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# The Learning Effectiveness of IoT-enhanced Historical Role-Play Educational Game < Unveil Dutch Times >

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## Abstract

This research aims to develop an Internet of Things (IoT)-based large-scale board game to enhance elementary school students' history learning. The game <Unveil Dutch Times> integrates role-playing, scenario design, and Internet of Things (IoT), and emphasizes player interaction and immersion to enhance learning with GNS theory. The game uses the historical background of the Dutch colonial period in Taiwan as the teaching content, and places students in scenarios based on real historical events, so that they can explore and solve historical problems from the perspectives of different characters, thus enhancing their understanding of and emotional connection to the historical events. The pre-test and post-test analyses of a class of 22 sixth-grade students showed that the students' understanding of history increased significantly after participating in the game. The students' overall response to the game experience was positive, and they found the game process interesting and educational. This research established that the integration of Internet of Things (IoT) technology and role-playing board games can enhance students' sense of historical identity, enable learners to understand and empathize with various perspectives, emotions, and experiences of people in the past, and promote historical thinking and respect for diversity, thereby improving the effectiveness of history learning. This research provides a framework for teaching and learning that can be generalized to other history contents and curricula. This learning approach not only deepens students' understanding of history, but also stimulates their interests and engagement in learning.

*Keywords:* Learning Effectiveness, Internet of Things (IoT), GNS Theory, Role-play game

## 1 Introduction

Nowadays, history education is often presented in traditional ways, such as listening to teachers telling stories or watching movies. Although these methods can deliver the basic information of historical events, they often lack interactivity and participation. Students are often passive receivers of knowledge, which makes it difficult for them to build up a real emotional connection and in-depth understanding to the historical events. This one-way approach to teaching may keep students from making connections with events, and ultimately reducing their interests and participation in history, thus affecting their learning effectiveness. Therefore, a sense of historical identity is essential for students, enabling learners to understand and relate to the

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perspectives, emotions and experiences of people in the past [1]. It enhances learners' understanding of and empathy with history while promoting historical thinking and respect for diversity [2].

Many researchers have attempted to utilize game-based learning to enhance the effectiveness of history learning [3][4], and it has been proven to be more effective than traditional education. However, in order to enhance the learners' sense of historical identity and put them in the shoes of historical characters, it is necessary to incorporate scenarios into the games and allow learners to take on the role of characters in the past [5][6][7]. In addition, incorporating technology to assist learners to immerse themselves more deeply into their roles can be even more effective [8].

Incorporating technological elements into games, such as IoT, can enhance the immersion and interactivity of the game, which further enhances the educational effectiveness [9]. However, the integration of IoT systems into educational games needs to be carefully designed to prevent learners from focusing only on technology and neglecting to learn [10]. At the same time, if the design of IoT systems is too complex, it may reduce learners' engagement and willingness to learn [11]. Therefore, incorporating IoT systems into games requires special attention to these aspects.

Few research studies have focused on integrating IoT into the history curriculum for young learners. The purpose of this research is to develop an IoT-based large-scale board game that can enhance the effectiveness of history learning for elementary school students. Through the features of IoT, the game <Unveil Dutch Times> aims to enhance students' immersion and interactivity, and is expected to enable students to become more engaged in the classroom and improve their learning outcomes through interactive learning with their peers.

This research investigates the effectiveness of history learning by integrating role-playing, scenario design, and IoT technologies by enhancing the interactivity and immersion of the game. <Unveil Dutch Times> aimis to provide an effective framework for history education board games to promote students' engagement and learning effectiveness in history learning.

# 2 Related Works

## 2.1 Gamism, Narrativism, Simulationism Theory (GNS Theory)

GNS theory is a model of game design that consists of three aspects: Gamism, Narrativism, and Simulationism, emphasizing role-playing that are entertaining and highly immersive [12]. Gamism is a key factor in designing engaging games, as it promotes interest in the game through competition between participants. Narrativism is used to attract players' interest through the storytelling of the background of the game, creating a compelling scenario in which the learner can be immersed in the background of the situation. Simulationism emphasizes the authenticity of the events in the game and the alignment with the real world, taking special care of the details in the game so as not to give the player the feeling of being out of the game during the process of playing. For this challenge, technology can be utilized to complement the solution.

