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Unplugged Coding Learning Package and A.I. Assisted Learning Tool to Support Computational Thinking for Elementary School Students

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Abstract

Research on Unplugged Programming Learning Package and AI-assisted Learning Tools to Support Computational Thinking for Elementary School Students. The objective of this research is to design and develop an Unplugged Programming Learning Package and AI-assisted Learning Tools to support computational thinking for elementary school students. The study was conducted using a one-group posttest design and involved 18 second-grade students in the 2022 academic year from Ban Pho Noi Nong Sim School.

The results of the research showed that the designed and developed Unplugged Programming Learning Package and AI-assisted Learning Tools supported computational thinking for elementary school students. The researchers designed and developed the package based on important principles and concepts of constructivist theory, computational thinking frameworks, and learning context. The design and development of the learning environment consisted of five components: 1) problem situation, 2) learning resources, 3) intellectual tools, 4) scaffolding, and 5) mentoring. The design principles were in line with the constructivist theory and computational thinking frameworks. The Unplugged Programming Learning Package and AI-assisted Learning Tools are expected to contribute to improving the computational thinking skills of elementary school students. The research findings may be useful for educators and curriculum developers who are interested in developing learning tools to support computational thinking for elementary school students.

Keywords: Computational thinking, Unplugged Coding, AI-assisted Learning Tools

1 Introduction

The current economy is undergoing a transformation towards the "New Economy" or Digital Economy, driven by knowledge, new ideas, information technology, and the internet. It is also referred to as the Knowledge-based Economy, Information Economy, and other similar names. The Digital Economy utilizes digital technology to increase efficiency from production to sales, enhance competitiveness, reduce costs, and add value to products and services. This leads to the development of the country's overall production capacity and economic growth. Thailand's Ministry of Digital Economy and Society has mentioned "Digital Thailand," which emphasizes the potential of digital technology in developing the country's infrastructure, data innovation, human resources, and other resources to drive sustainable economic and social development. The challenges of the digital age will transform the labor market by using new technologies

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such as robotics, artificial intelligence, and 3D printing, which can replace human labor in production, marketing, and customer service. Therefore, the future labor market will require highly skilled workers, such as data scientists and analysts, to fulfill more specialized tasks.

Coding still helps the country develop its ability to compete in the long-term digital industry. The concept of computation is a systematic process of analytical thinking to solve daily life problems. Teachers must instill the concept of computation in students from elementary to university levels, with an emphasis on practicing computational thinking to analyze problem details in real-life scenarios that are abstract. If teachers want students to learn skills in the 21st century, or what is called "Learning by doing," learning will only occur when they participate themselves. Therefore, teachers must create learning opportunities that are virtual through coding, which is a vital reason why teachers should design teaching and learning activities that integrate computational thinking with coding to enable students to practice thinking and problem-solving in realistic or similar situations. Teaching should be a computational thinking development process that enables students to confront real-life problem-solving situations because humans must solve problems all the time. The challenge of computational thinking lies in designing problem-solving processes that are clear enough to be applied to problem-solving. It is in line with teaching science in schools and universities, where teachers must provide clear guidance on how to solve problems.

Learning according to the constructivist theory believes that learning is a process of intellectual development in which learners create their own knowledge. The process of knowledge creation occurs when learners have experiences through the use of their senses, social interactions, and thinking processes. The process of learning occurs when learners attempt to link new information to existing knowledge by explaining, comparing, or checking the consistency of new information with existing understanding, resulting in the development of a more complex and resilient intellectual structure. When learners attempt to apply their existing knowledge structure to new situations, they may encounter cognitive conflicts that require them to modify their existing knowledge structure to create new knowledge. The effort to search for answers in order to reduce cognitive stress will lead to inquiry behavior and motivation to search for answers. When new situations have some similarities to existing knowledge structures, learners will use their existing knowledge as a guide to solve the problem of teaching management. Therefore, learners must attempt to link new experiences to existing knowledge and experiences to achieve complete learning. This is a process of learning that occurs within learners, who create knowledge from the relationships between what they see and their previous understanding by attempting to relate their understanding of events and experiences to existing knowledge and experiences.

Artificial Intelligence (AI) tools greatly assist in improving the education system and are an efficient tool for teachers, often helping to reduce the burden of managing the system. These technologies are not meant to replace teachers, but rather to help them use their time more effectively for student learning. AI is rapidly growing in the education sector and is becoming a valuable global market. This rapid growth is due to its ability to transform various aspects of the teaching and learning process. AI can create realistic learning environments, generate "smart content," fill gaps between learning and teaching, create individualized plans for each student, and much more.

