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THE DEVELOPMENT OF TEACHABLE MACHINE-ASSISTED SCIENCE LEARNING MODULES USING THE ADDIE MODEL TO IMPROVE STUDENTS' COMMUNICATION WRITING SKILLS

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Abstract: Communication writing skills are essential in science learning, yet students often demonstrate low ability in expressing scientific ideas in a structured and meaningful way. This study aimed to develop and evaluate a Teachable Machine-assisted science learning module to improve junior high school students' communication writing skills. The research employed a Research and Development (R&D) method using the ADDIE model and applied a one-group pretest–posttest design to examine effectiveness. The study involved 30 seventh-grade students, with data collected through validation sheets, observation sheets, communication writing tests, and student response questionnaires. The results showed that the module achieved a high level of validity (86%) and practicality (88%), indicating that it is appropriate and feasible for classroom implementation. The effectiveness analysis revealed a moderate improvement in students' communication writing skills, with an N-gain score of 0.67. Student responses also indicated positive perceptions toward the module, with an average score of 83%. These findings suggest that the integration of structured writing activities and interactive AI-based technology can support students in organizing and expressing scientific ideas more effectively. However, the results are limited by the short implementation period and the use of a single group. Therefore, further research is recommended to involve larger samples and extended implementation to better examine the potential of similar learning modules.

Keywords: Learning modules, Teachable machine, written communication skills, Natural Sciences

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INTRODUCTION

Education plays a vital role in shaping students' ability to adapt to social changes and technological developments. Science education, particularly at the junior high school level, is designed not only to develop students' understanding of natural phenomena but also to engage them in scientific processes and communication activities (Panggabean et al., 2021). In this context, students are expected to actively construct knowledge and communicate their understanding effectively, both orally and in written form (Herlina, 2019). From a constructivist perspective, learning involves the active construction of knowledge through meaningful engagement with ideas and experiences. In science education, language plays a central role in shaping understanding (Wellington & Osborne, 2001: 15). Writing also functions not only as a means of communication but as a tool for organizing and developing scientific ideas, making communication writing skills an essential component of learning

(Hyland, 2003: 2). This is consistent with the view that writing is a productive language skill that requires the integration of cognitive and linguistic processes (Brown, 2007: 335).

However, challenges in science learning are still frequently encountered, particularly related to students' low communication writing skills. Communication writing skills refer to the ability to express ideas, information, and scientific findings in a clear, structured, and effective written form (Meryastiti et al., 2022). These skills include transforming forms of representation, analyzing data, and explaining experimental results. Such abilities are crucial as they support students in organizing knowledge systematically and enhancing higher-order thinking skills, including critical and creative thinking (Naila et al., 2022). Nevertheless, in Indonesia, these skills remain relatively low, mainly due to teacher-centered learning approaches that emphasize memorization rather than active knowledge construction (Hastuti & Hidayati, 2018).

Writing skills play a significant role in helping students understand abstract scientific concepts and communicate them effectively (Yusefni & Sriyati, 2016). Previous studies consistently show that students' participation in science learning tends to be passive, with classroom interactions dominated by teachers, resulting in limited opportunities for students to develop communication skills (Hastuti & Handayati, 2018). This indicates that existing instructional practices and learning resources have not fully supported the development of students' communication writing skills.

The integration of appropriate learning media and teaching materials is therefore necessary to address this issue. Studies suggest that engaging and technology-supported learning media can enhance student motivation and participation (Putri et al., 2023). In addition, modules as structured teaching materials play an important role in facilitating independent learning; however, existing modules are still limited in supporting communication writing skills (Indayani et al., 2021). Learning modules can also support students in understanding complex concepts through structured and guided activities (Carlina et al., 2021). This highlights the need for innovative learning resources that not only present content but also actively engage students in meaningful learning activities.

