Harnessing Serious Games For Developing Indonesian Elementary School Students' Critical Thinking Attitudes

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Abstract

Critical thinking is one of the essential skills required in all fields in the 21st century. As a response to this need, one of the efforts that Indonesian policy-makers make is through developing Curriculum 2013 which is designed to equip students with the ability to think critically. However, instilling critical thinking skills from an early age without developing an individual's critical thinking attitudes is not a wise choice. It is because possessing critical thinking skills without having a willingness to use them will be less beneficial. This article presents the results of a literature study on how serious games, as a product of current advancement of digital technology, can be utilised to develop three critical thinking attitudes, namely, willingness to plan, the attitude of flexibility, and consensus-seeking attitude. Moreover, this article also presents three strategies that can be used to implement serious games in Indonesian elementary school context, namely, using ADDIE (analysis, design, development, implementation, and evaluation) model as a framework for developing serious games, adapting the existing serious games with BYOD (bring your own device) model, and promoting parental and family involvement.

Keywords:
Critical thinking attitudes; serious games; digital games; elementary school students.

Abstrak

Berpikir kritis adalah salah satu keterampilan penting yang dibutuhkan di semua bidang di abad ke-21. Untuk menjawab kebutuhan tersebut, salah satu upaya yang dilakukan para pengambil kebijakan di Indonesia adalah melalui pengembangan Kurikulum 2013 yang dirancang untuk membekali siswa dengan kemampuan berpikir kritis. Namun, menanamkan keterampilan berpikir kritis sejak dini tanpa mengembangkan sikap berpikir kritis individu bukanlah pilihan yang bijak. Hal ini karena memiliki keterampilan berpikir kritis tanpa kemauan untuk menggunakannya akan menjadi kurang bermanfaat. Artikel ini menyajikan hasil studi literatur tentang bagaimana *serious games*, sebagai produk kemajuan teknologi digital saat ini, dapat dimanfaatkan untuk mengembangkan tiga sikap berpikir kritis, yaitu, kemauan untuk merencanakan, sikap fleksibel, dan sikap mencari konsensus/kesepakatan. Selain itu, tulisan ini juga menyajikan tiga strategi yang dapat digunakan untuk mengimplementasikan *serious games* dalam konteks sekolah dasar di Indonesia, yaitu menggunakan model ADDIE (analisis, desain, pengembangan, implementasi, dan evaluasi) sebagai kerangka kerja untuk mengembangkan *serious games*, mengadaptasi *serious* games yang ada dengan model BYOD (*Bring Your Own Device* atau bawa perangkat Anda sendiri), dan mendorong keterlibatan orang tua dan keluarga.

Kata Kunci:
Sikap berpikir kritis; serious games; permainan digital; siswa sekolah dasar.

A. INTRODUCTION

Critical thinking is considered one of the vital skills needed to survive in the 21st century. A study conducted by Wagner (2008), in which he had several hundred interviews with various people from businessmen to education leaders, reveals that critical thinking and problem-solving are two of the most essential survival skills in the 21st century. Halpern (2003) points out that the need for critical thinking corresponds to a historical fact that every generation needs an additional education that has not existed previously due to the new challenge occurring in the current era. Therefore, it is necessary for today's education to prepare students to become a critical thinker.

There are several definitions of critical thinking proposed by experts. For instance, Ennis (1985) states that "critical thinking is reflective and reasonable thinking that is focused on deciding what to believe or do" (p. 45). Likewise, Halpern (2003) defines critical thinking as "the use of those cognitive skills or strategies that increase the probability of a desirable outcome" (p. 6). According to Luke, Stein, Foutz, and Adams (2007), there are seven critical thinking skills, namely, observing, interpreting, evaluating, connecting, problem finding, comparing, and flexible thinking. Furthermore, to identify whether someone is a critical thinker, there are several critical thinker attitudes, namely, willing to make a plan, being a flexible and persistent thinker, eager to do self-correction, being mindful, and being a consensus seeker (Halpern, 2003). Halpern (2003) argues that developing learners' critical thinking attitudes is as essential as developing their critical thinking skills because it is useless to possess critical thinking skills if learners never use them. Therefore, this article aims to discover a specific way to develop students' critical thinking attitudes.

