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Utilizing botley robotics to facilitate the development of computational thinking skills in children with visual impairment

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ABSTRACT

Computational thinking (CT) skills have become increasingly vital in the digital age, particularly for children with visual impairments, who often face challenges in accessing technological education. This study aims to explore the use of Botley Robotics as a tool to facilitate CT skills and its application in the learning context. Employing qualitative methods through observations, questionnaires, and interviews, this research involved two students with visual impairments from a special needs school in Indonesia, selected through purposive sampling. Botley, a screenless robot, served as the primary learning medium. The data collected were analyzed using the CT framework from Brennan and Resnick, which encompasses three main dimensions: computational concepts, practices, and perspectives. The findings indicate that Botley Robotics effectively facilitates CT skills in students, particularly in areas such as debugging, programming, and logical reasoning. Despite their visual limitations, the students demonstrated the ability to program the robot and understand complex statements and logical operators. The conclusions drawn from this research suggest that Botley can serve as a valuable tool for fostering CT skills among students with visual impairments by integrating concepts from the Brennan & Resnick framework. The tactile and auditory feedback provided by Botley enables children to develop problem-solving and logical thinking skills through direct interaction. This study highlights the significance of incorporating robotic technology into inclusive education and demonstrates the substantial potential of Botley Robotics to enhance both access to and the quality of education for children with visual impairments. Therefore, it is recommended that this technology be implemented more broadly within the context of inclusive education.

Keywords: blindness, Botley, computational thinking, educational robotics, visual impairment

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INTRODUCTION

In today's digital era, computational thinking (CT) skills are becoming increasingly important, especially for children, including those with visual impairments. CT encompasses a set of crucial abilities, such as understanding the basic principles that lead to consistent patterns (abstraction), developing systematic problem-solving instructions for similar problems (algorithmic thinking), recognizing similarities or differences in patterns, trends, and rules (pattern recognition), and breaking down complex data, processes, or problems into smaller components (decomposition) (Atmatzidou & Demetriadis, 2016). These skills are not only essential in the field of computer science but also significantly contribute to the development of high-level cognitive processes required across various disciplines. It is important to emphasize that CT includes various aspects, such as logical thinking, algorithmic thinking, pattern recognition, as well as evaluation and automation, all of which are highly relevant in addressing the challenges of the modern world (Grover & Pea 2018).

The application of CT in education is a crucial step, particularly in Indonesia, where access to technological education for children with visual impairments is often limited. Research shows that CT education from an early age can equip children with the foundational skills necessary to adapt to digital life in the future (Bocconi, S., Chioccariello, A., Kampylis, P., Dagienė, V., Wastiau, P., Engelhardt, K., Malagoli 2022). Many countries have integrated CT into their education curricula to empower children to recognize and apply these skills in everyday life (Chibaudel et al. 2020). It can be argued that young children have a greater capacity to acquire knowledge and skills, which they can use to their advantage (Yadav & Berges 2019). Moreover, children at a young age have the ability to develop programming and CT skills, making CT education a crucial foundation in the curriculum (Mich, Ghislandi, Massa, Mardare, Bisutti, & Giacomozzi, 2021).

However, children with visual impairments face significant challenges in acquiring computational thinking (CT) skills. They often struggle to access programming materials that are not designed to meet their needs, potentially hindering their skill development. Various limitations faced by students with disabilities include difficulties in generating movement, coding, and design (Brady, Salas, Nuriddin, Rodgers & Subramaniam, 2014). In this context, (Ahn et al., 2017) emphasize the need to develop educational tools that support CT practices and are accessible to children with visual impairments. The use of robotic technology can offer innovative solutions for visually impaired children to engage with technology education in a more inclusive and engaging way (Ragusa, G., & Leung 2023).

Effective learning media, such as the Botley robot, have the potential to enhance CT skills in children with visual impairments. Botley is a robot designed to teach basic programming concepts without the need for a screen, allowing children to learn without relying on digital devices that are often inaccessible (Costa, Araújo, & Henriques 2021). The development of educational games for visually impaired children involves multiple layers of learning, where children can explore a particular topic and participate in the design-thinking process (Metatla et al., 2020). Previous research also indicates that appropriate assistive tools can help visually impaired children recognize their physical environment through block-based programming (Metatla et al., 2020).