Therefore, researchers aim to promote the computational thinking of learners by applying Constructivist theory and AI tools to coding learning. The learning set becomes an innovative

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teaching method comprising problem situations, content, activities, multiple media, and computational thinking measurement tools. This learning activity set is organized to cater to the learners' abilities and interests, and they can learn to their fullest potential. Learners develop learning behavior changes through experience or practice that aligns with content, objectives, and various experiences, leading to effective and efficient teaching and learning.

2 Theorical Framework

The researcher has reviewed literature, studied principles, theories, and research related to the design and development of Unplugged programming learning packages and AI-assisted learning tools to support computational thinking for elementary school students. This is done to establish a theoretical framework based on 6 important foundations, including contextual foundation, psychology of learning foundation, learning theory foundation, computational thinking foundation, AI-assisted learning foundation, and technology foundation.

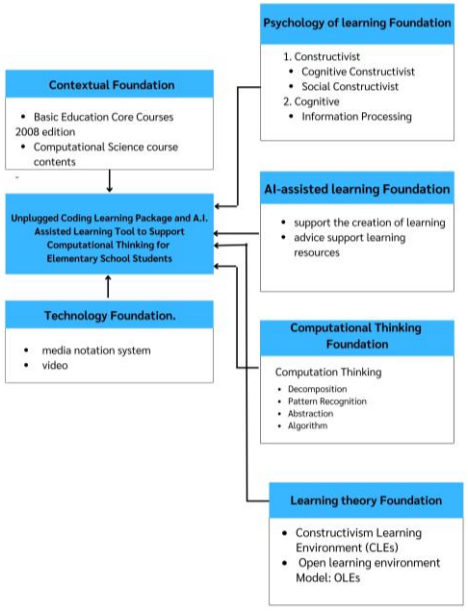

Figure 1: Theoretical framework

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From the theoretical framework of the unplugged programming learning package and the artificial intelligence learning tools to support computational thinking for elementary school students, the researcher has used this as a basis for designing a framework for creating an unplugged programming learning package and AI learning tools to support computational thinking for elementary school students.