In the Indonesian context, the importance of critical thinking has been recognized by policymakers and educators. Curriculum 2013 as the latest curriculum in Indonesia is designed to equip the young generation with the ability to think critically by establishing collaboration between teachers, students, and administrators, especially in mathematics and science learning (Kementerian Pendidikan dan Kebudayaan, 2014). However, there is a limited number of research performed to examine the condition of elementary school students' critical thinking because researchers in Indonesia tend to focus on university contexts (Asyari, Al Muhdhar, Susilo, & Ibrohim, 2016; Hadi, Susantini, & Agustini, 2018; Hakim, Liliasari, Kadarohman, & Syah, 2016; Mataniari, 2017; Zetriuslita, Ariawan, & Nufus, 2016) and secondary school contexts (Fuad, Zubaidah, Mahanal, & Suarsini, 2017; Nafi'ah & Prasetyo, 2015). Thus, it is necessary to find a specific method that can be utilised to aid Indonesian elementary school students in developing their critical thinking attitudes.

One of the methods that can be used for helping students in learning about critical thinking attitudes is utilising digital technology. Exploiting digital technologies such as the internet and digital games is considered as an appropriate way of supporting learning in the 21st century because they can facilitate students to learn about critical thinking and problem-solving in new ways (Saavedra & Opfer, 2012). Similarly, Prensky (2006) states that digital games not only engage children but also give them valuable things to learn through a suitable method so that they can prepare themselves to face the challenges of the 21st century. Thus, digital technologies,

especially digital games, can be harnessed to support learning including critical thinking attitudes.

Serious games are a type of digital games that have numerous potentials to support learning activities, one of which is about critical thinking. Serious games can be defined as games that, although can still entertain, are created for specific intentions more than just amusement (Abt, 1970; Baek, Ko, & Marsh, 2014; Emmerich & Bockholt, 2016; Michael & Chen, 2006). Serious games can be categorised into several types such as strategy, role playing, arcade, and realistic simulation (Southgate, Budd, & Smith, 2017). A literature review study conducted by Papanastasiou, Drigas, and Skianis (2017), which investigated the integration of serious games into learning between 2006-2016, has proven that serious games have various positive impacts for elementary school and even preschool students including on critical thinking, reasoning abilities, mathematical thinking, science course and language learning. Despite those benefits, serious games have not been widely used by educators for supporting learning in Indonesian schools. Although there are at least two studies carried out to explore the use of serious games in math learning (Iqbal, Machbub, & Prihatmanto, 2015) and critical thinking in science subjects (Putra & Iqbal, 2016), those studies were performed in secondary school contexts. Therefore, the idea of integrating serious games for fostering the development of Indonesian elementary school students' critical thinking attitudes should be further explored.

Hence, this article will present the analysis results of the effects of serious games on developing three critical thinking attitudes based on Halpern (2003) framework, namely, willingness to plan, the attitude of flexibility, and consensus-seeking attitude. This article will also propose three strategies that can be used to implement serious games in Indonesian elementary school context, namely, using ADDIE (analysis, design, development, implementation, and evaluation) model as a framework for developing serious games, adapting the existing serious games with BYOD (bring your own device) model, and promoting parental and family involvement. Finally, conclusions and implications will be drawn based on the findings of this study.

B. RESULTS AND DISCUSSION

1. The Effects of Serious Games on Developing Three Critical Thinking Attitudes

a. Developing Willingness to Plan

It is believed that planning is crucial in critical thinking. Planning can be defined as the capability of analysing a condition and making a cognitive simulation about future actions (Romero, Usart, & Ott, 2015). Halpern (2003) argues that planning is a first essential step for critical thinking and with repeated practice, learners can develop the habit of planning. In order to develop students' willingness to plan, it is necessary to provide a learning experience that can encourage them to make a plan before taking action.

In this case, serious games can be employed to create a learning situation in which students cannot be impulsive; instead, they must be cautious and make a plan. According to Romero et al. (2015), serious games enable students to do different levels of action planning. For example, when students play the game called SimCity, they are required to make a plan before they build the city with various buildings (British Boarding Corporation, 2002). In a study carried out by Shih and Su (2008), in which they created a game called William Adventure, students are required to do

critical observation and careful planning because they cannot finish the game with trial-and-error but with using clues to solve the problems in the game.