Regarding the relationship between GNS theory and learning effectiveness, there are few studies on the impact of games designed by GNS theory on learning effectiveness that directly point out the impact of GNS theory on learning effectiveness. Current research only points out that GNS theory can affect game immersion [13], while other studies point out that immersion may have an impact on learning outcomes [14], but few study has stated that GNS can bring

positive learning effectiveness. Therefore, further research is necessary to explore the direct relationship between GNS theory and learning effectiveness in educational games.

### 2.2 The Application of IoT in Games

Internet of Things (IoT) have been featured widely in life, and nowadays the application of IoT technology has been widely used in various fields, including education [15]. In educational games, IoT applications can provide players with a richer gaming experience and enhance the interactivity and immersion of the game [16]. Increasing the interactivity and immersion of learners can also improve learners' learning effectiveness [17]. Through IoT technology, games can interact more deeply with the real world and create more vivid game scenes for players [18].

## 3 Game Design

### 3.1 Game Flow

Game design is the soul of a game, determining its core and the level of engagement for players. In educational games, game design is especially crucial as it directly impacts students' learning effectiveness and engagement. Through GNS theory integrated with IoT technology, this section explores the basic concepts of game design such as student role-playing, scenario design, game objects, and the application of IoT technology. Attempts are done to strengthen students' sense of historical identity so that students can empathize with history, and at the same time promote historical thinking and respect for diversity in learning history, thereby enhancing the effectiveness of learning.

The game <Unveil Dutch Times> is set to last for 3 rounds, with each round lasting 30 minutes, roughly equivalent to two class periods. Initially, students listen to the Game Master's (GM) explanation of the historical background story, detailing the events happening at that time. Following this, students engage in self-reflection, followed by internal group discussions and then external diplomatic discussions. During these discussions, students, based on their assigned roles, attempt to find solutions beneficial to their ethnic group to resolve historical events. They also understand the circumstances and difficulties of that time, seeking the best solutions. Once students have resolved the events, the GM reveal the actual historical outcomes, prompting students to reflect on the differences between their discussions and historical realities. Next, students execute actions such as taxation, warfare, or trade based on their discussion outcomes. After the events, students have 8 minutes to control mBots to gather gaming resources on the map, increase population, enhance military strength, secure resources, and engage in trade to prepare for the upcoming event. The flowchart of one round is as shown in Figure 1.

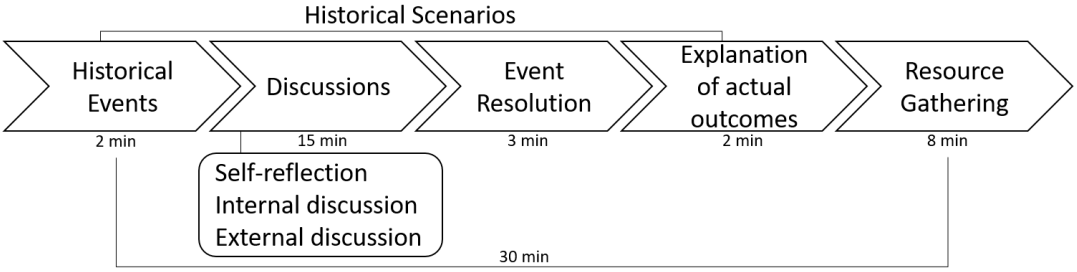


Figure 1: Flowchart of one round of the game <Unveil Dutch Times>

### 3.2 Historical Scenario and Roles

Based on historical facts, three conflicts during the Dutch colonial period are included in the game <Unveil Dutch Times>:

The Makatao Incident: Occurred in 1629, the Makatao tribe was not satisfied with the Dutch East India Company's land invasion and alliances with hostile tribes (Sinkan people) after their arrival in Taiwan. This dissatisfaction led to conflicts with the Dutch, resulting in the deaths of 63 Dutch soldiers. Which is a conflict between the Makatao and the Dutch.

Han- Indigenous Conflicts: As Taiwan's economy booms, immigrants from coastal China, primarily of Fujian descent, arrived in Taiwan for livelihood opportunities. The Han Chinese settlers brought new culture and lifestyles, leading to the gradual variety of Taiwanese society. However, the increasing population put pressure on the indigenous peoples' living space and food supply, resulting in cultural conflicts and resource competition between the indigenous peoples and the Han Chinese settlers. Which is a conflict between the Makatao, Sinkan people and Han Chinese settlers.

