Indonesian Journal of Education & Mathematical Science
Vol. 7, No. 2, Mei 2026, pp. 127~135
ISSN: 2721-3838, DOI: 10.30596/ijems.v7i2.29444

Development of an Electronic Student Worksheet on Perimeter and Area for Elementary School Students

Siti Nurani[1], Elan[2], Karlimah[3]
[1,2,3]Primary School Teacher Education, Universitas Pendidikan Indonesia, Tasikmalaya, Indonesia
sitinurani90@upi.edu, elanmpd@upi.edu, karlimah@upi.edu

ABSTRACT

Many elementary school students experienced difficulties in measuring the perimeter and area of plane figures. These difficulties were associated with misconceptions, an emphasis on memorizing formulas, and limited meaningful learning experiences across cognitive, affective, and psychomotor domains. This study aimed to analyze the need for developing an electronic student worksheet on perimeter and area for elementary school students. The research employed the analysis stage of the ADDIE development model. Data were collected through teacher interviews and document analysis, including curriculum documents and existing electronic worksheets. The findings indicated that current electronic worksheets provided opportunities to enhance motivation and conceptual understanding; however, they had not systematically integrated character values such as honesty, discipline, and cooperation. The results highlighted the urgency of developing a more constructive electronic student worksheet that integrated mathematical measurement concepts with character development. This needs analysis provided a theoretical and practical foundation for the subsequent design and development stages.

Keywords: Character education, electronic student worksheet, Perimeter and area

Corresponding Author:
Siti Nurani
Primary School Teacher Education,
Universitas Pendidikan Indonesia Kampus Tasikmalaya
Jl. Dadaha No. 18, Kelurahan Kahuripan, Kecamatan Tawang, Kota Tasikmalaya, Jawa Barat, Kode Pos 46115
Email Penulis: sitinurani90@upi.edu

1. INTRODUCTION

Mathematical ability is one of the main indicators of the quality of education at the global level. The results of the 2022 Programme for International Student Assessment (PISA) show that Indonesian students' mathematics achievement is still far below the OECD average, with a score of 379 out of an average of 472 (OECD, 2023). This low achievement reflects the weak numeracy literacy of Indonesian students, especially in relating mathematical concepts to real-life contexts. This condition poses a major challenge for the Indonesian education sector, which is striving to prepare a competitive generation for the 21st century. Efforts to improve the quality of mathematics education are also in line with the global agenda in Sustainable Development Goals (SDGs) point 4, which states that quality, inclusive and equitable education must be ensured and lifelong learning opportunities must be supported for all (UNESCO, 2023).

In the national context, the results of the 2022 Computer-Based National Assessment revealed that the numeracy skills of primary school students are still in the category of requiring special intervention (Kementerian Pendidikan Riset, dan Teknologi, 2024). One of the topics that often causes difficulties is measuring the perimeter and area of flat shapes. Previous studies have reported that students often have misconceptions in distinguishing between the concepts of perimeter and area, as well as difficulty understanding the relationship between formulas and their application in everyday life (Fajari, 2020; Ningtyas et al., 2023).

The results of field studies reinforce these findings. Teachers still predominantly use conventional methods such as lectures and printed worksheets, which tend to make students passive and only memorise formulas without understanding their conceptual meaning. As a result, many students experience difficulties when faced with story-based questions or contextual problems (İlhan & Aslaner, 2020; Nareswari et al., 2021). This fact confirms the need for learning media that is more interactive, contextual, and in line with the cognitive development characteristics of primary school students.

With the development of educational technology, electronic student worksheets have emerged as an alternative solution. Various studies have proven that Electronic Student Worksheets can increase motivation, learning outcomes, and student engagement through interactivity, visualisation of abstract

concepts, and instant feedback (Aliu et al., 2024; Arda Yatul Liani & Mailani, 2023; Gracin & Krišto, 2022; Indriani & Nuryadi, 2022; Susanti et al., 2025). The flexibility of electronic student worksheets, which can be accessed through digital devices such as mobile phones, tablets, laptops, and computers, also opens up opportunities for more dynamic learning, both at school and at home.

Furthermore, mathematics education not only serves to develop cognitive aspects, but should also be a means of shaping constructive character traits in students, such as perseverance, honesty, responsibility, discipline, and cooperation. Research shows that the integration of character education through digital media can have a positive impact on building constructive attitudes in students (Asror et al., 2024; Cipta et al., 2023; Tohri et al., 2022). Therefore, the development of electronic student worksheets should not stop at instructional functions alone, but must be designed as an instrument that supports the formation of students' character.

