The effective components of creativity in digital game-based learning among young children: A case study

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ARTICLE INFO
Keywords:
Digital game-based learning
Creativity
Creative thinking
Young children
Empirical evidence

ABSTRACT
Recent studies regarding digital game-based learning (DGBL) are increasing, having the potential to enable new forms of learning, however, it remains unclear how DGBL applications can impact young students’ creativity. The main purpose of this study is to investigate whether DGBL application technologies (tablets and smartphones), can improve creativity skills in preschool children (aged 3–6) and “what the main components effective of creative skills are to enhance learning for young children in DGBL”. In this study, the procedure is a case study and the researcher used a sample of apps that were preloaded onto one tablet for seven children aged 3–6 years old in grade Foundation Stage 1 and 2 in a selected Montessori pre-school in Malaysia. In the present study, during using educational digital games by young children, the students’ creative thinking process and the relationship between these components based on Analyzing Children’s Creative Thinking framework (ACCT) are investigated in order to understand perceptions of creativity skills involved in the learning approach. The findings suggest that DGBL can potentially affect students’ ability to develop creative skills and critical thinking, knowledge transfer, acquisition of skills in digital experience, and a positive attitude toward learning as well as provide for deep, insightful learning. The students experienced opportunities for engaging the creative thinking process in their activity and thinking issue understanding and learning in educational digital games. This study provides an outlook for researchers, game designers, developers in the field of DGBL, and creativity. This research provides new insights, advice, and effective suggestions on how to increase creative skills, motivate, and improve learning outcomes and demonstrate learning with DGBL composition in teaching young students.

1. Introduction

One of the most recent growing trends in today’s world is digital games using technologies such as tablets or smartphones for children at home or at school. Although research trends are increasing and research on digital games based on education and creativity is still active, the issue of fostering creativity based on these digital games in young children remains unclear. A number of researchers believe that digital games based on learning can create different forms of creative expression and improve the process of creative thinking and increase the level of learning in children (Cook & Bush, 2018), however, the extent of evidence in this field is very limited. One of the benefits of using creative elements in digital games is empowering young children to think creatively to find solutions to everyday problems in real life (Hooshvar et al., 2019). These digital games can help children to live in the real world and increase their level of learning by focusing on increasing children’s creative thinking skills, as psychologists suggested for children due to their mental health and positive effect on future lives (Behnamnia et al., 2020). Psychological studies show that the most important age for strengthening creativity and imagination in children is 2–6. According to psychologists, preschool age is a period in which children begin to form and grow more imaginatively than in any other age, therefore children in this age group (2–6 years) are engaged in creative activities and seem to be happier and more active. Hence these children can more easily adapt to real-life in the future (Beaty et al., 2014). Thus, individuals, through fostering creative thinking in childhood, are able to cope with a number of negative psychological processes, such as repetitively negative thinking. Creative thinking, on the other hand, helps people develop coping strategies and adopt adaptive thinking (Behnamnia et al., 2020). Creativity is defined as a set of abilities and skills motivating and discovering the ability to find a solution to challenging or difficult situations (Torrance, 1972). Digital gaming-based learning games, by focusing on the elements of creativity, can also improve students’ academic achievement and improve 21st-
century skills such as creativity, problem-solving, collaboration, and critical thinking (Bowman et al., 2015). The learning process based on digital educational games has the ability to stimulate children's curiosity to find new ways to solve problems by creating attractiveness in the visual space, which, in turn, increases children's satisfaction (Hooshyar et al., 2020; Lin et al., 2020). Therefore, in designing digital games by focusing on such elements as curiosity and challenge fantasy, children's interest and motivation can be increased, which in turn increases the interaction of digital games with children (Zupan et al., 2018).

Although these issues have entirely and repeatedly been emphasized by psychologists for the real lives of children, there are only a few studies that have examined students' creativity in the digital gaming environment, especially among preschoolers (Hooshyar et al., 2018a). Individual creativity, by definition, is a human trait that evokes positive emotions in the form of personal satisfaction (Csikszentmihalyi, 1996; Root-Bernstein, 2013). The potential for individual creativity can even be described as the creative endeavor of the individual in everyday life (Torrance, 1972; Csikszentmihalyi, 1996). The creative process can be taught to many researchers and found in all people as a “capacity to create” (Runco, 2010). Therefore, researchers have suggested that the scope of creative thinking should be considered as a major skill required in teaching digital games to students (Behnamnia et al., 2018). To format creative thinking in teaching, creativity is used as a skill to spread critical and creative thinking in order to solve students' problems for learning, which can also be used as an epistemological lens in the environment of digital games (Gilavand, 2019). Creative and innovative thinking is recognized as a fundamental component and educational technology to support student learning (Gangadharbatla, 2010; Lewis, 2009). However, while creativity is recognized as an innovative human potential in all major academic disciplines, the lack of sufficient evidence of the significant presence of creativity components in educational games, especially for young children is considered by researchers as a serious limitation in modern education (Atalayony et al., 2018). In previous studies, researchers emphasized the close relationship between learning and creativity. For example, Betz (1995) stated that digital games improve learning through the embodiment of experience and creativity (Renz, 1995). Prensky (2001) proved that innovation in digital games helps solve the problem of individual students (Preisky, 2001). Problem-solving seem to become more creative in students encouraged to learn based on digital games (Brunnet & Portugal, 2016). Moreover, Hamlen (2009) reinforces students' ability to play digitally-based games in problem-solving through creative solutions (Hamlen, 2009).

On the other hand, many researchers believe that young students can be encouraged to be creative, although creativity in humans is an inherent trait that only specialists such as geniuses have (Hooshyar et al., 2018b). Therefore, another way to achieve creative ideas is to foster creativity through education by providing technology skills in childhood; in other words, “creating by doing” is one way to foster creativity (Torrance, 1972; Vass, 2007; Mayer, 1989; Rose & Lin, 1984; Ward, 2007). A research done recently has encouraged creative learning techniques to help students outdo each other (Zupan et al., 2018). The concept of learning through digital technology plays an important role in enhancing students' creativity. This technology also reflects human creativity. Many of the creations and technologies, such as ideas, inventions, and applications, are based on the imagination and hypotheses of creativity (such as creating new products) (Gilavand, 2019). Another study found that students who used game-based learning applications were more likely to develop divergent thinking when solving problems (Diefenthaler et al., 2017; Hooshyar et al., 2019). However, there are very few studies and evidence to determine whether digital educational games can enhance creativity and then increase learning (Karwowski et al., 2019; Gong, 2020).

