

Children's Digital Games in Early Childhood Settings

How Developmentally Appropriate Are They?

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Children are growing up in a media-rich digital environment where they are immersed in new technologies in unprecedented ways. Digital games are one of these technologies, and young children play a wide range of digital games. Research studies suggest that digital games support children's learning and development. The paper aims to assess digital games used by children aged 5 to 8 in Jordan in terms of their appropriateness for children. A random sample of 35 digital games used by K–3 Jordanian children was selected to explore to what extent these digital games are developmentally appropriate for children.

The researcher developed a developmental scale that consisted of 12 criteria. The results indicated that digital games used by children showed a moderate level of appropriateness. Moreover, the results revealed domains related to “clear instruction,” “social interaction,” and “technical design” to be the most appropriate, while domains related to “nonviolence,” “real-work model,” and “age appropriateness” were found to be the least developmentally appropriate. Furthermore, there were significant differences in the appropriateness of children's digital games across age groups. These findings are discussed, and implications are set accordingly.

Keywords: digital games, kindergarten children, developmental appropriateness, developmental scale

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InTr o Duc Tlon

Today's children live in a media-rich digital environment where they observe technology, explore it, and play with it, such as personal computers, laptops, tablets, smartphones, digital games, and other mobile devices (Ihmeideh & Alkhawaldeh, 2017). There has been extensive use of digital games by children who play a wide range of digital games. Although digital games are commonly popular among children as a kind of entertainment, nevertheless, they also provide a learning opportunity. Research studies suggest that well-designed digital games have educational benefits and can help foster children's development in multiple ways (Griffiths, 2002; Shute & Ke, 2012).

As a result of the expanding importance of technology and digital media in people's lives, digital games have taken a prominent place in today's society. The fact that people who are used to playing games play for about 10,000 hours before they turn 21, and that this period largely overlaps with the time spent in primary school, provides considerable insight into the role of digital games in people's lives (McGonigal, 2011). In designing children's digital games, early childhood education researchers (e.g., Berkovsky et al., 2010; Gee, 2009) suggested that for a game to be successful, it must engage and capture the player's attention.

Research studies revealed that learning increased in children because of playing digital games, as these games develop children's level of engagement and motivation (Prensky, 2001). Thai et al. (2009) found that well-designed digital games can facilitate learning, skill building, and healthy development in young children. Others agree these games can promote children's cognitive development (Sun & Gao, 2016). On the contrary, poorly designed games can lead to sedentary behaviors that are time-consuming and that have little to do with improving children's learning and healthy development (Epstein et al., 2008). Additionally, poorly designed games can be very harmful, instilling fear and anxiety, "demonizing" ethnic and sexual stereotypes, celebrating poor health practices, and teaching other unpleasant and harmful lessons (Christakis & Zimmerman, 2009). Often, these games do not follow developmentally appropriate design elements, and do not reflect and build upon children's play and learning styles (Garrison & Christakis, 2005). Despite children using e-games more often, there are limited studies assessing the design elements and content of commercially accessible apps (Chuang & Chen, 2007; Gomes et al., 2017). Therefore, it is vital to conduct more research to encourage strategies for designing games that will work well and are

developmentally appropriate for young children. Publishers and designers who care about the quality and benefits of their digital games could employ these findings to boost the quality and usefulness of their games (Lieberman et al., 2009).

Developmentally Appropriate Digital Games

Although digital games are becoming more widely utilized in many educational settings, there is little advice on what constitutes a high-quality game that is developmentally appropriate for children (Blumberg et al., 2019). The concept of developmentally appropriate digital games derived from the definition of “developmentally appropriate practice” (DAP) was first articulated by the National Association for the Education of Young Children (NAEYC) in 1986. According to DAP, young children benefit more and are assisted in their learning when they are exposed to learning experiences compatible with their developmental level (NAEYC, 2009). NAEYC describes learning in the early years based on a set of principles: (a) learning should be based on children’s level of cognitive and social development; (b) learning should take into consideration the individual learning abilities and needs of each child, and (c) learning should reflect the social and cultural context (NAEYC, 2009).

