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Enhancing Computational Thinking through Constructionist Gaming in a Roblox-supported Virtual Makerspace

Gyuri Byun[1], Jewoong Moon[2], and Chen Sun[3]

[1] Youlhyun elementary school, Suwon, South Korea
[2] The University of Alabama, Tuscaloosa, United States
[3] The University of Manchester, Manchester, United Kingdom
quty9711@gmail.com

Abstract. This work-in-progress paper proposes the design of constructionist gaming within the Roblox 3D platform to teach CT among undergraduates. We introduce a learning system framework that combines Roblox with custom plugins for enriched game-making activities. This approach is designed to foster seamless learning experiences, extend education beyond traditional classrooms, and promote skills in problem-solving and collaboration. By leveraging Roblox's immersive environment, the study aims to design a dynamic platform for active learning and skill development, offering insights into the effectiveness of constructionist gaming in educational settings.

Keywords: Computational Thinking, Game Making, Roblox, and Constructionist Gaming.

1 Introduction

The integration of constructionist gaming emerges as a promising strategy for advancing digital literacy and computational thinking (CT) [1]. Constructionist gaming, characterized by its sandbox-like environments where learners can experiment with their ideas, plays a pivotal role in engaging learners' in active learning and fostering essential 21st-century skills [2] such as problem-solving, logical reasoning, and teamwork. Despite its potential for teaching CT, there is a research gap in educational practices regarding its integration into teaching methodologies. This study aims to bridge this gap by proposing a system of constructionist gaming within immersive 3D gaming platforms to effectively teach CT. As such, the current paper illustrates a design framework to utilize Roblox and various plugins to support learners' constructionist gaming processes and enhance CT development.

2 Literature Review

Constructionist gaming [3] is rooted in constructivist learning theory, which suggests that knowledge is best acquired through active engagement with the world. Constructionism posits that learners construct new knowledge on the foundations of their existing knowledge through interaction with their environment and through the process of creating something tangible [4]. This approach is particularly effective in the context of computational thinking [5], which involves not just understanding concepts but applying them in complex and often novel situations. With the advent of recent technologies, learners can engageconstructionist learning in more interactive ways, such as through simulation-based learning. Among various platforms, games have emerged as an ideal venue for constructionist learning. Game-making engages players in problem-solving, critical thinking, and understanding complex systems—all key facets of computational thinking. However, despite its potential [6, 7], empirical studies focusing specifically on the integration of constructionist gaming in 3D gaming platforms for teaching CT remain scarce. This highlights a need for a more concentrated exploration of specific studies that examine game-making's role in teaching computational thinking, aligning closely with our design goal.

3 System Design Framework

We are currently building a virtual makerspace within the Roblox platform, optimized for constructionist gaming, to enhance CT and digital literacy among undergraduates. This virtual makerspace will serve as a virtual sandbox where learners engage in game-making activities, fostering problem-solving skills and collaboration competency. Figure 1 portrays the parts of the virtual makerspace system connected.

