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Research Article

DEVELOPMENT OF EDUCATIONAL COMICS BASED ON SCIENTIFIC APPROACH TO IMPROVE UNDERSTANDING OF THE CONCEPT OF THE DIGESTIVE SYSTEM IN GRADE VIII STUDENTS OF MTs DARUL HIKAM

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Abstract
This research aims to develop educational comics based on *a scientific approach* to digestive system materials, assess their feasibility, test their effectiveness in improving understanding of concepts, and describe the response of MT students in grade VIII Darul Hikam to its use in science learning. The method used is research and development with the ADDIE model which includes the *stages of analysis*, *design*, *development*, *implementation*, and *evaluation*, with test subjects of 25 grade VIII students as well as instruments in the form of expert validation sheets, *pre-test* and *post-test* tests, and student response questionnaires. The results showed that the developed media obtained a very feasible category based on validation of 100% and 96% media experts, 88% material experts, and 95% and 95% of teachers' practicality, while their effectiveness was shown by an increase in the average score from 43.6 in *the pre-test* to 89.6 in the *post-test* with an N-gain of 0.80 in the high category. The novelty of this research lies in the systematic integration of scientific approaches into the narrative flow of educational comics that are adapted to the context of MTs students and digestive system materials. The scientific approach is integrated through observation scenes, character questions, information collection, reasoning of the digestive process, and communication of student learning outcomes in dialogue and gradual reflective activities of comics. The implications of this study show that educational comics can be an alternative science learning medium that is contextual, interesting, and supports active learning to strengthen students' understanding of concepts and help teachers implement student-centered learning according to the demands of the Independent Curriculum in the tsanawiyah madrasah environment more effectively and relevant to learning needs.

Keywords: Educational Comics; Understanding of concepts; Scientific Approach.

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INTRODUCTION

Natural Sciences at the MTs level require students not only to memorize facts, but also to understand concepts, cause-effect relationships, and their application in daily life (Ramdani, Syukur, Permatasari, & Yustiqvar, 2021). In learning practice, abstract material often poses difficulties because students have to imagine processes that cannot be directly observed. One of the materials that is often considered difficult is the human digestive system, because it includes organs, functions, and biological processes that take place sequentially and are interrelated (Gulo, Zebua, & Lase, 2024). This condition requires learning media that is able to present concepts in a more concrete, interesting, and easy-to-follow manner. On the other hand, modern science learning also demands students' active involvement in building knowledge through meaningful learning experiences (Singh & Khunyakari, 2023). Therefore, learning media innovation is an urgent need so that learning is no longer dominated by verbal explanations alone, but is able to encourage students to understand concepts in a complete and in-depth way.

The development of 21st century learning places interactive visual media as one of the important means in supporting the understanding of science concepts. Media that combines text, images, and narrative flow has proven to be more effective in helping students structure information in a structured manner and process it more easily. Educational comics are one of the relevant media because they present learning messages through illustrated stories that are communicative and close to the world of students (Abdullah & Nurhalizah, 2025). In the context of science, comics serve not only as a spark of reading interest, but also as a conceptual bridge to explain complex scientific processes. The use of comics can help students connect initial knowledge with new material through clear and concise visualizations (Peni, 2025). Thus, educational comics have the potential to be an alternative media that supports meaningful learning, especially in materials that require systematic illustration of processes and structures such as the human digestive system.

In addition to the visual aspect, science learning also demands an approach that actively involves scientific processes. *The scientific approach* directs students to observe, question, collect information, reason, and communicate the results of their understanding. This approach is in line with the student-centered learning character, because students do not just receive information, but build understanding through thinking and exploration activities (Zahroh, 2021). The integration *of scientific approach* into educational comic media provides an opportunity to make the media not only a tool for presenting material, but also a means of learning that leads students to follow the flow of scientific thinking. In learning the digestive system, these stages can be realized through the observation of organ illustrations, sparker questions in comic dialogues, reasoning on the order of the digestive process, and communicating understanding through discussion (Tobin, Khozim, Widowatie, & Rizal, 2021). In this way, educational comics do not stop at the function of visual entertainment, but really become a pedagogical medium that actively supports the construction of students' knowledge.