The NAEYC argued that any technology tools, including digital games, should be appropriate to the children’s age, meet individual differences among children, and reflect the cultural background and context of the country in which the children live (Dodge et al., 2003). The work of early childhood researchers (e.g., Edwards, 2005; Haugland, 2000; Siraj-Blatchford & Whitebread, 2003) emphasized the need to provide young children with developmentally appropriate technology and digital media. Early childhood researchers (e.g., Garrison & Christakis, 2005; Wartella et al., 2000) argue that many digital games for children are not developmentally appropriate, as they do not recognize or build on the ways young children play and learn. The games have not been evaluated with children to ensure that game play is enjoyable and helpful. Yet, there are some critical elements to ensure developmentally appropriate practices for technology integration. These elements are (a) educators should intentionally integrate the use of technology to maximize learning while managing screen time; (b) student use of technology should reflect a direct connection to instruction and result in demonstrated learning; (c) passive use of technology is not an acceptable replacement for active play and engagement with other children

and adults; (d) students at this age benefit from the opportunities to explore a variety of technology and interactive media; (e) students learn best when developmentally appropriate teaching practices guide the selection of classroom materials, including technology and interactive media; and (f) young children benefit from using technology to document their learning experiences. Developmentally appropriate contents are defined as materials suitable for the children's ages and abilities and not communicating harmful messages, supporting stereotypes, or compromising the emotional security of any child in the group. Materials that contain graphic violence and frightening or sexually explicit content are not considered appropriate for young children. Therefore, educators should carefully choose materials that enhance children's learning and creativity (Harms et al., 2019).

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In the views of Hirsh-Paseki et al. (2015), children learn most effectively when they are cognitively engaged while learning activities are relevant and involve social interaction. This is not to imply that learning cannot occur outside of these circumstances; rather, research studies demonstrate that these conditions often provide the right environment for learning to occur (Bagnato, 2017; Ihmeideh, 2015). Educational apps are, therefore, more likely to promote successful learning than those that do not if they incorporate some or all of these pillars into the learning setting.

Educators and researchers have begun systematically evaluating digital games to ensure that children receive developmentally appropriate digital games (Sweetser & Wyeth 2005).

To encourage deep learning, Gee (2009) established six essential features for outstanding digital games to encourage deep learning. These features are (a) an emotionally attached underlying rule system and game goal; (b) micro-control that creates a sense of intimacy or power; (c) learning opportunities; (d) a match between affordance and effectivity (a player's ability to carry out such an action); (e) modeling to make learning from experience more general and abstract; and (f) encouragement of players to enact. Gomes et al., (2017) conducted a study to assess the effectiveness of a digital game-based method to teach programming concepts to kindergarten children. The results revealed that some digital games were efficient in helping with the understanding of proposed concepts. The results did, however, imply that a grasp of programming ideas had been hampered by gaps in children's understanding of various

game interaction features. Clark et al. (2018) revealed that game playing is an essential element of a child's cognitive and social growth, as this type of learning is more effective for children than being asked to "recite" information from books. In a content analysis of the most popular apps for children under five, many of them were found to contain disruptive video advertisements or encouraged children to watch advertisements in exchange for rewards, both of which might distract young children from an app's core learning goals (Meyer et al., 2019, p. 33). In Taiwan, Chuang and Chen (2007) conducted a study to examine whether digital games, as opposed to traditional computer-assisted education, improve children's cognitive achievement. The findings show that playing digital games enhances participants' fact/recall processes and their problem-solving skills by helping them recognize various solutions to issues.

The researchers used different criteria in evaluating the quality of digital games. These criteria include, but are not limited to, age appropriateness, child in control, clear instructions, independence, nonviolence, process orientation, real-world model, technical features, and transformations, clarity (Haugland & Wright, 1997). Historically, the work of Haugland (1997), who developed a measure called the Haugland Developmental Software Scale, offered a clear understanding of what defines developmental software. Starting with "age appropriateness" and concluding with "transformations," the work is graded on a scale of 1 to 10. This scale is valuable for assessing preschool software, websites, and other digital resources. The researcher has designed a scale that includes some of these criteria for evaluating children's digital games implemented in Jordanian kindergartens.

sTuDy cOn TexT

In recent years, Jordan has witnessed a growing interest in using technology in the educational system. The education system in Jordan consists of a two-year cycle of education (preschool education), ten years of compulsory basic education (first grade to tenth grade), and two years of secondary education (eleventh grade and twelfth grades) (Ministry of Education, 2020). In the Jordanian context, children enrolled in K-3 (kindergarten, first grade, second grade, and third) are exposed to digital games through different resources, like play stations, video games, games apps on the Apple store or Android, and online gaming. Examples of the types of digital games implemented in Jordanian educational settings are

presented in Figure 1. For example, the electronic games implemented in kindergartens focus mainly on learning colors, alphabets, numbers, some puzzle games. In the first grade, the focus of the electronic games is on matching games between letters and words, games related to phonological awareness, and arranging numbers in ascending and descending order. In the second grade, children use electronic games to learn addition, subtraction, and sentence formation. In the third grade, electronic games become more complex as children learn games related to problem-solving, science experiments, and mathematics. One can argue that these digital games seem well designed and attractive, but without evaluating them, we do not know whether they are developmentally appropriate for children.