As mentioned earlier, in today's world, the use of technology such as iPhones or touchscreen tablets have also increased children's creativity (Lin et al., 2020). Researchers have found that more than 70 percent of young children between the ages of 2 and 6 have access to a tablet at home (Brittain, 2013). Another study by National Literacy Trust showed that of 1,028 young children aged 3 to 6 in the UK, more than 80 percent of children at school or at home had access to a tablet or smartphone at school or at home (Formby, 2014). On the other hand, with the increase in the number of learning-based programs in the market, parents' attention to these programs has also increased. Parents need to be aware of the factors that have a positive effect and increase children’s skills. It is important that parents be aware of the impact of digital games and the elements that help children develop their skills for future life (Behnamnia et al., 2018). In 2012, a researcher stated that more than 80 percent of the best-selling digital games for young children were focused on education in the Apple Store (Shuler and Levine, 2012). There are also several studies available showing that children have increased their creativity when using digital games and using technology (Grammenos & Antonia, 2018). Therefore, due to the increasing use of technology and educational games, it is necessary to determine the type of touch screen and the elements of digital educational games in order to develop children's skills, including creativity and increase their level of learning (Diefenthaler et al., 2017; Lin et al., 2020). In addition, families are concerned about the negative impact of these games on the behavior of young children and addiction to digital games in their children (Brooks and Sjöberg, 2020). Some researchers also believe that digital games reduce children's creativity and motor skills. Therefore, according to researchers, further researches are needed to clarify the impact of these games, especially on the development of creativity and skills of the 21st century on children (Brooks and Sjöberg, 2020; Gong, 2020).

Therefore, to address the above problems, this study examines the application of DGBL technology in tablets and smartphones, whether this technology (DGBL) can improve creativity skills in preschool children aged 3–6 years, and which one of the components of creativity can be more effective in strengthening young children's learning. In this study, the procedure is a case study and the researcher used a sample of apps that were preloaded onto one tablet for seven children aged 3–6 in grade Foundation Stage 1 and 2 in a selected Montessori preschool in Malaysia. In the present research, during using educational digital games by young children, the students' creative thinking process and the relationship between these components based on Analyzing Children’s Creative Thinking framework (ACCT) are investigated in order to understand perceptions of creativity skills involved in the learning approach. Therefore, the main purposes of this paper are as follows:

1. To provide the most effective components/features of fostering creativity skills in DGBL, and technology for learning in preschool level.
2. To present the overall effect of components/features of fostering creativity skills on students’ learning when DGBL is integrated into preschool level education.
3. To synthesize the potential of implementing DGBL and creativity components within preschool level education.

For as much as DGBL applications are an emerging technology, it is significant to provide an impact of its use in creativity skills and game-orientated educational settings. As such, this study strives to find answers for the following research questions:

1. What are the most effective components/features of fostering the creativity of DGBL apps?
2. Which features of the overall design in DGBL apps can foster creativity?
3. What is the relationship between children’s use of tablets and their creativity?
The findings inform a sound empirical basis useful for researchers and game designers, developers in the field of fostering creativity, and game-based preschool learning.

2. Framing creative thinking and theory in DGBL design

2.1. Creative thinking

Creativity or creative behavior and thinking in this study were determined by the context in which a creative action occurred. In children, creative behavior occurs through play and creative action; therefore, the study made use of two key frameworks as a tool to identify play and creativity in preschoolers when using digital programs. The first element in defining thinking or behavior was traced to Robson (2014) using the framework of “Analyzing Children’s Creative Thinking” (ACCT) (based on Vygotsky’s sociocultural theory of guiding creative talent (Vygotsky, 2004; Robson, 2014). This framework mostly emphasizes on the creative process, especially in young children, thus, instead of using cognitive tests, divergent thinking, which is not very suitable for young children, such as Torrance Tests for Creative Thinking (Torrance, 1972), ACCT is identified by using observable behaviors from young children that are associated with three areas: exploration (exploring; engaging in new activity; knowing what you want to do), involvement and enjoyment (trying out ideas; analyzing ideas; speculating; involving others) and persistence (persisting; risk-taking; completing challenges) (Table 1).

Since creative activity happens when children play and there are close links between play and creativity (Vygotsky, 2004). Play is very important for cognitive development, and is a ‘progressive’ activity because it drives children to acquire new skills, knowledge, and understanding (Vygotsky, 2004). Consequently, the author has chosen the second framework that is the use of divisions for Hughes (2002) taxonomy types of play in the real world, which was added to fully adapt the classification for a digital environment (Hughes, 2002) (see Table 2).

There are many classifications of play (e.g. Bird & Edwards, 2015; Caillou, 2001; Hutt & Gibby, 1979), but Hughes was chosen to study, as it identifies 16 different types of plays and can perform a small and large analysis. For example, unlike some other taxonomies, fantasy and imaginative play differ in some games and virtual worlds and Hughes’s scheme allows for this distinction, unlike some other taxonomies. These approaches to identify creativity on the one hand, given Hughes (2002) classification of creative play and creative functionality based on Robson (2014) framework, helped the researcher analyze children’s behavior to discover, develop ideas and things while playing with digital apps. Therefore, this study was performed based on two frameworks including both creative thinking and creative action (Robson, 2014; Hughes, 2002).

2.2. Technology

The educational technology previously provided a specific opportunity for the development of the creative process. This is also the case with digital technology which can stimulate the imagination in the game, such as physical games based on characters and game narratives encountered in video games or virtual worlds. This justifies why kids enjoy playing with toys that are digitally active (Ofcom, 2017). The present study also examined the relationship between children’s use of programs and their creativity. Some researchers are calling for a “new system for understanding the creative process” in the study of integrated technology learning (Gangadharam, 2010; Lewis, 2009; Rutland & Barlex, 2008; Spendlove, 2008). The cost of technological tools may make significant advances in the creative thinking process in educational settings. How students can develop the dimensions of their creative thoughts and actions in digital technology environments is ambiguous, requiring a foundation of experience. Studies of children’s creative uses of technology in homes have provided insights into how to use pills for children to take pictures or draw, yet there is a need to identify the range (Lanna & Oro, 2019).

