Implementation of Digital Games in Advancing Students’ Higher-Order Thinking Skills: A Review

Mazlina Ahmad¹, Noor Rohana Mansor¹, Roswati Abdul Rashid¹, Nurul Ain Chua¹ Rosdi Zakaria¹, Cho Min Sung²

¹University of Terengganu Malaysia  
²Hankuk Foreign Studies University  
mazlinaahmad@umt.edu.my

Abstract: The 4.0 industrial revolution transformed life remarkably. Dependence on technology is notable and influences the learning system in our country. In fact, its weight becomes more visible in the post-COVID-19 situation that strikes the world today. Online learning compels educators to be more creative in designing the learning process. One of them is to employ a digital game strategy in learning that utilises the elements of the game intending to motivate students, maximise positive feelings and engagement with the learning process. Furthermore, the application of this media can help to improve students’ higher-order thinking skills because through the digital game, students can explore innovative things as well as test their level of acceptance of the topics discussed in the lecture. Nonetheless, to what extent is the approach victorious in helping to overcome various problems in learning and able to improve students’ higher-order thinking skills? Therefore, this paper identified the implementation of digital games in learning and its implications for the advancement of higher-order thinking skills of students either at the secondary or tertiary education level. Extensive literature review methods were administered to identify and present data relevant to the current situation, especially in the learning atmosphere in this epoch of COVID-19 pandemic. In particular, this research addressed the fundamental concepts of digital games, its implementation and function in enhancing students’ higher-order thinking skills. Further, the researchers proposed that this study would contribute to educators, particularly in improving the efficiency of technology. Ergo, it would be supporting students to explore novel ideas.

Keywords: Higher-Order Thinking Skills, Digital Games, Technology and Learning

1. Introduction

Today’s learning method is seen as very permissive to allow the introduction of technology as a fresh medium in the modern world of learning. This phenomenon causes a dramatic transformation in the world of education from the conventional to the revolution of the use of technology as virtual world mediums that exist at the secondary and tertiary levels. This situation is evident when the world suffers COVID-19 pandemic, which reveals the importance of technology in the delivery of teaching and learning. Thus, it necessitates a very high commitment between students and educators. In the epoch of COVID-19 pandemic as well, there are various applications of the technology employed in learning, and inevitably, it is a must for educators to master the diversity of technological knowledge in the delivery of teaching and...
learning. Besides, in the 21st-century learning environment, it requires many skills for students to master, and one of them is the integration of information and communication technology (ICT) and higher-order thinking. The integration of these two components in learning becomes more interesting through the adoption of ICT elements such as text, audio, video, graphics, games, and animation that can grow the level of thinking in each learning phase. According to Mohd Nazri [1], there are several discoveries and technological developments involving multimedia and communication in 2016 that directly affect the daily activities of society today. These include live streaming technology, virtual and augmented reality, artificial intelligence, the internet-of-things (IoT), Big Data and App Streaming. All of these technologies also impact the learning patterns and styles of students today. The Malaysian Education Development Plan (2013-2025) outlined eleven shifts in transforming the national education system, and the 7th shift is ‘Utilising ICT to Improve the Quality of Learning in Malaysia’.

It is in line with the 21st Century ICT Literacy Model developed by the International ICT Literacy Panel in the Educational Testing Service (ETS, 2002), which states that ICT literacy assessment includes aspects of cognitive and technical skills. The cognitive skills of ICT in this model lead to the adoption of digital technology to manage information, communication tools or networks to ensure that one is prosperous and functional in society. In this model, there are several binding domains handled to measure an individual’s ICT cognitive skills. These domains refer to a person’s capacity to access, manage, integrate, evaluate and create information. This aspect should be applied in learning as early as primary level because, in addition to being able to master the control of technology, students will also be trained to apply higher order thinking through the technology afforded.

Nevertheless, the pattern of teaching and learning today is mostly still focused on educators, i.e. the practice of practice and memorisation of tips and formulas is often featured in learning [2]. This method restricts students’ capability to think because educators do not encourage students to come up with and develop their ideas. In the context of problem-solving, students are taught to memorise and remember the keywords provided in the question to find the answer. This method can only be used when solving routine problems. Students’ knowledge becomes restricted. Hence, they will encounter predicaments when involving non-routine questions that demand students to think critically and creatively as well as possess various methods in finding solutions. Furthermore, the teaching methods that are already used in learning do not promote the advancement of one’s thinking skills let alone improve creative thinking skills [3]. Critical thinking skills and creativity can be developed with the use of the technology accessible today. One of the reasons why the ICT-based curriculum is emphasised is because these features can inspire problem-solving and self-learning [4]. The technology employed should be relevant and interactive in order to promote students’ creative thinking.

