DESIGN AND IMPLEMENTATION OF CO-DESIGN PEDAGOGICAL SCENARIOS FOR LEARNING COMPUTATIONAL THINKING

Amos Oyelere Sunday
School of Computing
University of Eastern Finland
Joensuu, Finland
amossun@uef.fi

ABSTRACT

Recognizing effective approaches to communicate computational thinking (CT) ideas to K-12 learners is necessary. Co-design approach has been identified as an effective pedagogy for communicating CT ideas. However, there is a dearth of studies on co-design pedagogical scenarios. Hence, this study aimed at developing a CT learning co-design scenario, translate into artifact, and implement with Nigerian secondary school students.

CCS CONCEPTS

• Social and professional topics → Computer science education; Computing education program; K-12 education.

KEYWORDS

Computational thinking, Co-design, Pedagogy, Scenarios, K-12

ACM Reference format:
Amos Oyelere Sunday, 2023. Design and implementation of co-design pedagogical scenarios for learning computational thinking. In *28th Proceedings of ACM conference on Innovation and Technology in Computer Science Education (ITiCSE 2023), July 10-12, 2023. Turku, Finland.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3587103.3594139

INTRODUCTION

Recently, there has been growth in the body of literature on teaching and learning computational thinking (CT). This has continuously attracted the attention of researchers in the field of science, technology, engineering, and mathematics (STEM) and other educational technologists [10] to implement the learning and teaching of CT. According to Wing [12], CT is a process of thinking that involves problem generation and efficient solution provision via an information processor [12]. Similarly, Agbo et al. [1], indicated that CT is a prerequisite for programming comprehension and is the basic step required for learners to build skills for solving problems. Moreover, CT involves mastering other skills such as decomposition skills, abstraction skills, and algorithmic thinking besides problem-solving skills [4]. The interest that CT learning generates, specifically within K-12 education, has necessitated that different pedagogical strategies be explored to ensure effective learning of CT concepts. One of the recent approaches to promoting CT in schools is co-design pedagogy.

ITiCSE 2023, July 2023, Turku, Finland.

ACM ISBN 979-8-4007-0139-9/23/07.
https://doi.org/10.1145/3587103.3594139

In the meantime, various attempts by scholars have been made to define the term co-design but there is no universally accepted definition. Most of the co-design definitions were based on context. In educational research, co-design is referred to as a team-based facilitation process with specified roles for researchers, teachers, and developers to work collaboratively together to build an academic invention, design the prototype, and evaluate the prototype to meet the educational requirements [9]. This implies that co-design requires the active participation of teachers, researchers, and other education stakeholders in a collaborative design study with roles specification for participants that involve processes for innovating, developing, and evaluating artifacts or tools.

Although numerous studies have used co-design for facilitating, the teaching and learning of CT either online [2] or offline [13], there have been no defined scenario tools, or pedagogical design, for co-designing to learn or teach CT. However, this study aims to address the gaps identified earlier. This study will investigate a series of processes, pedagogical designs, and tools used for co-designing scenarios as pedagogy techniques to teach and learn CT, which will eventually translate into an educational tool and implementation, which could be used by high school students for co-designing to learn CT. Also, this study will identify and integrate some of the existing pedagogical processes, artifacts, methods, and tools used for learning CT into a co-design model, and build a pedagogical process, for facilitating the development of co-design scenarios to gain problem-solving skills and CT amid the secondary school students in Nigeria context. Furthermore, this study will address the outrageous inadequate or lack of co-design pedagogical learning processes in CT education in Nigerian secondary school settings. This study is relevant because it will enable young learners to be able to use co-design learning methods and tools to learn relevant skills in CT that can aid their future studies in computer science. Particularly, the overall objectives of this study will include recognizing if there are co-design processes, methods, or tools for learning and teaching CT; identifying the student's needs and requirements regarding the co-design approach in CT education; creating a co-designing model and pedagogical scenarios for learning CT; create and evaluate a prototype of a co-design platform for learning CT. Hence, the following are the research questions to guide my dissertation:

RQ1: What co-design methods and pedagogical processes and platforms are used for learning CT?

RQ 2: What are the user requirements necessary for a co-design platform for learning or teaching CT?

RQ 3: How do we implement co-design scenarios as pedagogy to facilitate learning and teaching CT?

RQ 4: What are the students' learning experiences in the co-design platform?

BACKGROUND OF THE STUDY

Lately, several studies were carried out on integrating and implementing CT in STEM courses in schools. A chuck of the studies aimed at developing curriculum [11], tools [2], and pedagogy [5] for learning and teaching CT. Also, diverse methods and tools were adopted in several CT research studies conducted in K-12 education [4] and higher institutions [2]. Meanwhile, co-design is another means of learning, teaching, and implementing CT. Various studies have adopted co-design as a technique used in developing their pedagogy models and learning artifacts with stakeholders [5].

Wu et al. [13] conducted a co-design study involving researchers and STEM teachers in secondary schools to develop CT curricula, to equip the STEM teachers with the required skills to integrate CT in their classrooms. Both unplugged and plugged activities were employed in the study. The study showed that through the co-design workshop, teachers were able to gain an understanding of CT curriculum integration skills. Eventually, the teachers were able to gain mastery of the integration process and how to be able to integrate many computational tools to engage students more and encourage them to practice CT STEM studies. Likewise, they gain more insight into computational tools and how to utilize them. Similarly, [2] carry out a study on utilizing an online co-design (OCD) for CT educational mini game. Zoom and WhatsApp platforms were used for the online co-design [2]. Agbo et al., research study highlighted processes, practices, or techniques used for conducting online co-design research, where the participants were researchers, students, and other stakeholders in education. The author asserts that the participants gain an understanding of how to create a CT interrelated mini game components and framework. Also, the participants develop collaborative skills by working together in a team to contextually build a mini game model [2].