Figure 1. Sample of Children's Digital Games Used in Jordanian Settings

In Jordanian educational contexts, the use of digital games has expanded dramatically during the last five years. During the Covid-19 pandemic, several Jordanian schools (mostly private schools) started using digital games in their classrooms. It is worth mentioning that the Ministry of Education began its Digital Schools Program in partnership with some international and private agencies to provide disadvantaged children with modern technology and digital media, such as digital games and other technological activities. The number of schools employing digital technology is likely to increase in the coming years (UNICEF-Jordan, 2015). Despite recent advancements in this field, many digital games implemented in the Jordanian context are not designed in line with what are known as developmentally appropriate criteria. The researcher noticed that most of the digital games offered to children do not motivate them enough. Fun is lacking in these games. In reality, most digital games are just basic models to practice grilling and drilling. Due to a lack of current research on this research line, this study being the first of its kind, will fill this gap and try to evaluate the appropriateness of digital games for children's development. Exploring the quality of the digital games children engage with is a top priority at this time, since some digital games may contain violence or inaccurate information or may be culturally inappropriate. Thus, this study was designed and carried out.

Research Questions

This study aims to evaluate digital games used by Jordanian children aged five to eight in terms of their appropriateness for children. More specifically, the following research questions guided the current study:

- To what extent do children's digital games used by K-3 children match the developmental criteria?
- How does the appropriateness of K-3 children's digital games vary based on children's age?

Methods

This quantitative study focused on evaluating children's digital games using a scale prepared for this purpose. The researcher developed this scale to assess 18 children's electronic digital games implemented in Jordanian classrooms.

population and sample

This research was carried out in 30 Jordanian kindergartens and primary schools. Only kindergartens and schools that implement digital games in their educational practices were selected. They were randomly selected from the established population frame. Digital games implemented in these kindergartens and schools were selected (N= 18) to determine their appropriateness for children.

Research Instrument

The researcher created a developmentally appropriate digital games scale for assessing digital games implemented in K–3. This scale was developed after an extensive review of related literature (e.g., Haugland and Shade, 1990; Haugland, 2005; Jackson, 2000; O’Sullivan & Scott, 2000). The scale is based on 12 criteria: age appropriateness, individual appropriateness, feedback, social interaction, technical design, interactivity, culture appropriate, clarity, knowledge challenges, expending challenges, appropriateness of the content, and nonviolence. The items on the scale were graded on a 5-point scale, with 5 being “outstanding” and 1 being “unsatisfactory.” The following are the criteria used to evaluate children’s digital games based on the developmentally appropriate digital games scale: “outstanding” from 5.00 to 4.00; “good” from 3.99 to 3.50; “fair” from 3.49 to 2.50; “poor” from 2.49 to 1.75; and “unsatisfactory” from 1.74 to 1.00. To test the validity of the scale, it was given to seven reviewers who are early childhood education and educational technology experts working at the Ministry of Education and two universities. The expert panel was asked to verify that the scale’s content was correct and adequate in terms of language clarity, to check the relevance of each item to the scale’s main domain, and to confirm that all scale items should be considered developmental criteria and be appropriate for the Jordanian context. Some items (in the scale) were added to the scale due to the experts’ changes, while other items were removed or modified.

The inter-rater reliability of the scale utilized in assessing e-games was examined on five digital games (excluded) from the research’s actual sample. Two research assistants scored each digital game separately. The researcher administrated the Kappa equation (Brennan & Silman, 1992) to test the reliability scores. The alpha score of this measure was 0.81, which was considered satisfactory for the purpose of the study.