The Guo Huaiyi Incident: While the Dutch East India Company's extensive cultivation in Taiwan improved the local economy, it also imposed strict controls and high taxes on the local Han Chinese population. This led to growing dissatisfaction among the populace, this ultimately leads to Guo Huaiyi's Rebellion. Which is a conflict between the Han Chinese settlers and the Dutch.

Throughout these events, players from different groups need to communicate and coordinate with each other, aiming to reasonably deal with the conflicts arising from historical events. The above three events show tension between four different ethnic groups, which reflects the chaotic colonial period of Taiwan. In the game, players experience each of these three events and attempt to find a solution from the point of view of the ethnic groups respectively. All ethnic groups are directly or indirectly affected by these events, which revealed the concept that no one can remain uninvolved when living in the same world.

Students were divided into four groups in the game, each portraying several major ethnic groups in Taiwan during the Dutch colonial period: the Dutch East India Company (referred to as the Dutch), Han Chinese, Makatao people, and Sinkan people. Based on the historical senario at that time, each ethnic group have different initial conditions, each has its own strengths. Students will role-play their ethnic group and utilize their group's advantages and disadvantages to attempt reasonable solutions to historical events. The initial values for each ethnic group are as shown in Table 1.

Table 1: initial values for each ethnic group

| Ethnic | Population | Money | Deerskin | Sugarcane | Rice | Military Strength | Learning Value |
|---|---|---|---|---|---|---|---|
| Dutch | 100 | 500 | 20 | 100 | 300 | 500 | - |
| Han Chinese | 200 | 100 | 5 | 200 | 200 | 100 | - |
| Sinkan people | 500 | 200 | 10 | 300 | 400 | 100 | 30 |
| Makatao people | 300 | 300 | 15 | 500 | 500 | 200 | 0 |

The explanations for each value are as follows: (1) Population: Affects the amount of resources collected and the consumption of food. (2) Money: It is used for trading in the game, allowing transactions with other ethnic groups, and as a source of claims after wars. (3) Deerskin: It is one of the primary export goods during that period and is the highest economic commodity in this game. (4) Sugarcane: It is another primary export good during that period and is the second highest economic commodity in this game. (5) Rice: It is another primary export good, serving as a food source for the population and of equal value to sugarcane. (6) Military strength: It indicates the military power of each ethnic group. Higher military values indicates higher winning rate of battles. (7) Learning value: The Dutch colonizers invented Sinkan Script, a Romanization of the indigenous language, to spread Christianity among the local indigenous people, encouraging them to learn Sinkan Script to understand Christianity. Through these different values of each ethnic group, learners are able to realize the differences between each ethnic group during the game, which strengthens the learners' awareness of the condition of each ethnic group and their sense of historical identity, that promotes the students' historical thinking and understanding of diversity in the process of the game, thus enhancing students' learning effectiveness of history.

## 3.3 Game Objects

The game objects consist of the game map, mBot, and tablets. The game map has five RFID sensing areas and two execution areas. The RFID sensing areas include the Hunting Zone, Sugarcane Farming Zone, Rice Farming Zone, Marketplace, and Church. Each RFID sensing area has five sensor cards beneath it for PN5180 RFID chip detection. The execution zones are the Trade Execution Zone and Event Execution Zone. Game map is as shown in Figure 2.

