Development of Questions on Human Digestive System Material to Strengthen Scientific Literacy for Grade V Students

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Article Info	ABSTRACT
	Low scientific literacy among students is often due to learning that is overly textual and lacks real-life context, as well as the dominance of memorization-based questions that do not stimulate scientific thinking. This study aims to develop an evaluation instrument in the form of scientific literacy-based questions for elementary students, specifically on the human digestive system. Using a mixed-method approach and Tessmer's formative evaluation model, the research began with 10 questions tested on 33 fifth-grade students. Initial analysis revealed that 6 questions were valid but had low reliability ($\alpha = 0.222$), while 4 were invalid. These invalid items underwent a formative evaluation process including self-evaluation, expert review, one-to-one, small group, and field tests. After revisions to wording and contextual relevance, the instrument's reliability improved to a moderate level ($\alpha = 0.460$), and all questions became valid. The students' average score also increased from 64 to 77.3. The final results indicate that the developed questions are valid, reliable, and aligned with students' cognitive stages. Furthermore, these scientific literacy-based questions enhanced the quality of evaluation, increased student engagement, and improved the appeal of the learning process in science education.

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1. INTRODUCTION

Science education at the elementary school level has a strategic role in building the foundation of scientific thinking from an early age. One important indicator of the success of science learning is students' scientific literacy skills, namely the ability to understand scientific concepts, interpret scientific information, and apply this knowledge in everyday life (Nurhanifah & Diah Utami, 2023). According to Hasanah & Silitonga (2020), scientific literacy is the scientific ability and understanding that allows someone to formulate questions, obtain and apply new information, explain natural phenomena, draw evidence-based conclusions, understand the nature of science, realize the role of science and technology in shaping the environment, culture, and intellectual life, and have concern and involvement in issues related to science. In the context of the 21st century which demands critical thinking skills, problem solving, and data-based decision making, scientific literacy is one of the competencies that must be developed through a meaningful and relevant learning process. The Merdeka Curriculum and various current education policies also emphasize the importance of strengthening scientific literacy as part of developing the profile of Pancasila students (Y. M. Sari et al., 2025).

One of the science materials taught to fifth grade elementary school students is the human digestive system. This material is not only related to the structure and function of the digestive organs, but is also closely related to healthy living habits and understanding of biological processes in the human body (F. P. H. Sari et al., 2024). Unfortunately, in learning practices, this material is often taught textually and separately from the context of students' real lives (Gaba et al., 2024). This causes students to not understand the importance of the material, so

that learning becomes less meaningful and has implications for their low ability to connect scientific knowledge with everyday situations (Dewi et al., 2021; Wirastuti & Julianto, 2023).

In addition to the learning approach, one important aspect that also determines the achievement of science education goals is the quality of the questions or evaluation instruments used. Well-designed questions not only function to measure knowledge mastery, but also as a tool to develop and stimulate students' scientific thinking skills (Hadianty et al., 2025). Currently, many questions used in elementary schools tend to be memorization-oriented, low in cognitive taxonomy, and less involved in real-life contexts (Arzfi et al., 2022; Nurhikmah, 2023; Putpitasarii et al., 2025). Questions like this are unable to develop real science literacy skills. Therefore, the development of questions that refer to aspects of science literacy is very important to support a more meaningful learning process and outcomes.

In the research of Melya et al. (2022), a teaching module was developed that supports the improvement of scientific literacy. This module is designed to support students' scientific literacy through a contextual approach. The validation results show that the module is very valid and practical for use in learning. Pratiwi & Indarini (2025) research has also developed FLISISPENSA media which is considered very suitable for use by educators as a supporting tool in the learning process that utilizes digital technology with a scientific literacy-based thinking approach. There have not been many studies that examine the development of questions by considering aspects of contextuality, relevance to students' real lives, and the level of scientific thinking that is in accordance with the cognitive development of grade V students. Thus, there is an urgent need to develop evaluation tools in the form of questions that are able to answer these challenges.