Data collection

After being validated and found reliable, the scale was suitable for assessing the educational games intended for children in these age groups from kindergarten to third grade. The researcher instructed three research assistants to evaluate each digital game using the developmentally appropriate digital games scale. The research assistants directly visited the kindergartens involved, met the principals, explained the study's objectives, and assured them that the information would be kept confidential. Kindergartens and schools visited were asked to provide the research assistants with a list of electronic games frequently used by children. Research assistants evaluated those electronic games outside of schools and kindergartens. All of the children's digital games included in this study were assessed independently by each evaluator.

Data Analysis

The percentage of agreement between each assessor was calculated. Means and standard deviations for each item included in the developmental scale were presented. The scale items were assessed on a 5-point scale, with 5 indicating "excellent" and 1 indicating "unacceptable." Additionally, one-way analysis of variance (ANOVA) was utilized to explore the differences based on the children's age.

Results

Results pertaining to research Question 1

Research question 1 examines to what extent children's digital games used by K-3 children match the developmental criteria. Descriptive statistics, including means, standard deviations, and ranks, were utilized to analyze the answer to this question. As shown in Table 1, data analysis indicated that the mean value for the total scale was fair (3.33), representing a moderate degree of appropriateness. The most developmentally appropriate category found in children's digital games was "clarity." This category, falling within the classification of "outstanding," had the highest mean score of 4.73, followed by "social interaction" with a mean score of 4.51, and "technical design" (Mean= 4.44). Next, the categories "nonviolence" and "expanding challenges" had mean scores of 3.77 and 3.76, respectively, falling within the "good" range. Moreover, the categories "independence," "feedback," and "appropriateness of the content" had mean scores of

3.30, 2.90, and 2.85, respectively, falling within the “fair” range. “Age appropriateness” was ranked as the least developmentally appropriate measure in children’s digital games with a mean score of 2.01, followed by the “culture appropriate” category with a mean score of 2.20; both of these categories were classified as “poor.”

Table 1. The Mean, Standard Deviation, and Rank of the Items Included in the Developmental Scale

No.	Category	Mean	Standard Deviation	Rank
1	Age appropriate	2.01	0.67	12
2	Individual appropriate	2.80	1.23	10
3	Expending challenges	3.76	0.92	5
4	Interactivity	3.72	0.68	6
5	Technical design	4.44	0.50	3
6	Social interaction	4.51	0.87	2
7	Culture appropriate	2.20	0.66	11
8	Clarity	4.73	0.39	1
9	Nonviolence	3.77	0.96	4
10	Feedback	2.91	0.80	8
11	Appropriateness of the content	2.85	1.06	9
12	Independence	3.30	1.25	7
	Total	3.33	3.35	

r results pertaining to r esearch Question 2

Research question 2 determines whether significant differences existed in children’s digital games due to the children’s age group (from 5 to 8 years old). To answer this research question, one-way ANOVA was utilized.

The data contained 18 digital games used by children ages 5 to 8 . The results showed statistically significant differences at $\alpha < 0.05$ in children’s digital games that are attributed to the children’s age group. These differences were found in the domains related to “clarity” $F(7.82) = P(0.00)$ and “appropriateness of the content” $F(18.82) = P(0.00)$ in favor of kindergarten children aged 5 years old. Furthermore, differences were also found in the “age appropriate” $F(19.65) = P(0.00)$ domain in favor of second grade children (aged 7).

Discuss Ion

Digital games have become increasingly essential in the lives of children in recent years. Effective design based on a developmental perspective is

crucial to the success of digital game-based learning. This study aimed to evaluate the digital games implemented in Jordanian kindergartens and primary schools in accordance with developmentally appropriate criteria.

The mean overall score on the developmental scale was 3.43, which was considered “fair” in this study. Educational technology tools are extensively used in many aspects of our educational practices; thus, it is clear that the designers of digital games have become more interested in this tool in early childhood classrooms. The designers may intend to adhere to the appropriate criteria in developing these digital games to meet children’s developmental levels. It is noted that most of the digital games implemented in Jordanian kindergartens and schools are digital games designed in western countries in which the designers may have adhered to developmentally appropriate criteria. However, there may be digital games of a commercial type that have been designed without considering children’s developmental levels. In the view of Lieberman et al. (2009), it is vital to develop game design strategies that work effectively and are developmentally appropriate for children.