Theoretically, this development is based on constructivism theory, which emphasises that knowledge is actively constructed by students through direct experience, exploration, and social interaction (Piaget, 1972; Vygotsky, 1978). With this foundation, constructive electronic student worksheets can become a medium that bridges conceptual understanding while fostering character values relevant to the Pancasila Student Profile in the Merdeka Curriculum.

Based on the above description, this study focuses on analysing the need to develop constructive electronic student worksheets on the subject of perimeter and area of flat shapes in primary schools. However, previous studies have not explicitly integrated character education within electronic student worksheets in a systematic and constructivist framework. Unlike previous studies that primarily emphasise the effectiveness or implementation of electronic worksheets, this study specifically highlights the integration of constructivist principles with character education values (such as honesty, discipline, responsibility, and cooperation) within the framework of the Merdeka Curriculum. The analysis was conducted through curriculum mapping, identification of teacher and student needs, and a literature review of relevant studies. This study offers a distinctive contribution by providing a comprehensive needs analysis that combines cognitive, contextual, and character-based dimensions as a foundation for developing innovative electronic student worksheets. The results are expected to provide a strong foundation for the design and development of innovative, contextual electronic student worksheets that are oriented towards character building in students.

2. RESEARCH METHOD

The analysis stage of the ADDIE model in this study consisted of four interconnected steps. First, curriculum analysis was conducted to identify the learning outcomes, learning objectives, and learning objective flow related to perimeter and area in the Merdeka Curriculum. Second, student characteristics analysis was carried out to identify students' cognitive development, misconceptions, and learning preferences based on teacher reports and previous studies. Third, teacher needs analysis was conducted through semi-structured interviews to identify classroom problems, limitations of existing worksheets, and teachers' expectations regarding electronic student worksheet development. Fourth, electronic student worksheet media analysis was conducted through a literature review to identify the strengths, weaknesses, and opportunities for integrating constructivist and character-based elements into the product design.

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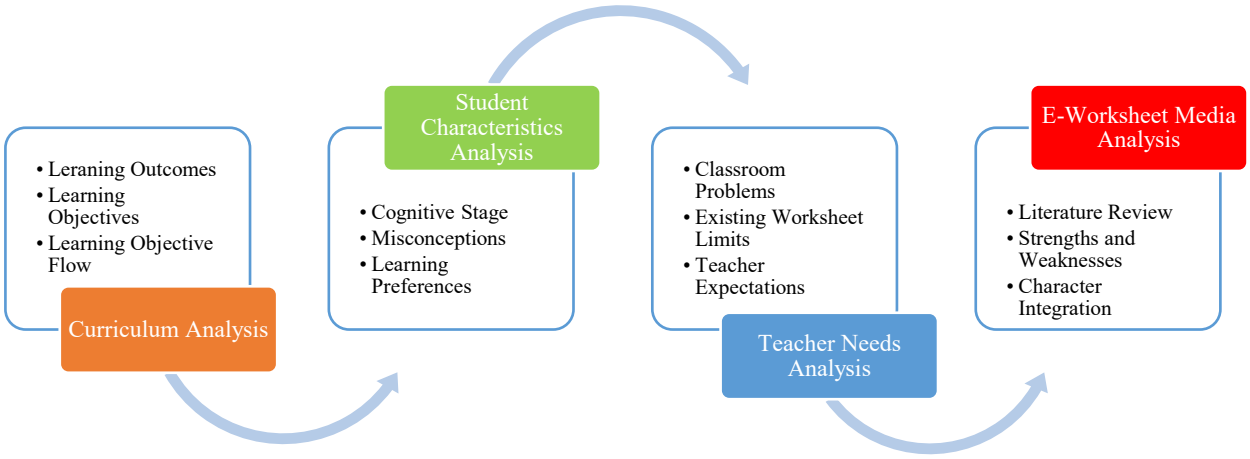

Fig. 1. Four Stages of the ADDIE Analysis Process

The collected data were analysed using two qualitative descriptive techniques, namely content analysis and thematic analysis. Content analysis was applied to curriculum documents and literature review data in order to identify the relevance of learning outcomes, learning objectives, misconceptions, and the strengths and weaknesses of existing electronic student worksheets. Thematic analysis was applied to teacher interview data through three stages: data reduction, coding, and categorisation. This analysis produced several major themes, including students' misconceptions regarding perimeter and area, limitations of existing learning media, and teachers' expectations for interactive and character-based electronic student worksheets. Finally, the findings from all data sources were integrated through triangulation to formulate the conceptual requirements for developing a constructive electronic student worksheet.