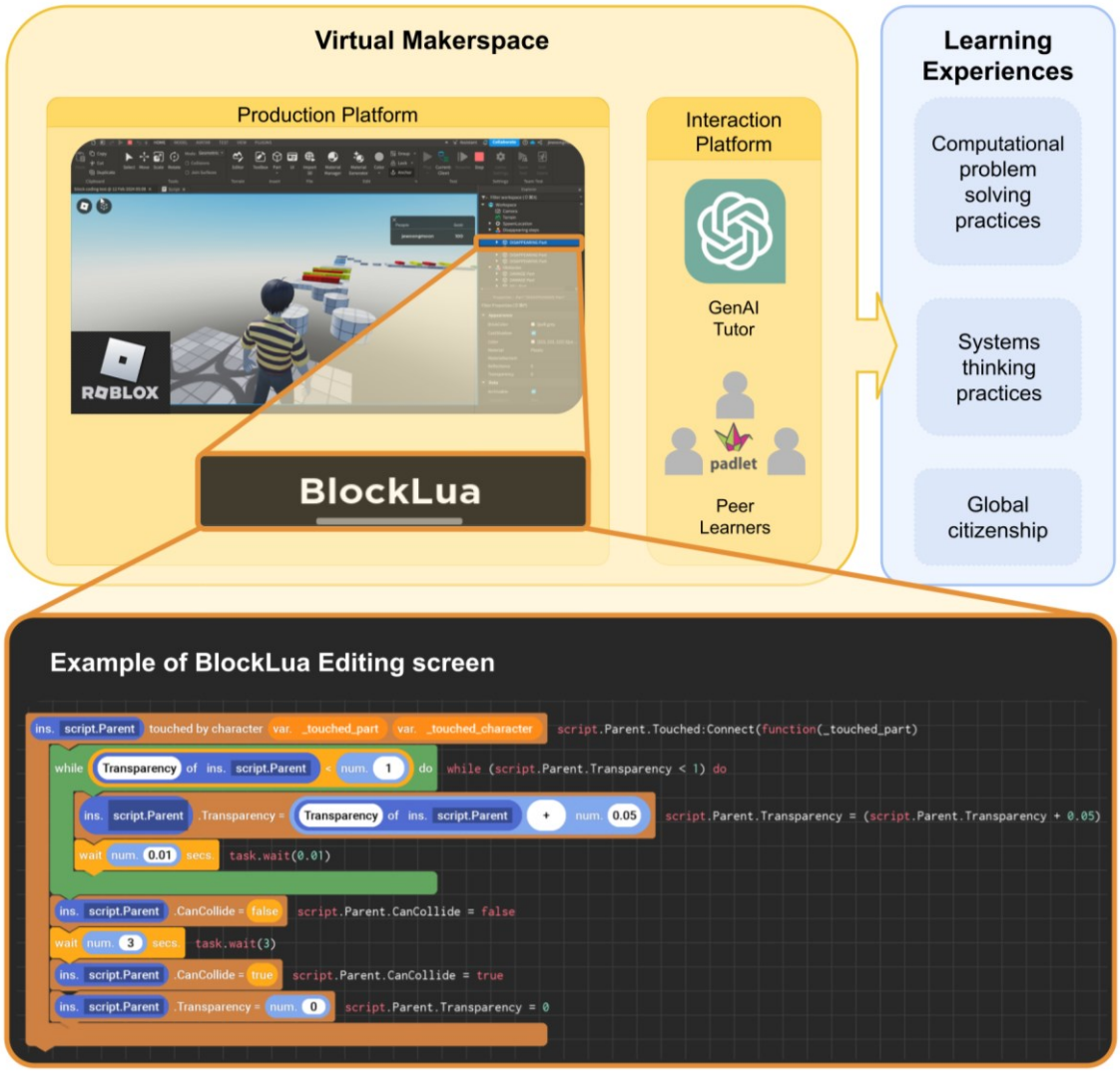

Fig. 1. Components of the virtual makerspace system: a) plugins to support game-making activities; b) embracing the latest generative AI as assistant tutor to support the game-making activities.

3.1 Learning Plan Design

The objectives of the curriculum will be to 1) cultivate CT competencies, including computational problem solving practices and systems thinking practices [6]; 2) foster students' understanding of global citizenship [3]. During the gaming making processes, learners can embed their idea into the algorithms and programming languages, and thus they can become familiar with relevant skills and CT competences. Furthermore, design experience of making games and sharing them with their peers help to foster their role as a media creator, aligned with the big idea of global citizenship. To aid learners in resolving challenges within their zone of proximal development [8], the researchers are currently investigating the capabilities of the generative AI assistant tutor.

