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Mobile Connectivity: Ubiquitous Learning with Web-Based Module to Promote Scientific Argumentation Skills in Science Learning

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Abstract: Argumentation skills are still a challenge in science learning. Teachers must develop innovative learning to promote various thinking skills, one of which is argumentation skills. This research aims to develop valid, practical, and effective modules based on the web. The type of research applied was educational development research (EDR) with the ADDIE development model. The data collection techniques and instruments include validation sheets, practicality sheets, tests, observations, interviews, questionnaires, and documentation. The research sample was class VIII-B SMPN 1 Sukowono, with 26 students. The data analysis results of the validity of the modules based on the web got an average score of 85% with highly valid criteria. The results of the learning implementation analysis got an average score of 85%, which is an outstanding category from the assessment of the three observers. Product effectiveness is obtained from test results and student response questionnaire sheets. The results of the product effectiveness analysis using the N-Gain test got an average score of 0.74 in the high criteria. Students can learn in various places and situations by accessing modules and collaborating with other students and other learning resources available on the network. Thus, the web-based module is feasible for improving argumentation skills.

Keywords: ubiquitous learning, web-based module, argumentation skills, science learning.

▪ INTRODUCTION

The 21st century demands improvements in various fields, including science and technology, especially education in Indonesia. The progression of science and technology impacts the implementation of learning, especially in science learning. Science learning aims to teach students to actively explore concepts, principles, and theories (Mabsutsah & Yushardi, 2022; Odden et al., 2021). Science learning is mastering science based on concepts, facts, and principles and emphasizing students to find concepts through discovering so that the understanding gained is deeper (Cairns & Areepattamannil, 2019; Caymaz & Aydin, 2021; Constantinou et al., 2018). Students learn science through inquiry activities to construct scientific knowledge. Students learn to make arguments by linking scientific conclusions with scientific evidence using logically coherent and clear explanations. Social interaction between students involving the argumentation process is essential in constructing scientific knowledge in science learning.

One of the crucial skills that students must have in science learning is scientific argumentation skills. Scientific argumentation is the ability to construct, support, evaluate, and confirm claims with arguments supported by accurate conceptual evidence (Zhu et al., 2020). Scientific argumentation links scientific evidence to claims accompanied by rational explanations about scientific phenomena (Hilala et al., 2023; Kundariati et al., 2021). Scientific argumentation skills involve social interaction and debating about science to construct inferences about scientific knowledge (González-Howard & McNeill, 2020). Ginanjar et al. (2015) argue that scientific argumentation skills cannot be separated from science, so students have scientific explanations,

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understandable views, and scientific evidence for what they have learned. Scientific argumentation skills are essential in building the courage to express a theory from the concepts or information learned (Minin & Fauziah, 2022). In addition, scientific argumentation skills help students make the right decisions when faced with various scientific social issues and support teachers and students in achieving learning objectives, so scientific argumentation skills need to be studied and improved (Riwayani et al., 2019).

Scientific argumentation skills in science learning are still unsatisfactory. Result research conducted by Sari & Nada (2021) shows that students prefer to take notes and underline important material during learning. Students still struggle to construct arguments in writing by providing rational explanations to link claims with scientific evidence when explaining scientific phenomena (Homburger et al., 2021; Mardiati et al., 2023). Rahmadhani et al. (2020) stated that low scientific argumentation skills are caused by a lack of understanding of the material, where students only express opinions based on what they know without referring to science theory. Teachers must provide appropriate support to students to use scientific evidence and reasoning to build arguments (Lieber & Graulich, 2022; Yang et al., 2021), one of which is by utilizing adequate learning resources. Previous researchers have developed modules to train argumentation skills and complement the availability of teaching materials about science. However, the modules compiled are still in printed form, so printing them costs money (Ramadhan & Raharjo, 2023). Based on the observations and interviews conducted at SMP Negeri 1 Sukowono, many teachers still do not utilize technology to support learning activities, and the media or teaching materials they use are less innovative. Teachers could not create digital teaching materials to help students learn independently because teachers tend to utilize media aids such as PowerPoint and science textbooks. In addition, the shortcomings of previous learning activities are that teachers do not use media or teaching materials that refer to clear guidelines or indicators to assist students in scientific argumentation skills.

