

DIGITAL MODULE AS INNOVATION IN ICT LEARNING: PREPARING HIGH SCHOOL STUDENTS' PROBLEM-SOLVING SKILLS THROUGH COLLABORATIVE CODING

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Abstract. Various competencies are essential for students to master in order to strengthen their competitiveness, particularly in the field of human resources in the 21st century. The integration of technology into learning media plays a crucial role in supporting the educational process. However, the lack of innovation in utilizing technology-based learning media often leads to suboptimal learning outcomes and limited acquisition of essential skills. This study aims to explore the need and opportunities for developing a digital learning module based on collaborative coding, with the goal of enhancing students' problem-solving abilities in ICT subjects. This research is a qualitative study employing a survey method. Data were collected through observation and a needs analysis questionnaire. Quantitative data from the questionnaire were analyzed descriptively using percentage-based analysis and presented in tabular form. The study involved 65 students from the first and second grades of a senior high school. The findings show that approximately 38% of students reported that traditional media such as PowerPoint were still predominantly used, while 24% indicated the use of printed materials. Furthermore, students expressed a positive perception toward the development and implementation of a collaborative coding-based digital module as an innovative approach in ICT learning. These findings can serve as a foundation for educators to design and apply digital learning modules that align with the demands of 21st-century education.

Keywords: Collaborative Coding, Digital Module, ICT Learning, Instructional Innovation, Problem-Solving Skills

1. INTRODUCTION

According to the current curriculum, learning requires students to actively develop essential skills through meaningful engagement in the learning process. In response to global education demands, many national curricula—including Indonesia's—have adopted scientific and project-based approaches to foster deeper learning and student autonomy (Estrada-Oliver et al., 2021; Sumarmi et al., 2021). These shifts aim to prepare students for 21st-century challenges by enhancing critical thinking, problem-solving, creativity, communication, collaboration, and digital literacy (Wrahatnolo & Munoto, 2018). Such competencies are fundamental in shaping future-ready learners who can adapt to rapid technological and social changes.

To effectively foster these competencies in classroom practice, learning environments must be supported by pedagogically sound and technology-integrated approaches. This includes the strategic use of Information and Communication Technology (ICT), which has significantly reformed the teaching and learning process (Azmi & Widiaty, 2021; Riskasari et al., 2022). ICT enables students to access a wide range of learning resources beyond traditional classrooms, encouraging autonomy and personalized learning experiences (Budiarto, 2020; Tran, 2019). Furthermore, its integration supports the creation of dynamic and interactive educational spaces that foster student engagement (Budiarto et al., 2020). In this context, educators are expected to move away from conventional methods and embrace more innovative, technology-based tools and strategies in their instruction (Han & Geng, 2023). Developing digital modules that integrate collaborative coding is one such innovation

that can enhance students' problem-solving skills, particularly within ICT-based learning environments.

ICT learning is not only aimed at equipping students with technical knowledge, but also at cultivating higher-order thinking and collaborative problem-solving skills. In this context, digital literacy and computational thinking are essential competencies that help students understand how technology shapes information, communication, and society. Effective ICT learning requires students to be actively involved in hands-on, minds-on, and socially interactive experiences that stimulate exploration, coding logic, and teamwork. However, field observations conducted in several high schools revealed that traditional instructional practices still dominate classroom activities. Teachers often rely on static media such as PowerPoint, while students passively copy notes with limited engagement in inquiry-based learning or collaborative exploration. This approach is misaligned with the core principles of ICT education, which emphasize active construction of knowledge and iterative learning processes. Furthermore, abstract programming concepts are often delivered without adequate support tools, which may hinder students' conceptual understanding and reduce motivation. Therefore, there is a growing need for innovative digital learning tools—such as interactive modules that incorporate collaborative coding strategies—to enhance student participation, engagement, and problem-solving abilities in ICT classrooms (Haddade et al., 2023; Novick et al., 2022; Pan, 2020).

Textbooks traditionally provide only textual material with supporting images, while modules and student worksheets typically contain summaries, assignments, and assessment questions. However, PowerPoint presentations often offer only basic material summaries, which are less engaging and do not encourage students to actively explore or think critically about the subject matter. Moreover, teaching materials often lack multimedia elements such as videos or interactive tools, which could help make abstract concepts—such as those related to ICT and coding—more tangible. As technological advancements continue to shape the education system, it is crucial to integrate digital learning tools that can foster student engagement and motivation. (Salin & Noor, 2018) emphasize that digital learning involves the use of digital media—such as text, images, and interactive components—delivered through online platforms, aimed at improving student outcomes and enhancing teaching effectiveness. One promising solution for ICT education is the use of interactive, ICT-based learning modules, which can integrate elements of collaborative coding. The rapid development of ICT offers opportunities for designing multimedia-based learning environments that encourage students to actively participate in coding exercises and problem-solving activities, thereby enhancing their ICT skills and fostering deeper learning (Juera, 2024; Utomo et al., 2021).