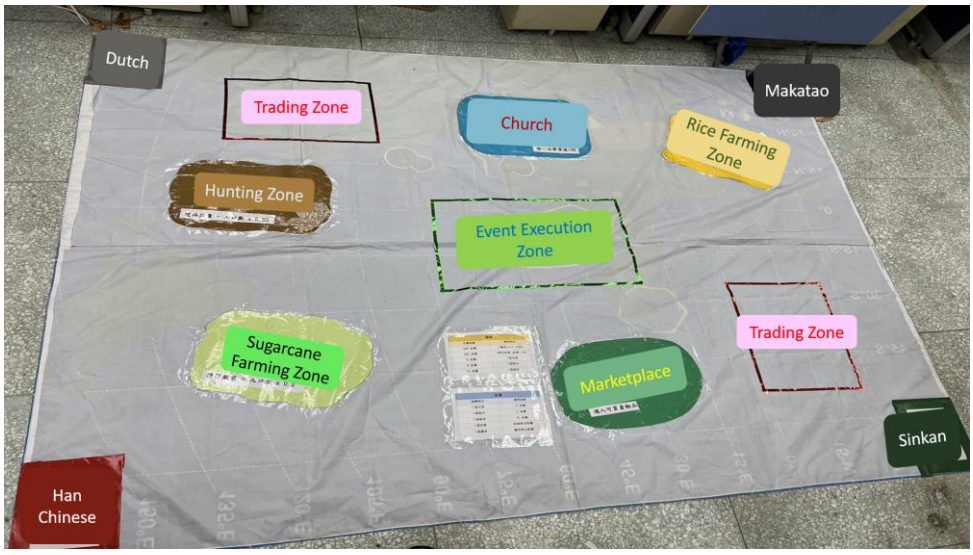


Figure 2: Game Map

For RFID sensing areas: (1) Hunting Zone: Entering this area allows players to obtain deerskin. The quantity obtained depends on the population size; the more population, the more deerskin obtained. Deerskin can be sold in the marketplace for money or used in trades with others. (2) Sugarcane Zone: Entering this area allows players to obtain sugarcane. The quantity obtained depends on the population size. (3) Rice Zone: Entering this area allows players to obtain rice.

The quantity obtained also depends on the population size. (4) Marketplace: In the marketplace, players can buy and sell items according to their needs. Players can purchase deerskin, sugarcane, or rice, as well as population size and military strength to develop their ethnicity. Players can also sell deerskin, sugarcane, and rice in the marketplace, using the money obtained to buy other items or trade with others. The marketplace is the main place for players to conduct transactions with GM, aiding in village development and strengthening power, making the game more strategic and enjoyable. (5) Church: Indigenous players entering the church will increase their learning value. The higher the learning value, the less tax they pay to the Dutch. Han Chinese and Dutch players entering the church will have no effects.

For execution areas: (1) Trading Zone: This area, marked in red outline on the map, is dedicated to player transactions. When two players want to trade, they must move their mBots to this area to initiate the transaction. (2) Event Execution Zone: The central green-bordered area on the map is the event execution zone. Its function is to execute events when they end, such as item trading or warfare. Players must move their mBots to this area to execute event resolutions.

Players use mBot robots to collect resources, trade, and engage in wars on the game map. Each mBot represents a character of different ethnicities. To enhance user interaction with the map, and enrich the game experience, IoT technology is incorporated and modified the mBots. In addition to the basic Bot components, an Esp32 control board, a PN5180 sensing chip, and a power bank is added. The Esp32 control board and PN5180 sensing chip are soldered together and installed on the bottom of the mBot as a sensing device. Whenever the mBot passes over a Sensor card on the map, it automatically displays the interactive interface of that area on the player's tablet.

### 3.4 IoT Integration

IoT technology plays a crucial role in the game, adding new dimensions and enriching players' gaming experiences. IoT is utilized to enhance both the player's engagement with the game and the relationships between players. By integrating IoT technology into the game, players can focus more on the game content and create a more immersive gaming environment. This enhances players' immersion and engagement with the game. The immersion of role-playing is enhanced through IoT technology, and the relationship between characters is skillfully designed with the difference of values between them in the game mechanism. This not only has an impact on the following events, but also enables students to experience the historical events in the game. Through IoT, students are able to engage more deeply in the game, while at the same time interaction between students is enhanced, and such interaction can lead to a better result in terms of learning outcomes.

In the game, there are many RFID sensor cards embedded in the map (Figure 3). After modification, the mBot functions as a mobile reader (Figure 4). When the mBot passes an RFID card, the corresponding interactive interface for that zone will pop up on the player's tablet (Figure 5). This eliminates the need for traditional board game mechanics where players have to physically move to interact with the GM to achieve their goals. This process may sometimes disrupt the immersion in the game's scenario. This problem is effectively addressed by the IoT system. Players can focus on the game's strategies and interactions, and can better immerse themselves in the roles they play. They can empathize with their respective ethnic groups and strive for the development of their own group.