According to Chew Fong Peng and Shashipriya Nadaraja [5] thinking is the basis for facilitating the growth of innovative education among students. It is evident when Unesco (2002) demonstrated the importance of ICT to drive individual competencies in terms of critical thinking, decision making, teamwork, dynamic management and assertive communication. Through the context of the interactive use of e-learning in the learning process at UA, integrated higher-order thinking intends to give students the skills to think critically and be able to generate new ideas. Students apply thoughts through understanding each lesson material that contains high-level questions, activities in e-learning that encourage thinking and problem-solving as well as learning methods that can lead to enhancing students’ reasoning.

2. Digital Games
Digital games are a source of entertainment for the past few decades and will continue to be a root of entertainment in the future [6]. Entertainment Software Association (2019) estimated that sales of digital games in 2018 exceeded the value of 43.4 billion USD. Digital games are engaged by as many as 164 million or 65% of the adult population in the United States. In Malaysia, the export value produced by
more than 60 local digital game developer studios was RM600 million [7]. These values symbolise that digital gaming is indeed in high demand and proficient of forming satisfactory income returns. Looking at the ability of digital games in attracting the interest and attention of students, educators began to exercise the initiative to blend digital games into the learning atmosphere.

Game-based learning is a form of student-centred learning that utilises digital games for educational purposes [8]. Digital games in education is a type of learning media that owns the potential to empower students to build understanding in each phase of learning. Connolly supported this view, and Stansfield [9] who defined digital games for education as “the use of computer-based game approaches intended at delivering, supporting, and enhancing teaching and learning, assessment and evaluation”. Prensky [10] defined digital game-based learning as an integration of educational content and computer games. It enabled the combination of computer and video games with different educational content to achieve better results compared to traditional learning methods. Digital games also involve the development of the mind, which requires a deeper level of thinking and provides students with a fun learning method without compromising the importance of learning concepts.

According to Huizenga [11] as well as Wong and Kamisah [12], mentioned that there is no explicit definition to describe digital game-based learning. Nevertheless, digital game-based learning is regularly defined based on several standard features. Digital game-based learning is a digital game-based learning approach [13]. All, Castellar & Van Looy [14] established digital game-based learning as the use of digital games for educational purposes, containing both entertainment and educational elements. Wiggins [15] related digital game-based learning as the use of digital games in the educational context to accomplish learning objectives.

3. Higher-Order Thinking Skills (HOTS)
According to the Global Digital Citizen Foundation (2015), HOTS is one of the 21st-century skills that students need to comprehend to them to compete in the future world. HOTS maximises the effectiveness of the mind to interpret, analyse or manipulate information to solve problems that cannot be answered through the routine application of existing knowledge [16, 17, 18]. Commonly, HOTS connects all types of general thinking such as critical thinking, creative thinking, problem-solving and decision making [19, 20]. There are also scholars such as Sternberg and Spear-Swerling [21] who dubbed critical thinking as HOTS. Some claimed that HOTS comprises of critical, reflective thinking and inquiry [22]. Whereas, the explanation of Sternberg and Spear-Swerling in a broader context referred to high-level thought processes consisting of analytical, creative and practical thinking. Nevertheless, critical thinking is accepted as one of the ingredients included in HOTS [23, 24]. According to Rajendran (2017), educators around the world considered a lot about teaching HOTS. Helping students master the skills of seeking knowledge on their own and improving HOTS is presently one of the goals of strengthening education programs. At the Institution of Higher Learning (IPT) level, as a graduate, the generation of brand-new notions needs to be stressed because the coursework assignments at IPT are more complex and challenging. Students are given various types of academic and non-academic projects that require them to solve problems creatively. Consequently, this opportunity should be appropriated by students to maximise the skills available to be applied in their assignments.

Nowadays, most students in IPT are provided with their gadgets that can be used in learning sessions. Smartphones are a very ‘intimate’ agent with the current generation, and if employed with the appropriate purpose, students will be able to explore much new information linked to their learning. Lectures are no longer bounded to listening to lectures from lecturers/educators only, but educators also need to be more creative to design novel manoeuvrings to stimulate students’ level of thinking to a higher level with the maintenance of technology. Game applications such as quizzes using Kahoot, and MyQuizz
are one of the methods that help intensify HOTS among students through problem-based learning strategies, active learning, game-based learning, and team learning.