Recent advancements in technology, particularly artificial intelligence (AI), provide new opportunities to support interactive and student-centered learning environments. AI-based tools enable learners to interact directly with data and phenomena, thereby promoting active learning and deeper understanding (Holmes et al., 2019; UNESCO, 2021). One such technology is Teachable Machine, an AI-based platform that allows users to train models using images, sounds, or poses (Pratama et al., 2022). Through this technology, students can classify real objects such as animals and plants and transform the results into written scientific reports (Fauzy, 2023). This process aligns with the principles of active and experiential learning, where students not only observe but also analyze and communicate their findings (Bruner, 1961: 32).

Although previous studies have explored the use of learning media, modules, and AI technologies in education, most of them focus on improving conceptual understanding or general learning outcomes. Research specifically integrating AI-based tools such as Teachable Machine into structured learning modules to enhance students' communication writing skills in science learning remains limited. Therefore, there is a need to develop an innovative learning module that integrates AI technology with activities specifically designed to foster communication writing skills.

Based on this gap, this study aims to develop a Teachable Machine-assisted science learning module using a systematic instructional design approach. The novelty of this study lies in the integration of AI technology, module-based learning, and communication writing skill indicators within a single learning framework. The module is also supported by QR codes that provide direct access to the Android-based Teachable Machine application, enabling students to engage in interactive and contextual learning. It is expected that this module will not only improve students' communication writing skills but also enhance their engagement and independence in learning.

METHOD

This research was conducted in the odd semester of the 2023/2024 academic year at MTs 2 Jember. The subjects of this study were 30 seventh-grade students selected using purposive sampling, based on their participation in science learning activities. The product developed and tested in this study was a Teachable Machine-assisted science learning module. This study aimed to develop and evaluate the validity, practicality, and effectiveness of the module in improving students' communication writing skills.

This study employed a Research and Development (R&D) method using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. In addition, to test the effectiveness of the developed product, this study applied a one-group pretest-posttest design, in which students' communication writing skills were measured before and after the implementation of the module.

In the Analysis stage, a needs analysis, student characteristics analysis, and curriculum analysis were conducted through observations and interviews with science teachers. The results showed that learning was predominantly teacher-centered and relied on textbooks, which did not adequately support students' communication writing skills. In the Design stage, the module structure, learning activities, and assessment instruments were designed based on communication writing skill indicators, including transforming representations, analyzing tables, and explaining experimental results. In the Development stage, the module was developed and validated by experts. The Implementation stage involved testing the module in classroom learning. Finally, in the Evaluation stage, data were analyzed to determine the validity, practicality, and effectiveness of the module.

The instruments used in this study included: (1) expert validation sheets, (2) observation sheets for practicality, (3) communication writing skill tests (pretest and posttest), and (4) student response questionnaires. The validation instrument was assessed by three experts (two science lecturers and one science teacher) to determine content validity. The practicality instrument was used by three observers to assess the implementation of learning activities. The effectiveness instrument consisted of essay-based tests designed according to communication writing skill indicators and a student response questionnaire using a Likert scale.

The validity of the instruments was established through expert judgment (content validity). In addition, the reliability of the test and questionnaire instruments was measured using Cronbach's Alpha to ensure the consistency of the instruments.

Data analysis techniques were carried out as follows. The validity of the module was analyzed using a percentage formula.

$$Expert\ Validation = \frac{Total\ empirical\ score\ achieved}{Expected\ total\ score} x\ 100\ \%$$

The practicality of the module was measured through observations made by three observers using an implementation sheet. The implementation assessment was measured based on whether or not the core activity of using the Teachable Machine-assisted module in the learning process was carried out. The results obtained were then analyzed using the following formula.

$$practicality\ score = \frac{total\ score\ obtained}{Maximum\ score} x\ 100\ \%$$

The effectiveness of the Teachable machine-assisted module as teaching material for improving communication writing skills was measured using a communication writing skills test and a student response questionnaire. The test scores obtained were then analyzed using the N-gain test to determine the extent of improvement. The formula used to determine the N-gain value is as follows.

$$<g> = \frac{(Average\ post-test\ score) - (Average\ pre-test\ score)}{Maximum\ score-(Average\ test\ score)}$$