Several studies have shown that the use of digital learning tools, such as interactive e-books, can positively impact student learning outcomes and enhance engagement in the learning process. In the context of ICT education, digital learning media such as flipbooks have been found to improve students' cognitive skills, including logical thinking and problem-solving abilities, particularly in subjects like mathematics and science. The development of innovative teaching materials, such as digital modules that integrate collaborative coding, helps students acquire new skills that are relevant to the 21st century. One of the innovations in the delivery of teaching and learning materials is utilizing interactive digital platforms, which offer a dynamic and engaging learning experience. These innovations serve as a valuable solution in ICT education, as they foster critical thinking, creativity, and collaborative problem-solving among students. Based on the positive results from the use of such digital tools, this study aims to explore the need for the development of collaborative coding-based digital learning media in ICT education, specifically for high school students (Evans & Midford, 2022; Kumar Basak et al., 2018; Qureshi et al., 2021).

2. RESEACH METHODS

This research is a qualitative study employing a survey method (Sugiyono, 2018). The participants in this study were 65 senior high school students from grades one and two in the Surakarta area, Central Java Province. Data collection was carried out through observation and the distribution of a needs analysis questionnaire. The questionnaire was randomly distributed to 65 students via a provided link. The quantitative data collected from the questionnaire were analyzed using descriptive quantitative techniques, with percentages presented in tables. This study specifically focuses on students' perceptions of the opportunities for the development and implementation of collaborative coding-based digital learning media in ICT education. As such, the observation sheets and questionnaires were designed to capture students' views on the use of instructional media in ICT learning, their perceptions of the potential for developing and using digital modules such as collaborative coding platforms, and their reasons for supporting the integration of such tools in the classroom.

3. RESULTS AND DISCUSSION

Based on the results of student questionnaires, it was found that students felt unhappy when learning exclusively using textbooks, modules, or printed textbooks. This sentiment is reflected in the types of instructional media frequently used by teachers in classroom learning.

Table 1. Soybean Raw Material Purchase Data for 2024

Media Type	F (N=65)	%
Module Printed	19	29.02.00
Text Book	15	23.01
Powerpoint	25	38.05.00
Worksheet	6	09.02
Total	65	100

As seen in Table 1, nearly 38.5% of students stated that in-class learning predominantly involved PowerPoint presentations, followed by the use of modules, textbooks, and worksheets. Students expressed a clear desire for more engaging learning media that incorporates not only textual content but also audiovisual elements such as videos to enhance their understanding.

Students reported that many ICT-related topics, such as coding, remain abstract and difficult to understand with traditional media alone. This indicates a pressing need for interactive digital learning modules, particularly those incorporating collaborative coding activities, to provide students with hands-on, engaging learning experiences. Integrating ICT-based learning tools such as collaborative coding platforms would improve students' problem-solving abilities and understanding of ICT concepts. Students expressed positive perceptions of the potential for digital modules to enhance their learning experiences, especially in preparing them for the 21st-century digital world.

Table 2. Students' Perceptions of the Flipbook Development

Student's Response	F (N=65)	%
Agree	58	89.02.00
Neutral	7	10.08
Disagree	0	0
Total	65	100

Almost all students, or 89.2% of the 65 students, agreed to the development and use of flipbook-based digital books. Flipbooks, which are electronic books in the form of soft files, differ from traditional textbooks, which are physical. The advantage of flipbooks lies in their ability to incorporate multimedia elements, such as audio files, videos, and

bibliographies in the form of links. This feature allows students to directly access external websites for further information, such as details about the human body's defense system. Additionally, the flipbook development allows for the inclusion of more comprehensive learning indicators, making the material presented more complete and engaging.

The positive responses from students indicate a strong interest in using flipbook-based digital learning media to enhance their ICT learning experience. Students reported that the interactive features of flipbooks, especially the integration of multimedia content, made the material more understandable and accessible. This is in line with the need for innovative digital tools in ICT education, particularly those that can support collaborative coding and enhance problem-solving skills.

Table 3. The Attractiveness of the Flipbook-Based Digital Media Feature

Reasons for Choosing a Flipbook	F (N=65)	%
Interactive	18	27.07.00
There are learning videos	5	07.07
There are practice questions	6	09.02
More attractive appearance	26	40.00.00

From Table 3, it is known that there are various reasons students chose flipbook-based digital books to be used in learning ICT. The primary reason was that students found the flipbook to have a more attractive appearance (40%). This was followed by the inclusion of interactive elements in the media (27.7%). Students also stated that the flipbook was more engaging because it did not only contain text, but also incorporated images and videos (15.4%). Additionally, some students appreciated that the flipbook provided practice questions (9.2%) and learning videos (7.7%). These features suggest that flipbook-based digital learning media have the potential to significantly enhance students' engagement and understanding in ICT education by offering interactive, multimedia-based learning experiences.