Furthermore, a study conducted by Ulicsak and Williamson (2010) has revealed that 66% teachers in the United Kingdom (UK) believed that digital games could be a supportive tool for developing children's high-order thinking skills such as planning. Also, this study reveals that strategy games such as Age of Empires require players to plan the next move to defeat the opponent (Ulicsak & Williamson, 2010). In other words, playing strategy games is potentially beneficial for developing students' willingness to plan. Moreover, by repeatedly practising through playing serious games, there is a high probability of elementary school students exhibit the willingness to plan in other contexts.

Despite the positive response shown by teachers and benefits of serious games for developing the willingness to plan, their implementation is not without challenge. In a report about the use of games in UK primary schools, although teachers engaged enthusiastically in the discussion about serious games that were designed to facilitate students in learning about making a plan, teachers felt that it was challenging to justify with the intended curriculum (McFarlane, Sparrowhawk, & Heald, 2002). Thus, analysing the alignment between serious games and the intended Indonesian curriculum is crucial.

To conclude, serious games can be harnessed for creating a learning experience in which elementary school students can develop the habit of planning. Although different genres of serious games have potential to foster the habit, serious games can be considered the most effective one. Thus, by using serious games, especially strategy games, teachers can cultivate the

first attitude of a critical thinker in elementary school students that is willing to plan. In addition, before integrating serious games into learning, it is essential to align the games with the expectation of the curriculum.

b. Developing Attitude of Flexibility

The second attitude of a critical thinker is demonstrating flexibility in thinking. A critical thinker will not make a hasty judgement; instead, he/she will gather more information, evaluate evidence, consider new alternatives, and try new ways of thinking (Halpern, 2003). It is believed that schools will play important roles in the process of creating critical thinkers who have flexibility in thinking. In this century, there is a need of shifting the paradigm about schools from thinking of schools as places where students learn about certain things to places where students learn to become flexible and adaptable individuals who can live in an ever-changing society (Veen & Vrakking, 2006). Therefore, schools should become institutions where young people are educated to become critical thinkers with flexible thinking so that they will be able to deal with the challenges and problems in this era.

Serious games arguably have the potential to develop students' attitude of flexibility. According to Romero et al. (2015), serious games allow various levels of flexibility depending on the change in the contextual demands. A study carried out by Butcher, Runburg, and Altizer (2017), in which they harnessed a serious game named Dino Lab for improving critical thinking of K-12 students, provides us with a decent example of how a serious game can be utilised in the process of learning about flexibility in thinking. Dino Lab is a 3D simulation game that allows the students to create dinosaurs by considering several features of dinosaurs such as strength, weight,

speed, stance (bipedal or quadrupedal) (Butcher et al., 2017). This game encourages students to show the attitude of flexibility in thinking because it was designed based on "if-then" rules to successfully build the dinosaur (e.g., if a student created a bipedal dinosaur, then its leg strength must be bigger than its total weight) (Butcher et al., 2017). Furthermore, a serious game in which the players play specific roles can also be used to develop students' attitude of flexibility. By allowing players to change their roles within a game, a flexible thinking attitude can be fostered (Aynsley, Nathawat, & Crawford, 2018). Thus, the features of serious games such as "if-then" rules and changing roles will be valuable in the process of fostering students' flexible thinking.

However, teachers have to consider some possible challenges such as regarding the cognitive load when increasing the complexity of the games (e.g., the complexity of the "if-then" rules). A study carried out by Curtis and Lawson (2002) has revealed that the more complex the game, the higher cognitive load will be. When the intrinsic cognitive load is high, and a large amount of extraneous cognitive load is added, the learning goals might not be reached (Sweller, 1994). Therefore, the cognitive load must be taken into consideration before designing an instructional design.

In conclusion, to cultivate the attitude of flexibility in thinking, serious games can be integrated into the teaching and learning process. There are at least two features of serious games that can influence students' flexible thinking, namely, "if-then" rules and changing roles. Moreover, it is essential to have a new perspective about schools by thinking of school as a place where students can learn to become a flexible person who can solve the problems of

the 21st century. In addition, it is also essential to select a game that is suitable for the development stage of elementary school students as well as their cognitive capacity.

c. Developing Consensus-Seeking Attitude

The last, but definitely not the least, the attitude of a critical thinker that will be discussed in this article is the consensus-seeking attitude. This attitude is essential for students if they want to become a critical thinker because without this disposition their idea might become worthless and exist only in their brain no matter how critical they are. Halpern (2003) argues that a critical thinker, in order to turn thoughts into actions, should become a consensus seeker who has sufficient interpersonal skills such as communication skills and capability of finding ways to reach a compromise and agreement. To develop students' consensus-seeking attitude, implementing collaborative learning collaborative learning can be an effective solution. According to Panitz (1999), the fundamental premise of collaborative learning is consensus building through cooperative interactions. Therefore, it is essential to create a learning environment that facilitates students to collaborate and work with others so they will be able to achieve the consensus-seeking attitude.