The N-gain results were then interpreted based on the criteria proposed by Hake (1998). To strengthen the analysis, inferential statistical tests were also conducted. A normality test (Shapiro–Wilk) was used to determine data distribution. If the data were normally distributed, a paired sample t-test was applied; otherwise, a non-parametric Wilcoxon test was used to determine whether there was a significant difference between pretest and posttest scores. The student response questionnaire was analyzed using the following formula.

$$Point = \frac{Item\ score\ obtained}{Maximum\ score} \times 100\ \%$$

The development of this module began with the Analyze stage, which included an analysis of needs, student characteristics, and the curriculum. Observations and interviews with science teachers at MTs 2 Jember showed that learning was generally conducted orally with books as the main source, which did not support students' written communication skills. A Teachable Machine-based module is needed to improve these skills by providing a more varied and interactive learning experience. Student analysis shows that they tend to get bored with static material and are more interested in hands-on practice, while curriculum analysis shows that the "Classification of Living Things" material is suitable for supporting these skill objectives in the Merdeka Curriculum implemented in schools.

RESULT AND DISCUSSION

Results

The development of the Teachable Machine-assisted module began with the Analysis stage, which revealed several fundamental problems in science learning. The findings indicate that learning activities were predominantly teacher-centered and relied heavily on textbooks, limiting students' opportunities to actively construct knowledge and express their understanding in written form. This condition contributes to the low development of communication writing skills, as students are not sufficiently engaged in activities that require them to organize and communicate ideas. In addition, students showed a preference for interactive and hands-on learning experiences rather than static materials. This finding highlights the importance of designing learning environments that actively involve students in meaningful tasks. In science education, such active engagement is essential because language and writing play a crucial role in shaping students' understanding of scientific concepts (Wellington & Osborne, 2001: 15).

In the Design stage, the module was systematically developed to address these identified needs by integrating activities that explicitly train communication writing skills. The module structure was not only designed for content delivery but also to facilitate students' ability to transform information, analyze data, and explain experimental results. This design reflects the view that writing is not merely a means of communication but also a cognitive tool that helps students organize and develop their understanding (Hyland, 2003: 2). Therefore, each activity in the module was intentionally structured to engage students in writing-based tasks that require interpretation, explanation, and representation of scientific information.

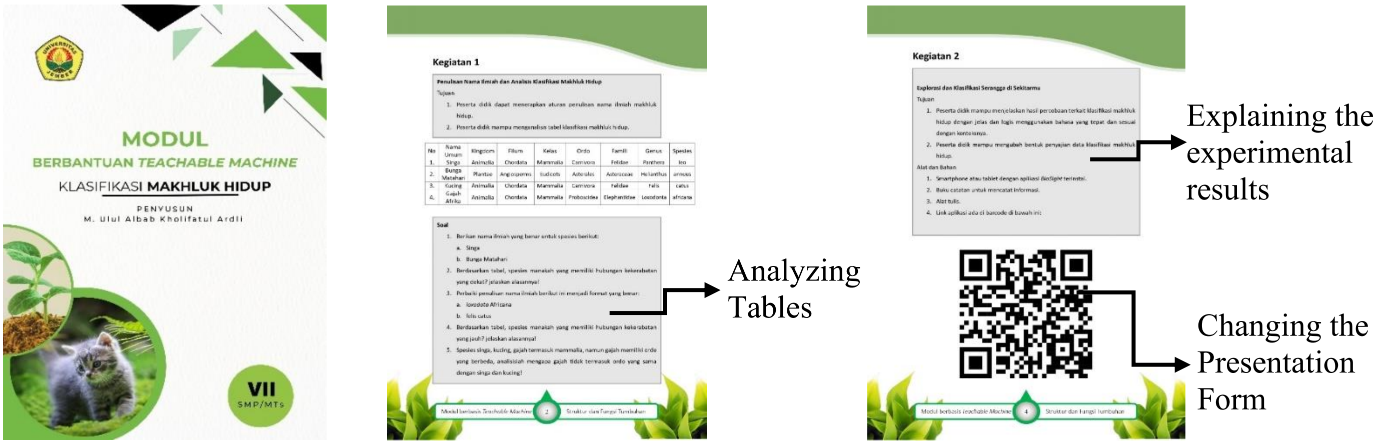

Figure 1. Cover and indicators of communication writing skills in the module

The integration of Teachable Machine into the module further strengthens the learning design by providing interactive and contextual learning experiences. Through this technology, students are not only passive recipients of information but actively involved in identifying and classifying living things using real data. This process enables students to connect abstract scientific concepts with real-world observations, making learning more meaningful.