The development of questions on the human digestive system material by referring to scientific literacy indicators is a strategic effort to bridge the gap between curriculum demands and real learning conditions in the field. Questions that are designed contextually and require students to analyze, conclude, and make decisions based on scientific data can be an effective means of strengthening students' scientific literacy skills (V. E. Sari et al., 2023). In addition, this development also provides an alternative for teachers in conducting more holistic and meaningful learning evaluations.

The novelty of this research lies in the comprehensive development process through multi-layered formative evaluations, as well as a focus on specific digestive system material that has not been widely developed in the form of scientific literacy questions for elementary school level. Although the multi-layered formative evaluation approach has been used in various studies, the novelty of this research lies in its integration with the specific content of the human digestive system, the cognitive needs of elementary school students, and the context of the Independent Curriculum (Kurikulum Merdeka). In addition, this study not only produced valid and reliable questions, but also quantitatively demonstrated an improvement in students' learning outcomes. Therefore, this approach offers both practical and theoretical contributions to the development of science learning evaluations based on scientific literacy at the elementary education level.

The development of scientific literacy-based questions offers several advantages over other learning methods in improving students literacy, especially at the elementary school level. By designing questions that are contextual and connected to real-life situations, students are encouraged to think critically, analyze information, and make decisions based on data rather than memorization. These questions are also aligned with curriculum learning objectives, allowing teachers to assess competency achievement more accurately and meaningfully. In addition, question development enables differentiated instruction, as question difficulty levels can be adjusted to meet diverse student needs. This method also promotes active student engagement and supports independent learning. Another advantage is that the developed questions can be statistically analyzed for validity and reliability, making the evaluation results measurable and useful for improving the learning process. In other words, question development serves not only as an assessment tool but also as an effective learning strategy to enhance students' scientific thinking skills and overall scientific literacy.

Based on this background, the purpose of this study is to develop questions on the human digestive system material that aims to strengthen scientific literacy for fifth grade elementary school students. This development is expected to produce evaluation questions that are not only in accordance with student characteristics, but also able to support students' involvement, understanding, and scientific thinking skills in science learning.

2. RESEARCH METHOD

This study employed a mixed-method approach, combining both quantitative and qualitative methods. The quantitative phase aimed to assess the quality of the developed instrument through statistical analysis, including item validity testing using Pearson Product Moment correlation and reliability testing using the Cronbach's Alpha coefficient. This method aligns with the study by Mutluer (2023), who developed a Scientific Literacy Scale and evaluated its construct validity and internal consistency using similar statistical techniques. Meanwhile, the qualitative phase followed Tessmer's formative evaluation model, which includes five stages: self-evaluation, expert review, one-to-one evaluation, small group evaluation, and field testing. This model was similarly applied by Munawarah et al. (2025) in their development of a critical thinking test instrument based on ethnomathematics.

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They used step-by-step formative evaluation to revise and refine the instrument based on feedback from experts and students, ensuring its validity and practicality.

The research aims to develop questions based on scientific literacy on the material of the human digestive system for fifth grade elementary school students. The development process is carried out systematically and through two main stages, namely the quantitative stage which focuses on the design and initial testing of questions, and the qualitative stage which focuses on the evaluation and revision of questions through a formative approach.

Several data collection techniques were employed in this study, including classroom observation, document analysis of the curriculum and teaching materials, interviews with teachers, and written tests using Google Forms. Quantitative data analysis was used to assess the validity and reliability of the questions, while qualitative analysis was applied during the formative evaluation phase and in interpreting expert feedback and student responses.

In the initial stage, a needs analysis was conducted based on quantitative data through the distribution of questionnaires to teachers and students. The questionnaire consisted of 15 statements using 1-5 point Likert scale, designed to identify students' understanding and challenges related to the human digestive system topic. The data obtained were used as the basis for designing 10 scientific literacy-based questions relevant to the students' characteristics. This process remains within the scope of the quantitative approach, as it is based on the collection and analysis of numerical data to support instrument development. The following are indicators of science competency to measure scientific literacy skills.