3. RESULTS AND DISCUSSION

The Merdeka Curriculum Analysis shows that at the end of Phase C (grades V–VI), students are expected to be able to determine the perimeter and area of various flat shapes (triangles, quadrilaterals, and polygons) and their combinations (Learning Outcomes). This achievement emphasises not only procedural mastery but also conceptual understanding that enables students to relate perimeter and area to everyday contexts.

From the learning outcomes, a number of learning objectives were derived, including: (1) explaining the concept of perimeter through concrete measurements, (2) calculating and comparing the area of flat shapes with unit squares, and (3) solving contextual problems related to perimeter and area, such as calculating the perimeter of a yard or the area of a room carpet.

Furthermore, the learning objective flow is designed as a systematic sequence of achievements. The learning objective flow for this topic includes: (1) identifying objects around us that are flat shapes, (2) measuring the length of sides to find the perimeter, (3) using unit squares to understand area, (4) generalising the perimeter and area procedures into formulas, (5) applying these concepts in real-life situations, and (6) reflecting on the measurement results to reinforce understanding.

However, preliminary study results indicate that implementation in the field is still limited to mastery of formulas without exploration of contextual meaning. Students are often directed to memorise formulas without meaningful experience, resulting in weak conceptual understanding and disrupted transfer to contextual problems (Esra & Şükrü, 2017; Hurrell, 2021). This condition reinforces the urgency of developing digital learning media, such as electronic student worksheets, which can bridge the demands of the curriculum with classroom learning practices.

A. Teacher Need Analysis

The results of the teacher need analysis show that students still often experience confusion in distinguishing between the concepts of perimeter and area, especially when questions are presented in

the form of stories or contextual problems. Teachers also assessed that the printed worksheets that have been used tend to be monotonous and only emphasise memorisation of formulas, thus not encouraging active participation or critical thinking skills in students. This condition shows a gap between the demands of conceptual understanding-based learning and learning practices that are still procedure-oriented.

Most teachers expect electronic student worksheets to be interactive, easily accessible, and equipped with contextual illustrations that can help students understand the relationship between mathematical concepts and their application in real life. Digital media is also seen as facilitating independent and collaborative learning, in line with the spirit of the Merdeka Curriculum, which emphasises project-based learning, differentiation, and strengthening the Pancasila student profile (Kementerian Pendidikan Riset, dan Teknologi, 2024).

These findings are consistent with the research of Cirneanu & Moldoveanu (2024) and Brown (2017) which shows that the use of digital media can significantly increase learning motivation, student engagement, and mathematics learning outcomes. The research by Ramadhani & Rahayu (2024) also confirms that constructivist-based electronic student worksheets can strengthen students' critical thinking skills, while Susanti et al. (2025) found that the integration of electronic student worksheets in geometry learning encourages active student engagement through visualisation and interactive exercises.

Thus, teachers' needs indicate the need for innovation in the form of developing constructive electronic student worksheets that not only serve as a means of understanding the concepts of perimeter and area of flat shapes, but also support the achievement of the Merdeka Curriculum's objectives in building numeracy skills, logical thinking, and holistic character building in students.

B. Analysis of Student Characteristics

Primary school students, especially those in Grade 5, are at the concrete operational stage according to Piaget's theory of cognitive development (Piaget, 1972; Santrock, 2018). At this stage, students' thinking abilities are still highly dependent on real objects, direct experiences, and concrete visual representations. Therefore, mathematics learning on the subject of perimeter and area of flat shapes requires media that can present realistic, simple, and interactive visualisations so that abstract concepts are easier to understand.

Interviews with teachers revealed that students tend to be more enthusiastic when learning involves visual stimuli such as pictures, animations, and simple games. Conversely, when learning focuses solely on lectures and memorising formulas, students quickly become bored and find it difficult to understand how concepts relate to everyday applications. For example, students often get confused when asked to calculate the perimeter of a fence or the area of a carpet, even though they have memorised the formula used.

In addition, the characteristics of the current generation of students also show that they are no longer unfamiliar with digital technology. Many primary school students are accustomed to operating mobile phones, tablets, and computers, both for playing games and accessing simple learning applications. This shows that the use of digital media in learning, including through electronic student worksheets, has great potential because it is in line with the habits and initial skills that students already possess.

The difficulties experienced by these students are in line with the findings of Hanan & Alim (2023) and Ningtyas et al. (2023) which reveal that misconceptions on the topics of perimeter and area generally arise due to the lack of contextual media in learning. This condition reinforces the importance of providing constructive electronic student worksheets that not only presents practice questions but also provides visual illustrations, digital simulations, and contextual activities that are in line with the cognitive characteristics and digital skills of primary school students.