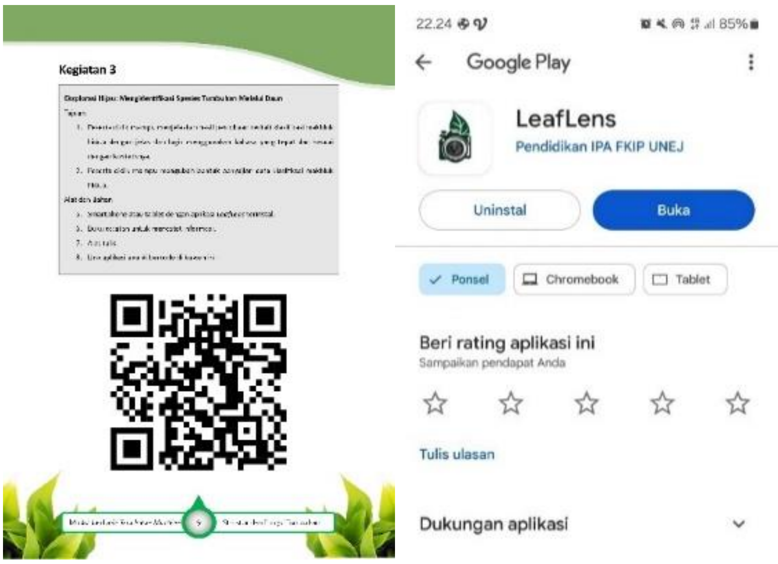

Figure 2. Integration of Teachable Machine in the module

Moreover, the use of QR codes and an Android-based application enhances accessibility and ease of use, which contributes to a more practical and student-centered learning environment. Such technology-supported learning environments are known to promote active engagement and deeper understanding, as students interact directly with learning materials and receive immediate feedback from the system.

Figure 3 Interface on Android application

Furthermore, the design of activities that involve real objects, such as observing plants and animals, plays an important role in supporting experiential learning. By engaging directly with real phenomena, students are encouraged to observe, analyze, and communicate their findings in written form. This approach not only improves conceptual understanding but also strengthens communication writing skills, as students must translate their observations into structured scientific explanations. The integration of observation, classification, and writing activities in a single learning process demonstrates how the module facilitates the development of both conceptual knowledge and communication skills simultaneously.