Table 1.Science Competency Indicators

Indicator	Sub Indicators
Explaining Phenomena Scientifically	Using scientific knowledge to explain natural phenomena.
	Identify, generate, and use scientific models and representations.
	Make and justify predictions based on scientific knowledge.
	Explain the implications of scientific knowledge for society.
Designing and Evaluating Scientific Inquiry	Identify questions that can be investigated scientifically.
	Propose and evaluate ways to explore scientific questions.
	Describe and evaluate how scientists ensure the reliability of data and explanations.
Interpreting Data and Evidence Scientifically	Converting data from one form of presentation to another.
	Analyze and interpret data and draw appropriate conclusions.
	Identifying assumptions, evidence, and reasoning in scientific texts.

(Rini et al., 2021)

After the questions were designed, the instrument trial was conducted on 33 fifth-grade students at SD Negeri 8 Sekayu, selected through purposive sampling. This school was chosen based on accessibility, the school's willingness to participate, and the curricular alignment. The questions were given in the form of a written test using a google form. The results of students' answers from this initial trial were then analyzed to measure the validity and reliability of the questions. The validity test was carried out using correlation analysis between question items. A question item is declared valid if the correlation value of the calculated results (r count) is greater than the r value in the table (r table), which in this case is 3.882. Meanwhile, to measure the extent to which the measuring instrument provides consistent results, a reliability test was carried out using the Cronbach Alpha coefficient. Questions that meet the valid and reliable criteria will be retained as the final questions. Meanwhile, questions that are invalid or unreliable will enter the next research stage for improvement. Reliability assessment refers to the criteria as follows.

Table 2.Reliability Criteria

Reliability Value	Information
< 0.20	Very Low
0.20-0.40	Low
0.41-0.60	Currently
0.61-0.80	Tall
0.81-1.00	Very high

(Safi'i et al., 2024)

The second stage is qualitative research, which is carried out through a formative evaluation process. This evaluation aims to improve invalid or unreliable questions so that they are suitable for use. Formative evaluation is carried out through five stages, namely self-evaluation, expert review, one-to-one evaluation, small group evaluation, and field test (Rajagukguk & Rambe, 2022). In the self-evaluation stage, researchers review the questions from the aspects of construction, language, and suitability with scientific literacy skills. After that, the

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questions are reviewed by two experts, each from the fields of elementary education and science education to get input in the expert review stage. Furthermore, the questions are tested individually to one student in the one-to-one evaluation stage to determine the extent to which students understand the questions and the difficulties they experience.

After revision based on feedback in the one-to-one stage, the questions were then tested on small groups of three students in the small group evaluation stage. This process aims to see the clarity of instructions, attractiveness, and functionality of the questions in measuring scientific literacy. The revised questions from this stage were then retested on a large group of 33 different students in the field test stage. The results of this final trial were reanalyzed to ensure the validity and reliability of the questions.

3. RESULT AND DISCUSSION

This study aims to develop questions on the human digestive system material that can strengthen the scientific literacy of fifth grade elementary school students. The development process is carried out in stages through quantitative and qualitative approaches. The results of both stages indicate that the development of questions can produce instruments that are not only statistically valid and reliable, but also in accordance with student characteristics and the principles of scientific literacy.

In the initial stage, namely quantitative research, researchers compiled 10 questions based on a needs analysis that included students' difficulties in understanding the concept of the digestive system, the limitations of questions used by teachers so far, and suitability to the curriculum. The questions were designed with a scientific literacy approach that emphasized the context of everyday life, understanding scientific concepts, and reflective thinking skills. For example, one of the questions presented a case of a child who experienced digestive problems after eating certain foods, and students were asked to identify possible disorders and explain the processes that occur in the body. Questions like this require students to understand concepts, analyze, and relate information to real life.

After the compilation, the questions were tested on 33 fifth grade students from an elementary school. The results of the validity test using correlation analysis between questions showed that 6 questions had significant correlation values, above the r-table (0.344), which means that the questions were valid. Meanwhile, the other 4 questions were invalid because their correlation values were below the r-table value. Furthermore, the reliability of the questions was calculated using the Cronbach Alpha formula, and a value of 0.222 was obtained, which indicates that the questions have a low level of internal consistency. This is due to the limited number of questions used, which is only 10 questions. Too few questions will tend to produce low alpha values, even if the correlation between the questions is good (Widhiarso, 2014). The following is a table of question validity in the quantitative approach.