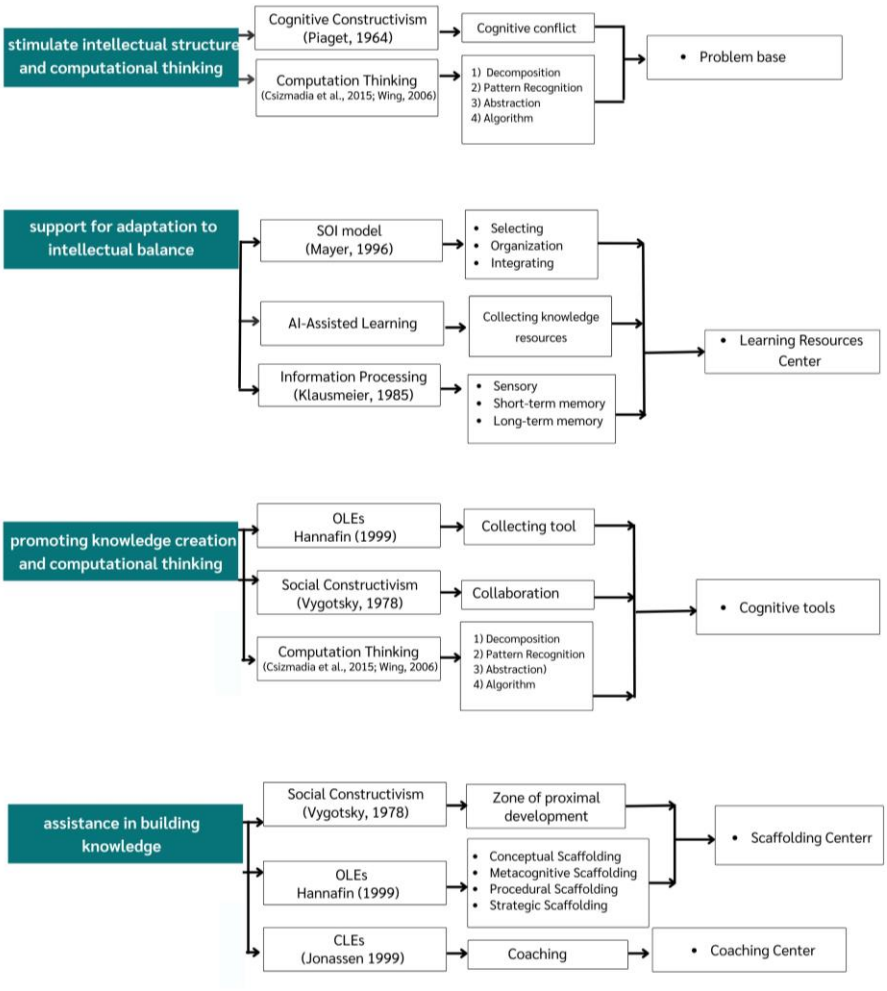

Figure 2: Design Framework Concept

3 Methodology

This research is a development-oriented research, using the research and development framework of Richy & Klein (2005) and Isara Kanjana (2016), which includes three phases: Phase 1 - Design and Development, Phase 2 - Evaluation, and Phase 3 - Validation.

The target group for this research are 18 second-grade students from Ban Pho Noi Nong Sim School, Seka District, Bueng Kan Province, as well as experts who will be conducting the evaluations.

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4 Analysis

The researcher analyzed educational data, theoretical principles, and related research. They studied the context of student learning, synthesized theoretical frameworks, synthesized design frameworks, and analyzed data through summarization and analytical interpretation.
The text describes the design and development of an unplugged programming learning package and AI-based learning tools to support computational thinking for elementary school students.

The researchers have designed and developed an unplugged programming learning package and AI-based learning tools to support computational thinking for elementary school students. They have used the important concepts and principles of constructivist theory, computational thinking, and learning context as the foundation for the design, along with designing and developing a learning environment with five components:

Problem situations, to motivate students to solve problems using Cognitive Constructivism problem design that stimulates external motivation to search for answers and find solutions through various prepared information sources.
Learning resources, which are sources of information that students can use to seek knowledge, solve problems, and find answers on their own.
Intellectual tools, which are tools that begin with stimulating students with problem situations to create intellectual imbalances by encouraging them to explore different possible solutions and to engage in reflective thinking.
Learning communities, which are groups of people who share a common interest and can work together to achieve a common goal in solving problems and creating new knowledge.
Assessment and reflection, which are essential components of the learning environment that enable students to evaluate their progress and adjust their learning strategies accordingly.
The evaluation results of the effectiveness of the Unplugged Programming Learning Package and AI-assisted learning tools to support computational thinking for elementary school students are as follows.
1. Evaluation of the outcomes found that the quality and alignment of the learning enviroment design and development framework based on constructivist theory were assessed by various experts in content, media, and learning environment design. The content was improved by following the experts' recommendations, including making it more concise and easier to understand, enlarging the font for clearer visibility, and using colored text to emphasize important points. The media was also improved by adjusting its components such as background colors, icons, and symbols to align with the subject matter, making it more outstanding and clearer, and using easy-to-understand illustrations. Moreover, the learning environment design was improved by adjusting the problem situation to fit the students' context, making the content more concise and clear, and making it easier for students to understand.
Content: The package of unplugged programming learning and AI-assisted learning tools for computational thinking support for elementary school students is highly suitable overall. When considering each aspect individually, the content quality of the system is the highest level, as the presented content is clear, comprehensive, and conducive to students' learning and knowledge exploration. The problem situation can also promote students' computational thinking development.

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Media: The media package of unplugged programming learning and AI-assisted learning tools for computational thinking support for elementary school students is of high quality overall.

Instructional Design: The instructional design of the package of unplugged programming learning and AI-assisted learning tools for computational thinking support for elementary school students is of high quality overall.