2.3. Principles of digital game-based learning

For the purposes of this study, the researcher also sought to investigate the effects of digital game-based learning environments on how it relates to encouraging creativity and learning skills in children. Numerous game-based learning frameworks and principles were considered, including those detailed by the National Research Council (2019) and those provided by Bee (2007), Squire (2008), Preneky (2003), and Malone (1981) (Bee, 2007; Durga & Squire, 2009; Preneky, 2003; Malone, 1981). In addition, the principles of creative learning (CBL Model) (Bellotti et al., 2010) and the principles of education (creative teaching) (ARCS Model) (Keller, 2000) in digital educational game environments were considered, then regarding these references, some definitions of DGBL principles indicated in Table 3 selected by the author. The principles of these frameworks were selected owing to their impact on learning, including strengthening students’ creativity and providing opportunities for knowledge.

As mentioned earlier, children, through engaging in creative activities, can better express their inner desires, which, in turn, play a key role in how they feel empowered and then improve their learning (Hsiao et al., 2014). Hence, figure (1) indicates how the components of creativity can foster creativity and improve learning by linking to the principles of learning in digital environments (Wilson et al., 2020) (see Fig. 1). In addition, figure (1) shows how learning is influenced by teachers’ creativity and the interactions that take place with children, and the environments in which children interact can be nurtured through teacher training (Hsiao et al., 2014) (see Fig. 1). Teacher

Table 1
Adapted Rubric from ACCT framework (Robson, 2014).

<table>
<thead>
<tr>
<th>Types of creative thinking</th>
<th>Codes</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exploring,</td>
<td>E1</td>
<td>Tending to discover the potential of a challenge, activity or substance</td>
</tr>
<tr>
<td>Engaging in the new activity</td>
<td>E2</td>
<td>Ready to get involved in an activity and coming up with an idea</td>
</tr>
<tr>
<td>Knowing what you want to do</td>
<td>E3</td>
<td>Enjoyment of being curious when choosing a game</td>
</tr>
<tr>
<td>Involvement and enjoyment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trying out ideas,</td>
<td>I1</td>
<td>Finding a new path, using previous or new knowledge to obtain an idea or hypothesis</td>
</tr>
<tr>
<td>Analyzing ideas,</td>
<td>I2</td>
<td>Providing an idea and to make a decision whether or not to pursue it</td>
</tr>
<tr>
<td>Speculating,</td>
<td>I3</td>
<td>Expressing opinions and asking teachers or friends about their activity</td>
</tr>
<tr>
<td>Involving others,</td>
<td>I4</td>
<td>Engaging with other children or adults to develop an idea or activity</td>
</tr>
<tr>
<td>Persistence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persisting,</td>
<td>P1</td>
<td>Resistance to the game and enduring the ambiguity of the game</td>
</tr>
<tr>
<td>Risk taking,</td>
<td>P2</td>
<td>Taking risks and learning from mistakes</td>
</tr>
<tr>
<td>Completing challenges</td>
<td>P3</td>
<td>To believes in own self and expressing a sense of self-efficacy, self-esteem, and the joy of finding solutions to challenges</td>
</tr>
</tbody>
</table>

*Note. Definitions were slightly modified by the researcher for the purpose of this study and were used to guide the evaluation of aspects of creative skills demonstrated in the artwork. Adapted from Thinking Creatively in Action and Movement for preschool level, based on the ACCT framework by Robson (Robson, 2014).
support for the development of creative skills can influence children's learning in digital environments (Kaul et al., 2017).

2.4. Role of teachers and parental engagement

Teachers can be valuable resources for creating creative files through DGBLs and their teaching approaches. Children need to feel that their creative aspirations are recognized and supported when using digital-based learning (Clark & Moss, 2011). Furthermore, children need to be able to express themselves effectively for communicating their ideas. Teachers support children's creative skills by encouraging children to explore, experiment, and hypothesize. In addition, teachers and supervisors can demonstrate their concern by implementing effective approaches in the curriculum that can demonstrate children's creative skills in music, sports, science and math, and divergent thinking in digital game-based learning. It is also worth mentioning that teachers and parents shape children's interaction with technology (Nikken & Jansz, 2014). In this section, the role of theories and values of teachers and parents' presence along with children when using tablets and their management in the use of programs are considered. Past values, beliefs, and experiences of parents and teachers have a direct impact on children's interactions with digital media. For example, one of the mothers who took part in the interview said;

“I talked to my son about the importance of balance in IPad consumption, and children should be taught how much they can use the tablet every day, even if a tablet using for a learning process.”

Other parents are also concerned about the potential negative

Table 3
Principles of digital game-based learning (DGBL).

<table>
<thead>
<tr>
<th>DGBL Principles</th>
<th>Purpose/Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspiration</td>
<td>The learner is motivated to perform self-evaluation and self-regulated learning.</td>
</tr>
<tr>
<td>Personification</td>
<td>Each learner develops a personal learning strategy, and creates his or her own learning environment while playing.</td>
</tr>
<tr>
<td>Gamification</td>
<td>Learning as a game, using game thinking to solve problems.</td>
</tr>
<tr>
<td>Attention</td>
<td>In the beginning, student's early attention to the game is increasingly important. This can be achieved by engaging in a query which students have to give examples of problems related to their learning goals.</td>
</tr>
<tr>
<td>Relevance</td>
<td>Students' new knowledge aligns with their prior knowledge.</td>
</tr>
<tr>
<td>Confidence</td>
<td>If students feel that they are reaching what they are learning goals, they will gain more self-motivation and confidence.</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Satisfaction occurs when the student understands that learning outcomes have real values which they can use in other contexts.</td>
</tr>
</tbody>
</table>
impact of using digital game technology, wishing to play with children outdoors (in the real-world) to strike a balance between digital and non-digital games. Based on the researcher’s observation, parents have had positive comments about the use of tablets and apps, defining a wide range of benefits for their children, such as the learning and development of social and personal skills. They also noted that children are accidentally attracted to applications that focus more on entertainment and children’s learning levels have been higher in programs focused on entertainment. The mediation of teachers and parents is about how to help children access, use, and think about games (Livingstone & Helsper, 2008). Preliminary studies of children’s interactions with television show type of help children have from parents and teachers included three categories: restrictive mediation, interactive mediation, co-viewing mediation (Nathanson, 1999) & (Warren, 2003). In another study, some researchers developed tools to assess parental and teacher mediation when using applications (Nikken & Jansz, 2014). They expanded their division into four intermediate styles, which were more reliable and common. Active mediation (for example, helping the child with what to use in the applications) A limited mediation (general restrictions such as time constraints for using digital games), a limited intermediary (content restrictions such as banning the use of annoying programs) and monitoring (observing and monitoring children continuously when using digital games). These fourfold categories can generally be asked of parents and teachers to perform in a school or home setting to evaluate children when using tablet and digital gaming techniques. In this study, the author has used active mediation when, for example, the child is having difficulty managing the tablet in a timely manner. In another case, parents and teachers are actively involved in the implementation of some games, in which the child is confused (whether to choose the start button or something else).