The context of the need for learning media innovation is also increasingly relevant to the implementation of the Independent Curriculum which emphasizes contextual, flexible, and student-centered learning. Within this framework, teachers are required to design learning that is able to accommodate the differences in student characteristics and encourage their involvement optimally (Mugara & Ali, 2025). However, in practice, science learning in many classrooms is still dominated by lecture methods and the use of conventional teaching materials. As a result, students tend to be passive, bored quickly, and lack the opportunity to construct concepts independently. The material of the human digestive system becomes increasingly challenging when presented only through verbal explanations without adequate media support (Mutia, Sismia, Ramadhani, & Suryapuspita, 2025). Therefore, media that suits the needs of MTs students is needed, visually appealing, easy to understand, and still in harmony with the demands of scientific learning. Educational comics based on *scientific*

approaches are seen as having strong potential to answer these needs because they are able to present more contextual and participatory learning.

In terms of material characteristics, the human digestive system contains interconnected concepts, starting from the main organs, the function of each organ, to the process of processing food in the body (Pratiwi, 2023). This concept often leads to misconceptions when presented separately or too abstract. Students need to see the relationships between components in order to understand the overall functioning of the system correctly. Educational comics provide an opportunity to display the process in the form of a logical story sequence, so that students can follow the digestive flow from beginning to end more easily (Maesaroh, 2021). In addition, character illustrations and dialogues in comics can create a learning atmosphere that is closer to the student's experience, so that the material does not feel unfamiliar. By combining visualization, narrative, and scientific approaches, this media is expected to be able to improve understanding of concepts while maintaining students' attention to learning. This is what makes the development of educational comics on digestive system materials have high academic and practical urgency.

Although various studies have shown that comic media can increase students' motivation and understanding, there are still important gaps in its development. Some previous research has not fully integrated the stages *of the scientific approach* into the comic narrative flow, so the activities of observing, questioning, reasoning, and communicating have not yet appeared as a unit of learning (B. D. Lestari et al., 2024). In addition, media development often only focuses on product feasibility or improvement of general learning outcomes, not specifically highlighting the understanding of concepts in digestive system materials in MTs environments that have student characteristics and curriculum demands (Annisa, 2025). Therefore, this research is here to fill this gap by developing a scientific approach-based educational comic designed according to the needs of grade VIII students of MTs Darul Hikam, as well as assessing its feasibility and effectiveness in improving the understanding of the concept of the digestive system more comprehensively.

The novelty of this research lies in the development of educational comics that not only present digestive system material in the form of narrative visuals, but also explicitly assemble the stages *of the scientific approach* into the content and storyline of the comic. This novelty makes comics not just a picture reading medium, but a learning tool that guides students to carry out the scientific thinking process gradually (Latifah & Sunanto, 2025). In addition, this research was prepared in the context of MTs Darul Hikam by considering the characteristics of grade VIII students, science learning needs, and the demands of the Independent Curriculum. The focus on improving concept understanding also emphasizes the contribution of research, because the media developed is directed not only to attract interest in learning, but to deepen the mastery of concepts systematically (Aisyah, Psb, & Sofiyah, 2025). Thus, the resulting product is expected to have theoretical and practical value as a model for developing science learning media that is innovative, contextual, and relevant to today's learning needs.

Based on this description, this research aims to develop an educational comic based on *a scientific approach* on digestive system materials to improve the understanding of concepts for grade VIII students of MTs Darul Hikam. The formulation of this research problem is: how is the process of developing educational comics based on *a scientific approach* on digestive system materials that are valid and suitable for use; how effective is the use of educational comics in improving students' understanding of concepts; and how do students respond to the use of these media in science learning. This research is expected to produce learning media that is not only visually appealing, but also able to support the scientific learning process and strengthen conceptual understanding in a meaningful way. Thus, the results of the research can be an innovative alternative for science teachers in developing more active, contextual, and in accordance with the needs of students.

RESEARCH METHOD

This research uses *the Research and Development* (R&D) method with the ADDIE model which includes *the analysis, design, development, implementation,* and *evaluation* stages (Rahayu, 2025). The selection of this method is based on the purpose of the research, which is to produce a product in the form of a valid, feasible, and effective *scientific approach-based* educational comic to improve understanding of the concept of the digestive system in grade VIII students of MTs Darul Hikam (Waruwu, 2024). The research was carried out at MTs Darul Hikam with the test subjects of 25 grade VIII students in the even semester of the current school year. The ADDIE model was chosen because it provides systematic steps to identify learning needs, design products according to the characteristics of students, develop media, test its use in the classroom, and evaluate product quality in an ongoing manner (Safitri & Aziz, 2022). Thus, this method is relevant to the focus of research that not only assesses learning outcomes, but also emphasizes the process of developing contextual, structured, and applicative learning media according to the needs of science learning in madrasas.