Thus, this study aims to explore the use of the Botley robotic system in facilitating computational thinking skills in visually impaired children and how its application can be integrated into their learning processes. This research is expected to make a positive contribution to the quality of education for visually impaired children in Indonesia, as well as pave the way for the development of more inclusive educational tools in the future.

METHOD

This research is exploratory in nature, using a qualitative approach to explore the richness of knowledge ingrained in the phenomena (Perry, 2023). The case of adopting Botley robotics to facilitate the development of computational thinking for low-vision students is unique and may not be replicable in similar contexts. Therefore, the research purposively selected two students with vision impairment from Indonesia's special needs schools (Creswell and Creswell, David 2017). Student A was in the 9th grade, with low vision and total blindness, while Student B was an 8th grader who has been totally blind since birth. In purposive sampling, participants or subjects are selected based on certain considerations, such as experience, characteristics, or specific knowledge about the phenomenon being studied.

This research utilized the Botley Robotics learning medium, a learning robot designed to introduce programming and algorithm concepts to children. This robot is highly interactive and is designed to help children learn in a fun and engaging way (Kock, 2018). The components of Botley include the robot body, programming cards, remote control, coins and obstacles, sensor tape, and a game board.

Figure 1. Botley and supporting devices (Kock, 2018)

The research was conducted in several stages, following the stages outlined by Budiyanto and his associates (2020), which included preparation, introduction, implementation, and closing stages. In the preparation stage, teachers were introduced to the Botley robot device, including its components, operation methods, and how to program it by inputting instructions. In the introduction stage, students were introduced to Botley through tactile exploration, starting with the interface, components, and operation methods. Students were also taught how to input instructions for the robot to perform according to the commands given. In the implementation stage, students engaged in activities using the robot based on challenges provided by the teacher. The teacher set challenges involving tracks that the robot had to navigate, with additional obstacles and missions added once students succeeded. The students' task was to arrange instructions and input code so that the robot could function correctly within a duration of 30 minutes. During this stage, observation activities were conducted to monitor how students interacted with the Botley robot. Finally, the closing stage involved interviews and questionnaire filling, assisted by the teacher, regarding the use of the Botley robot and the development of computational thinking (CT) skills during the robot activity.

The research employed observation (Taherdoost, 2016), and in-depth interviews (Eppich, Gormley & Teunissen, 2019)as the data collection techniques. The associated instruments were developed based on the framework for the development of computational thinking (CT) as outlined by Brennan and Resnick. Both systematic observation and non-participant observation (Maheshwari, Chaturvedi & Sharma 2021). were utilized in the research. Systematic observation involved observing the behavior or phenomena in a structured and organized manner according to a predetermined guideline. In contrast, non-participant observation involved the researcher observing the participants' behaviors without directly engaging or interacting with the observees. Questionnaires were administered to the two visually impaired students after the activities were completed, using a Likert scale for evaluation. As depicted in Table 1, the Likert scale is a rating scale designed to gauge the perceptions, opinions, or attitudes of individuals or groups, thus revealing the aspect being measured (Warmbrod, 2014). The purpose of the questionnaire was to understand the students' experiences while using the Botley robot, with the following scoring criteria:

Table 1. Score Assessment of Questionnaire Instruments

Criteria	Score
Strongly Agree (SA)	5
Agree (A)	4
Neutral (N)	3
Disagree (D)	2
Strongly disagree (SD)	1

Interviews were conducted face-to-face, involving direct questions and answers between the researcher and the informant or speaker. The interviews were used to validate the data already collected through the questionnaire.

The collected data were then analyzed using descriptive qualitative data analysis (Doyle, McCabe, Keogh, Brady & McCann, 2020.) to determine how the Botley robotics facilitate the development of computational thinking (CT) skills in children with visual impairments. The purpose of the descriptive analysis of the questionnaire data was to present the collected data succinctly and clearly, providing essential information from the data gathered (Dulock, 1993).