Thus, the development of electronic student worksheets is expected to bridge students' limitations in understanding abstract concepts through interactive digital media that is based on real experiences and relevant to their habits in using technology.

C. Electronic Student Worksheets Media Analysis

The analysis of electronic student worksheets media in this study was conducted through a review of a number of relevant scientific articles. The results of this literature synthesis were used to map the

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roles, advantages, and aspects that must be considered in the development of constructive electronic student worksheets.

A review of the literature shows that electronic student worksheets plays a significant role in improving student learning outcomes, motivation, and engagement in mathematics learning. Compared to printed student worksheets, electronic student worksheets is able to provide interactivity, clearer visualisation of concepts, and instant feedback that helps students understand abstract concepts such as the perimeter and area of flat shapes more concretely (Aliu et al., 2024; Arda Yatul Liani & Mailani, 2023; Gracin & Krišto, 2022). With these advantages, teachers can more easily deliver context-based learning that promotes students' conceptual understanding.

In terms of facilities, electronic student worksheets is highly flexible as it can be accessed through various digital devices, such as mobile phones, tablets, laptops, and computers. This accessibility allows for more dynamic learning both at school and at home. Research Aliu et al. (2024) and Susanti et al. (2025) confirms that the availability of various digital devices provides great opportunities for students to learn independently or collaboratively without being limited by space and time. Therefore, the development of electronic student worksheets must take into account compatibility with various digital devices commonly used by students and teachers.

In addition to technical aspects, electronic student worksheets must also integrate constructive character values that are essential in learning. Constructive character includes perseverance, honesty, responsibility, discipline, and cooperation, which can be instilled through contextual problem exploration, group discussions, and reflection. Research by Bonanzinga et al. (2022), Tohri et al. (2022), and Asror et al. (2024) confirms that digital media is effective in fostering constructive attitudes in students, so that electronic student worksheets not only performs cognitive functions but also becomes a means of character building through interactive activities, visualisation, and instant feedback.

Furthermore, the development of electronic student worksheets needs to consider three main aspects, namely didactic, constructive, and technical (Hosnan, 2016; Majid, 2014; Prastowo, 2015). These three aspects can be further detailed in Table 1 below:

Table 1. Didactic, Constructive, and Technical Aspects in the Development of Constructive Electronic Student Worksheets

No	Aspect	Indicator	Statement	Description
1	Didactic	Alignment with the learning outcomes of the Merdeka Curriculum	“The material on perimeter and area is presented by linking mathematical concepts to real-life contexts.”	Constructivism: knowledge is built through students' real experiences (Piaget, 1972;Vygotsky, 1978).
		Application of contextual learning	"Questions are presented in the form of everyday problems, such as calculating the cost of a house fence or classroom carpet."	Contextual learning helps students connect concepts with their experiences (Johnson, 2002).
		Integration of constructive character values (honesty, responsibility, cooperation)	"Instruction emphasises the importance of cooperation and honesty in completing tasks."	Character education reinforces attitudes of responsibility, honesty, and discipline (Bonanzinga et al., 2022; Tohri et al., 2022)
2	Constructive	Activities encourage independent exploration	"Students are asked to find the perimeter patterns of several flat	Constructivism: knowledge is not transferred but actively

			shapes before being introduced to the formula."	constructed by students (Bruner, 1996).
		Providing space for reflection and discussion	"At the end of each worksheet, there are reflection questions: what difficulties did the students encounter and what strategies did they use?"	Reflection strengthens metacognition in learning (Schunk, 2012).
		Developing a constructive attitude: Responsibility: completing tasks on time a. Cooperation: sharing roles within the group b. Discipline: following instructions properly c. Honesty: not copying classmates' answers	"Students are asked to work in groups to complete contextual problems, with clearly defined roles."	Constructive values support the formation of the Pancasila Student Profile (Kementerian Pendidikan Riset, dan Teknologi, 2024)
3	Technical	Attractive, simple, and interactive display design	Multimedia learning theory emphasises simple visuals so that students focus on the material	"electronic student worksheets uses soft colours, simple icons, and clear navigation." (Mayer, 2009).
		Accessibility via mobile phones, tablets, laptops, computers	"LKPD is designed to be compatible with various web-based or application-based digital devices."	Flexible access enhances the reach and effectiveness of digital learning (Aliu et al., 2024)
		Multimedia features (images, videos, animations) to visualise concepts	"Extensive flat shape materials accompanied by video animations about the use of carpets in the classroom."	Digital media helps bridge abstract concepts to concrete ones (Susanti et al., 2025)

Thus, the electronic student worksheets media analysis confirms that the development of this product must meet didactic, constructive, and technical standards while also considering digital tools and the integration of character values. This provides a strong theoretical and practical foundation for the design of constructive electronic student worksheets in the next design stage.