Studies have shown that serious games can be used to create a collaborative learning situation. Multiplayer serious games have been successfully utilised in various contexts as the enablers for collaboration (Bluemink, Hamalainen, Manninen, & Jarvela, 2010; Häkkinen, Bluemink, Juntunen, & Laakkonen, 2012; Hämäläinen, Oksanen, & Häkkinen, 2008). For instance, Bluemink et al. (2010) executed a study to examine how a 3D multiplayer game named eScape can

be employed to create a space for collaborative activities. Since the main goal of this game is to solve five tasks collaboratively, the game was equipped with an avatar feature and the participants were allowed to communicate by using microphones and headphones (Bluemink et al., 2010). The results showed that vivid interactions (e.g., asking questions, giving explanations, and exchanging information) had led to constructive collaborative activities (Bluemink et al., 2010). This study has demonstrated that serious games, especially those with the multiplayer feature, have excellent potential in creating a space for collaboration.

Furthermore, in the context of elementary school, serious games can be applied in the learning process of various school subjects. For example, a serious game named Minecraft has been widely used for building a collaborative learning environment in various subjects such as mathematics, geography, physics, and ecology (Papanastasiou et al., 2017). In geography class, students can learn collaboratively to explore landforms such as mountains and beaches (Papanastasiou et al., 2017). Thus, serious games hold massive potentials that can support collaborative learning including in elementary school context.

Even though serious games can serve as the enabler for collaborative learning in which students develop their consensus-seeking attitude, teachers must be still aware of potential problems that might occur. For instance, in a collaborative learning situation, students might not reach a consensus; instead, they end up with holding different opinions (Smit, 1989). Therefore, teachers have to emphasise that the aim of using the game is to improve their consensus-seeking skill and attitude.

To conclude, in order to realise his/her ideas, a critical thinker must become a consensus seeker. Teachers can play a role as a facilitator who provides a collaborative learning environment, one of which by using serious games. It is because the essence of collaboration is based on consensus building which is the opposite of competition (Panitz, 1999). McGonigal (2011) believes that "online gamers are among the most collaborative people on earth" (p. 244). However, teachers must still give clear guidance before and during the implementation of serious games to avoid misunderstanding of the learning objectives. It is expected that serious games can be a game-changer in the process of teaching and learning including in developing students' consensus-seeking attitude through a collaborative learning environment.

2. Strategies for Implementing Serious Games in Indonesian Elementary School Context

a. Using the ADDIE Model as a Framework for Developing Serious Games

Before developing serious games that will be used to support learning, it is crucial to select an instructional design framework. It is expected that by using a particular framework, the process of creating an instructional design will be organised and systematic. One of the instructional design frameworks that teachers, educators, and game developers can use is the ADDIE model. According to Molenda (2015), ADDIE is an umbrella term used to label the generic process of Instructional System Design (ISD) consisting of five stages, namely, analysis, design, development, implementation, and evaluation. Jeuring, van Rooij, and Pronost (2014) state that this model has been widely used in developing ISD (e.g., teaching methods

and educational games). In relation to serious games, ADDIE model has been used as a framework in many instructional designer with various purposes and contexts (Alcid, Bandril, De Guzman, & Lopez, 2017; Braad, Žavcer, & Sandovar, 2016; García, García-Martínez, Navarrete-Ibañez, & Cervelló-Donderis, 2013; Jeuring et al., 2014; Sahrir & Alias, 2012; Zakaria, Salleh, & Nawi, 2016). Thus, it is recommended to use ADDIE as a framework for designing serious games, which in this case, is aiming to develop elementary school students' critical thinking attitudes. In the following paragraphs, each stage of ADDIE will be further described.

