Effects of Digital Game-Based Learning on Elementary Science Learning: A Systematic Review

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ABSTRACT Digital game-based learning (DGBL) has been perceived as an engaging teaching approach to foster students’ learning and motivation. There are different opinions about the potential benefits of gaming on students’ academic achievements, motivation, and skills in science courses due to the lack of empirical evidence and mixed results. To address this issue, this paper provides a review of relevant literature from 2006 to 2017 to examine the effects of using educational computer games in teaching science at the elementary education level. This paper employed a multidimensional framework to classify learning outcomes from studies of DGBL applications in the area of elementary science education. The findings of this review show a promising potential of DGBL, particularly in the area of content understanding. However, the findings of the review also suggest that there is a need to provide additional research in order to gain a more comprehensive picture of the educational effectiveness of DGBL. Hence, researchers are advised to conduct more randomized controlled trials (RCTs), various learning modes (e.g., collaborative and individual), and comparisons of DGBL to traditional methods of teaching. Furthermore, the researchers are highly encouraged to examine the effectiveness of DGBL applications in other areas, such as problem-solving and critical thinking. The findings of this review can benefit educational computer game designers, educators, and practitioners in the area of science education, particularly at the elementary level.

INDEX TERMS Digital game-based learning, science education, serious games, systematic review.

I. INTRODUCTION

Computer games are one of the most popular leisure activities among children and adolescents [1], [2]. The earliest trends in research assessing the psycho-social effects of computer games focused on their negative effects such as addiction [3], aggressive behavior [4], and poor academic performance [5].

The prevalence of computer games has henceforth collectively and interchangeably called serious games or Digital Game-Based Learning (DGBL) [6] prompted researchers and educators to use this medium in education [7]–[9]. A serious game is a computer game designed for learning, training, and behavior change [7], [10], [11]. It is suggested by a number of scholars that the utilization of serious games could benefit students’ learning engagement [11], learning performance [12], and motivation [13]. However, other studies showed the contrary, namely that DGBL environments did not produce positive learning outcomes [14], [15].

In response to the contradictions of previous findings, this study synthesized several literature reviews to examine the empirical effectiveness of the DGBL approach. Some of the studies provide support to the claim that DGBL is a promising instructional style. For example, Vogel et al. [16] performed a quantitative meta-analysis with 32 articles spanning from 1986 to 2003 and revealed that learners who used DGBL obtained greater cognitive gains and demonstrated better attitudinal outcomes than students who learned via the traditional teaching method. Similarly, Connolly et al. [7] and Boylest et al. [17] analyzed 129 papers ranging from 2004 to 2009 and 143 papers from 2009 to 2014, respectively and


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