D. Integrated Summary

When integrated, the results of the curriculum analysis, teacher needs, student characteristics, and electronic student worksheets media analysis show a coherent narrative, namely "The development of constructive electronic student worksheet is urgently needed to bridge the gap between conceptual understanding and contextual application of perimeter and area of flat shapes in primary schools." This integrated presentation confirms that curriculum requirements, challenges in classroom learning practices, student readiness, and evidence from media analysis all point to the same conclusion.

In summary, these findings reinforce the literature emphasising the importance of student- centred, character-based, and technology-integrated learning media in mathematics education. Furthermore, this study shows that constructive character-based electronic student worksheets, when designed based on didactic, constructive, and technical principles, can develop not only cognitive achievements but also values such as honesty, responsibility, discipline, and cooperation.

Table 2. Integrated Summary of the Analysis of Curriculum, Teachers, Students, and Electronic Student Worksheet Media in Relation to Development Needs

No	Data Source	Key Findings	Integrated Integration
1	Curriculum Analysis	The Merdeka Curriculum requires students to master the concepts of perimeter and area both procedurally and contextually. The curriculum has the strength of emphasising conceptual understanding and real-life application. However, in practice, the implementation in schools is still often limited to formula memorisation and has not fully reflected the intended contextual approach.	The curriculum analysis indicates that an electronic student worksheet is needed to bridge the gap between curriculum expectations and classroom practice by promoting conceptual and contextual understanding.
2	Teacher Needs Analysis	Teachers reported that students still have difficulty distinguishing between perimeter and area, especially in contextual problems. Existing printed worksheets are considered monotonous and mostly focus on procedural exercises. The strength of current practice is that teachers already recognise the importance of contextual and interactive learning. However, the weakness lies in the limited availability of digital learning media that support these needs.	These findings indicate that teachers need interactive and contextual electronic student worksheets that can support students' conceptual understanding and strengthen the Pancasila Student Profile.
3	Student Characteristics Analysis	Fifth-grade students are at the concrete operational stage and tend to learn more effectively through visual, contextual, and interactive activities. They are also familiar with digital devices such as mobile phones, tablets, and computers. However, students still experience misconceptions regarding perimeter and area because learning is often presented abstractly and procedurally.	These findings show that electronic student worksheets are appropriate for students' cognitive development and digital habits, making abstract concepts easier to understand through interactive and visual representations.
4	Analysis of Electronic Students Worksheet Media	Previous studies indicate that electronic student worksheets have several strengths, including increasing learning motivation, improving conceptual understanding, providing interactive visualisations, and being accessible through various digital devices. However, most existing	These findings indicate the need to develop an electronic student worksheet that not only utilises digital and interactive features, but also integrates contextual learning, constructivist activities, and character values relevant to the Merdeka Curriculum.

	electronic student worksheets still have weaknesses, such as focusing mainly on procedural exercises, lacking contextual problems, and not systematically integrating constructivist and character education elements.

4. CONCLUSION

This study aimed to analyse the need for developing a constructive electronic student worksheet on perimeter and area of plane figures for elementary school students using the analysis stage of the ADDIE model. The findings confirmed that although the curriculum emphasised conceptual and contextual understanding, existing printed student worksheets remained procedural and less supportive of meaningful learning experiences. Teachers reported limitations in instructional media, and students, who were at the concrete operational stage and familiar with digital devices, required interactive and contextual learning support. The literature review further supported the effectiveness of electronic student worksheets in enhancing motivation, learning outcomes, and constructive character formation.

These results indicate a clear gap between curriculum expectations and classroom practice, thereby confirming the urgency of developing a constructive electronic student worksheet that integrates conceptual understanding, contextual application, and character education. The development of such digital learning media is expected to support numeracy literacy while fostering values such as honesty, responsibility, discipline, and cooperation in line with the objectives of the Merdeka Curriculum.

The findings also provide prospects for further development and broader implementation. Future research may focus on the design, validation, and experimental testing of the developed electronic student worksheet across different grade levels and subjects to evaluate its effectiveness and sustainability in improving students' mathematical understanding and character development

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