It was also found that the most developmentally appropriate category found in children’s digital games was “clarity,” followed by “social interaction” and “technical design.” This finding was not surprising because designers of digital games may have a solid knowledge of the digital games’ criteria that require clarity. This criterion of “clarity” is crucial to the children’s continuation of the e-game; for instance, if the instructions are unclear, the child will flee from the game and leave it. Lieberman et al. (2009) argued that digital games should give clear, repeatable verbal and visual information explanations and presentations. The designers may also be aware of children’s need to play digital games with their peers, so they encourage social interaction. Digital games become social activities when opportunities for social interaction exist. Muller & Perlmutter (1985) pointed out that children will participate in cooperative social engagement when playing digital games in the classroom. Moreover, technical features such as sound and graphics can arouse children’s desire and interest to continue playing.

Furthermore, the results revealed that the categories “nonviolence” and “expanding challenges” were classified as “good,” while the categories “independence,” “feedback,” and “appropriateness of the content” were ranked as “fair.” There is no doubt that the criteria that are related to nonviolence and appropriateness of the content are some of the critical criteria in designing digital games. Obviously, depictions of violence negatively affect children’s behavior, so the goal is to develop children’s growth and learning, not to develop negative values. Haugland (2005) stressed the

importance of avoiding depictions of violence in children's digital software. Anderson et al. (2004) suggested that digital games with violent content enhance aggressive behavior, antagonism, fear, and desensitization to violence in young children. Most of the digital games included in the study encourage independence, as children need not rely on teachers or parents to complete the game or to move from one level to another.

Lastly, "age appropriate" and "culture appropriate" were ranked as the least developmentally appropriate in children's digital games and were classified as "poor." This may reflect that the designers of the digital games, despite their sufficient knowledge of the technical features of the e-game, may not be aware of the educational dimensions of the products. In the views of Hirsh-Paseki et al. (2015), when developing and marketing an app, some e-game developers have specific learning objectives, such as teaching children how to add and subtract, while others have no clear learning goals and design their e-games only for entertaining.

Digital games must be designed by specialists in early childhood education and technical designers. The digital games' designers must consider the developmentally appropriate principles and ensure that the e-game is appropriate for the child's age, individuality, and culture. This criterion is one of the core standards of the NAEYC (2009), which emphasizes the importance of designing developmentally appropriate technology tools by experts in early childhood education and development.

The results also revealed statistically significant differences in the domains related to "clarity" and "appropriateness of the content" in favor of 5-year-old children. It is noted that digital games for kindergarten children (aged 5 years old) have more appropriate content than digital games designed for first graders (aged 6 years old) and second graders (aged 7 years old). This may be because there is a great emphasis on the content for younger children to ensure its safety and appropriateness. Differences were also found in the "age appropriateness" domain in favor of second-grade children. This means that the digital games for second-grade children were more age appropriate than those designed for kindergarten and first-grade children. This result may seem expected because designing digital games that are age appropriate for kindergarten children may be difficult in the absence of input from specialists in early childhood education.

concl us lon

It may be concluded that children's digital games are developmentally appropriate to a considerable extent. There were significant differences in

children's digital games due to children's groups, as kindergarten children have more developmentally appropriate digital games. The Jordanian Ministry of Education needs to take a leading role in assessing the quality and appropriateness of children's digital games being implemented in their schools. It must ensure that schools avoid using digital games that are either ineffective with children or inconsistent with their development and learning. Digital games should offer something valuable for young children. The selection of digital games is undeniably an important and necessary responsibility for those who work with young children. Furthermore, major stockholders should ensure that children's digital games are designed by professionals, comprised of teachers and people who are knowledgeable about technical design and its applications, as well as individuals who have a good understanding of children's development and learning.

Teachers in kindergarten and primary school need to be trained to make informed decisions about how to best implement developmentally appropriate digital games in their classrooms, as well as to assist parents in learning about the best methods to introduce digital games at home. Indeed, as children spend most of their time at home and may use digital media, parents need to understand how to assist their children's learning while playing digital games. To reflect Arabic culture, traditions, and customs, game designers in the Arab world should be encouraged to create digital games in Arabic. In this regard, digital game developers who are interested in designing and assessing digital games across the world could find the results of this study beneficial from the criteria of the developmentally appropriate digital games utilized in this research.

One limitation of this study is that no effort was made to study the perspectives of children, teachers, parents, or digital games designers to get a more detailed picture of the effectiveness of children's digital games and how they are designed, selected, and used in classrooms and homes. As a result, it would be useful to do further studies on these aspects. Moreover, there is a need for more studies to compare children's digital games in different contexts worldwide.

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