RESEARCH APPROACH AND METHODS

A mixed research methodology will be applied which comprised quantitative and qualitative research methods. Also, design science research (DSR) will be used in this research study to form the pragmatic procedures of creating the new artifacts for providing solution to the identified problems. DSR is a research method which involves pragmatic processes to build a new artifact to proffer solution to real-world problems [7]. Several research studies have applied DSR in their studies [7] [3]. DSR methodology was used by [8] to create and build a mobile application for facilitating computer science education. DSR was also utilized by [6] to design and build a mobile application for improving teaching and learning in Zimbabwe university. Additionally, a five steps process of DSR was used to co-design online VR mini game for learning CT by [3], which will be adapted to build co-design scenarios as a pedagogical tool for teaching and learning CT. The proposed steps include:

Explicating the problem activity: This first phase of the study will involve conducting a systematic literature review study on existing literature to identify the pedagogical processes, tools, resources, or artifacts of co-design used to learn CT.

Requirement definition activities: The second phase of the study will involve conducting an experimental study to test the existing co-design tools for learning CT with secondary school student to collect information on users' needs and how to use them.

Design and evaluate activity: This third phase of the study will involve brainstorming to generate ideas from the existing pedagogical processes to create new co-design pedagogical scenarios for learning CT.

Demonstrating artifact activity: The fourth phase of the study will involve the creating co-design artifacts or tools for learning CT.

Evaluating the artifact activity: The last phase will involve the analysis and evaluation of the new co-design platform with secondary school students in Nigeria.

MY RESEARCH PROGRESS

I am in my first year into my Ph.D., which is indicated that I am still in the early stage of my research. I am at the verge of submitting my systematic literature review study, which aggregates findings of scientific papers on co-designing for learning CT to a reputable journal. The next plan is to conduct an experimental study with existing co-design tool for learning CT with secondary school student in Nigeria. I anticipated being part of the doctoral consortium to receive helpful advice and feedback on research design and technical aspects. I look forward to gaining new insight into my study and restructure my research question moving forward. While existing literature have been focusing on designing co-design tools, this study will develop and implement co-design as a pedagogical scenario for learning CT; my study will involve developing a contextual scenario and artifacts with specification on Africa context, in the discussion on co-design as a pedagogy for learning CT in K-12 education.

REFERENCES

[1] Agbo, F. J., Oyelere, S. S., Suhonen, J., & Adewumi, S. (2019). A systematic review of computational thinking approach for programming education in higher education institutions. In Proceedings of the 19th Koli Calling International Conference on Computing Education Research (pp.1-10).

[2] Agbo, F. J., Oyelere, S. S., Suhonen, J., & Laine, T. H. (2021). Co-design of mini games for learning computational thinking in an online environment. *Education and information technologies*, *26*(5), 5815-5849.

[3] Agbo, F. J. (2022). *Co-designing a smart learning environment to facilitate computational thinking education in the Nigerian context* (Doctoral dissertation, Itä-Suomen yliopisto). https://erepo.uef.fi/handle/123456789/27287

[4] Grover, S., & Pea, R. (2013). CT in K–12: A review of the state of the field. *Educational researcher*, *42*(1), 38-43.

[5] Hadad, S., Shamir-Inbal, T., Blau, I., & Leykin, E. (2021). Professional development of code and robotics teachers through small private online course (SPOC): Teacher centrality and pedagogical strategies for developing computational thinking of students. *Journal of Educational Computing Research*, *59*(4), 763-791.

[6] Maphosa, V., Dube, B., & Jita, T. (2021). Sustainable information and learning access at a rural university in Zimbabwe through a mobile application. *International Journal of Information and Education Technology*, *11*(2), 82-87.

[7] Naidoo, R. G. (2012). An exploratory survey of design science research amongst South African computing scholars. *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference* (pp. 335- 342). South Africa: ACM.

[8] Oyelere, S. (2017). Design and development of a mobile learning system for computer science education in Nigerian higher education context. (Doctoral dissertation, University of Eastern Finland). https://erepo.uef.fi/handle/123456789/18930 .

[9] Roschelle, J., Penuel, W., & Shechtman, N. (2006). Co-design of innovations with teachers: Definition and dynamics.

[10] Tang, X., Yin, Y., Lin, Q., Hadad, R., & Zhai, X. (2020). Assessing computational thinking: A systematic review of empirical studies. *Computers & Education*, *148*, 103798.

[11] Wang, C., Shen, J., & Chao, J. (2021). Integrating computational thinking in stem education: A literature review. *International Journal of Science and Mathematics Education*, 1-24.

[12] Wing, J. (2011). *Research notebook: Computational thinking—what and why*. The Link Magazine.

[13] Wu, S., Peel, A., Bain, C., Anton, G., Horn, M., & Wilensky, U. (2020, April). Workshops and co-design can help teachers integrate computational thinking into their k-12 stem classes. In *Proceedings of International Conference on Computational Thinking Education 2020*.