The description of the problems above shows a need for product development of teaching materials to improve scientific argumentation skills. Teachers can develop various learning resources to support students in constructing scientific arguments, including modules about science subject matter. The modules are examples of teaching materials containing material and evaluation questions as a reference for improving student abilities. Modules that are packaged digitally can help students learn independently (Dari & Sudatha, 2022). According to Rojikin et al. (2022), the preparation of modules prioritizes student independence during learning so that students can solve a problem independently. In this study, researchers developed teaching material products in the form of web-based modules, namely Google Sites, which are systematically designed starting from the cover page, module profile, module guidelines, learning competencies, concept maps, learning activities, glossaries and bibliographies and learning activities arranged in google sites cannot be separated from indicators of scientific argumentation skills.

The advantages of web-based modules are that they make any features in the module contained in the link so that modules can widely reach all links available in big data. Web-based modules make it easy for teachers and students to access learning materials uploaded to Google Sites. Teachers and students do not need to use flash drives, which can cause viruses to enter the computer (Ratnawati et al., 2023). In addition, modules developed using the website provide features to insert learning videos

(Mahmudin et al., 2022). Modules can help learning activities take place pleasantly so that students are more interested in learning. Therefore, the research developed a web-based module that is expected to help students learn science and develop their scientific argumentation skills by utilizing the dynamic features contained in the module.

▪ METHOD

Web-based module products are developed by referring to educational development research (EDR). This method aims to create a product and then measure the quality of the teaching material products that have been produced. The product that has been made is a module teaching material about the digestive system to improve the scientific argumentation skills of SMP Negeri 1 Sukowono students in the odd semester with 26 students. The research was implemented on Jl. Imam Sukarto 14, Krajan Balet Baru, Sukowono, Jember, East Java 68194. The study was conducted in the odd semester of the 2023/2024 academic year.

The web-based module was developed using the ADDIE development model (Branch, 2009), which is implemented through five stages, including analysis, design, development, implementation, and evaluation. The selected science learning material is about the digestive system. The web-based module was designed to involve aspects of scientific argumentation skills following the subject discussed. The ADDIE development model has a progressive process requiring several expert tests. Refinement of the final product is based on restricted scope, broad scales, and revisions. Although the process is shortened, there is already a test and review process so that the resulting product includes good product criteria, can be tested empirically, and has little chance of errors occurring.

This research aims to obtain a web-based module that is valid, practical, and effective. Data analysis of web-based modules' validity, practicality, and effectiveness was carried out through several studies, including product validity, product practicality when used in learning, analysis of student responses to product use, and analysis of scientific argumentation skills.

Validity analysis is used to calculate the average total validation score from 3 validators. Product validity is determined by calculating the ratio between the expert validation score and the maximum score. The calculation results are then referred to the value criteria on a particular scale to determine the web-based module's validity level. The validity criteria are shown in Table 1 below (Akbar, 2013).

Table 1. Validity criteria

Percentage (%)	Category
81 – 100	Very Valid
61 – 80	Valid
41 – 60	Enough Valid
25 – 40	Not Valid

Practicality analysis is based on the results of assessment of the learning implementation obtained by the observer. Three observers gave judgments based on observations of the implementation of each learning step using the web-based science module. Students' activities during the learning process by utilizing the web-based science module became the focus of observation by the observers. The practicality of the product is determined by calculating the ratio between the learning implementation score and the

maximum score. The calculation results are then categorized based on Table 2 (Nesri & Kristanto, 2020).

Table 2. Practicality criteria

Percentage (%)	Category
$80 < P \leq 100$	Very Practical
$60 < P \leq 80$	Practical
$40 < P \leq 60$	Less Practical
$25 < P \leq 40$	Not Practical

The effectiveness of the web-based module was analyzed from the contents of the scientific argumentation skills test and the student response questionnaire sheet. The test to measure scientific argumentation skills is an essay test consisting of three questions asking about claims, evidence, and reasoning. Student response data was obtained through a questionnaire completed by students after using web-based module products. The response questionnaire consisted of 20 question items that explored students' interests, motivations, and responses to the use of web-based modules in learning. Student response questionnaire data was accumulated and calculated to get a percentage of student responses to web-based module products. Student responses to the web-based module are calculated based on the ratio of the achieved score to the maximum score. The calculation results that have been obtained are then categorized based on Table 3 (Apsari, 2014)

Table 3. Student response criteria

Percentage (%)	Category
$80 < P \leq 100$	Very Good
$60 < P \leq 80$	Good
$40 < P \leq 60$	Good Enough
$20 < P \leq 40$	Bad

Scientific argumentation skills are analyzed from the test results, namely the pre-test and post-test. The results obtained from the test are then calculated using the N-gain formula so that the value of the scientific argumentation skills can be known. The value of the N-gain that has been obtained is then categorized based on the provisions in Table 4 below (Hake, 1998).