Figure 3: Sensor cards embedded in map

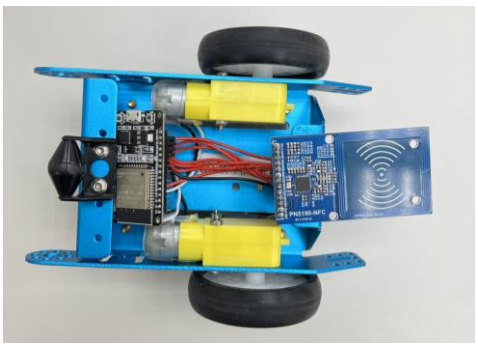

Figure 4: mBot after modification


Figure 5: Example of players' tablet screen

# 4 Research Methods

## 4.1 Research Structure

The activity in this study is conducted through a large-scale board game set in the Dutch colonial period, aiming to allow learners to role-play historical ethnic groups of that era. Through gameplay, participants can understand the historical context and develop the ability to think from different perspectives. This game is designed for participants who are upper elementary school students, therefore the experiment was conducted on a sixth grade class in an elementary school in Taiwan. Participants are divided into four groups of five to six members each, with a total of 22 participants, including 10 males and 12 females. The study used quantitative methods to analyze the learners' learning evaluation results before and after playing the game as well as their satisfaction with the game.

In this activity, students first took a quiz to determine their prior knowledge. Next students were randomly divided into 4 groups. Then, the rules of the game, the background, and the tablet use was introduced. After the explanation, the game immediately proceeded to the first historical event, and the game ended after three rounds of events. After the game, participants filled out a post-test and a questionnaire to examine their learning effectiveness. Finally, the teacher led a reflection session on the events in the game. The total length of the activity was approximately 3 hours, which was about three periods of class. The flowchart of the activity is as shown in Figure

6.


Figure 6: Activity Flowchart

### 4.2 Research Tools

In order to evaluate the learning effectiveness of the learners, pre-test and post-test were used in this study. The questions were designed according to the major events that happened in Taiwan during the Dutch colonial period. Both the pre-test and the post-test consisted of 10 multiple-choice questions each worth 10 points, with a total of 100 points. The questions corresponded to the events in the game and were divided into four categories: Event 1, Event 2, Event 3, and Historical Background. There are 3 questions each for the three events and one for historical background. The questions in the pre and post-tests are similar, but the order of the questions and options are different.

In addition to the learning effectiveness of the learners, this study aims to know whether the learners were immersed during the game. Therefore, a satisfaction questionnaire was included to investigate the learners' thoughts on gaming experience, learning experience, social interaction, and use of technology after playing the game, with five questions for each aspects. A five-point Likert-scale, with 5 strongly agree and 1 strongly disagree, and two brief survey questions on game design suggestions were used to investigate learners' perceptions.

### 4.3 Data Analysis

This study mainly focuses on quantitative methods to analyze students' learning effectiveness and satisfaction. The pre- and post-tests were conducted using a paired-sample t-test to analyze the learners' understanding of each events of the Dutch colonial period after playing the game. The satisfaction questionnaire was analyzed by calculating the average of learners' scores in different aspects such as game experience, learning experience, social interaction, and use of technology, and qualitative textual suggestions were made to reflect on the game.

## 5 Result

### 5.1 Learning Effectiveness

In order to investigate the effectiveness of role-playing, scenario design and IoT technology on students' learning outcomes, this study utilizes pre-test and post-test to analyze learners' learning outcomes after playing the game. In order to investigate the effects of different historical events in this game on learners' learning effectiveness, the evaluation results were analyzed based on the four topics: Event 1, Event 2, Event 3, and Historical Background.

Total of 22 pre-tests and post-tests from all participants were collected. Based on the results, the total mean score of the pre-test was 52.27, while the total mean score of the post-test was 79.09, which showed significant improvement (p=.000) after playing the game (Table 2). This

represents that learners can learn about history after playing this board game. The design of the game <Unveil Dutch Times> with the integration of role-playing, scenario design, and IoT technology is effective for learning historical events.