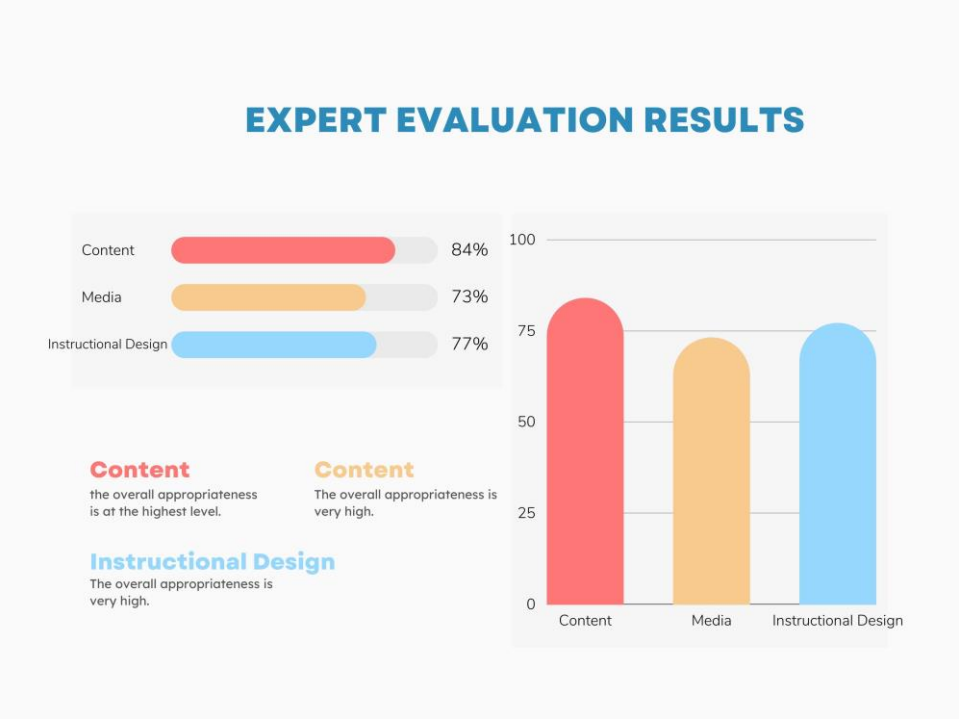

Figure 3: Expert evaluation results

2. Regarding the contextual evaluation, it was found that the evaluation of the learning environment by developing the learning environment and experimenting with a sample group that is similar to the target group, which is 16 fourth-grade students from Ban Phot Noi Nong Sim School, to find a suitable teaching context and to create the highest efficiency in learning with the learning environment.

From the analysis of the basic contextual foundations of the students, the researcher studied the contextual requirements of Ban Phot Noi Nong Sim School, which aims to develop students to be good people with desirable characteristics, knowledge and abilities according to the basic education curriculum, Buddhadasa 2551. The learning process focuses on the importance of students and follows the central curriculum. The Science and Technology learning area is related to Indicator 4 of Technology.

Standard 4.2: Understand and apply computational thinking concepts to solve real-life problems as a step-by-step and systematic process, using information and communication technology efficiently, having knowledge, being ethical, and having morality.

The researcher used a survey questionnaire with three categories to assess the context of the learners, which are technology, pedagogy, and computational science.

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The first category is related to technology.