Descriptive analysis of the observational data concerning student activities while operating the Botley robot utilized the CT assessment framework developed by Brennan and Resnick (2012), which comprises three key dimensions of computational thinking: computational concepts, computational practices, and computational perspectives. Assessment was based on the instructions inputted into the robot and the process of creating those instructions for the Botley robot (Brennan & Resnick 2012)

The interview data were analyzed descriptively, adopting the interactive model developed by Miles and Huberman (1984). Following data analysis, the meanings were interpreted to answer the research questions. Eventually, the gist of the meanings was drawn into a conclusion by comparing and contrasting them with the relevant theories. To ensure the validity and reliability of this research, validation will be conducted to enhance the credibility of the qualitative research. The validity criteria according to Ary and his associates (2014) include credibility, transferability, dependability, and confirmability.

RESULTS AND DISCUSSION

Following the trial implementation of Botley robotics with children with visual impairments, a comprehensive dataset was gathered through observations, questionnaires, and interviews. Table 2 presents the data collected from the questionnaire, while Table 3 displays the data collected from the observations.

Table 2. Questionnaire Result

No	Statement	Score	
		Student A	Student B
1.	When operating the robot, I identify the instruction steps individually	4	3
2.	I input instruction codes separately to create a complete action instruction	5	4
3.	I create repeated actions with the same set of instructions or procedures	4	4
4.	I use the "transmit" button function to move the robot	5	5
5.	I can move a specific object	4	3
6.	I input an action to execute a specified task when an object touches another object	5	4
7.	I input other instructions when encountering different conditions	5	4
8.	I use the "object detection" button function for If/Then programming	4	3

9.	I use the "loops" button function to create repetitions	4	3
10.	I employ the same method as before to input command instructions	5	4
11.	I engage in experiments with Botley	5	5
12.	I engage in repeated experiments and progressively refine the instructions I input for the robot	4	3
13.	I obtain ideas for the robot's path from previous robot experiments	3	3
14.	I ensure that all instructions or procedures work as intended	4	4
15.	Whenever I encounter problems in instructing the robot, I endeavor to identify the root cause and work to resolve it	4	5
16.	I used the instructions suggested by the teacher to run the robot properly	5	5
17.	I separate instructions when the robot's path is more complex to simplify the formulation of the robot's instructions	4	4
18.	I divide various sets of instructions into smaller components before combining them into a complete action	4	4
19.	I understand that computing is more than just something to consume; it is a medium for thinking	4	5
20.	I can achieve and develop more than I can independently by collaborating with others	5	5
21.	After attempting to operate the robot using a series of instructions, I have concluded that technology and programming are important in today's world	4	5

Table 3. The Results of Observational Data on Student A

No	Indicator	CT Skill	30 minutes			Notes
			I	II	III	
1	CT Concepts					
	Students identify a sequence of individual instruction steps	*Sequences*	√			Student A identified instructions to determine the path the robot would take.
	Students input instructions to create a complete sequence of actions	*Sequences*		√		Student A inputted instructions to control the robot's movement using the remote control.
	Students generate a series of the same instructions and establish a looping action	*Loops*		√		Student A generated looping instructions for the same robot path.
	Students activate devices to record actions from the remote	*Events*	√			Student A enabled the "sound on" function to record sounds from the robot.
	Students can move specific objects	*Events*		√		Student A added instructions to move the robot.
	Students input an action to execute a specified task when an object touches another object	*Events*		√		Student A added instructions to ensure that the robot avoids obstacles in its path.
	Students input other instructions when encountering different conditions	*Parallelism*		√		Student A modified instructions when the robot failed to reach its destination.
	Students use the "object detection" function for If/Then programming	*Conditionals*		√		Student A employed object detection to facilitate robot movement.
	Students use the "loops" button function to create repetitions	*Operators*			√	Student A provided loop instructions for repeating movements.