Table 3.Validity of Questions

No.	Question Number	r value (validity)	Information
1	Question 1	0.483	Valid
2	Question 2	0.103	Invalid
3	Question 3	0.123	Invalid
4	Question 4	0.459	Valid
5	Question 5	0.043	Invalid
6	Question 6	0.355	Valid
7	Question 7	0.192	Invalid
8	Question 8	0.584	Valid
9	Question 9	0.477	Valid
10	Question 10	0.435	Valid

Invalid questions 2, 3, 5, and 7 were then followed up at the qualitative stage through formative evaluation. At the self-evaluation stage, revisions were made to the questions. It was found that the questions did not provide meaningful stimuli and had wording that was too abstract and difficult for students to understand. Therefore, the wording of the questions was re-arranged to make them more concrete, communicative, and in accordance with students' experiences. The revision of the questions was carried out as follows:

Table 4.Revision of Self Evaluation Stage Questions

No	Questions Before Revision	Questions After Revision	Reason for Revision
2	Explain the function of the small intestine in the digestion process based on the information in the picture!	What processes occur when food passes through the mouth, throat, and stomach?	Provides a comprehensive context of the process to make it easier for students to understand.

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No	Questions Before Revision	Questions After Revision	Reason for Revision
3	What will happen if the food we consume is too hard?	What can happen in the stomach if the food is not smooth enough when it enters?	Emphasizes specific parts of the digestive system and encourages cause-and-effect reasoning.
5	What can be done to prevent worm infections?	Mention two ways to avoid digestive problems such as diarrhea!	Using common digestive disorders to get closer to the student experience.
7	What should be done after receiving treatment to prevent worms from returning?	If you were to create an advertisement to prevent digestive diseases, what short sentence would be interesting?	Encourage student creativity and application of knowledge in communicative forms.

Input from the expert review stage strengthened the findings. Two experts suggested that the questions be improved by clarifying the context and using more communicative language. Based on the experts' evaluation, several questions still needed editorial improvements to be more on target and in accordance with scientific literacy principles. The editorial changes were adjusted to avoid ambiguous questions and increase the appeal of the questions. Further revisions at this stage are as follows.

Table 5.One to One Stage Question Revision

No.	Questions Before Revision	Questions After Revision	Reason for Revision from Expert Validator
2	What processes occur when food passes through the mouth, throat, and stomach?	Explain the processes that occur in the mouth, esophagus, and stomach when someone is eating?	The wording has been clarified and the terms have been adjusted to be more scientific but still easy for elementary school students to understand.
3	What can happen in the stomach if the food is not smooth enough when it enters?	What happens in the stomach if the food you chew is still large or coarse?	The cause-effect elements are emphasized and the sentence structure is improved to make it more logical and scientific.
5	Mention two ways to avoid digestive problems such as diarrhea!	Mention 2 short tips to avoid diarrhea!	The use of the term "quick tips" is considered more familiar and interesting to students, and describes the purpose of the question.
7	If you were to create an advertisement to prevent digestive diseases, what short sentence would be interesting?	If you were asked to create an advertisement about how to avoid diarrhea, what slogan would you use?	The questions focus on specific diseases so that students can provide more relevant and creative answers.

The evaluation continued at the one-to-one stage, where the four questions were tested directly on one student. Through this approach, students were guided in working on the questions and the researcher guided and observed the students' work process. The results showed that students could understand the meaning of the questions well, answered them easily, and there were no questions that needed to be revised at this stage. This shows that the previous revision had succeeded in simplifying the language and clarifying the context of the questions according to students' understanding.

