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Is Digital Game-Based Learning Possible in Mathematics Classrooms?
A Study of Teachers' Beliefs

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ABSTRACT

The literature reports that while digital educational games are used in the elementary classroom, they are rarely, if ever, used in the upper secondary mathematics classroom. In order to investigate this situation, a survey was conducted to determine what upper secondary school mathematics teachers think about digital games and what obstacles and limitations they perceive in using DGBL as a teaching approach. The results indicate that mathematics teachers view digital games as a useful teaching tool; however, the lack of knowledge about teaching with digital games and shortage of appropriate games for teaching upper secondary mathematics seems to discourage them from using them as a main teaching tool. These findings imply that professional development should be designed with a focus on teacher training. Furthermore, the development of constructionist-based games should be considered, where games are based on meaning-making rather than practicing mathematical content, as has previously been the case.

KEYWORDS

Barriers, Classroom Implementation, Digital Educational Games, Mathematics Instruction, Upper-Secondary Mathematics Teachers

INTRODUCTION

Over the past two decades, mathematics education has been rethought in the context of integrating digital technologies into the classroom. This has led to an apparent need to change the way mathematics is taught, away from siloed and fragmented traditional approaches towards integrated, interdisciplinary, and holistic approaches. Digital game-based learning (DGBL), an approach introduced by Mark Prensky (2001) as a descendant of game-based learning (GBL), can be a powerful tool in supporting this transformation of mathematics education. DGBL is a learning approach based on the idea of

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using digital games for educational purposes. Moreover, DGBL is also associated with important 21st century skills such as critical thinking, creativity, problem-solving, agency, collaboration, communication, and digital literacy (Gee, 2005; Williams-Pierce, 2019).

While DGBL has gained popularity in research in recent years (Byun & Joung, 2018; Fadda et al., 2021; Coleman & Money, 2020; Hussein et al., 2022), little attention has been paid to the opportunities it can provide for upper secondary mathematics. Mathematics in upper secondary grades is abstract, often lacks meaningful contexts, and is associated with negative student attitudes such as lack of motivation, disengagement, and lukewarm interest (Ashcraft, 2002; Hannula, 2002). Integrating DGBL practices into secondary mathematics classrooms in a fruitful way, where students take an active role in their learning process, could be an essential pedagogical strategy to address this long-term problem. However, a significant issue with DGBL in general is the relatively low rate of adoption among teachers who continue to use traditional approaches and tools for teaching mathematics (Rüth et al., 2022). Teachers play a key role in bringing this approach into practice, thus to a certain extent their opinions and beliefs are the starting point for developing and implementing digital games for teaching mathematics at the secondary level. The purpose of this study is to explore upper secondary mathematics teachers' perspectives on the challenges and barriers related to implementing DGBL in their classrooms.

THEORETICAL BACKGROUND

Digital Educational Games and DGBL

This section distinguishes between educational or serious games, entertainment games, and gamification in order to explain the authors' stance on the position of digital educational games, as despite their similarities, these terms are not interchangeable. Digital games, also called video games or computer games, are played on a computer, game console, smartphone, or tablet (Fadda et al., 2022). Educational games combine learning with gameplay (Hussein et al., 2022). To distinguish them from entertainment games, in the gaming industry educational games are referred to as serious games. Serious games often use graphical simulations of reality to meet learning or training goals for a specific stakeholder or user group (Martens & Muller, 2016). However, serious games may also be designed for purposes other than education, such as behaviour change or therapy. Thus, two terms came to existence: applied games and educational games. Because the applied game does not necessarily teach (e.g., applied games may be used for healthcare), we will use the term digital educational game for games used in an educational context where the intention is to learn rather than to have fun. The term gamification describes the utilization of game design elements in non-game contexts (Deterding et al., 2011). Gamification is often limited to points, badges, levels, and leader boards. Some scholars view gamification more broadly. For instance, Chou (2019) identifies eight core drives—epic meaning, accomplishment, empowerment, ownership, social influence, scarcity, unpredictability, and avoidance—that can be found in various games. These drives may inspire the gamification of other activities. This paper examines the use of digital educational games as opposed to the use of gamification. DGBL is seen as a student-centred approach in which educational goals and content are incorporated into games to encourage students to learn and advance their knowledge and skills by providing an engaging learning environment.

Teacher Perceptions and Barriers to Using Digital Educational Games

New technological developments have prompted the creation of digital educational games that are intended to complement learning as well as be incorporated into teacher practices and curricula (Callaghan et al., 2018). However, teachers' instructional practices are guided by what they believe about mathematics and the teaching and learning of mathematics (Liljedahl, 2008; Thurm & Barzel, 2022). Thus, what constitutes a DGBL environment in the school is closely related to how teachers