No	Indicator	CT Skill	30 minutes			Notes
			I	II	III	
	Students use commands in the same manner as before	*Data*		√		Student A applied the same command to navigate more challenging paths with the robot.
2.	CT Practices					
	Students experiment with Botley	*Being Incremental and Iterative*	√			Student A added another component to the robot to move objects.
	Students develop programs independently	*Being Incremental and Iterative*			√	Student A independently evaluated instructions when the robot deviated from the set trajectory.
	Students obtain new ideas by utilizing the solutions of previous program	*Being Incremental and Iterative*			√	Student A provided alternative instructions when the robot's path deviated or when it failed to move properly.
	Students ensure everything works as intended	*Testing and debugging*			√	Student A ensured that the robot reached its destination by sensing its position.
	Students resolve issues that arise as a result of incorrect programs	*Testing and debugging*			√	Student A promptly removed the incorrect code through the remote control when the robot failed to adhere to the intended path.
	Students enhance the complexity of their work by using or remixing others' work	*Reusing and remixing*				Student A followed the teacher's recommended instructions because they were simpler and more effective.
	Students categorize various action sequences into smaller parts	*Abstracting And modularizing*		√		Student A inputted instructions one by one when the robot's path underwent complex turns.
	Students integrate program sequences into complete actions	*Abstracting And modularizing*			√	Student A inputted the complete set of instructions in one go after thoroughly analyzing all the pathways of the robot.
3.	CT Perspectives					
	Students recognize and articulate that computing is not merely a tool for consumption, but rather a medium for thinking	*Expressing*			√	Student A engaged in a discussion with the teacher over the malfunctioning of the robot's movement.
	Students recognize the capacity to accomplish more collaboratively with others	*Connecting*			√	Student A requested the teacher to add obstacles into the robot's path.
	Students experience a sense of authority to ask inquire about the world and technology.	*Questioning*			√	Student A inquired about buttons that they could not operate, including the "sound on" and "light" buttons.

The study revealed that the participants arranged the robot's paths, enabling them to determine the robot's direction. This is consistent with Hooshyar (2021), who found that possessing this ability allows students to effectively organize steps in the correct sequence, resulting in the successful completion of tasks (Fagerlund, Vesisenaho & Häkkinen, 2022). It was also added that effective project planning is essential in programming to prevent potential design errors, such as the inability to execute plans.

Figure 1. Student A felt the robot's path before inputting the code through the remote control

In the CT loops skill, each indicator must be executed during the robot's running activity. This aligns with Hooshyar (2021), who stated that the CT loop skill involves repeating an action multiple times. However, the CT loop skill was not identified during the interview. Furthermore, the results of the questionnaire and observations showed that Students A and B successfully performed each indicator of the CT events skill, demonstrating progress in their development. Nevertheless, the interview process was unable to identify any indicators in this aspect. This is consistent with Nouri (2020), who stated that events focus on conditions in which something occurs as a result of another underlying factor.

The questionnaire yielded scores ranging from 4 to 5 for the CT parallelism skill. However, during observation, students discovered that the robot deviated from its designated path, necessitating them to modify the robot's instructions. This suggests that both students exhibited a high level of awareness in their application of CT parallelism skills when operating the robot, as confirmed by their execution of each indicator of the CT parallelism skill. However, both students failed to recognize the CT parallelism skill during the interview. (Park & Shin, 2019) concurred that parallelism is implemented in a project when a sequence of instructions is executed simultaneously.

In this study, Student A demonstrated CT conditional skill scores ranging from 3 to 4. Meanwhile, during observation, Students A and B used the "object/detection" menu to activate the robot's ability to take different actions when it encounters obstacles that cannot be passed. This indicates that Students A and B were well aware of the implementation of the CT conditional skill when operating the robot, as demonstrated by their performance of the skill indicators. However, throughout the interview, they were unable to recognize the CT conditional skill. This is in line with (Hooshyar et al., 2021), who argue that conditionals are predetermined decision-making methods that rely on past conditions to facilitate the desired outcomes.