Table 4. N-gain score category

Percentage (%)	Category
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Medium
$g < 0.3$	Low

▪ RESULT AND DISSCUSSION

Analysis Stage

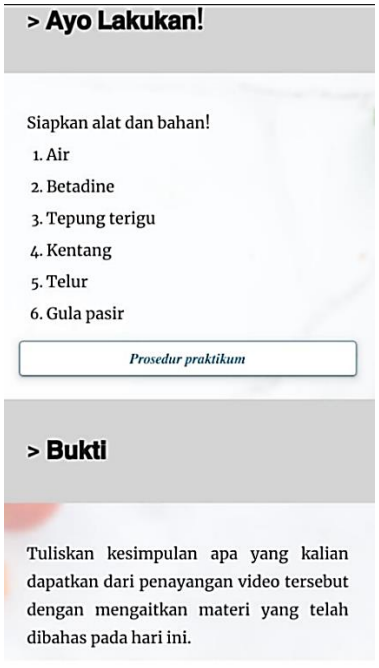
Based on the analysis of the results of observations carried out at the school as a research site, namely SMP Negeri 1 Sukowono, the school has never implemented learning activities using modules based on Google sites in the learning process. In the learning at SMP Negeri 1 Sukowono, the teacher provides learning using printed book

media and gives assignments and practice questions listed in the book. Based on the results of interviews, students of SMP Negeri 1 Sukowono Jember East Java, to be precise, class VIII B with 26 students, on average, have low scientific argumentation skills and need to be improved when the science learning process. In addition, the average student in the research school already has a smartphone, which makes it easier for researchers to develop digital teaching materials. The curriculum used as a learning reference is the 2013 curriculum.

Design Stage

Learning tool design starts with the learning implementation plan, syllabus, and web-based modules. The web-based module on the subject matter of class VIII, namely the human digestive system, consists of a cover, table of contents, preface, concept map, introduction, learning activities, evaluation, feedback, answer key, glossary, and bibliography. The module cover is the initial display when you first open the module. The introduction to the module contains a description of the module, module identity, essential competencies, learning materials, and instructions for use. Three learning activities also include indicators of scientific argumentation skills, one of the activities is proposing a science claim, evidence, reasoning, and mobile connective activity as shown in Figure 1. Students can learn independently by reading the material in the module. Students can also learn by connecting with other students or with other learning resources in an internet connection. Learning outcomes are realized in the form of poster designs developed by students collaboratively. Feedback contains links that students can access to respond to the use of modules based on Google Sites. The glossary on the module includes definitions of words that tend to be challenging to understand to support deeper student understanding, and the last page of the module is a bibliography containing references that researchers have cited.

(a)



(b)

(c)

Figure 1. Dynamic features; (a) claim, (b) evidence, (c) mobile connective activity

Development Stage

The validation process by experts and product revision carries out the development stage. In addition to the module validation, the lesson plan and syllabus were also validated. The results of the validator's research on the development results can be observed in Table 5.

Table 5. The results of the validation

Assessment Aspect	Interval Score			Percentage (%)	Category
	V1	V2	V3		
Contents and materials	0.80	0.88	0.92	86	Very Valid
Appearance	0.81	0.94	0.92	89	Very Valid
Language	0.85	0.80	0.75	80	Very Valid
Average	**0.82**	**0.87**	**0.86**	**85**	**Very Valid**

The results of the validation of modules based on Google Sites obtained an average score of 85% with a very valid category. The validation results show that the developed module has fulfilled the content and construction aspects. The content aspect is related to the need and state of the art. The need is related to the thinking skills developed in learning using the module. Scientific argumentation is the skill of reasoning accompanied by the support of scientific evidence and rational explanation. Argumentation skill is one of the high-level thinking skills that are demanded in learning today. In the aspect of state-of-the-art, learning resources in the form of electronic modules used to develop argumentation skills are new. Students can explore the virtual world to conduct

investigations and find scientific evidence to support their claims and arguments. In the construction aspect, the developed module has fulfilled the elements of systematics, science content, language, and appearance. All of these aspects have been adequate in supporting students' activities when learning to propose evidence-based arguments. This result shows that the modules developed following the module components, starting from the cover page, module guide, learning competencies, concept maps, activity sheets, glossary, and bibliography (Cheva & Zainul, 2019). The language used in the module is easy to understand and includes indicators that can train scientific argumentation skills. This result is in line with the opinion of Ridho et al. (2020) that the language aspect is the central aspect to support the validity of the product because language can make it easier for readers to understand the material contained in the product, starting from the sentences that are arranged effectively, there are standardized terms, sentences according to the age of students, and proper spelling. Researchers also make revisions from validators to improve the quality of modules. The revisions in question include the results, suggestions, and comments of validators on the developed modules, as shown in Table 6.