3. Methods

In this study, the researcher used two main methods to collect data; semi-structured questionnaires and semi-structured interviews. Questionnaires include several open-ended questions that provide qualitative data and several closed-ended questions (by selecting the suggested answer) with semi-text criteria. Both types of questions are directed and supervised by teachers and professors at the preschool level taken from Marsh research (Marsh et al., 2018). Nine series of effective training digital application game designed and introduced by reputable companies was also reviewed, evaluated (by Marsh in 2018), and selected (Marsh et al., 2018). The games also provided rewards, having the most download in the Apple Store by 2020 (see Table 4). The author installed these applications on an iPad so that the teachers could share them with the children. The applications were sometimes chosen by kids, but in some cases, kids were directed to specific programs by the teachers and researcher.

The children’s actions were entirely recorded by the author’s mobile phone camera, which focused on the child’s interaction with the screen. Teachers needed to fill in the forms provided by the researcher after observing the preschoolers’ activities. The interviews were conducted for one week with each of the 7 participants and 2 teachers and 7 parents of the participants. The researcher collected 20 min of interview data from each participant in the scheduled sessions. Interviews took place in a place similar to the Montessori school for young children in Malaysia, where all interviews were conducted to ensure privacy in a
quiet place. Prior to the interview, teachers and parents signed a consent form (Appendix A & B). Each interview took place at a time when the teachers were present there. The questionnaires were prepared based on Hughes' taxonomy and ACCT framework, with examples presented in each section focusing on observing teachers from participants (7 young children).

The interviews, having been conducted, were singly transcribed by the researcher using Rev.com. The text was sent to the relevant partners (parents and teachers) and verified. The data obtained from the interview was then encoded using Nvivo software (see Table 5).

3.1. Participants

All children in Foundation Stage classes 1 and 2 were invited to participate in the research. The children's age is outlined in Table 6. In this project were used a touchscreen tablet (iPad). The tablet's form factor and size offer more opportunities for supporting collaboration between peers. These devices allow the movement of children with the device along the area where the activity is being carried out (Nacher et al., 2016). Prior to the video recording session, all the children had experience using tablets, although not all of the children have necessarily access to tablets in their homes. The participants recruited in this research project consisted of Montessori preschool.

In this study, purposeful sampling has been used to identify teachers whose experience is in the research and pre-school question (Creswell, 2014). This includes selecting people who are knowledgeable about the experience, particularly education in digital game learning. Teachers needed to have a teaching position at the preschool level as well as at least one year of teaching experience (Appendix B).

3.2. Member checking

During one week, the author conducted the members' checking with each teacher and the participants' parents. Copies of the interview were sent to each participant after a week. The week after the observations, the checklists were sent to the parents and teachers of each participant. Each document was sent via email to the relevant participants. The members were interviewed and some of the observations were shared with each participant, and all the information was confirmed to be correct and valid.

<table>
<thead>
<tr>
<th>No</th>
<th>Name of digital game-based learning applications</th>
<th>Training focuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 1</td>
<td>AR flashcard – alphabet &amp; more</td>
<td>English language skills &amp; Science (learn the names of animals)</td>
</tr>
<tr>
<td>Game 2</td>
<td>Meet the animals</td>
<td>Science (learn about animal and their habits), music</td>
</tr>
<tr>
<td>Game 3</td>
<td>Toca Boca Nature</td>
<td>Science (learn about environment)</td>
</tr>
<tr>
<td>Game 4</td>
<td>Toca Boca Doctor</td>
<td>Science and knowledge (medical and human body)</td>
</tr>
<tr>
<td>Game 5</td>
<td>Cheebies story time</td>
<td>Science, Knowledge, Roll playing, music</td>
</tr>
<tr>
<td>Game 6</td>
<td>Squiggle</td>
<td>English language skills, reading &amp; writing</td>
</tr>
<tr>
<td>Game 7</td>
<td>Cheebies play time</td>
<td>Science, Math, Constructing &amp; creative activities</td>
</tr>
<tr>
<td>Game 8</td>
<td>Minecraft</td>
<td>Science, Technology, Mathematics, Engineering (STEM)</td>
</tr>
<tr>
<td>Game 9</td>
<td>Peppa pig collection (paint box)</td>
<td>Memory, Matching, Sorting, Constructing &amp; creative activities</td>
</tr>
</tbody>
</table>