Furthermore, the questionnaire for CT operators indicated that students obtained scores ranging from 3 to 4. This suggests that Students A and B were sufficiently aware that they had applied CT operator skills when operating the robot, as demonstrated by their performance on indicators associated with this skill. However, the interview failed to ascertain the CT operator's skills. This is consistent with Dagienė and Stupuriene (2016), who argue that operators are complex constructs that can be developed using logical operators such as *and*, *or*, and *not*.

Regarding CT data, both Students A and B executed the same commands on a more challenging robot path. Based on the questionnaire results, Student B achieved a score of 4 on the attached indicators, demonstrating successful performance of the first indicator of the CT data skill during the robot operation activity. Moreover, Student A achieved a score of 5 on this indicator, and both Students A and B were fully aware of their performance on the CT data skill indicators during the robot operation activity. In contrast, the CT data skill was not identified during the interview. This supports shut and sun, who stated that data involves the process of storing, retrieving, and updating information that can be reused.

The questionnaire results indicated that Student A obtained scores of 5, 4, and 3, while Student B received scores of 5, 3, and 3 for CT incremental and iterative skills. Both Students A and B demonstrated a clear understanding of the application of CT incremental and iterative skills during the robot operation activity, as proven by their performance on each indicator of the skill. Supported by interview data, Student A utilized tactile perception and numerical analysis to estimate the direction and number of steps taken by the robot. Subsequently, Student A input instructions into the robot through the remote control. If the robot were to halt or deviate from the path, it would return to the starting point to rectify the code based on the previous instructions. Student A would then reevaluate the robot's path, seek help from the teacher, or opt to repeat the process. This strategy closely resembles Student B's approach, where he felt the path taken, deleted and replaced any mistakes in the code, and, if he encountered difficulties after trying again, sought help from the teacher for the correct code. This is supported by Nouri, who argues that incremental and iterative design involves a repetitive sequence of testing, peer feedback, code review, and bug rectification.

Students A and B completed the first indicator. They assessed the robot's position after it had moved to confirm that it had successfully reached its destination. Additionally, Students A and B also completed the second indicator. They quickly deleted incorrect code via the remote control when the robot deviated from the intended path. According to the questionnaire results, Student A received scores of 4 and 4, while Student B received scores of 4 and 5 on each indicator of the CT testing and debugging skills. During the robot operation activity, Student B demonstrated a high level of awareness in applying CT testing and debugging skills. This was evident in their execution of each indicator of the CT testing and debugging skill.

The interview results revealed that Student A used the remote control by pressing buttons corresponding to the intended direction. In addition, Student A reported tactile feedback when the robot either halted or deviated from its intended path. Student A then returned the robot to its starting point, deleted, and corrected the code. Meanwhile, Student B identified any errors in the code and promptly deleted and replaced the incorrect code. If Student B encountered difficulty after making another attempt, they sought assistance from the teacher to obtain the correct code. This aligns with Shute, Sun and Asbell-Clarke (2017) who state that testing and debugging involve a trial-and-error process to evaluate and correct errors.

Based on the research results, Students A and B showed improvement in the CT skill of reusing and remixing. Table 1 indicates that Students A and B received a score of 5 and performed the CT reusing and remixing skill indicators. Statements from Students A and B during the interview corroborated the development of their CT skills. Student A reported that they sought guidance from the teacher and repeated the process, while Student B mentioned that they made another attempt and, when faced with difficulty, sought guidance from the teacher for the correct code. This aligns with Zhang and Nouri (2019) that reusing and remixing entails the process of combining or modifying an element within an original program.

Students A and B demonstrated the first indicator of the CT skill of abstracting and modularizing by sequentially inputting instructions when the robot encountered complex turns in its path. Furthermore, they completed the second indicator. Both students simultaneously inputted full instructions after thoroughly analyzing all possible paths for the robot. This corroborates Zhang and Nouri (2019) who argue that abstracting and modularizing involve breaking down a procedure into smaller parts that can be recombined to achieve a more complex process.

