Towards Computing Education for Lifelong Learners: Exploring Computational Thinking Unplugged Approaches

Friday Joseph Agbo
Willamette University
Salem, OR, USA
fjagbo@willamette.edu

Connor Everetts
Willamette University
Salem, OR, USA
cleveretts@willamette.edu

Abstract

Older adults are underrepresented in computing education; broadening participation in computing has remained predominantly at K-12 and college settings. Yet, the population of older adults is increasing across many regions. Strategies for broadening participation in computing education for adult learners have been under-explored. This poster reports our effort towards broadening participation in computing for adult learners by exploring how computational thinking problem-oriented unplugged activities might help to gently introduce older adults into computing education. Being an exploratory study, data was collected using a mixed method approach. This report presents preliminary findings that suggest the potential benefits of computing education for older adults, including social collaboration and demonstration of computational thinking practices that could help them to remain active while aging. Moreover, future research direction in this regard is also discussed.

CCS Concepts

• **Social and professional topics** → **Adult education**.

Keywords

Computing education, Lifelong learning, Adults education, Broadening participation, Computational thinking

ACM Reference Format:
Friday Joseph Agbo and Connor Everetts. 2024. Towards Computing Education for Lifelong Learners: Exploring Computational Thinking Unplugged Approaches. In *Proceedings of the 2024 ACM Virtual Global Computing Education Conference V. 2 (SIGCSE Virtual 2024), December 5–8, 2024, Virtual Event, NC, USA*. ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3649409.3691084

1 Introduction

In developing strategies to broaden participation in computing education for adult learners, pedagogical approaches that are akin to the traditional process deployed in formal settings such as K-12 and colleges may not work well [11]. Lifelong learners, in the context of this study, are older adults (senior citizens) who are retired from work-life and comes from varied field of endeavours; possessing huge experiences that could foster self-regulated learning experience. Beyond active learning experience, computing education could motivate older adults' collaboration and stimulate their brains while aging [7]. However, computing education has yet to gain serious attention for adult learners. To democratize computing education, there is the need to broaden participation to include underrepresented groups such as adult learners.

Computational thinking (CT) was popularized by Jeannette Wing [13]. Although the term exists long before the digital computers [4], it emphasizes problem-solving capabilities by drawing on a range of mental models that reflect the field of computer science [13]. While CT education has concentrated on formal K-12 and college settings [2], scholars claim that it is a universal skill for everyone to learn and use in addressing domain problems [5]. A few studies have shown the use of CT in promoting adults learning, social life, and cognition [14]; however, CT unplugged activities have been under-explored in the context of adult education [12]. Therefore, this study reports our efforts towards bridging the identified gap by exploring how CT problem-oriented unplugged activities may help to foster older adult's interest in computing education and to investigate how this approach sparks other learning outcomes for lifelong learners. The **research question** is *do CT unplugged activities positively impact older adults and broaden their participation in computing education?*

2 Related Work

Computing education for older adults has existed for decades but has yet to gain a strong research trajectory [1, 11]. However, a growing body of research is exploring computing education in the informal setting including lifelong learning [11]. For example, Sarsa et al. [10] and Guo [6] investigated the motivation behind older adults' engagement in learning programming. Elsewhere, national government and university professors are developing courses on computer programming to teach older adults (up to 100 years old) how to code [8]. In addition, Ohashi et al. [9] developed a curriculum to teach senior citizens how to code who will in turn transfer the knowledge by teaching programming to younger learners in the elementary school within their locality.

3 Research Design and Methods

This study designed a 3-hour long session embedded with lecture and hands-on practices to demonstrate CT for lifelong learners at the Institute for Continued Learning (ICL) at a university in the Pacific Northwest of the United States. The objectives of the lecture were to: 1) teach the older adults what CT is and is not, 2) introduce them to traditional CT concepts (algorithmic thinking, problem decomposition, abstraction, pattern recognition, and generalization), and allow them to use CT practices to solve unplugged activities to gain problem-solving strategies using the six- thinking hats by De Bono [3].

SIGCSE Virtual 2024, December 5–8, 2024, Virtual Event, NC, USA

ACM ISBN 979-8-4007-0604-2/24/12
https://doi.org/10.1145/3649409.3691084

Three CT unplugged exercises adapted from Bebras computing challenge (2023 examples) were deployed during the session. Each activity was targeted at achieving a specific learning objective. For example, tower of blocks - which could showcase optimization problems in computer science - was meant to teach computational practices of problem abstraction and generalization. Other examples are the *treasure box* and *electric cars* puzzles used to engage the older people to collaboratively work in groups.

Treasure box puzzle was meant to help older adults to gain higher-order thinking, logical and deductive reasoning, whereas the electric car puzzle was meant to help them gain problem decomposition, abstraction, algorithmic thinking, modeling, and simulation skills. Using this problem which is similar to the famous traveling salesman problem in computer programming, older adults were exposed to complex concepts in computing such as optimization.

3.1 Participants

This study was conducted with cohorts of 55 ICL members. The ICL goal is to foster a community of older lifelong learners that do not aim to earn a degree but learn new things and to remain active. Member gave their consent to participate in our activities and to collect data for research purposes. In addition, this study has obtained an approval from the authors' institutional review board.