In the *analysis stage*, the researcher conducts observations of science learning, interviews with teachers and students, and examines the need to identify learning problems in the digestive system material. The findings of this stage are the basis for the preparation of learning objectives, indicators, material content, and characteristics of the comic to be developed. In the *design stage*, the researcher compiles *a storyboard*, storyline, characters, dialogues, illustrations, and the integration *of scientific approach* steps, namely observing, questioning, trying, reasoning, and communicating into each part of the comic (Andini, 2022). Furthermore, in the *development stage*, the initial product is created and validated by material experts, media experts, and learning practitioners to obtain substantial and technical input. Revision of validation results results in a product that is more feasible to implement. At *the implementation* stage, comics are used in grade VIII learning, then at the *evaluation stage* , a thorough assessment of the feasibility, practicality, and effectiveness of the media is carried out so that it is known that it is suitable for the research objectives and learning needs of students in the context of the actual local tsanawiyah madrasah.

The research instruments consist of expert validation sheets, concept comprehension tests in the form of *pretest* and *posttest*, observation sheets on learning implementation, and student response questionnaires to the use of educational comics (Purwanto & Widodo, 2022). Qualitative data was obtained from validator suggestions, observation results, and teacher input to revise the product to suit the material of the digestive system and characteristics of MTs students. Data analysis was carried out descriptively, quantitatively, and inferentially. Validation scores and questionnaires were analyzed using percentages to determine the feasibility and practicality categories of media (Santika, 2023). The improvement of concept understanding was analyzed using the N-gain test, then continued with the normality prerequisite test and *the paired sample t-test* if the data was distributed normally. The analysis technique was chosen so that the effectiveness of educational comics based on *scientific approaches* can be proven empirically and academically and provide an objective basis for drawing conclusions about product quality and its impact on science learning.

RESULTS AND DISCUSSION

Educational comic media in science learning is understood as a visual-narrative medium that combines images, text, storylines, and symbols to convey concepts in a coherent, interesting, and easy-to-understand way for students on abstract materials such as the human digestive system (Sahal & Azha, 2025). The theoretical relevance of the use of comics can be explained through *Paivio's Dual Coding* Theory which asserts that information will be easier to process and store when presented through two cognitive channels at once, namely verbal and visual, so that students obtain a stronger mental representation of scientific concepts (Luo, 2022). In addition, Mayer's *Multimedia Learning* Theory emphasizes that learning becomes

more effective when words and images are combined in an integrated manner, as the combination helps reduce cognitive load and improve interinformation connectivity (Mayer, 2024). On this basis, educational comics deserve to be positioned as a learning medium that is theoretically able to support product development in this research.

The *scientific approach* is the second theoretical foundation because science learning essentially emphasizes the process of acquiring knowledge through systematic scientific activities, not just passive receiving information. This approach includes the stages of observing, questioning, trying or gathering information, reasoning, and communicating, all of which are designed to encourage students to build knowledge actively, critically, and reflectively (Alarcon, Talavera-Mendoza, Paucar, Caceres, & Viza, 2023). In the context of educational comic development, *the scientific approach* is not only understood as a learning strategy in the classroom, but also as a principle of media content design, so that storylines, dialogues, illustrations, and activities in comics can lead students to follow the scientific thinking process gradually. This alignment is important with the ADDIE development methods used in the research, as each stage of product development is geared towards producing content valid, pedagogically relevant, and effective media in supporting student-centered learning.

The third theoretical foundation is the theory of concept understanding which places the ability to understand, re-explain, connect, and apply concepts as important indicators of the success of learning science, especially in the material of the digestive system which contains organ structures, functions, and biological processes that are mutually continuous (Ristiani, Ali, & Apriyanto, 2025). Conceptually, concept understanding does not stop at the ability to remember terms or facts, but includes the ability of students to build meaning relationships between concepts to avoid misconceptions and be able to use their knowledge to explain real phenomena. In the material of the digestive system, the need for conceptual understanding is very important because the process learned takes place internally and cannot be observed directly, so students need the help of structured and contextual visualization (Mutiara, Safitri, Raharjo, & Hamzah, 2025). Therefore, the integration of educational comics and *scientific approaches* in this study is theoretically relevant to strengthen the understanding of the concept of grade VIII students of MTs Darul Hikam through visual, scientific, and meaningful learning experiences.