Regarding the CT skill of expression, Students A and B achieved scores of 4 and 5, respectively. This indicates their awareness of utilizing the CT skill of expressing themselves during robot operation activities. Interviews corroborated these findings, as Student A stated that they actively developed their problem-solving skills by utilizing the robot and expressed interest in tackling more challenging tasks. Meanwhile, Student B acknowledged their ability to contemplate the robot's movements, trajectory, and the instructions they inputted, expressing contentment and a readiness to explore more challenging paths. This aligns with Shute, Sun, and Asbell-Clarke (2017) who contend that computing functions as a medium for fostering creativity and expression.

On the CT skill connecting indicator, both Students A and B achieved a score of 5. This indicates their strong awareness of utilizing the CT skill of connecting while engaging in robot operation activities. Statements from Students A and B during interviews corroborated this claim, as Student A expressed a desire to acquire further knowledge through more demanding tasks, while Student B conveyed enthusiasm and a willingness to explore more challenging paths. This aligns with

Shute, Sun, and Asbell-Clarke (2017), who propose that connecting involves the perception of communicating and collaborating with others through computation.

According to Table 2, both Student A and Student B tended to demonstrate the first indicator in terms of questioning. Student A inquired about buttons that they were unable to operate, such as the "sound on" and "light" buttons. Meanwhile, Student B asked about other learning technologies besides the Botley robot. The results from the questionnaire indicated that Students A and B exhibited a high level of awareness in utilizing the CT skill of questioning throughout the robot operation activities. Student B's interview statement confirmed this, noting that they would ask the teacher for the appropriate code if they encountered any challenges. This aligns with the findings of Shute, Sun, and Asbell-Clarke (2017), who state that questioning involves a sequence of actions aimed at investigating real-life technological issues.

From the analysis, several applications of robot learning media for education include:

1. **Non-Visual Visual Programming**: Botley adopts a screen-free coding method, enabling visually impaired children to follow instructions through physical or auditory formats. These children can use tactile command cards, such as those in Braille, or access audio instructions to effectively comprehend logical commands (Costa et al., 2021)
2. **Physical Interaction with Botley**: Botley is designed with buttons on its body that facilitate programming, enabling children to provide instructions without the need for visual input. This feature allows visually impaired children to engage with the robot directly, fostering an understanding of its functionality through tactile interaction (Erwin et al., 2001).
3. **Audio and Sensory Feedback**: Botley is equipped with a sound system that provides feedback in the form of audio, which is essential for visually impaired children. Botley produces sounds when receiving commands, moving, or completing tasks, allowing children to follow and correct the programming process intuitively.
4. **Problem-Solving and Logical Learning**: By using Botley, visually impaired children can learn how to plan steps logically to achieve specific goals. Thinking processes such as "if-then logic," looping, and instruction sequences can be taught tactilely and audibly, thereby enhancing computational thinking skills.
5. **Environmental Exploration**: Botley can be programmed to move in a certain space. Visually impaired children can use spatial understanding, supported by Botley’s audio cues, to visualize and understand their surroundings through the robot’s movements.

By using Botley, access to programming and the development of computational thinking is made more inclusive for visually impaired children from the aforementioned explanations, it is evident that the Botley robotics kit can fasilitate the CT skills of students with visual impairments, as it encompasses various dimensions of CT, as described by Brennan and Resnick.

CONCLUSION

The conclusions drawn from this study indicate that the Botley robot can facilitate the development of computational thinking (CT) skills in students with visual impairments by emphasizing the integration of concepts from the Brennan & Resnick framework that they have already mastered. This strategy enables students to effectively tackle new problems. This conclusion is based on a comprehensive analysis of descriptive data, observations, and interviews, all of which align with the indicators for the development of CT skills. The results and discussion show that both observations and questionnaires effectively identify all CT skills in children with visual impairments. However, the interview data only identified CT skills in the following sequence: being incremental and iterative, testing and debugging, reusing and remixing, abstracting and modularizing, expressing, connecting, and questioning.