3.2 Data collection and analysis

This study gathered qualitative data from participants by printing unplugged activities on paper (Figure 1 right) and then distributed them to the participants for group work. Each group consist of two minimum and four maximum members (see Figure 1 left). After each activity, the authors retrieved the papers from the participants and analyzed their scribbled notes. In addition, the presentation made by each group, discussing thought processes leading to their solution were audio-recorded and transcribed. These data collected from the printed activities and their audio transcribed presentation were analysed thematically and presented in the next section.

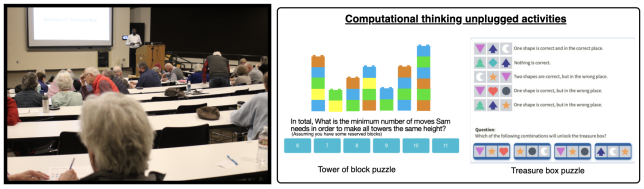

Figure 1: (left) Group collaborations applying problem-solving strategies & (right) examples of unplugged activities.

4 Findings

The analysis shows that older adults were engaged in collaborative work to demonstrate CT practices such as *abstraction* as shown in Table 1. Group explanations (see excerpts below), indicates that they applied elimination and exclusionary processes in unravelling the puzzles: *"we eliminated that and we ended up with choosing option B"*; *"you can eliminate the Christmas tree which is correct in number two and if you do that you isolate the star which must be in the right position"*; *"what we did was to eliminate the blue car as it can only do the upper route..."*. These adults showcased their prior experience in unraveling these CT problems but were not very familiar with algorithmic design. It is interesting to note that unpopular CT practices such as reverse engineering and deductive reasoning [4, 5] are demonstrated by these adults, indicating the unique learning process exhibited by adults which makes the traditional pedagogy unsuitable for them.

Table 1: CT practices demonstrated by older adults

CT Practices	Frequency of occurrence
Abstraction	7
Algorithmic design	2
Reverse engineering	2
Simulation	1
Deductive reasoning	1
Debugging	1
Collaboration	7

5 Future Work

This initial study revealed several research opportunities to better understand how to foster meaningful computing education for older adults. For example, our future study will further explore self-regulated learning strategies by using plugged approach where we teach older adults how to code using block-based and text-based programming languages.

References

[1] Friday Joseph Agbo. 2024. Broadening Participation in Adult Education: A Literature Review of Computer Science Education. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education V. 1*. 11–17.
[2] Friday Joseph Agbo, Solomon Sunday Oyelere, Jarkko Suhonen, and Sunday Adewumi. 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*. 1–10.
[3] Hani Yousef Al Jarrah. 2019. Six thinking hats: An analysis of the skill level of Jordanian vocational education teachers and the extent of skill application. *Space and Culture, India* 7, 1 (2019), 170–185.
[4] Peter J Denning and Matti Tedre. 2019. *Computational thinking*. Mit Press.
[5] Shuchi Grover and Roy Pea. 2013. Computational thinking in K–12: A review of the state of the field. *Educational researcher* 42, 1 (2013), 38–43.
[6] Philip J Guo. 2017. Older adults learning computer programming: Motivations, frustrations, and design opportunities. In *Proceedings of the 2017 chi conference on human factors in computing systems*. 7070–7083.
[7] Yong Gu Ji, Junho Choi, Jee Yeon Lee, Kwang Hee Han, Jinwoo Kim, and In-Kwon Lee. 2010. Older adults in an aging society and social computing: A research agenda. *Intl. Journal of Human–Computer Interaction* 26, 11-12 (2010), 1122–1146.
[8] Yutaro Ohashi, Hidemi Yamachi, Yasuhiro Murokoshi, Fumihiro Kumeno, and Yasuhiro Tsujimura. 2019. Designing Programming Education Course for Senior Citizens: Lifelong Learning in the Age of the 100-Year Life. In *Proceedings of the 2019 ACM Conference on International Computing Education Research*. 315–315.
[9] Yutaro Ohashi, Hidemi Yamachi, Yasuhiro Murokoshi, Fumihiro Kumeno, and Yasuhiro Tsujimura. 2020. Development of a programming course for senior citizens taught by senior citizens. In *Proceedings of the 2020 8th International Conference on Information and Education Technology*. 18–23.
[10] Sami Sarsa, Arto Hellas, and Juho Leinonen. 2022. Who Continues in a Series of Lifelong Learning Courses?. In *Proceedings of the 27th ACM Conference on on Innovation and Technology in Computer Science Education Vol. 1*. 47–53.
[11] Sergio Sayago and Ángel Bergantiños. 2021. Exploring the first experiences of computer programming of older people with low levels of formal education: A participant observational case study. *International Journal of Human-Computer Studies* 148 (2021), 102577.
[12] Yucnary-Daitiana Torres-Torres, Marcos Román-González, and Juan-Carlos Pérez-González. 2020. Unplugged teaching activities to promote computational thinking skills in primary and adults from a gender perspective. *IEEE Revista Iberoamericana de Tecnologias del Aprendizaje* 15, 3 (2020), 225–232.
[13] Jeannette M Wing. 2006. Computational thinking. *Commun. ACM* 49, 3 (2006), 33–35.
[14] Diego Zapata-Rivera, Carol Forsyth, and Hillary Molloy. 2019. Supporting Computational Thinking Skills for Adults.. In *SLLL@ AIED*. 28–31.