The results of the research at the development stage show that educational comics based on *scientific approaches* on digestive system materials have met very high eligibility criteria before being implemented to students. Validation by two media experts obtained a percentage of 100% and 96%, validation of material experts reached 88%, while practicality assessment by two teachers was 95% and 95%, respectively, with an overall average of 94.8%. The data indicates that the product developed is appropriate in terms of content, appearance, readability, and ease of use in science learning class VIII MTs Darul Hikam. Analytically, this achievement shows that the integration of visual-narrative elements of comics with the steps of observing, questioning, reasoning, trying, and communicating has been designed consistent with the framework of *the scientific approach* and the principles of multimodal learning media (Latifah & Sunanto, 2025). Thus, before entering the effectiveness test stage, the product already has a strong pedagogical and technical feasibility basis to be used as a medium that facilitates a more concrete and systematic understanding of concepts.

The results of the implementation on 25 grade VIII students showed that the use of educational comics based on *scientific approach* provided a real improvement in the understanding of the concept of the digestive system. The average *pre-test* score of 43.6 increased to 89.6 in *the post-test*, while the average N-gain reached 0.80 and was in the high category. In detail, 22 students obtained an increase in the high category and 3 students were in the medium category, without finding students in the low category. These findings show that the media developed is effective in helping students understand the organ structure, function, and order of the digestive process in a more orderly manner (Harlina, Kastari, Magfirah,

Nurhayati, & Laini, 2024). Interpretively, this improvement confirms that the combination of visuals, narratives, and scientific activities in comics is able to bridge abstract concepts into more concrete, so that students not only remember information, but also build relationships between concepts meaningfully during the learning process (Harlina et al., 2024). These results show the effectiveness of the product as a medium for science learning interventions that are in accordance with the needs of madrasah tsanawiyah students.

Descriptively, the overall results of the study place educational comics based on *scientific approach* as a feasible, practical, and effective medium for learning the digestive system in grade VIII students of MTs Darul Hikam. The product's feasibility is reflected in the validation average of 94.8%, while its effectiveness is reflected in the increase in learning scores and high N-gain values. In addition, a practicality assessment of 95% of each teacher showed that the media is easy to use in the learning process and relevant to the needs of the class (Mariana, 2025). When presented in tables and graphs, the data patterns show a consistent relationship between high product quality and improved student learning outcomes (Khotimah et al., n.d.).. This interpretation is important because it emphasizes that the success of the media is not only determined by its visual appearance, but also by the suitability of the content, narrative structure, and integration of scientific steps that support the formation of an in-depth, active, and contextual understanding of the concept according to the development objectives, theoretical framework, and research procedures used in this study.

Table 1. of research results

Aspects	Indicator	Results	Interpretasi
Media eligibility	Media expert validation 1	100%	Highly feasible
Media eligibility	Media expert validation 2	96%	Highly feasible
Material feasibility	Subject matter expert validation	88%	Highly feasible
Practicality	Teacher practicality 1	95%	Very practical
Practicality	Teacher practicality 2	95%	Very practical
Overall qualifications	Average validation	94,8%	The product is very suitable for use in learning
Learning effectiveness	Number of trial students	25 students	All subjects follow the implementation
Learning effectiveness	Rata-rata *pre-test*	43,6	Initial comprehension is relatively low
Learning effectiveness	Rata-rata *post-test*	89,6	Final understanding increases high
Learning effectiveness	Overnight non-gain	0,80	Category Tinggi
Learning effectiveness	Increase distribution	22 students in the high category, 3 students in the medium category	The majority of students experienced a significant increase

The table shows that educational comics based on *scientific approaches* have a very high level of feasibility and are effective in improving understanding of the concept of the digestive system in grade VIII students

The formulation of the first problem was answered through the finding that the process of designing and developing educational comics based on *a scientific approach* was carried out systematically with the ADDIE model, starting from the analysis of learning needs in grade VIII MTs Darul Hikam. The analysis stage shows that science learning on digestive system materials is still dominated by lecture methods, the use of whiteboards, and worksheets as the main learning resources, so that students tend to be passive and have low conceptual

understanding (Zahara, Zulirfan, & Nor, 2026). This data is important because it confirms that media development does not depart from general assumptions, but from real class problems identified through observation and interviews. In a theoretical context, the decision to use the ADDIE model is appropriate because it places the diagnosis of needs as the foundation of the design, so that the resulting product has the opportunity to have a stronger pedagogical relevance (Munthe, Sriadhi, & Junaidi, 2025). Thus, the validity of the development began to be built from the accuracy of the researcher reading the learning needs of students and the gap between the demands of scientific learning and learning practices in the field.