The first stage is the analysis. It is arguably that this initial stage is the most crucial stage in the ADDIE model because by doing analysis, instructional designers will reduce the amount of time and effort spent for the whole process (Aldoobie, 2015). In this stage, an instructional designer must analyse the current condition of students (e.g. their needs and problems), instructional goals, steps needed to reach the goals, and measurable learning objectives (Aldoobie, 2015). For instance, in a study conducted by Jeuring et al. (2014), in which they developed the Moth game for teaching about optics in secondary school level, the analysis stage helps researchers to set several learning objectives such as to utilise the lens formula. With regard to critical thinking attitudes, the instructional designers can analyse, for example, students' habit of planning in order to determine whether elementary students are impulsive individuals or great planners. Therefore, the role of the analysis stage in determining the success of the ADDIE model implementation is indispensable.

The second stage is the design. In this stage, instructional designers should think how to facilitate learning so that

the learning objectives can be achieved (Aldoobie, 2015). The analysis results must become the basis for designing serious games. For example, Jeuring et al. (2014) designed the levels of their game based on the results of the interview with a teacher about the order of learning about optics. Regarding critical thinking attitudes, the game can be designed to facilitate students' collaboration so they can learn how to seek consensus; thus, it must be equipped with a chat box.

The third stage is the development. This phase will be much easier if the two previous phases have been done correctly (Aldoobie, 2015). Jeuring et al. (2014) used this phase for designing the contents, programming the game, and debugging the result. The process of creating a serious game can be done by using single software such as GameMaker 8.1 (Jeuring et al., 2014) or combination of multiple software such as Unity 3D, JavaScript, UnityScript, and 3D Studio Max (Alcid et al., 2017). The choice depends on the complexity of the game developed.

The fourth stage is implementation. In this stage, the game that has been designed and developed is used. Before the game is implemented in the planned classroom, it is recommended to test the game in the experimental classroom (Jeuring et al., 2014). In order to provide ease of access, the game can also be published in a digital distribution service such as Google Play (Alcid et al., 2017) or a website (Jeuring et al., 2014). Also, it is also essential to prepare the teacher, students, and the learning environment (Aldoobie, 2015); thus, the implementation process can be executed in accordance with expectation.

The last stage is the evaluation. This stage is important to evaluate the product that has been designed, developed, and implemented. For instance, instructional designers can

evaluate the game aesthetics such as the game graphics and objects (Alcid et al., 2017). Various techniques can be employed to conduct evaluation such as by using questionnaires (Alcid et al., 2017; Jeuring et al., 2014). After performing the evaluation, the process can be repeated from the beginning or from one of the steps (e.g., the implementation process must be repeated) because the ADDIE model is not only sequential but also iterative (Molenda, 2015). Therefore, the evaluation stage is important to improve the quality and appropriateness of the serious game.

b. Adapting the Existing Games with BYOD Model

Besides creating and developing new serious games, there is an alternative for elementary school teachers who intend to integrate serious games for supporting learning that is adapting the existing games. Many serious games are suitable for developing elementary school students' critical thinking attitude. For example, serious games such as SimCity, Age of Empires, and the Settlers are useful for elementary school students because by playing these games, they are encouraged to collaborate with peers and make a plan before taking actions (McFarlane et al., 2002).

When teachers intend to integrate serious games into the classroom, whether they create their own games or they adapt existing games, they have two options regarding the devices that will be used, that is using devices available at the school or asking students to bring their own devices. This method is known as bring your own device (BYOD). According to Song (2014), BYOD is "the technology model where students bring a personally owned mobile device with various apps and embedded features to use anywhere, anytime for the purpose of learning". Thus, the students can play

serious games for learning both during the learning process at school or outside the school. Cheng, Guan, and Chau (2016) suggest that BYOD is conducive for developing students' 21st-century skills (e.g., critical thinking). Furthermore, there is a similarity between BYOD and mobile learning. BYOD model focuses on facilitating personalised learning in which students' unique needs and choices are more valued, while the basic concept of mobile learning is about ubiquitous learning chances provided by mobile devices and wireless networks (Cheng et al., 2016). Therefore, the BYOD model is chosen because it allows the students to adjust their learning, which is supported by serious games, to their needs and choices.