Table 6. The revision of the web-based module

Component Improvements	Validator Suggestions	Before Revision	After Revision
Appearance	Rechecking the features on the website because some are not working	The table of contents icon cannot be clicked, so the table of contents does not appear	Clickable table of contents icon
Language	Sentences are still confusing in meaning and need to be reorganized	The sentences used in the module are a little complicated	The sentences used in the module are more clarified

Implementation Stage

The implementation of a web-based module was conducted in the science learning process for 4 meetings. At each meeting, students learn science using the web-based module, starting with the teacher's explanation of the instructions for its use. Students learn science according to the material description and learning activities contained in the media. Students are also allowed to carry out science processes in hands-on and mind activities and explore the virtual world. These activities are carried out as part of the investigation process to obtain scientific evidence that can be used to support argument claims. The argument claims from each student are discussed and debated by other students to obtain a valid argument formulation based on mutual agreement on the discussion results. The model of student interaction with the web-based module and other learning resources is shown in Figure 2.

The results of the development trial obtained are data on the implementation of learning using modules based on Google Sites through the assessment of the three observers. Analysis of the implementation of the learning process can be seen in Table 7.

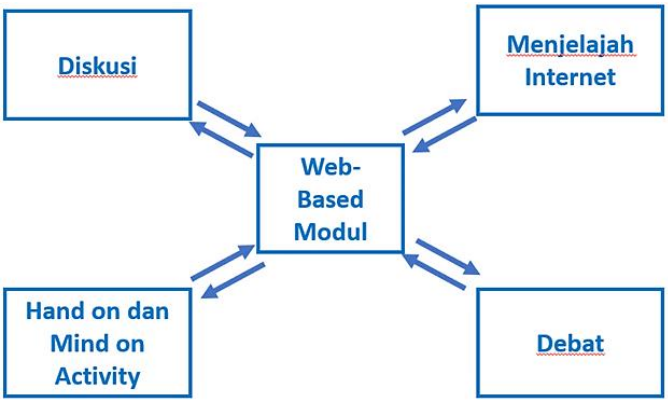


Figure 2. Interaction model between students with web-based module.

Table 7. The practicality data of learning implementation

Lesson To	Percentage Observer (%)			Percentage (%)	Criteria
	O1	O2	O3		
1	83.33	90.00	85.00	86.11	Very Practical
2	87.00	88.33	88.33	87.77	Very Practical
3	85.94	84.38	90.63	86.97	Very Practical
4	87.50	87.50	84.38	86.45	Very Practical
Mean	85.86	87.55	87.08	86.83	Very Practical

The results of observations of the implementation of learning using modules based on Google Sites, which were carried out with four lessons, reached 86.83% with efficient criteria. Web-based modules are feasible to use in science learning. The activities in the lesson plan can be appropriately implemented. These results are in line with research conducted by Sari & Nada (2021) that shows that the development of technology-based modules can be a means and motivation for learning and facilitate the learning process.

Evaluation Stage

The summative evaluation results were obtained from data on improving scientific argumentation skills and student responses after using the module. The summative results that have been carried out are as follows:

Scientific Argumentation Skills

This stage measures the effectiveness of using modules based on Google Sites to learn science material on the human digestive system obtained from pre-test and post-test scores to obtain data on improving scientific argumentation skills. The test scores of scientific argumentation skills were analyzed using the N-gain formula and can be observed in Table 8.

Table 8. Gain of argumentation skills

Test	Mean	N-gain	Category
Pre-test	50.85	0.74	High

Post-test	87.46

The result of the student N-gain analysis was 0.74, which is a high category. This result shows increased scientific argumentation skills after applying modules based on Google Sites during learning activities. The test questions students did before using the module got an average score of 50.85. In contrast, after using the module, they got an average score of 87.46, which means that the module has succeeded in improving scientific argumentation skills, especially in the material of the human digestive system. The average value obtained was then calculated again using the N-gain formula with a result of 0.74 (high category). Furthermore, the calculation of N-gain on each indicator of scientific argumentation ability can be seen in Table 9.