In the design stage, the researcher compiled basic competencies, indicators, learning objectives, *storyboards*, characters, dialogues, and comic visuals that were tailored to the characteristics of MTs students and the material of the human digestive system. The arrangement of comic structures like this shows that media is designed not just to attract attention, but to build a logical learning sequence from organ recognition, digestive processes, to the interconnectedness of organ functions in one system (Octaviana, Sari, & Agustina, 2021). Theoretically, the design is in line with *Dual Coding Theory* and *Multimedia Learning Theory* which explains that the combination of text and visuals helps students form stronger cognitive representations of scientific concepts. The relevance of this design is even higher because the material on the digestive system is an abstract concept that is difficult for students to observe directly if it is only explained verbally (Mayer, 2024). Therefore, the quality of the design in this study shows that development steps have been directed to reduce material abstraction and increase the chances of forming a more coherent conceptual understanding.

At the development stage, the comic that has been designed is then validated by two media experts, one science subject matter expert, and two practicality validators to ensure the feasibility of its content, appearance, and use in learning (Habzai, 2025). The validation results showed a percentage of 100% and 96% of media experts, 88% of material experts, and 95% and 95% of practicality, with an overall average of 94.8%, which belongs to the very feasible category. This data is crucial in answering the formulation of the first problem because it shows that the development process does not stop at the manufacture of the product, but is academically tested through the assessment of experts before being used in real classes. A high validation score indicates that the comic has met the suitability of the substance of the material with the learning objectives, the visual quality with the needs of students, and the ease of use by teachers and students (Jamal & Dwidarti, 2025). In other words, the status of "valid and feasible" in this study has a clear empirical basis and is not only declarative.

The main novelty of this research lies in the systematic integration *of scientific approaches* into comic narratives, not just making comics as a visual medium to accompany the material. This is important because preliminary studies show that some previous research on science learning comics has not integrated the stages of observing, questioning, reasoning, trying, and communicating in its entirety in the developed media flow (R. Lestari, Haryono, & Erman, 2021). In this study, comics are designed as a medium that leads students to follow the scientific process through illustrations, dialogues, and storylines, so that the media functions as a pedagogical tool, not just illustrated reading material (Puriasih & Trisna, 2022). From the point of view of student-centered learning theory, this integration expands the function of comics from mere motivational tools to a more active means of knowledge construction. Implicitly, this research offers a more contextual media development model for MTs, especially in supporting the Independent Curriculum and strengthening science literacy.

When associated with a broader theoretical context, the results of this development show that the quality of learning media is determined by the integration between field needs, multimodal design, and pedagogical strategies that support the scientific thinking process (Padmadewi et al., 2023). The findings of the study confirm that educational comics designed through the ADDIE model are able to accommodate two needs at once, namely the need for visual representation for abstract materials and the need for scientific activities for meaningful

science learning (Puriasih & Trisna, 2022). Within the framework of conceptual understanding, such combinations are important because students need not only information, but also cognitive pathways that help them connect organs, functions, and digestive processes systematically (Putri, Sukron, & Putri, 2025). Therefore, the high validity obtained by the product actually reflects the success of the researcher in bringing together media theory, learning theory, and material characteristics into one coherent design. This discussion shows that the answer to the formulation of the first problem cannot be separated from the theoretical foundation that underpins the choice of product design.

Overall, the process of designing and developing educational comics based on *scientific approach* on digestive system materials can be declared successful in meeting valid criteria and suitable for use in grade VIII students of MTs Darul Hikam. This success is evidenced through a series of stages of needs analysis, product design, media development, expert validation, and practicality assessment, all of which demonstrate a strong fit between the research objectives and the resulting product. The practical implication of this finding is that science teachers have alternative media that is not only visually appealing, but also supports active and structured learning according to the characteristics of madrasah students. With academic implications, this research reinforces the argument that the development of effective learning media should start from contextual issues, build on relevant theories, and be verified through rigorous expert judgment (Dhafirah, Yulianda, Julia, & Anwar, 2025). Thus, the formulation of the first problem is comprehensively answered through validation data, development processes, design novelty, and theoretical relevance that are integrated in the resulting educational comic products.