The small group stage was conducted by involving three students representing high, medium, and low ability levels. The researcher only acted as an observer while the students were working on the questions. During the process, students were allowed to discuss with each other. The three of them helped each other and discussed when one of them had difficulty understanding the questions. However, when working on question number 7, they showed confusion about the term "slogan". After the researcher explained the meaning of the word, they were able to answer the question correctly. After the session was over, the researcher interviewed the three students regarding the readability of the questions, the clarity of the instructions, and the appeal of the content. All three agreed that the term "slogan" made it difficult for them to answer. Based on this input, the researcher decided to revise question number 7 to make it easier for students to understand. The revision of the questions was carried out as follows.

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Table 6.Revision of Small Group Stage Questions

No.	Questions Before Revision	Questions After Revision	Reason for Revision
7	If you were asked to create an advertisement about how to avoid diarrhea, what slogan would you use?	If you were asked to make an advertisement to prevent people from getting diarrhea, what kind of invitation sentence would you write?	Avoid terms that are unfamiliar to students and replace them with more communicative language.

The final stage, namely the field test, again involved 33 students from the same elementary school but different classes. The re-validity test showed that the four questions that were initially invalid have now experienced an increase in correlation value and are included in the valid category. Here is the validity table:

Table 7.Field Test Result Question Validity Table

No.	Question Number	r value (validity)	Information
1	Question 2	0.578	Valid
2	Question 3	0.732	Valid
3	Question 5	0.697	Valid
4	Question 7	0.590	Valid

The overall reliability of the questions also increased to 0.460, indicating that the questions had moderate internal consistency. Although the reliability did not reach "high" due to the limited number of questions used, there was an increase in reliability at the initial test stage and after the formative evaluation was conducted. This shows that the formative evaluation process that was carried out proved effective in improving the quality of the questions.

Table 8.Reliability Value Comparison

Stage	Reliability Value
Initial Test	0.222
After Formative Evaluation	0.460

The improvement in the quality of the questions is also reflected in the average score of students in answering questions before and after the revision. Before the revision, the average student score was 64, while after the revision it increased to 77.3. This shows that the revised questions are better able to facilitate students in scientific thinking and understanding the material in depth.

These results provide an important contribution to efforts to strengthen scientific literacy in elementary schools. The development of questions carried out showed that by designing questions based on real-life contexts and emphasizing scientific reasoning, students became more interested, involved, and able to demonstrate deeper understanding. This finding is in line with the opinion of Limiansih et al. (2024), who emphasized that scientific literacy is not only related to mastery of scientific facts, but also to the ability to apply knowledge in everyday decision-making. In addition, the results of this study strengthen the research of Fajarwati et al. (2025) which shows that scientific literacy-based questions can support critical thinking skills and connect scientific concepts with social problems.

Thus, this study shows that the development of questions based on scientific literacy not only supports the quality of learning evaluation but also strengthens students' scientific abilities from an early age. This process can be used as a reference in developing questions for other materials and levels, as well as a model for implementing the Independent Curriculum which emphasizes competence and in-depth understanding through meaningful assessments.

4. CONCLUSION

This study demonstrates that the development of scientific literacy-based questions on the topic of the human digestive system for fifth-grade elementary students successfully produced evaluation instruments that are valid, reliable, and aligned with students' cognitive development. Through the stages of formative evaluation, the quality of the questions significantly improved in terms of content, language clarity, and real-life contextual relevance. The increase in reliability from 0.222 to 0.460, along with the rise in students' average scores from 64 to 77.3, indicates that the instrument is effective in supporting students' scientific thinking skills. These findings show a clear alignment between the initial objectives stated in the introduction and the outcomes achieved, while also emphasizing the importance of integrating scientific literacy into classroom assessments to bridge the gap between curriculum demands and actual learning practices. The results of this study can serve as a model for developing other scientific literacy-based instruments in different science topics at the elementary level. Future research is recommended to test the instrument on a broader and more diverse population to assess its consistency,

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apply Item Response Theory (IRT) for a deeper analysis of item characteristics, and explore the use of interactive, technology-based question formats as well as cognitive interviews to enhance student engagement. Longitudinal studies are also needed to examine the long-term impact of scientific literacy-based assessments on students' scientific reasoning abilities.

5. ACKNOWLEDGEMENT

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