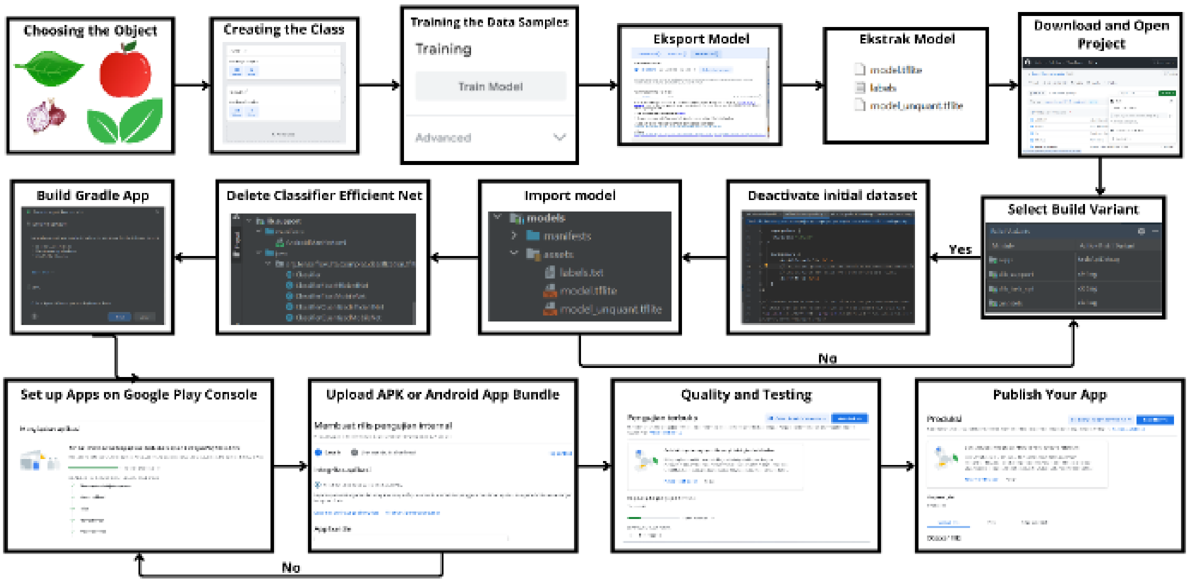

Figure 4. Application development stages

The development process shows that the module was designed not merely as a teaching material, but as a learning tool that actively supports the development of communication writing skills through structured activities, technology integration, and meaningful learning experiences. This aligns with the need for innovative learning resources that move beyond traditional approaches and provide opportunities for students to actively construct and communicate their understanding in science learning.

Discussion

The development of the Teachable Machine-assisted module followed the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. In the Analysis stage, observations and interviews revealed that science learning was still predominantly teacher-centered and relied on textbooks, limiting students' opportunities to develop communication writing skills. Students also showed greater interest in interactive and hands-on learning activities, indicating the need for more engaging learning media.

In the Design and Development stages, the module was systematically created by integrating communication writing skill indicators, including transforming representations, analyzing tables, and explaining experimental results. The module was also integrated with Teachable Machine technology to provide interactive and contextual learning experiences.

The validation results indicate that the module achieved a "very valid" category with an average score of 86%. The results can be seen in Table 1.

Table 1. Validation results

Assessment Aspect	ValidationPercentage (%)			Percentage (%)	Category
	1	2	3		
Graphic Aspects	88	83	100	90	Very Valid
Language Aspects	70	85	100	85	Very Valid
Content Aspects	90	75	90	85	Very Valid
Average	**83**	**81**	**97**	**86**	**Very Valid**

This result shows that the module has met the criteria in terms of content, language, and graphical aspects. The high score in the graphical aspect indicates that the visual design supports students' engagement, while the content and language aspects reflect the suitability of the material with students' cognitive levels. Expert validation is essential to ensure that the developed product is appropriate and to identify areas for improvement (Husada et al., 2020). Suggestions from validators, such as improving the clarity of instructions and adjusting the cognitive level of questions, contributed to refining the module before implementation.

In terms of practicality, the module achieved an average score of 88%, indicating that it is highly practical for classroom implementation. This is in line with the criteria of practicality, where learning materials are considered practical if they can be easily used and implemented effectively in classroom learning (Nesri & Kristanto, 2020). The results can be seen in Table 2.

Table 2 Practicality results

No	Assessment Activity	Observer		
		1	2	3
1.	Students read the module instructions.	100	100	93
2.	Students understand the material in the module.	80	80	95
3.	Students observe and identify plants and animals using the Teachable Machine app.	87	87	87
4.	Students complete activities 1, 2, and 3.	91	91	100
5.	Students present the results of their discussions.	62	87	87
Average		**84**	**89**	**92**
Total average		**88**		
Category		**Very practical**		

The high practicality score indicates that the module is easy to use and can be effectively implemented in classroom learning. The integration of Teachable Machine and QR codes facilitates access to learning resources and encourages student participation. However, variations in some activities, such as presenting discussion results, indicate that students still need support in developing communication skills. This suggests that practicality is influenced not only by the design of the module but also by students' readiness and experience in communication-based learning.

The effectiveness of the module was evaluated through pretest and posttest results, which showed an N-gain score of 0.67 in the moderate category. The results can be seen in Table 3.

Tabel 3. The effectiveness of the learning module

Component	**Class VII F**		***N-gain <g>***	**Category**
	Pretest	***Posttest***		
Number of Students	30			
Lowest Score	25	60	0,67	Middle
Highest Score	60	100		

The increase in scores from pretest to posttest indicates that the module contributes to improving students' communication writing skills. This improvement reflects the role of structured learning activities in guiding students to actively process and communicate scientific information.