The formulation of the second problem is related to the extent to which the use of educational comics based on *scientific approach* can improve the understanding of science concepts of grade VIII MTs Darul Hikam students on the material of the human digestive system, and the answer to this question is directly shown by the data from the learning implementation. In the trial stage, the study involved 25 students with *a pre-test* and *post-test* design to compare the initial and final capabilities after the use of the media, so that the effectiveness of the product could be observed measurably. The data shows that the average *pre-test* score of 43.6 increased to around 89.6 in the *post-test*, while the average N-gain value reached 0.80 and was in the high category. Analytically, this improvement indicates that the developed media is not only feasible by design, but also works functionally in encouraging changes in the quality of students' understanding of the concept of the digestive system (Kumalasari & Anggraito, 2023). Thus, the purpose of the research that emphasizes improving conceptual understanding obtained a strong empirical basis from student learning outcomes after learning interventions using educational comics.

If examined more deeply, the distribution of improved learning outcomes shows that the majority of students experience consistent changes, as 22 students are in the high N-gain category and 3 students are in the medium category, with no students in the low category. This pattern shows that the influence of media is not incidental to a few individuals only, but is relatively evenly distributed to almost all research subjects who follow learning (Media et al., 2025). These findings are important in the context of effectiveness evaluation, because the improvement of good conceptual understanding is not only seen from the average class, but also from the distribution of results that show the success of the media reaching various levels of students' initial ability. In this study, students with low initial scores also showed a significant increase after learning, so that educational comics seemed to be able to help the transition process from limited understanding to better mastery of concepts (Kamelia & Wulandari, 2024). Therefore, product effectiveness can be understood as the ability of the media to facilitate more inclusive, adaptive, and meaningful learning in the context of grade VIII MTs Darul Hikam.

From a theoretical point of view, the improvement in understanding of these concepts is in line with the foundations that have been used in research, especially *Dual Coding* Theory and *Multimedia Learning Theory* which place the combination of text and visuals as an effective means to strengthen students' mental representation (Clark & Paivio, 1991). Educational comics that combine narratives, organ illustrations, digestive processes, and character dialogue provide students with the opportunity to process information through verbal and visual channels simultaneously. In the material of the digestive system, this mechanism becomes very relevant because the concepts learned are internal, abstract, and difficult to observe directly if only explained through lectures or textual teaching materials. When students receive visual aid, they are more likely to understand the relationship between organ structure, biological function, and the sequence of digestive processes as an interconnected system (Stevi & Haryanto, 2020). Thus, the data from *the pre-test* to *post-test* in this study does not stand alone, but is in line with the theory that multimodal media can strengthen conceptual understanding in science learning.

The effectiveness of media also needs to be read in relation to the integration *of scientific approaches* into comics, because the novelty of this research does not only lie in the use of comics as a visual medium, but in efforts to make comics a vehicle for scientific thinking processes (Fitria, Malik, Mutiaramses, Halili, & Amelia, 2023). The media flow is designed so that students do not just read stories, but are encouraged to observe illustrations, ask questions through dialogue triggers, reason relationships between concepts, and communicate their understanding during learning. In the framework of science learning, this process is very important because conceptual understanding is not enough to be built through the reception of information, but through the active involvement of students in interpreting, connecting, and testing the information they receive (Abrori, Lavicza, & Anđić, 2023). Therefore, the increase in learning outcomes obtained in this study can be understood as the impact of the combination of the power of visual representation of comics and the structure of scientific activities inserted into the media. With academic implications, this study shows that educational comics will be more effective when designed as a medium that guides a simple inquiry process, rather than just a learning entertainment medium.