The needs analysis was also conducted through field observations. Based on the results of field observations at senior high schools, it was found that teachers had not fully optimized several aspects of learning support, such as teaching models and media. The teaching model applied by the teacher has not been able to encourage students to actively construct their own knowledge. Most students remained passive, only recording the information provided by the teacher without actively exploring or seeking new knowledge. The media used by the teacher, in the form of PowerPoint presentations, was simple and only contained key points and minimal material summaries, which were less engaging and did not foster students' curiosity about the subject matter.

Interviews with teachers revealed that the material on the body's defense system was still considered difficult, as it is abstract and occurs inside the body, making it challenging to observe directly. During observations, the learning media used in the classroom included textbooks, modules, student worksheets, and PowerPoint presentations. However, the textbooks lacked core competencies, basic competencies, and learning indicators, and only contained text with supporting images. Modules and worksheets provided material summaries, assignments, and daily test questions, but they did not incorporate interactive or multimedia elements that could enhance engagement. PowerPoint presentations only offered brief material summaries, which were not informative or interesting enough to stimulate students' curiosity.

Furthermore, the teaching materials lacked supporting multimedia, such as videos or interactive elements, to make abstract topics like the body's defense system more tangible and engaging. This highlights the need for innovative learning tools, such as interactive digital modules based on ICT and collaborative coding, to foster active learning and problem-solving skills among students.

The results of the study showed that the low use of digital-based learning media by

teachers is unfortunate, especially considering that in the era of the industrial revolution learning media 4.0, technology has become an integral part of human survival (Lasfika et al., 2022; Trisiana et al., 2020). The media used by teachers tends to be traditional and simple, which only includes key points and material summaries that are minimalist, less engaging, and fail to stimulate students' curiosity about the subject being taught (Li et al., 2024). The flipbook-based digital media for ICT learning, particularly for collaborative coding and problem-solving tasks, is an innovative solution to enhance engagement and facilitate learning.

In the context of ICT education, such media should go beyond simple text and include interactive elements such as videos, coding exercises, and practice questions. The use of ICT-based learning tools is critical for fostering deeper understanding, especially when dealing with abstract concepts, like the body's defense system in biology, which can be effectively explored through digital modules. Therefore, the integration of digital learning media that includes multimedia content and collaborative coding exercises can help address the gaps found in traditional teaching methods and better prepare students for the challenges of the 21st century (Kumar Basak et al., 2018).

Although the use of learning media is still largely conventional, there is a variety of media being used. According to the survey, teachers still rely on print modules, PowerPoint presentations, and student worksheets, all of which have their advantages in supporting student achievement and increasing interest in learning (Ninghardjanti et al., 2021; Pan, 2020). However, there is a growing need for digital modules that can be integrated with ICT to provide a more interactive, engaging, and effective learning experience. Based on the survey results, students showed a positive response toward the development and use of digital modules in ICT learning. This positive reception can be attributed to the characteristics of digital modules as interactive, technology-based, and user-friendly learning tools. These modules can incorporate interactive exercises, videos, and practice questions, offering a more dynamic learning experience.

Previous research has indicated that the use of digital modules as learning media can improve student learning outcomes and skills (Triyanto et al., 2022). Additionally, digital modules can be adapted to various learning approaches, making them versatile tools for creating an innovative, engaging, and active learning environment. The integration of digital modules with collaborative coding activities enhances student engagement and problem-solving abilities. These digital tools can help bridge the gap between theoretical knowledge and practical application, empowering students to gain valuable skills for the 21st century. Furthermore, digital modules provide both a means of delivering material and a resource for independent student learning, fostering greater autonomy. Overall, digital module-based learning media is an essential innovation for ICT education, especially in the era of Industry 4.0, helping to achieve the desired learning outcomes and better prepare students for future challenges.

CONCLUSION

Based on the results of the study, it shows that during the learning process, teachers tend to use traditional media and learning models. Several studies have found that the use of digital modules as a medium for digital learning has various benefits for students. It is hoped that the results of this research can serve as a foundation for the continued development of digital module products to support learning and as a basis for teachers to provide innovations in the implementation of teaching practices. While many studies have shown that the use of interactive and multimedia-based learning tools, such as digital modules, positively impacts improving student achievement both academically and practically, further studies can be conducted by other researchers as part of the ongoing development and application of digital modules in ICT education, particularly in fields like collaborative coding. The use of innovative digital teaching materials will help motivate students to be more engaged in the learning process, making education more effective and aligned with the demands of the 21st century.

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