4. The Application of Digital Games in Learning and Its Relation to Students’ Higher-Order Thinking Skills

Digital games are a modern advanced technique that employs virtual interaction experiences through computer or telephone intermediaries (human-computer interaction (HCI), psychology and digital game development to stimulate human involvement and motivation. It is because the application of digital games is competent in influencing shifts in human behaviour [25]. The realm of education also receives an impact from these digital games [26, 27, 28]. Kapp [29] explicitly stated in his book that digital game approach in education could help students improve their learning experience by stimulating various skills such as higher-order thinking skills (HOTS), 21st-century skills and problem-solving skills.

In Malaysia, a paper entitled “Digital games: A new approach in future education” was presented to discuss the benefits of game-based learning based on studies that were conducted. The conclusion from this paper is that digital games produce a positive effect and fitting to be performed in Malaysia [30]. Past studies also confirmed that the use of digital games in learning could better critical thinking and level of problem-solving skills [31, 32, 33, 34, 35], enhance creativity [36, 37] and student performance. It is because when playing digital games, players need to do analysis, synthesis and critical thinking to achieve game goals and game planning [38]. When playing, content and how to play requires new skills and knowledge that anyone who has played may never have experienced. Players need to try where there are tests and answers to problems that need to be faced and resolved, along with high determination to accomplish the goal [39]. The effort and seriousness manifested by the players to achieve the goals of the game indirectly generate the creativity and critical thinking of the players as they continuously strive with various methods to achieve what is desired. Players will give complete focus and attention while playing because almost all digital games compel players to think creatively and give full concentration while playing. It is a quintessential mechanism in the 21st century, learning that students need complex thinking in decision making [40] following the needs of higher-order thinking skills applied among students.

Study of Nurfazliah Muhamad et al. [41] discovered that one of the ways that could be used to select and analyse digital learning games is based on the model of Magic Bullet introduced by Becker [42]. Four things need to be taken into account in making a choice of games, specifically things that must be learned (things I must learn), things that can be learned (things I can learn), learning outside the game (external learning) and unexpected learning (coincidental learning). In this model, the four things asserted are as follows:

i) Things I can learn: This category is something that is deliberately designed by the game designer where the designer includes all the elements that the player can learn from the game including all domains (cognitive, psychomotor and affective) and all categories (remembering, understanding, applying, analysing, evaluating, creating). This category should not be associated with the primary goal of the game. For example, if a player does not know what is in this category, the player can still achieve that goal.

ii) Things I must learn: This category is a subset of the first category. In this category, players need to know what to learn to win or achieve the goals of the game. Usually, there is more than one method for the player to achieve the goal in a single game. It depends on the knowledge of the player himself.
Learning outside the game (external learning): This category is learning that takes place outside the game that is something obtained after playing digital games. Players can relate what happens in the game to situations outside the game.

Coincidental learning: This is a category that is included in anything triggered by the game. This item is not designed for games, but game designers hope players can relate it to other things.

His research focused on the logic game, which is the Frog Jumping Game to teach algebra to students and to explain the variety of strategies and methods that can be used in problem-solving. The results of the research determined that students use the maximum level of thinking to plan strategies to achieve goals in the game. If the initial strategy used is unsuccessful, the student will plan a different strategy and try again to come up with a solution. The guidance from teachers and friends eases in the engendering of creative concepts to resolve given problems. Thus, the minds and thoughts of students will develop further enhancing their critical thinking and creativity.

The conclusions of his study are supported by Huang and Soman [43]. They listed some examples of the use of digital games in education, specifically at the National University of Singapore in programming courses, Healthcare University in healthcare education for users and Deloitte Leadership Academy in corporate training education. The findings of his study revealed that digital games in education influence the development of higher-order thinking skills. Thus, it successfully moves students' motivation even in different fields.

Additionally, the study of Wood and Reiners [44] suggested the use of leader-boards in the domain of education as used in their studies related to logistic and supply chain to encourage active learning and involvement students. Among the studies from researchers such as Annetta [45], Moreno [46], Papastergiou [47], and Van Eck [48] confirmed that digital games are useful tools when used in the teaching process and learning because it accelerates students cognitive response to their learning. The studies of Batson and Feinberg [49], De Freitas [50], and Papastergiou also confirmed that the use of digital games is more successful in motivating students in learning than conventional teaching methods.

Furthermore, studies Tobias et. al [51] also registered that digital game-based learning can improve cognitive level abilities such as attention skills, increased memory capacity, working memory ability to store and manipulate spatial images, decision-making speed, and assignments.