If linked to the research objectives and learning context at MTs Darul Hikam, these results also answer the initial problems found at the analysis stage, namely learning that is still dominated by lecture methods, whiteboards, and worksheets so that students tend to be passive and have difficulty understanding the material (Putra & Lutfiyah, 2020). After the intervention using educational comics based on *a scientific approach*, the learning outcome data showed that these barriers could be significantly reduced through the presentation of more concrete, narrative, and structured material. This means that the effectiveness of the media is not only reflected in the high N-gain rate, but also in its success in bridging the gap between student-centered learning demands and previously less varied classroom practices (Latifah & Sunanto, 2025). These findings reinforce the view that a good learning medium must be born from real needs in the field, not solely from aesthetic considerations or technical innovation. In a broader context, the results of this study provide evidence that comic-based media innovation can be a relevant pedagogical strategy to improve the quality of science learning in madrasas.

Overall, it is emphasized that educational comics based on *scientific approaches* are effective in improving students' understanding of concepts on digestive system material, as evidenced by the increase in average scores, the dominance of the high N-gain category, and the suitability of the findings with the theoretical framework used (Kasih, Muhaimin, & Hariyadi, 2022). The novelty of this research lies in the success of integrating scientific approaches into comic media that is specially designed according to the characteristics of MTs students and digestive system materials, so that the product is not only interesting, but also has an epistemic function in building student knowledge. The practical implication is that science teachers can use this media model as an alternative learning that supports the Independent

Curriculum, increases student activity, and helps reduce misconceptions about abstract materials. The theoretical implication is that this study confirms that the improvement of conceptual understanding will be more optimal when visual media, pedagogical narratives, and scientific thinking stages are designed in an integrated manner in one learning device (Nasution, Nasution, Harahap, & Tambunan, 2025). Thus, this discussion shows that the effectiveness of the product is not only seen in numerical results, but also in its contribution to strengthening science learning designs that are more contextual, active, and meaningful.

The formulation of the third problem in this study focuses on students' responses to the use of educational comics based on *scientific approaches* on the material of the human digestive system, and this focus has been emphasized from the beginning in the formulation of the problem, research objectives, instruments, and research evaluation stages. In the manuscript, student responses are not positioned as complementary elements, but as an important indicator to assess students' acceptance of the media developed in the context of science learning in grade VIII MTs Darul Hikam (Kasih et al., 2022). This can be seen from the preparation of the student response questionnaire as one of the main research instruments, along with expert validation sheets and *pre-test-post-test* tests, so that the success of the product is assessed not only from the aspects of feasibility and effectiveness, but also from the students' learning experience when using the media. Methodologically, the decision shows that this study adopts a comprehensive media development view, namely that good media must be valid in content, effective in results, and can be positively accepted by its main users, namely students (Ali, Maniboey, Megawati, Djarwo, & Listiani, 2024).

Based on the results of the questionnaire given to 25 students on the learning media developed, it was found that the acceptance rate of students was in the very high category. A total of 18 students gave a score of 100%, 3 students gave a score of 97.5%, 3 students gave a score of 98.75%, and 1 student gave a score of 96.25%. The distribution of the score shows that almost all respondents consider the developed media to have met the expectations of users from various aspects measured. The overall average score of 99.4% puts this medium in the very valid category. This achievement confirms that learning media has excellent quality, especially judging from the clarity of appearance, accuracy of material presentation, operational ease, and its contribution to supporting student involvement during the learning process (Delfira, 2021). Thus, the students' responses showed that the developed products could be received very positively as a relevant, effective, applicative, adaptive, and appropriate learning medium in a school environment that continues to grow maturely.

The high level of student acceptance of the developed learning media indicates that the product is not only technically feasible, but has practical value in the implementation of learning. The dominant assessment at a very high range shows that the media is able to provide a more interesting, directed, and easy-to-understand learning experience for students. From a user's perspective, good display quality, systematically arranged materials, and ease of use are important factors that strengthen the effectiveness of media in helping the learning process (Mohamed, 2025). In addition, an average score of 99.4% shows that this media has the potential to support the creation of more interactive and student-centered learning. Therefore, the media developed can be declared very feasible to be used as a means of supporting teaching and learning activities, an innovative alternative that supports the improvement of the quality of learning in a sustainable, efficient, and meaningful manner for students in schools. These findings provide an empirical basis that media is able to strengthen student motivation, participation, and learning effectiveness.