The Botley robotic device can be used to facilitate the development of CT skills in visually impaired children by referencing the Brennan & Resnick framework. Despite their visual limitations, these children demonstrated the ability to understand complex statements and logical operators while programming their robots. This process allows students to develop comprehensive CT skills by focusing on the three dimensions of CT: CT concepts, CT practices, and CT perspectives, as outlined in the framework.

By leveraging the tactile and auditory feedback provided by Botley, visually impaired children can practice skills such as problem-solving, testing, and iteration through direct interaction. This approach helps enhance their logical and abstract thinking abilities, which are crucial for mastering CT. Devices like Botley offer more inclusive opportunities for visually impaired children to explore and engage with programming in a way that is accessible and engaging.

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REFERENCES

Ahn, J. H., Sung, W., Lee, S. W., & Hee, J. (2017, March). COBRIX: A physical computing interface for blind and visually impaired students to learn programming. In Society for Information Technology & Teacher Education international conference (pp. 727-733). Association for the Advancement of Computing in Education (AACE).

Atmatzidou, S., & Demetriadis, S. (2016). Advancing students' computational thinking skills through educational robotics: A study on age and gender relevant differences. Robotics and Autonomous Systems, 75, 661-670. doi: 10.1016/j.robot.2015.10.008.

Ary, D., Jacobs, L. C., & Razavieh, A. (2014). Introduction to research in education edition. Belmont, CA: Wadsworth Cengage Learning.

Bocconi, S., Chioccariello, A., Kampylis, P., Dagienė, V., Wastiau, P., Engelhardt, K., . . . Malagoli, C. 2022. *Reviewing Computational Thinking in Compulsory Education: State of Play and Practices from Computing Education.*

Brady, T., Salas, C., Nuriddin, A., Rodgers, W., & Subramaniam, M. 2014. *MakeAbility: Creating Accessible Makerspace Events in a Public Library*. Public Library Quarterly.

Brennan, K., & Resnick, M. 2012. *New Frameworks for Studying and Assessing the Development of Computational Thinking. Paper Presented at the Proceedings of the 2012 Annual Meeting of the American Educational Research Association*. Vancouver, Canada.

Budiyanto, C., Fitriyaningsih, R. N., Kamal, F., Ariyuana, R., &. Efendi. 2020. "Hands-on Learning in STEM: Revisiting Educational Robotics as a Learning Style Precursor. *Open Engineering. 10*(1):649-657.

Chibaudel, Q., Johal, W., Oriola, B., JM Macé, M., Dillenbourg, P., Tartas, V., & Jouffrais, C. (2020, October). " If you've gone straight, now, you must turn left"-Exploring the use of a tangible interface in a collaborative treasure hunt for people with visual impairments. In Proceedings of the 22nd International ACM SIGACCESS Conference on Computers and Accessibility (pp. 1-10). doi: 10.1145/3373625.3417020.

Costa, R., Araújo, C., & Henriques, P. R. (2021). Melodic-Teaching computational thinking to visually impaired kids. In Second International Computer Programming Education Conference (ICPEC 2021). Schloss-Dagstuhl-Leibniz Zentrum für Informatik.

Creswell, John W., and J. Creswell, David. 2017. *Research Design Qualitative, Quantitative, and Mixed Methods*. 5th ed. SAGE Publications.

Dagienė,, V., & Stupuriene, G. (2016). Bebras--A Sustainable Community Building Model for the Concept Based Learning of Informatics and Computational Thinking. *Informatics in education, 15*(1), 25-44.

Doyle, L., McCabe, C., Keogh, B., Brady, A., & McCann, M. (2020). "An Overview of the Qualitative Descriptive Design within Nursing Research." *Journal of Research in Nursing,* 25(5):443-455.

Dulock, H. L. 1993. "Research Design: Descriptive Research." *Journal of Pediatric Oncology Nursing* 10(4):154–57.

Eppich, W. J., Gormley, G. J., & Teunissen, P. W. 2019. "In-Depth Interviews. Healthcare Simulation Research: A Practical Guide." 85-91.