Although digital game-based learning is believed to have many advantages as learning aids, there are still researchers who conclude that game-based learning can not yet revolutionise education. Connolly et al [52], Mayer [53, 54]. There is no consistent evidence that game-based learning can develop thinking and reasoning skills, even playing "real-time strategy games" (RTS).

A study from Hanus and Fox [55] reported that students who are involved with the digital game environment in education score low marks in examinations. It is because there are students who set a high reliance on any forms of technology, particularly these digital game applications. Furthermore, its implementation in the context of education is complex and not comfortable. Cheong et al. [56] and Aparicio et al. [57] stated three important things that need to be considered to implement digital games in education. These elements are understanding target users, identifying tasks that need to be completed and using a combination of game mechanics and dynamics to encourage participation as well as motivate them to complete tasks well using optimal levels of thinking. In this case, it clearly revealed that the dimension of higher-order thinking skills is not easy to form if viewed from one aspect only. Therefore, it is imperative to analyse the characteristics and needs from the perspective of students before implementing digital games in education. By doing so, its implementation can affect the thinking, motivation and involvement of students. Overall, there is no adequate evidence to support the use of game-based learning to improve one’s cognitive skills [58]. The issue of digital games becomes an
impetus for the evolution of digital game-based learning that is more focused on delivering the objectives of learning [59].

The study of Khairuddin Nisa et al. [60] which focused on digital games, namely Geoplay for Geography subjects, affirmed that digital games were developed by focusing on activities aimed at testing students’ thinking skills based on Bloom’s cognitive taxonomic levels. i.e. remembering, understanding, analysing, applying, evaluating and creating. Digital game testing based on Bloom or cognitive taxonomy is also suggested in the gamification process. Gilbert [61], Kapp et al [62], Tan, [63]. Even Kapp et al. also suggested those game activities appropriate to Bloom’s level of taxonomic thinking to be applied in learning. His study also affirmed that the digital game is very relevant in learning the subject of Geography because there are various elements of thinking skills applied in the game. Based on the level of thinking skills from Bloom’s Taxonomy, students need to produce six storyboards consisting of six levels, namely remembering, understanding, applying, analysing, evaluating and creating.

Studies on learning based on the implementation of digital games in increasing HOTS among students also involve various subjects at the secondary level such as English [64], Geography [65] Mathematics [66], and Physics [67]. According to Rayner [68] studies on the use of digital game-based learning in support of creativity are also conducted [69]. The conclusions of these studies determined that digital game-based learning shows a positive impression on student learning. Positive outcomes such as encouraging collaboration [70], improving problem-solving skills [71], enhancing student performance and confidence [72] and interest in learning [73] proved that digital games applied in learning are potentially used in learning environments.

5. Recommendations and Conclusions
Based on the highlights, the researchers concluded that the employment of digital games in learning today is very appropriate to continue in line with the learning environment of the 21st century. Most of the review obtained also revealed that digital games hold a positive effect on the development of students’ thinking both at the secondary and tertiary levels. Most students also own adequate technological facilities, namely smartphones or laptops, to use for learning purposes. Further, to ensure the achievement of learning based on digital games, educators play a vital purpose in determining the direction of learning.

Currently, almost all educational institutions not only in Malaysia but also in other countries practice online learning due to the COVID-19 pandemic. Therefore, educators need to be more inventive to optimise the effectiveness of technology in their lectures and then encourage students to be more skilled in a field. In producing students with 21st-century skills, teaching patterns also need to be in line with the progress of the current generation. Students need to be exposed to teaching methods that can prompt creative and critical thinking. The convenience of technology needs to be appropriated so that its application can reflect an essential impact on students. Relevant technology is the technology that is interactive and can attract students. It is because in solving non-routine problems, students need to possess high interest and motivation so that they keep trying to find a solution. Without high motivation, chances are students will start to give up and no longer want to maintain the attempts. Accordingly, the use of digital games or game-based learning is an appropriate method in assisting to improve students’ HOTS.

6. Conclusion
Digital games own the potential to make students more consistent in their learning as well as hone their thinking skills. Although digital games are seen as very pertinent to facilitate learning objective as well as build key talents, some predicaments worry parents and society, specifically students who like to play digital games face the problem of lack of social skills and communication. Ergo, perpetual research needs to be done to guarantee the best method for realising digital games without involving more significant
problems later on. Hopefully, this research will render excellent benefits and guidance for educators and students in securing the stable learning of digital game-based scholarship.

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