3.2 Game-Making Platform Selection

Our constructionist gaming platform aims at satisfying the following criteria: 1) low-threshold-high-ceiling [9, 10]: The game making platform should provide various levels of programming tools for learners with different skill levels; 2) repeated trials [11]: learners should be able to repeatedly and immediately observe the results of their programming throughout the development process; 3) learner collaboration [12]: learners should be able to collaborate with their peers within the game making platform; and 4) Presentation of work [12]: learners can exhibit their own products to their peers and also experience the games of their peers. We accordingly chose Roblox as the game making platform of this research wherein learners can develop their own 3-D games and exchange one another's game design ideas and CT-related thoughts.

3.3 Learning Experience Design

Learning experiences via the proposed platform can be divided into three main categories: 1) understanding of structure and logic of the text-based programming languages; 2) interactions that happen through a separate interaction platform (e.g., online media for a community channel); and 3) collaboration and interactions that occur on the game-making platform.

First, learners can make their first understanding about the text-based programming languages through the comparison between the block- and text-based scripts. With the usages of the Roblox plugin BlockLua [13], the programming script of each object can be converted from the text-based code scripts to the block-based expressions. Furthermore, the text and block-based codes will be juxtaposed in the Roblox studio platform. Given this layout's features, learners can easily connect the text-based codes with the understandable block-based codes,thereby helping them to construct their logical understanding of text-based codes with visual augmentations. By dragging and dropping code blocks, learners can immediately see the results of their code, promoting active experimentation and learning.

Second, the learners are able to enhance their ability to devise, revisit, and refine design ideas in a collaborative manner. Within the virtual makerspace, the learners can experience two kinds of interaction: collaboration with a GenAI-empowered tutor and peer students. Learners can get additional scaffolding about their design challenges through the interactions with the GenAI tutor and shape various ways of scripting, related to CT. The GenAI tutor adjusted the levels of game making challenges by dividing the confronted problem into simple questions [12].

Third, learners are able to engage in collaborations across various communication channels and game making platforms. Through the interactions occurring in the virtual makerspace, the learners can observe the design and deployment processes of others' artifacts, refinement of their own works, and ways of requesting peer feedback through collaborations. Such social interactions within game-making and community platforms can lead to interpersonal conversations and shared works in virtual makerspace. The seamless transition between these platforms allows learners to effectively discuss and execute collaborations. The . The resulting products of these collaborations may be re-posted to the virtual makerspace, inspiring further collaboration among peers. It enables learners to publish their games and share them with a global community, providing opportunities for feedback, collaboration, and further learning.

3.4 Discussion and Conclusion

This preliminary exploration has sought ways to build a virtual makerspace world within the Roblox platform, aimed at enhancing CT and digital literacy among undergraduates through constructionist gaming. By leveraging the interactive and immersive capabilities of Roblox, coupled with educational employment of plugins to facilitate diverse representations of the learning content at varying levels, the study proposed a novel approach to learning that emphasizes problem-solving, and collaboration in a digital environment. This approach not only aligns with constructivist learning theories, which advocate for active engagement and knowledge construction through tangible creation, but also leverages the interactive and immersive capabilities of modern gaming platforms to enhance learning experiences. The proposed virtual makerspace within Roblox would serve as a promising model for fostering essential 21st-century skills among undergraduates. The system's design, emphasizing game-making activities, collaboration, and immediate feedback, directly supports the development of CT competencies.

4 Limitations and Suggestions for Future Research

Since our platform design is in its early stages, our findings are currently limited to work-in-progress design and deployment. Ongoing data collection has been conducted to examine its feasibility and effectiveness (i.e.,user

engagement, and the actual learning outcomes achieved). Our design aims to offer valuable insights into how constructionist gaming in immersive environments influences computational thinking and digital literacy through upcoming evidence-based validations. Future research should further explore users' learning experiences in depth, investigating how learners and educators interact with Roblox-supported constructionist gaming platforms, their levels of engagement, and the usability and accessibility of the system. Understanding these aspects is crucial for refining the design and functionality of the makerspace to better meet learners' needs and preferences. Subsequent design experiments will be considered to uncover learning experience design principles that align with the proposed system.

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