Erwin, E. J., T. S. Perkins, J. Ayala, M. Fine, and E. Rubin. 2001. "'You Don't Have to Be Sighted to Be a Scientist, Do You?' Issues and Outcomes in Science Education." *Journal of Visual Impairment and Blindness* 95(6):338–52. doi: 10.1177/0145482x0109500603.

Fagerlund, J., Vesisenaho, M., & Häkkinen, P. 2022. "Fourth-Grade Students' Computational Thinking in Pair Programming with Scratch: A Holistic Case Analysis." *International Journal of Child-Computer Interaction,* (100511):33.

Grover, S., & Pea, R. 2018. "Computational Thinking: A Competency Whose Time Has Come. Computer Science Education: Perspectives on Teaching and Learning in School." 19.

Hooshyar, D., Malva, L., Yang, Y., Pedaste, M., Wang, M., & Lim, H. (2021). An adaptive educational computer game: Effects on students' knowledge and learning attitude in computational thinking. Computers in Human Behavior, 114, 106575. doi: 10.1016/j.chb.2020.106575.

Kock, E. d. 2018. "Botley Robot Teaches Coding without Screens - The Coding Robot Activity Set Review." Retrieved (https://www.techagekids.com/2018/05/botley-robot-teaches-coding-no-screens.html).

Maheshwari, S. K., Chaturvedi, R., & Sharma, P. (2021). Effectiveness of psycho-educational intervention on psychological distress and self-esteem among resident elderly: A study from old age homes of Punjab, India. Clinical Epidemiology and Global Health, 11, 100733.. doi: 10.1016/j.cegh.2021.100733.

Metatla, O., Bardot, S., Cullen, C., Serrano, M., & Jouffrais, C. (2020, April). Robots for inclusive play: Co-designing an educational game with visually impaired and sighted children. In Proceedings of the 2020 CHI conference on human factors in computing systems (pp. 1-13).. doi: 10.1145/3313831.3376270.

Mich, O., Ghislandi, P. M. M., Massa, P., Mardare, V., Bisutti, T., & Giacomozzi, D. 2021. "A Framework for Educational Robotics in Kindergarten: A Systematic Literature Review and Analysis. International Journal of Digital Literacy and Digital Competence (IJDLDC)." 12(2):22–53.

Miles, M. B., & Huberman, A. M. (1984). Qualitative data analysis. Beverly Hills.

Nouri, J., Zhang, L., Mannila, L., & Norén, E. (2020). Development of Computational Thinking, Digital Competence and 21st Century Skills When Learning Programming in K-9. *Education Inquiry. 11*(1):1–17.

Park, Y., & Shin, Y. 2019. "Comparing the Effectiveness of Scratch and App Inventor about Learning Computational Thinking Concepts. Electronics." 8(11):1269.

Perry, N. E. 2023. *Using Qualitative Methods to Enrich Understandings of Self-Regulated Learning. In Using Qualitative Methods To Enrich Understandings of Self-Regulated Learning*. Routledge.

Ragusa, G., & Leung, L. 2023. "The Impact of Early Robotics Education on Students' Understanding of Coding, Robotics Design, and Interest in Computing Careers. Sensors." 23(23):9335.

Shute, V. J., Sun, C., & Asbell-Clarke, J. 2017. "Demystifying Computational Thinking. Educational Research Review." 22:142-158.

Taherdoost, H. 2016. "Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research." *SSRN Electronic Journal*. doi: 10.2139/ssrn.3205035.

Warmbrod, J. R. 2014. "Reporting and Interpreting Scores Derived from Likert-Type Scales." *Journal of Agricultural Education* 55(5):30-47.

Yadav, A., & Berges, M. (2019). Computer science pedagogical content knowledge: Characterizing teacher performance. ACM Transactions on Computing Education (TOCE), 19(3), 1-24. doi: 10.1145/3303770.

Zhang, L., & Nouri, J. 2019. "A Systematic Review of Learning Computational Thinking through Scratch in K-9. Computers & Education." (141):103607.