Table 2: Total Grade Paired Sample t-test

| Total Grade | N | Means | SD | t | p |
|---|---|---|---|---|---|
| Pre-test | 22 | 52.27 | 23.285 | -6.495*** | .000 |
| Post-test | 22 | 79.09 | 20.215 | | |

****p* < .001*

In order to study the effect of the same game mode but different historical contents on the learning effectiveness of the students. This section shows the analysis results of students' learning outcomes in two parts, namely learning effectiveness of the historical events and background. The learning effectiveness of Event 1, Event 2, and Event 3 were shown in Table 3. The paired t-test results show that there is a significant improvement (p=.000, p=.015, p=.023) in the learning outcomes of the students. This indicates that with the same mode of game play, learners can achieve similar learning outcomes, even with different historical content.

Table 3: Learning effectiveness of Event 1, Event 2, and Event 3

| Learning Effectiveness | N | Means | SD | t | p |
|---|---|---|---|---|---|
| Event1-Pre-test | 22 | 36.05 | 28.746 | -5.933*** | .000 |
| Event1-Post-test | 22 | 76.96 | 24.090 | | |
| Event2-Pre-test | 22 | 61.82 | 34.594 | -2.654* | .015 |
| Event2-Post-test | 22 | 91.68 | 30.514 | | |
| Event3-Pre-test | 22 | 58.82 | 32.516 | -2.295* | .032 |
| Event3-Post-test | 22 | 75.41 | 23.627 | | |

***p*<.01, **p* < .05, ****p* < .001*

The results of the paired sample t-test on the Historical Background indicates that learners were able to effectively understand the historical context of that time after playing the game (Table 4). This also proves that playing this game <Unveil Dutch Times> can be effectively enhance the learner's sense of historical identity(p=.005), as the learners understand and resonate with the perspectives, backgrounds, and experiences of people in the past, thus increasing the effectiveness of the learning outcome.

Table 4: Learning effectiveness of Historical Background

| Historical Background | N | Means | SD | t | p |
|---|---|---|---|---|---|
| Post-test | 22 | 81.82 | 39.477 | 3.130** | .005 |
| Pre-test | 22 | 50.00 | 51.177 | | |

***p* < .01*

### 5.2 Satisfaction

In order to find out whether the studentss perspecitve to the game, , a satisfaction questionnaire was included in this study to investigate the students' thoughts on the gaming experience, learning experience, social interaction, and the use of technology. The mean scores of the five questions for each aspect of the questionnaire are shown in Table 5. The results indicated that there was a high score in each aspects (mean=4.25, 4.09, 4.03, 4.10). Participants mentioned that the content of the game was interesting and they would like to have more time to play the game. Moreover, participants also mentioned that the IoT system could help them to control the information and focus on the events in the game.

Table 5: Questionnaire Survey Results (N=22)

| Aspects | Mean Score |
|---|---|
| Game Experience | 4.25 |
| Learning Experience | 4.09 |
| Social Interaction | 4.03 |
| The Use of Technology | 4.10 |

## 6 Conclusion

This study develops a large-scale educational board game that integrates role-playing, scenario design, and IoT to enhance learners' sense of historical identity, enable learners to understand and empathize with the perspectives, emotions, and experiences of people in the past, and promote historical thinking and respect for diversity, thus enhancing learners' learning effectiveness in history. The results showed that learners were able to make significant improvements in their learning of history by taking on roles while discussing and engage in historical events in a scenario-based environment. In addition, learners felt immersed and interested in the learning process. For students in the information era, IoT systems are effective in helping them to engage in learning while maintaining a passion for learning and achieving excellence. This provides a framework for a large-scale IoT educational board game for history education, which can achieve similar results if the historical content is replaced with the content from other eras to meet the needs of the curriculum.

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## References

[1] Harris, R., & Reynolds, R. (2014). The history curriculum and its personal connection to students from minority ethnic backgrounds. Journal of Curriculum Studies, 46(4), 464-486. https://www.doi.org/10.1080/00220272.2014.881925

[2] Ahmad, A. R. (2010). The acquisition of conceptual understanding of historical thinking in the context of multi ethnic students in Malaysia. Historia: Jurnal Pendidik dan Peneliti Sejarah, 11(2), 24-37. https://www.doi.org/10.17509/HISTORIA.V11I2.12326

[3] Lin, Y. Z., & Shih, J. L. (2022). Personality Matters? Learning Behavior Analysis of Complex Board Game. The 30thInternational Conference on Computers in Education (ICCE 2022), (Vol. 2, pp. 511-517).