Further analysis of each communication writing skill indicator shows varying levels of improvement. The results can be seen in Table 4.

Table 4. Indicator achievement results communication writing skills

Indicator of *Communication writing skills*	**Average *Pretest* score**	**Average *Posttest* score**	***N-gain***	**Category**
Changing the presentation format	10,5	18,3	0,82	High
Analyzing the table	7,34	8,64	0,65	High
Explaining the experimental results	7	14,8	0,60	Average

The highest improvement occurred in the ability to transform forms of representation, while the ability to analyze tables and explain experimental results showed moderate improvement. This indicates that different indicators require different levels of cognitive processing and practice intensity.

The results of the student response questionnaire further support the effectiveness of the module, with an average score of 83% in the "very good" category. The results can be seen in Table 5.

Table 5. Results of student response questionnaire analysis

No.	**Aspect**	**Percentage (%)**	**Category**
1.	Attractive	84	Very Good
2.	Content	83	Very Good
3.	Languange	82	Very Good

Average Score	**83**	Very Good

These results indicate that students responded positively to the module in terms of interest, material, and language, suggesting that the module successfully creates an engaging and understandable learning environment. The results of this study indicate that the Teachable Machine-assisted module is valid, practical, and effective in improving students' communication writing skills. The high validity score reflects that the module has been designed in accordance with learning objectives and student needs, integrating appropriate content, language, and visual elements.

The practicality results show that the module can be easily implemented in classroom settings. The integration of interactive technology, such as Teachable Machine, supports student-centered learning by encouraging active participation. This finding indicates that technology-based learning environments can enhance engagement and make learning more meaningful.

The effectiveness results demonstrate that the module contributes to improving communication writing skills, as indicated by the N-gain score. This improvement can be explained by the design of the module, which integrates writing activities into the learning process. Writing serves as a tool for organizing and developing ideas, allowing students to construct their understanding more effectively (Hyland, 2003: 2). In addition, the role of language in science learning is essential, as it helps students interpret and communicate scientific concepts (Wellington & Osborne, 2001: 15).

The analysis of each indicator shows that structured and repetitive activities are particularly effective in improving skills related to transforming representations. Meanwhile, skills that require higher-order thinking, such as analyzing data and explaining experimental results, show moderate improvement, indicating the need for more intensive practice. These findings are consistent with previous studies that highlight the importance of structured learning modules in developing students' communication skills (Prihatin, 2022).

Student responses further confirm the effectiveness of the module, as students showed high levels of interest and positive perceptions of the learning process. This suggests that the integration of technology and interactive activities can create a more engaging learning environment.

However, several limitations were identified, including students' lack of confidence in expressing ideas and difficulties in adapting to technology-based learning. These challenges indicate that the development of communication writing skills requires continuous practice and support. In addition, repeated exposure to similar test items may influence learning outcomes, so variation in assessment is recommended to minimize bias (Puspikawati & Megatsari, 2018). Therefore, future research should consider longer implementation periods and additional scaffolding strategies to optimize learning outcomes. Overall, the findings suggest that the Teachable Machine-assisted module has strong potential as an innovative learning resource that supports both conceptual understanding and communication writing skills in science learning.

CONCLUSION

This study aimed to develop a Teachable Machine-assisted science learning module to improve junior high school students' communication writing skills. The results indicate that the developed module meets the criteria of validity, practicality, and effectiveness, with findings suggesting that it is appropriate for classroom use and can support learning activities effectively. The effectiveness analysis shows a moderate improvement in students' communication writing skills, indicating that the integration of structured writing tasks and interactive technology helps students organize and express scientific ideas more clearly. These findings imply that technology-assisted modules can provide meaningful learning experiences that support both conceptual understanding and communication skills; however, the results are limited by the short implementation period and the use of a single group. Therefore, further research is recommended to involve larger samples and longer implementation durations to better examine the potential of similar learning modules.

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