With regard to Indonesian context, the implementation BYOD strategy will be successful due to several reasons. In 2016, around 43% (111 million) of Indonesians owned smartphones and about 15% (39 million) own laptops or personal computers (Balea, 2016). The fact that there are around 16 million gamers in Indonesia aged between ten and twenty (Newzoo, 2017) makes it even more possible to harness serious games with BYOD model for learning because they are familiar with using their devices for gaming. Furthermore, BYOD is also suitable with the recent change of Indonesian curriculum which has shifted from teacher-centered to student centered curriculum (Kementerian Pendidikan dan Kebudayaan, 2013). It is because BYOD supports student-centered learning by giving them opportunities to decide what they want to learn and how to learn it by utilising their device (Cheng et al., 2016). Despite the positive impacts of BYOD, several challenges such as technical issues and teacher readiness must still be anticipated (Cheng et al., 2016). In other

words, being aware of the potential issues will lead to a higher probability of the successful BYOD model implementation.

3. Promoting Parental and Family Involvement

It is necessary to promote parental and family involvement in the process of implementing serious games in Indonesian elementary schools both regarding the serious games and the BYOD model. In terms of serious games, a recent study carried out by Prameswari, Suharto, and Prabowo (2017) showed that parents of elementary school students in Indonesia had negative responses toward digital games because they thought that Android-based educational games are not suitable for children (around 68,9%) and as learning media (80%). Thus, there is a need to shift the paradigm about digital games by learning from other countries because studies have shown that parents in several countries have a positive attitude towards the use of serious games for learning. For instance, a study conducted by McFarlane et al. (2002), in which they investigated perceptions of parents of elementary school students in the UK, has revealed 85% of the parents believe that digital games have positive contributions to learning. Those parents said that digital games are beneficial not only for subject knowledge such as math learning (around 45%) and spelling (around 30%) but also for developing skills such as planning and collaboration (20% each) (McFarlane et al., 2002). Furthermore, a study carried out by Chalak and Ahmadi (2016) has shown that around two-thirds of the parents surveyed in Iran believed a serious game named Mingoville was conducive to English learning in elementary school level. It is expected that by learning from other countries, parental and family involvement in the

process of integrating serious games into learning can be promoted in Indonesia.

With regard to BYOD strategy, parental and family involvement is also vital because family approval and involvement will ensure the success of BYOD program (Maher & Twining, 2017; Scholz, 2016). Furthermore, the BYOD program itself will also benefit parents and their children because they can take part in the learning process both at home and at school (Ofsted, 2011, as cited in Maher & Twining, 2017). Thus, it is necessary to engage parents in the process of implementing BYOD because not only their support is needed, but also they will get advantages from the program.

C. CONCLUSION

This article has presented the study results regarding the use of serious games for developing Indonesian elementary school students' critical thinking attitudes. The first part of results and discussion section focuses on explaining the impacts of serious games on three critical thinking attitudes, namely, willingness to plan, the attitude of flexibility, and consensus-seeking attitude. Firstly, serious games, especially strategy games such as SimCity and Age of Empires, are the most potential game genre for developing students' willingness to plan because students are required to make a plan in order to advance further in the games. Secondly, several features of serious games such as "if-then" rules and changing roles can foster the development of students' attitude of flexibility in thinking which is vital in the 21st century. Finally, serious games such as Minecraft can facilitate students in developing their consensus-seeking attitude by providing them with a space for collaboration.

The second part describes three strategies to implement serious games in

Indonesia, especially at elementary school level. The first strategy is using the ADDIE model as a framework in the process of developing serious games because numerous instructional designers have used it in different contexts. ADDIE is an iterative model consisting of five phases, namely, analysis, design, development, implementation, and evaluation. The second strategy is adapting serious games which have been available in the market with BYOD strategy. The third, which is the last strategy, is promoting parental and family involvement because Indonesian parents tend to have negative attitudes towards the utilisation of digital games for learning.

Furthermore, based on the study results, there are several implications for educators, researchers, and policymakers in Indonesia. Firstly, educators should start to recognise the enormous benefits of serious games, one of which is developing students' critical thinking attitudes. Secondly, it is crucial for researchers to conduct more studies regarding critical thinking and the integration of serious games into learning, especially in elementary school contexts. Finally, policymakers should establish cooperation between schools and game developers in order to ensure the availability of serious games for supporting learning. Also, they are expected to encourage universities and other institutions which prepare teacher candidates to equip those candidates with technological competencies.

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