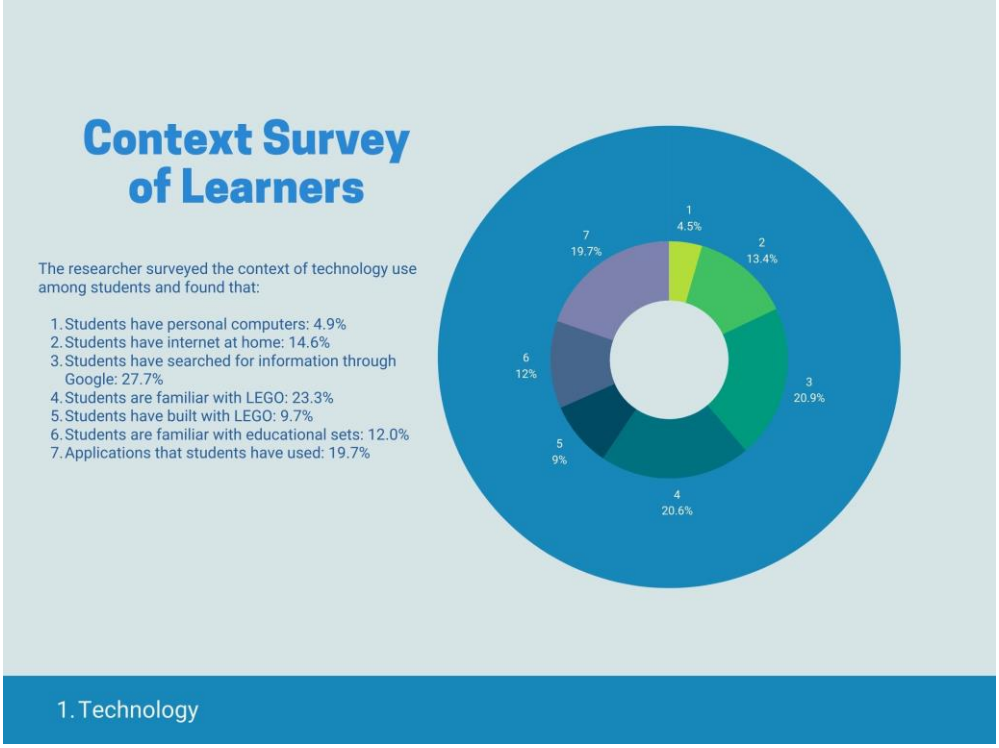

Figure 4: Student Context in Technology

The researcher surveyed the context of technology use among students and found that:

Students have personal computers: 4.9%

Students have internet at home: 14.6%

Students have searched for information through Google: 27.7%

Students are familiar with LEGO: 23.3%

Students have built with LEGO: 9.7%

Students are familiar with educational sets: 12.0%

Applications that students have used: 19.7%

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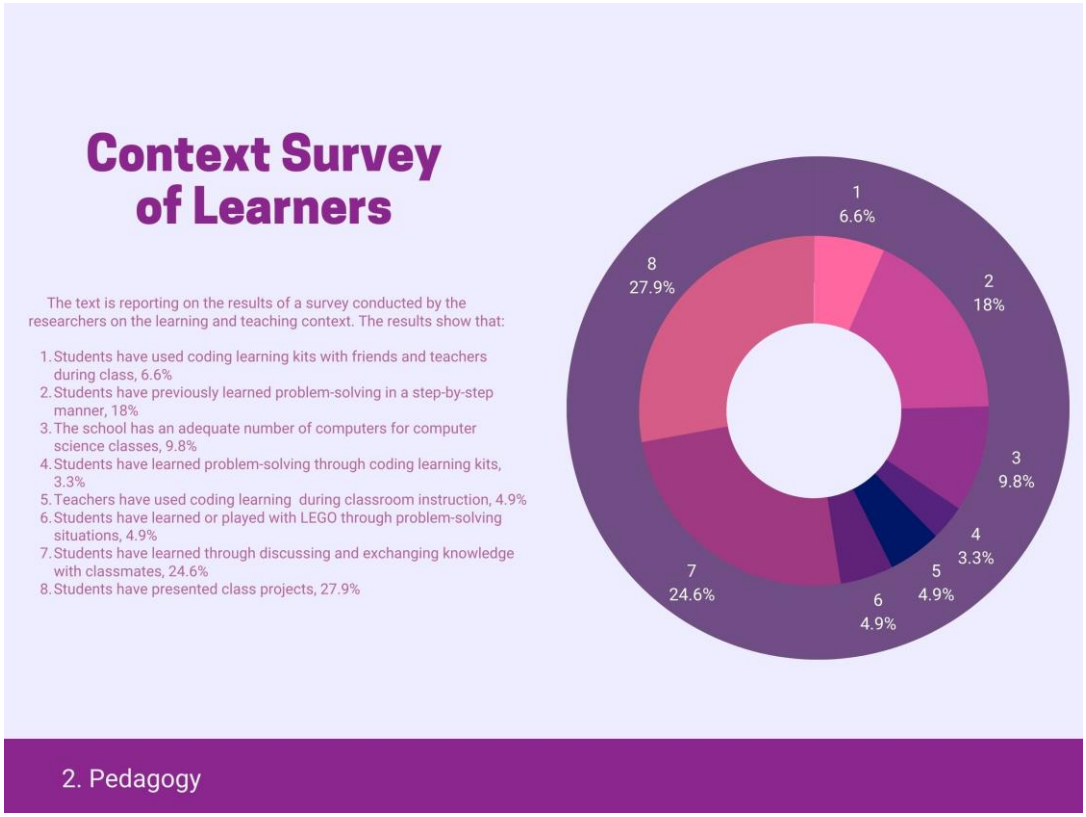

Figure 5: Pedagogy

The text is reporting on the results of a survey conducted by the researchers on the learning and teaching context. The results show that:

Students have used coding learning kits with friends and teachers during class, 6.6%
Students have previously learned problem-solving in a step-by-step manner, 18%
The school has an adequate number of computers for computer science classes, 9.8%
Students have learned problem-solving through coding learning kits, 3.3%
Teachers have used coding learning during classroom instruction, 4.9%
Students have learned or played with LEGO through problem-solving situations, 4.9%
Students have learned through discussing and exchanging knowledge with classmates, 24.6% Students have presented class projects, 27.9%