Table 5

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Instrument detail</th>
<th>Output</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations (manual and video)</td>
<td>The observations were made based on a case study. The researchers looked at children who were using games based on digital education, and when children stopped playing, the researcher stopped watching. Access observations were made in accordance with parental permission and moral satisfaction, and video observations were made in a location with facilities and similarities to the Montessori school preschool. A monitoring schedule was also created to facilitate the process and ensure that all relevant data was recorded. Extensive narrative was provided of the process of creative development of children and their learning rate in games based on digital education from the research's point of view.</td>
<td>Children's and teachers' perspectives were recorded their creativity and justification for creative decision-making to enhance learning.</td>
<td>The research was done in a similar environment to Montessori Kindergarten and Preschool. Selection of children and monitoring of the continuous flow of children in the conflict with digital games to collect data. Data collection, monitoring, and research-based activities were performed by the researcher.</td>
</tr>
<tr>
<td>iPad and digital game-based learning applications</td>
<td>A semi-structured interview was used to questions for the children. The table questionnaire contains several open questions that produce qualitative data and several closed questions that provide semi-metrics. In the first phase, on nine of the occasions (top effective nine educational games), the author recorded and the teacher was present to the children. The apps were introduced to children and, then children were recorded during using the apps. The children were recorded when using apps sometimes chosen by themselves but at times they were directed to specific apps by the researcher and teachers. The children's observation and videos provided an insight into their preferences and decision making around their creativity skills, play-learning, and overall design of DGRL resources.</td>
<td></td>
<td>The children used the iPad during digital games, which was another source for the researcher's research on the impact of technology on creativity and learning.</td>
</tr>
<tr>
<td>Researcher-led activities</td>
<td>The children took part and were observed in four different structured activities: 1. DGRL and creativity skills 2. DGRL and play 3. Principles of GBL apps and learning 4. Difficulty of the use of games.</td>
<td></td>
<td>Data were monitored and collected within ten days. Simultaneously with the children's play, the time of use and selection of digital games was considered by the researcher.</td>
</tr>
</tbody>
</table>
Table 6
Demographic profiles of the case study children.

<table>
<thead>
<tr>
<th>No</th>
<th>Name (pseudonym)</th>
<th>Gender</th>
<th>Age at start of study</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Olivia</td>
<td>Female</td>
<td>6 years</td>
<td>Key stage 1</td>
</tr>
<tr>
<td>2</td>
<td>Yu Xin</td>
<td>Male</td>
<td>5 years 8 months</td>
<td>Key stage 1</td>
</tr>
<tr>
<td>3</td>
<td>Mani</td>
<td>Male</td>
<td>5 years</td>
<td>Foundation stage 3 (Reception)</td>
</tr>
<tr>
<td>4</td>
<td>Michael</td>
<td>Male</td>
<td>4 years 3 months</td>
<td>Foundation stage 3 (Reception)</td>
</tr>
<tr>
<td>5</td>
<td>Max</td>
<td>Male</td>
<td>4 years 6 months</td>
<td>Foundation stage 2 (Reception)</td>
</tr>
<tr>
<td>6</td>
<td>Ian</td>
<td>Female</td>
<td>3 years 8 months</td>
<td>Foundation stage 2 (Reception)</td>
</tr>
<tr>
<td>7</td>
<td>Lela</td>
<td>Female</td>
<td>3 years 2 months</td>
<td>Foundation stage 1 (Nursery)</td>
</tr>
</tbody>
</table>

3.3. Ethical protection of participants

In this research, the consent of the children's parents has been obtained. Ethical procedures were informed by the BERA Ethical Guidelines (2011). In addition, much attention was paid to body language and other issues indicating children's discomfort. For example, if a teacher stated that the participating child was feeling uncomfortable and tired, the interviews and video recording would be stopped (Dockett & Perry, 2011) (see Appendix A).

3.4. Data-Collection procedure and analysis

After collecting the interview data, the author began transcribing the information and verifying the validity and coding process. To analyze the interview data, the researcher used Hatch's inductive analysis model (Hatch, 2002). Using the Nvivo software, the author was able to create codes that revealed an original idea or concept in each interview question asked of teachers after seeing the children. Finally, the researcher managed to create a set of 128 codes using the initial encryption process of Saldana (Saldana, 2015). Re-analyzing the data provided an opportunity for the author to find ideas or concepts that he had lost during the initial reading and put them in the appropriate code. According to the themes and concepts, the researcher initially identified 128 codes, which were reduced to 30 codes using the model coding method. Table 7 shows some examples of how transcriptions were coded.

4. Result

According to themes and their descriptions, findings are divided into the following sections:

1. DGBL and creativity skills,
2. DGBL and play,
3. Principles of DGBL and pedagogy in applications,
4. The difficulty of the use of games.

In the first stage, the types of creative activities and applications that children use as a creative activity were discussed. This was followed by discussing all aspects of creative thinking based on the ACC framework (Robson, 2014). The most significant is the growth of creativity in the following three parts from a subsection of “Exploration and engagement”; “E1: Exploring”, “E2: Engaging in a new activity”, “E3: Knowing what you want to do”. In the second section, according to the characteristics of the game in classifying the factors influencing the development and strengthening of play and creativity in children, it was considered based on the classification of Hughes (Hughes, 2002). The results include things like; “objective play”, “exploratory play” and “creative play” that not only enhance children's play but also enhance their creativity. Then, in Section 3, the principles of digital games based on learning, which include creative learning and creative learning, are examined. Section four focuses on describing the difficulty of using games.

4.1. DGBL and creativity skills

In this section, the author's observations about children were two categories of creative activities and creative thinking;

4.2. DGBL and creative activities

The observation shows that selected digital games based-learning can be effective in encouraging preschoolers to play and improve their creativity. Observations and information collected from teachers in the interview environment as well as parents show that the digital environment, due to its high appeal to young children, allows children to play and explore for a longer period of time, which has an important role in fostering creativity and play children. There is no stress condition for young children in the digital environment compared to the school environment. Subsequently, this wholly causes the child to subconsciously pay more attention to learning and to increase his/her understanding of the issues being taught. Among the digital games studied, applications that included subjects such as storytelling, interactive books, and visual display, painting, and coloring attracted the most attention from children as creativity activities (see Table 8). According to teachers, the recurrence of digital games selected by the researcher has led preschool children to improve in some skills, including writing, painting, collage, and other artistic and creative activities. For example, Olivia's teacher says:

“Olivia was a very calm and shy child, and she rarely wrote English alphabets in the classroom in the traditional way on the paper. After watching the digital games on the iPad, she interested in applications”

Olivia's teacher says:

“I think the game space had interesting colors and interesting characters that made the kids more attracted to it and continue to focus on the iPad with more attention”.

Olivia’s teacher continued:

“After a while, Olivia started painting and drawing in these applications. So, this shows the depth of psychology's effect on the creative process in children’s learning. On the other hand, this means that after using digital games, the child will gradually become interested in learning to write the alphabet.”

