home appliances
- D. Connected portable devices that can be worn on the body

Question 11 Not yet answered Marked out of 1.00

What led to the Industrial Revolution 2.0?

Select one:

- A. Use of electrical machines improves the efficiency
- B. Advances in technological components
- C. Advances in transistors and integrated circuits
- D. Use of steam engines to serve higher demands

Question 12 Not yet answered Marked out of 1.00

Which of these is an example of the type of industry affected by of the Industrial Revolution 1.0?

Select one:

- A. Telegraph industry
- B. Telecommunications industry
- C. Automotive industry
- D. Textile industry

Question 13 Not yet answered Marked out of 1.00

What is the use of cloud computing?

Select one:

- A. To examine a large volume of data
- B. To automate tasks without human intervention
- C. To imitate processes performed on a computer
- D. To access data and programs over the Internet

Question 14 Not yet answered Marked out of 1.00

What is the challenge of big data?

Select one:

- A. Connected devices issues
- B. Insufficient data volume
- C. Data quality issues
- D. Inadequate autonomous devices

Question 15 Not yet answered Marked out of 1.00

Which of these is an example of IoT in agriculture?

Select one:

- A. Smart climate monitoring
- B. Smart payment system
- C. Smart washing machine
- D. Fitness tracker

You can preview this quiz, but if this were a real attempt, you would be blocked because:

This quiz is not currently available

Question 1 Not yet answered Marked out of 1.00

Why is the Industrial Revolution 4.0 invention an important development?

Select one:

- A. Electrical machines are more efficient in cost, effort and maintenance
- B. Interconnected machines can be monitored virtually
- C. Computers can automate the entire production process
- D. Steam engines increase productivity and scale in goods mass production

Question 2 Not yet answered Marked out of 1.00

Which of these is an example of additive manufacturing?

Select one:

- A. Autonomous robot
- B. Online software
- C. 3D printing
- D. Smart assistance

Question 3 Not yet answered Marked out of 1.00

Which of these are the challenges of IoT in health care?

I. Privacy

II. Security

III. Data accuracy

IV. Device configuration

Select one:

- A. I, III, IV
- B. I, II, III, IV
- C. I, II, III
- D. I, II

Question 4 Not yet answered Marked out of 1.00

What is the use of cloud computing?

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- C. To access data and programs over the Internet
- D. To automate tasks without human intervention

Question 5 Not yet answered Marked out of 1.00

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- A. It allows different scenarios to be experimented
- B. It allows prototype to be created easily
- C. It creates unique blend of digital and physical worlds
- D. It can analyze massive data

Question 6 Not yet answered Marked out of 1.00

Which of these is NOT the benefit of IoT in smart city?

Select one:

- A. Able to control individual smart devices within the city
- B. Able to have smart air quality control of the city
- C. Able to implement smart parking system in the city
- D. Able to use smart traffic control in the city

Question 7 Not yet answered Marked out of 1.00

What does it mean by smart wearable?

Select one:

- A. Connected devices to address urban issues
- B. Connected devices to automate home appliances
- C. Connected portable devices that can be worn on the body
- D. Connected machinery that can self-optimized

Question 8 Not yet answered Marked out of 1.00

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Select one:

- A. Smart climate monitoring
- B. Fitness tracker
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- D. Smart payment system

Question 9 Not yet answered Marked out of 1.00

What is the purpose of system integration?

Select one:

- A. To overlay virtual objects to the real-life environment
- B. To link different systems to act as a single system
- C. To join process that builds the system parts layer by layer
- D. To access the system over the Internet

Question 10

Not yet answered Marked out of 1.00

Which of these is an example of the invention from the Industrial Revolution 3.0.?

Select one:

- A. Cloud technology
- B. Combustion engine
- C. Software systems
- D. Spinning jenny

Question 11

Not yet answered Marked out of 1.00

What is the use of smart grid?

Select one:

- A. To automate the connected machinery
- B. To remotely control connected home appliances
- C. To virtually control and monitor field operations
- D. To control the changes in electricity usage and issues

Question 12

Not yet answered Marked out of 1.00

What is the challenge of big data?

Select one:

- A. Connected devices issues
- B. Insufficient data volume
- C. Inadequate autonomous devices
- D. Data quality issues

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What does it mean by Industrial Revolution 1.0?

Select one:

- A. Expansion to allow automated communication amongst machines
- B. Transition from manual to machine production
- C. Development of electrical machines
- D. Expansion of computer and microprocessor

Question 14 Not yet answered Marked out of 1.00

Which of these is an example of the type of industry affected by of the Industrial Revolution 1.0?

Select one:

- A. Textile industry
- B. Telecommunications industry
- C. Telegraph industry
- D. Automotive industry

Question 15 Not yet answered Marked out of 1.00

What led to the Industrial Revolution 2.0?

Select one:

- A. Use of electrical machines improves the efficiency
- B. Advances in transistors and integrated circuits
- C. Advances in technological components
- D. Use of steam engines to serve higher demands

Appendix C Students Learning Motivation Questionnaire

REV-OPOLY QUESTIONNAIRES

*Required

1. Name *

2. Matric No *

3. Age *

Mark only one oval.

- 18 and below
- 19-21
- 22-24
- 25-27
- 28-30
- 31 and above

4. Gender *

Mark only one oval.

- Female
- Male

5. Semester *

Mark only one oval.

- 1
- 2
- 3
- 4
- 5
- 6
- Other: _____

6. School *

Mark only one oval.

- School of Business Management (SBM)
- School of Technology Management & Logistics (STML)
- School of International Studies (SOIS)
- School of Government (SOG)
- Islamic Business School (IBS)
- School of Multimedia Technology & Communication (SMMTC)
- Other: _____

Section A : Features

Please choose the appropriate response for each item.
(1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree or 5 - Strongly Agree)

REV-OPOLY Overview Video

http://youtube.com/watch?v=bdPJ0QBJUFY

7. I like the layout and colours in REV-OPOLY because they are attractive. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

8. I like the audio, video, image in 2D and 3D effects in REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. I can easily learn to play REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. I think REV-OPOLY is simple to use. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

11. I can effortlessly understand REV-OPOLY's instructions. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. I think REV-OPOLY is eye-catching. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section B : Learning

Please choose the appropriate response for each item.
(1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree or 5 - Strongly Agree)

13. I can study emerging technology revolution concepts while playing REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

14. I can understand the concepts of the emerging technology revolution much better when playing REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

15. I am more focused when learning with REV-OPOLY compared to the traditional method. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. I can learn with other players while playing REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

17. I like that I can discuss the concepts with other players while playing REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

18. I am confident that I will pass a test, after using REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section C: Satisfaction

Please choose the appropriate response for each item.
(1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree or 5 - Strongly Agree)

19. I have so much fun learning about emerging technology revolution concepts while using REV-OPOLY that I would like to learn more about it. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

20. I enjoy learning with REV-OPOLY because it is engaging. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

21. I am pleased to play such a well-designed game. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

22. I believe REV-OPOLY creates a fun and lively learning environment. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

23. I am confident in playing REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

24. I would recommend REV-OPOLY to others. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Section D: Motivation

Please choose the appropriate response for each item. (1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree or 5 - Strongly Agree)

25. I am motivated to learn about emerging technology revolution concepts when using REV-OPOLY. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

26. I feel that REV-OPOLY makes me want to know more about the emerging technology revolution concepts. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

27. I would like to use board games as one of the learning tools in other courses. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

28. I would play REV-OPOLY with my friends again. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

29. I think it is important for me to get all the answers correct. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

30. I feel good when I successfully complete the game. *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

31. Comment / feedback *