A DESIGN THINKING APPROACH IN GAME DESIGN-BASED LEARNING

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ABSTRACT
Design Thinking (DT) is a user-centred methodology where designers develop innovative solutions by exploring users' needs, defining problems, prototyping, and presenting designs (Huq & Gilbert, 2017). Existing research suggests that incorporating DT in education can enhance students' skills (Scheer et al., 2012) and knowledge acquisition (Cook & Bush, 2018). However, challenges remain, such as aligning DT with curricula, adapting to existing school structures, and managing the inherent ambiguity of the process (Carroll et al., 2010; Al-Zebdyah, 2022; Panke, 2019).

This paper presents preliminary findings from two school interventions conducted under the ongoing European project "*Extending Design Thinking with Emerging Digital Technologies*" (Exten.(D.T.)[2]). Following a design-based research methodology (Bakker, 2018), the project employs constructionist media, to enhance the pedagogical value, digitization and implementation of Design Thinking (DT) in school settings. In this context, learners engage with key concepts and generate powerful ideas by constructing and tinkering with digital creations that hold personal or collective meaning (Papert, 1980; Kafai & Burke, 2015). In this paper, we focus on how this approach can not only facilitate DT implementation in schools but also align with curriculum objectives, enhancing domain-specific knowledge.

During the DT activities designed for the interventions discussed here, students tackled real-world issues by designing and refining digital games, based on the preferences and feedback from a certain audience. Using two free, open-source digital authoring tools, ChoiCo and SorBET, they created or modified digital game prototypes from scratch, employing a block-based programming language. ChoiCo supports the development of choice-driven simulation games (Grizioti & Kynigos, 2021), while SorBET enables users to modify or fully design classification games (Grizioti & Kynigos, 2024).

In the first intervention, a group of six 12-year-old students in a Math class worked in teams and modified the ChoiCo game: "*Shopping in the Supermarket*"[1]; designed to

[1] http://etl.ppp.uoa.gr/choico/?shopping_Eng

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engage them with concepts like multiplicative relationships, arithmetic operations, and mental calculations. Players select products from a pantry that alter predefined fields such as "Money," "Total Pieces," "Health," and "Joy," represented by positive or negative values or algebraic expressions. The objective is to collect as many pieces as possible without letting any of the variables exceed preset upper or lower limits (e.g., keeping *"Health"* above zero). The students' task was to adapt the game to create a more engaging math practice experience for younger students (ages 10-11). Acting as designers, students modified the game's content by adding or removing products or fields, defined the consequences of choices, and programmed the game rules using block-based programming.

In the second intervention, titled *"Cyber Security with SorBET"*, 30 students aged 12-13 in a computer science class, collaborated in pairs and designed classification games aimed at raising awareness about online safety for various stakeholders, such as their friends or family members. In these games, as players, users need to correctly classify the falling objects, in a critical-time context, by placing them in the appropriate category - applying decision-making practices to achieve high scores. As designers, the students determined the game categories, chose the objects to be displayed for classification (as images or text), and set the pace and frequency at which they would be displayed, during gameplay.

Throughout both interventions, two researchers guided the students, helping them navigate the digital tools and facilitating their activities. Data collection methods included audio recordings of students' discussions, screen recording videos, questionnaires, and interviews with students to capture their learning experiences and reflections.

Preliminary results underscore the potential of integrating constructionist media into Design Thinking activities to support domain-related learning outcomes. In the *"Shopping in the Supermarket"* project, students effectively used negative number values to represent negative consequences while also engaging in meaningful data collection and analysis (Shah & Hoeffner, 2002). They gathered user feedback through questionnaires and interpreted the data using graphical representations (Garfield & Ben-Zvi, 2009). Additionally, students developed and solved numerical and algebraic expressions (Radford, 2018) and integrated verbal problem-solving tasks into their modified games.

Similarly, in the cybersecurity project, students reported a deeper understanding of cybersecurity concepts, evident in their ability to incorporate the information they gathered into their game designs. For instance, a team focused on online phishing developed game elements that depicted suspicious messages or ads containing scam details, which they composed themselves using images or text editors. These objects were then assigned to categories as "*definitely trustworthy*", *"appears safe but needs investigation"*, or *"scam"*. During interviews, a student commented: *"I learned about firewalls, which I knew nothing about, and I learned about different viruses and how they get into our computers"*. Another student pointed out that learning occurred *"both from the online resources given and the fact that apart from just reading them* *we used them to create something for someone else - a game"*, emphasizing the hands-on approach under which they accessed learning content, underscoring the value of designing with others in mind.

In conclusion, integrating constructionist media into DT activities holds promise for creating dynamic, collaborative learning environments that promote concept development and domain-specific learning outcomes aligned with curriculum objectives. By leveraging digital authoring tools, DT provides a purposeful, context-driven framework that emphasizes relevant, user-focused problem-solving, enabling students to apply their knowledge in meaningful, real-world scenarios. Further research and broader implementations could yield deeper insights into the educational benefits of such interventions. Future directions include the development of a specialized DT model for educational in-school settings and the creation of robust assessment tools to support educators in evaluating student learning outcomes.

Keywords: Design Thinking, Game-Based Learning, Educational Technology

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