It seems that children aged 3 to 4 are more likely to play applications with fewer challenges. However, the results of the interview show that children between 4 and 6 years old were very interested in challenging and fast games. Girls were more interested in coloring games than boys. Older children were more interested in photography and educational games, and younger children were more interested in simpler games such as storytelling and watching movies. According to parents and teachers, children have made good progress in learning the alphabet using these applications.

Through these programs that were installed on the iPad, teachers were able to get closer to the child's world. For example, another teacher said:
Lela was a very young child who did not speak English. Before playing with these applications, it was a little difficult to communicate with her. But she interacted more with us through painting and collage in these digital games. Gradually, she became more familiar with the letters of the English alphabet.

Another teacher stated that she had seen obvious creativity in pre-school children through applications. She mentioned puzzles or making things like Lego Minecraft and said:

“Mani was very interested in Lego. Some digital games provided him with various parts such as wheels, body parts, and doors, and he could build a car on his own, which was very enjoyable for him. On the other hand, Mani’s creativity in these applications was expanded unconsciously by choosing colors and placing different parts of Lego in other angles.”

In addition, music is a key element in the creative lives of young children. Music programs enable children to compose new own songs and listen to music extensively. This opens up a new world of science and art to children’s perspectives. Another teacher said:

“Ian created his song by touching the tablet buttons and then listening to it with pleasure. The applications gave him the opportunity to get to know the musical notes and their sound by playing them. Hence, it allowed a child (3 years old) to make his own music.”

4.2.1. DGBL and creative thinking

The children were mostly interested in exploring. In some games, they tended to discover a challenge and activity. For example, Olivia’s teacher said:

“She was trying to touch the game’s menu buttons on the tablet so she could understand the rhythm of the game. She showed that she enjoys it, and in the next step, the shapes and the charm of the digital game’s atmosphere encouraged her to spend more time playing.”

In other cases, the child was ready to engage in an activity and come up with an idea. This condition can be individualized or accompanied by another child or adult. This type of activity also has an indirect effect on children’s social skills indirectly. An example of this activity was observed in the movements and behavior of “Max” by the researcher. The following is an example of researcher’s observation:

“Max looked at the other children as they played with an application for painting and coloring, he drew a yellow circle on the tablet touch screen with a finger and told another child (sitting next to him) with a satisfied smile that it was the sun.”

On the other hand, it can be said that stimulating curiosity and creating a good interaction between digital games and children were reasons to continue playing with apps installed on the iPad. For example, when the child is making Lego in the Minecraft application. In the next part of researcher’s observations, she found that in order for children to receive better understanding in application games, the physical action and behaviors of children show that they wanted to find a new path using previous knowledge, in order to obtain a new idea or hypothesis that demonstrate the degree of flexibility or originality of thinking in the direction of creative thinking and divergent critical
thinking. For example, Yu Xin’s teacher says:

“He chose a green triangle and a red circle and then put them together and said it was a tomato and pretended to eat it.”

In summary, this study has provided a wide range of insights into children's creativity such as creative thinking, problem-solving, curiosity, exploring, et, through the use of applications. Based on ACCT framework, the most noticeable and most visible are three parts from a subsection of themes of Exploration and engagement that shows More

Table 9
Promoting creative thinking in DGBL applications.

<table>
<thead>
<tr>
<th>No</th>
<th>Name of digital game-based learning applications</th>
<th>Promoting creative thinking (code)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 1</td>
<td>AR flashcard – alphabet &amp; more</td>
<td>E1, E2, E3, P2</td>
</tr>
<tr>
<td>Game 2</td>
<td>Meet the animals</td>
<td>E1, E2, E3, I2, P1</td>
</tr>
<tr>
<td>Game 3</td>
<td>Toca Boca Nature</td>
<td>E1, E2, E3, I1</td>
</tr>
<tr>
<td>Game 4</td>
<td>Toca Boca Doctor</td>
<td>E1, E2, E3, P3</td>
</tr>
<tr>
<td>Game 5</td>
<td>CBeebies story time</td>
<td>E1, E2, E3, I4</td>
</tr>
<tr>
<td>Game 6</td>
<td>Squiggle</td>
<td>E1, E2, E3, P1</td>
</tr>
<tr>
<td>Game 7</td>
<td>CBeebies play time</td>
<td>E1, E2, E3, I3, I4, P1, P3</td>
</tr>
<tr>
<td>Game 8</td>
<td>Minecraft</td>
<td>E1, E2, E3, I1, P1, P2</td>
</tr>
<tr>
<td>Game 9</td>
<td>Peppa pig collection(paint box)</td>
<td>E1, E2, E3, I1, I3</td>
</tr>
</tbody>
</table>

4.3. DGBL and play activity

Data were analyzed in relation to the types of Hughes plays (Hughes, 2002). When the children were taking the tablet 16 types of plays were observed in the game, mentioned in Table 2 for each type of play with an example in this project. Educational digital games have become integrated into children's play styles. For example, when children used traditional playing activities such as building a Lego house, they replaced the use of Lego games in digital virtual space using tablets. By using DGBL applications, imagination and fantasy in children were strengthened because it was observed that children were interested in applications based on favorite characters and TV programs such as Peppa Pig and CBeebies story time. As Ian’s mother noted, “Ian’s interested in choosing apps that were related to the TV shows (such as Peppa Pig).” These applications also created a space of creative, objective, and acquired such as; creating virtual worlds (eg, Minecraft), science adventure (for example, Toca Boca Nature). Sometimes children liked specific aspects of applications to support their non-digital play. For example, Olivia’s teacher, who observed her student’s dancing behavior in a CBeebies episode, found that Olivia only liked the music of the app. Hence, according to the Table 11 results obtained in this evaluation of the features the types of Hughes games (Hughes, 2002), Objective play/Exploratory play/Creative play, have more nurtured in children (see Table 10).