Table 9. Gain of each skill aspect

Aspects	Mean Score		*N-gain* <g>	Category
	Pre-test	Post-test		
Claim	82.50	98.72	0.96	High
Evidence	39.70	90.60	0.84	High
Reasoning	30.30	71.80	0.60	Medium

N-gain analysis on each aspect of scientific argumentation skills shows the claim aspect calculated N-gain value of 0.96 with a high category. The evidence aspect calculated an N-gain value of 0.84 with a high category, and the reasoning indicator calculated an N-gain value of 0.60 with a medium category. From the results of the N-gain analysis, the claim indicator gets the highest score, and the reasoning indicator receives the lowest score. Some students still have difficulty providing scientific explanations for scientific phenomena and making connections between scientific claims and evidence. These results align with previous research where students still have to learn hard to offer scientific explanations linking claims with scientific evidence (Dawson & Carson, 2020; Sinatra & Lombardi, 2020). However, the results of the N-gain value show a significant increase in scientific argumentation skills compared to before the use of the module products. The results of the study follow previous research, which states that the use of web-based learning aids can facilitate students in constructing arguments (Lin et al., 2020), so they can relate between the components of argumentation. Students could make connections between claims and scientific evidence using logical explanations.

Students Response

Student responses were analyzed using a questionnaire sheet to measure the effectiveness of modules based on Google Sites and the calculation of N-gain values. The results of the student response analysis can be seen in Table 10.

Table 10. The student's response to the web-based module

Aspects	Percentage (%)	Category
Interest	85.00	Very Good
Motivation	81.50	Very Good

Feedback	82.00	Very Good
Students Response	**82.83**	**Very Good**

Based on the analysis results, the average percentage of the three aspects of the assessment, which consisted of interest, motivation, and response, reached 82.83%, with an outstanding category. The interest aspect obtained a percentage value of 85% with a perfect category, the motivation aspect obtained a percentage value of 81.5% with an excellent category, and the response aspect obtained a percentage value of 82% with an exceptional category. This result shows that the module based on Google Sites could make the learning process more interesting, more interactive, and able to convey material in the form of video footage so that students are more excited and not bored when learning because the material presented is easier to understand, besides that in the aspect of motivation, the use of google sites-based modules that have been designed attractively can increase student motivation in studying the module and the material in it can be conveyed optimally (Mahmudin et al., 2022). In response, the sentences used in the Google Sites-based module are clear and easy to understand, the language is easy to understand, and the letters are easy to read.

The module developed by researchers is undoubtedly designed practically and includes several indicators of scientific argumentation in each learning activity consisting of claims, evidence, and reasoning to encourage students to express their opinions scientifically. Some student activities in the module include students being directed to scan or access the module barcode using the link provided. Students also answer several questions listed in the module in learning activities 1 to 3; the question link in each learning activity is a Google Forms link. Researchers also linked the Canva link so that students could collaborate with their group friends directly on the link to answer questions. In addition, students can also study independently at home because the module has provided a platform for students to answer questions, and the answers are immediately recorded so that students know if they got the right or wrong score. The ease of use of modules increases students' response to learning. This condition aligns with previous research that shows that modules based on Google sites add flexibility to learning activities (Septiara & Saino, 2022). The same thing was stated by Herawati & Muhtadi (2018) that digital-based modules that contain images, materials, or simulations can help students achieve their learning needs.

The use of innovatively packaged technology can be used to develop thinking skills in science learning. Students can develop their argumentation skills through learning activities guided by the learning stages in the module. Students learn to build claims, provide evidence, and provide scientific explanations that connect evidence to claims. Learning activities are connected between students and students with other learning resources in cyberspace. Thus, students can learn to adapt to conditions and learn to use mobile devices that enable ubiquitous learning.

▪ CONCLUSION

The results of developing teaching material products, namely modules based on Google sites, are declared valid, practical, and effective for improving scientific argumentation skills in science learning. The module developed obtained a beneficial category, and the practicality of the module received a percentage of implementation for

all meetings with a convenient category. The average pre-test and post-test calculation results with the N-gain test obtained a high category. They showed that the average student response results were in a suitable category. Then, it can be concluded that the Google Sites-based module product can be applied to the science learning process in junior high school to improve scientific argumentation skills. The resulting module can enrich learning resources, become an innovative reference source for teachers in the learning process, and support independent learning. The features contained in the module can help students obtain scientific evidence, construct scientific explanations, and make claims. Students can utilize the features in the module to conduct investigations and discussions in the context of debates to explain scientific phenomena so that their scientific argumentation skills improve. Teachers can utilize the results of this study as well as redesign it to suit the needs of the classroom.

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