[4] Yu, Z., Yu, W. H., Fan, X., & Wang, X. (2014). An exploration of computer game-based instruction in the "world history" class in secondary education: A comparative study in China. PLoS One, 9(5), e96865. https://doi.org/10.1371/journal.pone.0096865

[5] Chan, H. Y., Liu, S. W., & Hou, H. T. (2022). An Analysis of the Acceptance and Anxiety of a Historical Strategic Planning Game by Combining Real Person Non-player Character Mechanism. [Paper presentation]. In The 14th Asian Conference on Education (ACE2022), Japan (pp. 157-161).

[6] Covaci, A., Ghinea, G., Lin, C. H., Huang, S. H., & Shih, J. L. (2018). Multisensory games-based learning-lessons learnt from olfactory enhancement of a digital board game. Multimedia Tools and Applications, 77, 21245-21263. https://doi.org/10.1007/s11042-017-5459-2

[7] Huang, H, & Shih, J. (2022). Integrating Design Thinking into Interdisciplinary Course with STEM-based Robotic Game. American Journal of Educational Research, 10(10), 599-611. https://doi.org/10.12691/education-10-10-3

[8] Keleszade, G., Ozkul, A.E. & Güneyli, A. (2018). The effectiveness of technology-assisted history teaching based on peace training: The case of history of Cyprus. Qual Quant 52, 2469–2485 (2018). https://doi.org/10.1007/s11135-017-0657-6

[9] Petrović, L., Jezdović, I., Stojanović, D., Bogdanović, Z., & Despotović-Zrakić, M. (2017). Development of an educational game based on IoT. International journal of electrical engineering and computing, 1(1), 36-45. https://www.ijeec.org/index.php/ijeec/article/view/13/9

[10] Aldowah, H., Rehman, S. U., Ghazal, S., & Umar, I. N. (2017, September). Internet of Things in higher education: a study on future learning. In Journal of Physics: Conference Series (Vol. 892, No. 1, p. 012017). IOP Publishing. https://doi.org/10.1088/1742-6596/892/1/012017

[11] Husnanda, A., & Ikhsan, J. (2021, March). Developing Science Education Game Based on Internet of Things (IoT): Materials and Methods Overview. In 6th International Seminar on Science Education (ISSE 2020) (pp. 892-898). Atlantis Press. https://doi.org/10.2991/assehr.k.210326.128

[12] Edwards, R. (2001). GNS and other matters of role-playing theory. The Forge, 14, 1-15. http://www.indie-rpgs.com/articles/1/

[13] Shih, J. L., Jheng, S. C., & Tseng, J. J. (2015). A simulated learning environment of history games for enhancing players' cultural awareness. Interactive Learning Environments, 23(2), 191-211. https://doi.org/10.1080/10494820.2014.997249

[14] Felege, C., Romsdahl, R., Hunter, J., Hunter, C., & Ellis-Felege, S. (2019). Immersive field experiences lead to higher-level learning and translational impacts on students.

Journal of Environmental Studies and Sciences, 9, 286-296. https://doi.org/10.1007/s13412-019-00555-y

[15] Pappas, G., Siegel, J., Vogiatzakis, I. N., & Politopoulos, K. (2022). Gamification and the Internet of Things in Education. In Handbook on Intelligent Techniques in the Educational Process: Vol 1 Recent Advances and Case Studies (pp. 317-339). Cham: Springer International Publishing. https://www.doi.org/10.1007/978-3-031-04662-9_15

[16] Abdulrazic, M. O. M., Sanzana, M. R., & Ng, K. H. (2022). Integrating Internet-of-Things (IoT) into a Cultural Game Authoring Tool: An Innovative Approach in Maker Education. Engineering Proceedings, 27(1), 50. https://doi.org/10.3390/ecsa-9-13371

[17] Cheng, Y. W., Wang, Y., Yang, Y. F., Yang, Z. K., & Chen, N. S. (2020). Designing an authoring system of robots and IoT-based toys for EFL teaching and learning. Computer Assisted Language Learning, 34(1-2), 6-34. https://doi.org/10.1080/09588221.2020.1799823

[18] Pappas, G., Siegel, J., Vogiatzakis, I. N., & Politopoulos, K. (2022). Gamification and the Internet of Things in Education. In Handbook on Intelligent Techniques in the Educational Process: Vol 1 Recent Advances and Case Studies (pp. 317-339). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-04662-9_15