4.4. Principles of DGBL and pedagogy in applications

During the project, it was observed that children respond positively to emotions when trying to learn skills and technical techniques. Most of the time, they were excited and calm instead of being upset or sad or bored. By looking at children, the researcher found that positive emotions help them to practice more. At the same time, practicing and efforts are a positive experience for young children. For example, children were almost always excited when digital technology was used for learning. Young students were curious to know how digital educational games work and what happens. The discovery of new features in digital games based on education has provided an opportunity to continue and create a learning process by doing activities that children have happily experienced. During the use of digital educational games, young students were eager to help each other with their initiative in using iPads and digital educational programs. From the researcher’s observations, it was concluded that children are engaged in learning as well as entertainment using digital technology. Teachers encouraged children to focus on using digital technology for specific purposes. Examples include children focused on educational games in mathematics, writing digital alphabets in the English language, and exploratory work in environmental science. Therefore, digital learning for young children leads to experience, analysis, composition, and evaluation of information obtained.

The researcher with a closer look at the data obtained from interviews with teachers, parents, and children, as well as videos, found that children’s participation in the use of digital technology for learning varies depending on the nature of the teaching and learning activities. In this study, the individual preferences of young students differ in terms of how teachers guide children in creative processes to create digital content. In structured activities, the teacher gave the children detailed instructions on how to make it. For example, the teacher asked kids to put three different shapes (circle, triangle, square) in their place in the virtual game. Meanwhile, in another case, it is the game itself that gives the child instructions for making a Lego. Sometimes a teacher or teaching-based digital game did not provide precise instructions on how to express for a new idea. For example, sometimes the teacher asked children to draw a shape needed in a digital game. The results emphasize that digital tools may encourage preschoolers to actively participate in work and learn together through problem-solving (Mills et al., 2013; Kubicki et al., 2015). In addition, sometimes while playing, the child is inspired by the challenges of the game, develops his or her own strategy for solving the problem, and uses creative thinking, all of which creates new knowledge one by one. For example, one teacher said;

“In a game where the child has to control the behavior of the character to help him survive in the new world and develop his skills. So the child has to change some of the factors of the game and learn new techniques and skills while playing.”

Teachers at the preschool level should be innovators who motivate, and challenge children to use digital technology for a variety of
learning purposes. Teachers make learning in digital-based games easier for children. The results suggested that teachers should reflect on their own specific methods and be flexible to adapt to the growing digital environment at different times to nurture young students. Therefore, in this study, with the emphasis on creativity in digital education, the main focus is evaluating components of creativity to measure in the level of learning. This study considers theoretical approaches and practical solutions for one of the most popular trends in modern teaching based on creativity. As mentioned in the principle in DGBL in the Table 11, the case study presented in this study describes creativity-based learning, which includes two categories principles; creative learning, and creative teaching. The use of these principles can be a creative approach based on education that can be effective in strengthening children's learning while fostering creativity. According to definitions of principles of DGBL (see Table 3), the results show that the themes of “inspirational” and “Personification” are more prominent on the basis of the DGBL principles of creative learning and that “attention” and “communication” are more prominent in the principles of creative teaching (see Table 11).

### Table 11

<table>
<thead>
<tr>
<th>No</th>
<th>Name of digital game-based learning applications</th>
<th>Principles of DGBL and pedagogy in applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 1</td>
<td>AR flashcard – alphabet &amp; more</td>
<td>Inspiration/Personification/Attention/Relevance</td>
</tr>
<tr>
<td>Game 2</td>
<td>Meet the animals</td>
<td>Personification/Gamification/Attention/Relevance</td>
</tr>
<tr>
<td>Game 3</td>
<td>Toca Boca Nature</td>
<td>Inspiration/Personification/Gamification/Attention/Relevance/Confidence/Satisfaction</td>
</tr>
<tr>
<td>Game 4</td>
<td>Toca Boca Doctor</td>
<td>Inspiration/Personification/Relevance/Confidence/Satisfaction</td>
</tr>
<tr>
<td>Game 5</td>
<td>CBeebies story time</td>
<td>Inspiration/Personification/Attention</td>
</tr>
<tr>
<td>Game 6</td>
<td>Squiggle</td>
<td>Inspiration/Personification/Attention/Relevance</td>
</tr>
<tr>
<td>Game 7</td>
<td>CBeebies play time</td>
<td>Inspiration/Personification/Attention/Relevance</td>
</tr>
<tr>
<td>Game 8</td>
<td>Minecraft</td>
<td>Inspiration/Personification/Gamification/Attention/Relevance/Confidence/Satisfaction</td>
</tr>
<tr>
<td>Game 9</td>
<td>Peppa pig collection(paint box)</td>
<td>Inspiration/Personification/Attention/Relevance/</td>
</tr>
</tbody>
</table>

Fig. 2. Game Difficulty.

4.5. Game difficulty

In this section, the difficulty in the use of games for children is assessed. This difficulty is divided into three categories: Difficult (is unable to do/unaware of), average (needs some assistance), easy (is able to do unassisted).

Application settings should be easy with audio and video support to prevent confusion for children. The main page of digital games should not have many views and complexities for children. Repetition of characters, shapes, colors, signs, movements, music, and sounds can be used as a signal to stimulate a child’s response. By using color and design features, the child can be attracted to the application and his/her creativity can be improved, and subsequently, their learning can be increased. On the other hand, if parents and teachers can activate or deactivate the features of the program (this should be provided by the program designer), they can focus more on developing children’s creativity and learning. For example, parents and teachers’ access to enabling and disabling program features in program settings to determine the level of digital game challenge for children can gradually increase creativity and problem-solving in children.

In addition, using too much text in the program menu confuses the child, therefore it is recommended to use visual symbols for applications. Feedback and rewarding the child’s performance is also an important solution to strengthen his/her skills and increase the level of learning, and on the other hand, the child is motivated to continue playing. For example, coins or stars can be given to game characters as a reward. However, not all games need rewards because the game itself is inherently provided motivating for children. Audio items in digital games should also be reinforced to remind children by sounding the desired symbol and to guide the child. Also, applications better have voice questions that the child should think about to answer. This result shows that the most used by children are in items such as “Swipe the Screen”, “Trace shapes with fingers”, “Volume”, “Drag item” (see Fig. 2).