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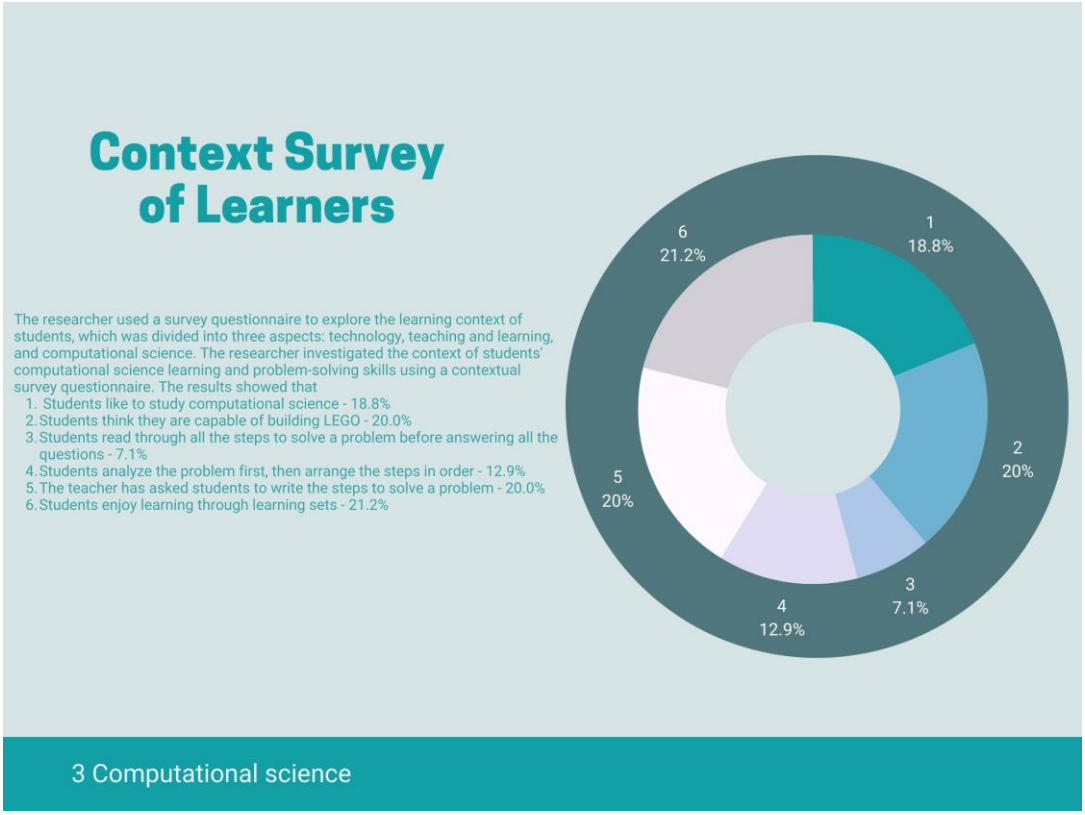

Figure 6: Computational science

The researcher investigated the context of students' computational science learning and problem-solving skills using a contextual survey questionnaire. The results showed that:

Students like to study computational science - 18.8%

Students think they are capable of building LEGO - 20.0%

Students read through all the steps to solve a problem before answering all the questions - 7.1%

Students analyze the problem first, then arrange the steps in order - 12.9%

The teacher has asked students to write the steps to solve a problem - 20.0%

Students enjoy learning through learning sets - 21.2%

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3. In terms of environmental design for learning, most learners believe that problematic situations can stimulate interest and a desire to solve problems because simulating problem scenarios similar to those encountered in daily life allows learners to participate and be involved in the situation, which leads to a stimulation to solve problems.

5 Result

The design and development of Unplugged programming learning package and AI-assisted learning tools to support computational thinking for elementary school students were conducted by the researchers. They based their design on the important principles and concepts of constructivist theory, computational thinking framework, and learning context. They used the design and development of the learning environment as the foundation for the five components: 1) problem situation, 2) learning resources, 3) intellectual tools, 4) support base, and 5) consultancy. These components align with the principles and theories used in the design, which include constructivist learning theory and open learning environment (OLEs) design principles. However, the outcome of this study differs from previous research on the design of computational thinking training centers. The researchers designed and developed a set of learning tasks and activities for students to practice computational thinking skills.

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