5. Discussion

The study looked at components of creativity and learning levels in children under the age of six when using a number of selected digital games based on education. Here are the game categories based on Hughes ‘categories of play mentioned in the text of the article (Hughes, 2002), as well as categories of creativity components that were identified based on Robson’s ACTT framework (Robson, 2014). Careful analysis of children’s films under the age of six with teachers using selected applications showed that they are different in terms of creative thinking, play, and learning. It is obvious from the observations that some of the applications were better designed to improve the game and creativity and then increase in learning than other programs. The applications that promoted the most play and creativity were those that were specific to this age group, such as “CBeebies Playtime” and “Peppa’s Paintbox” which were subsequently successful DGBLs to increase learning. A closer look at these educationally-based digital
games reveals that fostering intellectual skills such as creativity, problem-solving, collaboration, and critical thinking is stimulated by the presence of game elements such as fantasy, curiosity, and challenge (Yang, 2012; Hwang et al., 2012).

Although children’s individual characteristics also affect their interaction with the use of programs, the greater appeal of digital games through spatial design with specific colors and the creation of characters that are age-appropriate may make interaction faster. Hence, DGBLs proper for this age group (preschool level) lead to faster interaction and the child will be more involved in the game and subsequent learning. An example for this age group is the use of the Minecraft application, which has led to a wide range of games and creativity skills and divergent thinking. According to reports and interviews teachers and parents, what in most cases led to creativity and raised the level of learning in children is the appropriateness of the digital games and the fact that these DGBLs had a deep connection with the children. Digital games, designed to address issues such as problem-solving, have improved children’s creativity and playability. On the other hand, these digital games also have a positive effect on the learning process and speed up the learning process in children by the problem-solving skill. While digital games did not focus on the problem-solving, they limited play and creativity and reduced learning in children under the age of six. The findings of this study also suggest that digital game-based learnings are suitable for combining creativity and topics such as science, technology, engineering, and mathematics (STEM), as it enables children to demonstrate the abstract and complex concept of the invisible based on real-life. This feature can be seen through three-dimensional games or other scientific visual phenomena, which is undoubtedly a specialized approach through digital games.

On the other hand, if the components of creativity and digital games based on education are combined with topics such as geography, social sciences, history, linguistics, and art, it will be more attractive for young children. Educational games based on education and creative components strengthen children’s ability to solve learning problems and interact and facilitate learning. However, more studies are needed to understand how performance and technology in DGBL applications work (Grammenos & Antona, 2018).

In addition, this study also highlights the important practical implications of creativity, especially for developers and teachers at the preschool level who want to use digital game-based learning programs in their classrooms. Teachers and designers of digital educational games need to understand how to foster the creativity of young learners so that they can increase the level of children’s learning while using the game. Teachers need to acquire the knowledge to use the technology and skills of digital games in order to keep up with the advancement of technology and digital games based on education. Creativity and teaching methods should be designed in such a way that sufficient independence is created for children and within the framework of the principles of education, which leads to the flourishing of children’s creativity. Since this study shows that interactive learning by developing creative skills using education-based digital game technology can be designed to support a variety of activities in young children. Hence, these DGBLs can be taught in different locations and learning spaces such as classrooms and make school easier and more effective at the preschool level (Gong, 2020). It seems that educational-based games with creative components can lead to fun, knowledge acquisition, increased interaction in young children, and on the other hand, strengthen the skills of cooperation in children along with improving learning.

Furthermore, due to the special feature of cyberspace in educational-based digital games, it is possible to reduce the financial costs of doing creativity and learning activities compared to doing these activities in the real world with traditional classroom methods for teachers and education. However, further researches need to be carried out to know how to design educational-based digital games on a variety of topics with creative components. Therefore, the need for more research is felt to enhance the learning and thinking and creativity of young students and to improve the work experience and processes of students in programs based on digital education programs (Beghetto & Karwowski, 2018; Gong, 2020; Lin et al., 2020).

The findings of the present study suggest that if program designers wish to design educational-based digital games that foster play and creativity and increase children’s focus on learning, they should incorporate several practical features into the game’s settings. Given the value that high-quality digital educational games can play in promoting children’s play and creativity, it is important that teachers and parents make changes to preschool-level settings when using applications in the curriculum. Since some children are more involved in playful and creative activities, if parents and teachers can enable or disable the features of the program such as determine the level of challenges, can focus more on developing creativity and learning among young children. Parents, doctors, and child psychologists need to be aware of the quality of the programs, as this can make a valuable difference in the purchase and selection of applications for children and their children. While there is evidence of gaming on other operating systems or hardware, such as Xbox, etc. recent research suggests that using tablets is the dominant screen in children’s lives. Data obtained from a researcher in 2017 shows that using tablets has increased dramatically in the lives of children under the age of six (Ofcom, 2017), hence, more research and insights are needed on the emerging types of emerging digital educational games and using tablets.

6. Limitation

Previous studies have shown that using a case study as the procedure in research has weaknesses as well as advantages (O’Neill et al., 2005; Kaufman & Beghetto, 2013). In interviews and writing with a limited time schedule and formal settings for a specific phenomenon, it actually prevents the possibility of examining and accessing the wider dimensions of participants’ behavior compared to long-term scheduling, which can be one of the limitations. In addition, the number of participants in this study is very small. The outcome of this study with this small number of participants may be different from the results of research on a large group of young children. Therefore, for future studies to increase the accuracy of the research results using more participants is suggested.

7. Conclusion

The purpose of this paper was to investigate the findings collected from the interview with teachers, parents, and young children (pre-schoolers 3–6 years old) based on a case study. This research explains how young children are encouraged to play creatively while playing digital educational games on tablets. The most effective features and components of creativity in learning in digital games and the link between them were examined. The role of teachers was also mentioned to stimulate the attitude of preschool students in strengthening creativity in digital educational games. Teachers in digital educational games with young children can be effective in creating the necessary motivation for learning, creativity, and other necessary skills in young children. Teachers can help preschool children to understand the problems and challenges in the digital space of educational games to empower children in the real world to face problems. This research could have a significant impact on children’s future lives in terms of innovation in empowering the conscious mind to provide the necessary solutions for life issues. This study provides a perspective on researchers, game designers, developers in the field of digital games based on education and creativity. This research provides insightful advice and effective suggestions on how to increase creative skills, motivate and improve learning outcomes, and demonstrate learning by combining DGBL in the teaching of young students.
Acknowledgements
This research is partly supported by University of Malaya research grant IIRG001B-19SAH. This work is also supported by the Interdisciplinary Research Programme Grant (IIRG) under project IIRG031B-2019.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.childyouth.2020.105227.

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