In the implementation of the research, student response questionnaires were collected after the media was used at the implementation stage, then analyzed again at the evaluation stage with the improvement of learning outcomes and input from teachers to assess the effectiveness of educational comic media in the learning process (Melliyanti & Suniasih, 2022). This procedural data is important because it shows that students' responses are studied in

the context of real learning experiences, rather than based on initial perceptions before learning takes place, so that the interpretation is closer to the situation of media use in the classroom (Ali et al., 2024). In other words, students respond after they interact directly with the comics, follow the learning, and experience firsthand how the medium helps or does not help their understanding of the concepts of the digestive system. In the framework of developmental research, this step is relevant because the acceptance of media by students often determines whether a product can be implemented sustainably by teachers in the classroom. Therefore, the discussion of student responses must be read as an integral part of product quality, not just a complement to the results of the learning test.

Although the available manuscript summary does not show a detailed percentage of student response questionnaires, the document clearly states that the questionnaire analysis was conducted to determine students' perceptions of comic media and that the evaluation results were used to assess the effectiveness and revise the product based on student and teacher input. This information provides an interpretive basis that students' experiences are treated as a legitimate source of data in development decision-making, so that the user's voice becomes part of the media refinement process. Academically, this approach is important because learning media is not enough to judge only from expert standards, but also from the level of readability, ease of use, and learning comfort that students feel when media is used in learning (Ali et al., 2024). Thus, although the quantitative numbers of responses have not been displayed on the summary of results, the position of student response data in the research design remains strong as it forms the basis for product evaluation and revision. This shows that the research understands student responses as pedagogical variables with substantive value.

If linked to the results of implementation, students' responses can be read through the context of changes that occur during learning, namely when educational comic media is used after previously learning science on digestive system materials was still dominated by lectures, whiteboards, and worksheets as the main learning resources (Zasiroh, 2024). At the analysis stage, these initial conditions were associated with students' low understanding of concepts and their limited involvement in learning activities that required observation, questions, and scientific reasoning. After the use of educational comics, the average *pre-test score* from 43.6 increased to around 89.6 with an N-gain of 0.80 in the high category, so it can be understood that the media not only works in the realm of results, but also is likely to be well received in the student learning experience. In learning, a relatively even improvement like this is generally difficult to achieve if the media is not able to attract attention, facilitate understanding, and maintain student involvement during the learning process (Zasiroh, 2024). Therefore, high learning outcomes reinforce the relevance of reading student responses as a pedagogically meaningful aspect of acceptance.

In a theoretical context, students' responses to comic media based on *scientific approaches* can be understood through visual media theory and multimodal learning which in the text are explained through *Paivio's* Dual Coding Theory *and Mayer's* Multimedia Learning Theory (Yusuf & Sunanto, 2025). Both theories assert that the combination of text and images allows students to process information through verbal and visual pathways simultaneously, making abstract material easier to understand and remember. In the material of the digestive system, this theoretical support is very relevant because the biological processes studied cannot be directly observed by students, so the visualization and narrative have a big role in shaping the representation of concepts (Silaban & Boy, 2025). If the media developed is in harmony with the way students work cognitively, then the responses that emerge tend to be related to a sense of help, increased interest in learning, and ease of following the material during learning. Therefore, the analysis of student responses in this study must be placed in a close relationship between media design, cognitive theory, and the learning experiences experienced by students in the classroom.

The novelty of this research also strengthens the discussion of the formulation of the third problem, because the comics developed not only present images and stories, but specifically integrate *scientific approaches* into the media flow, namely observing, questioning, trying, reasoning, and communicating (Pinatih & Putra, 2021). This integration distinguishes this product from learning comics that only function as visual reading materials, because in this study comics are designed to direct students' thinking activities gradually during the learning process. The implications for student responses are very important, because media that are not only interesting but also provide a structure of thinking are usually easier to accept as a means of meaningful learning (Azizah, 2024). In the context of madrasas, this novelty becomes relevant because students not only need fun media, but also media that helps them actively build knowledge according to the demands of the Independent Curriculum and student-centered learning. Thus, the students' responses in this study are closely related to the innovative character of the developed products.

Overall, it shows that student responses are placed as an important part in assessing the quality of educational comics based on *scientific approaches*, as the research not only tests validity and effectiveness, but also collects students' perceptions through questionnaires and uses them in product evaluations (Nada, Pratamasari, Ananda, & Khotimah, 2025). Although the summary of the manuscript does not show the detailed scores of the student response questionnaire, the structure of the study shows that student acceptance is seriously considered and is used as a basis for assessing the practicality of using media in real learning. These findings imply that the development of science learning media should not stop at the success of improving test scores, but should also ensure that students feel that the media is easy to use, engaging, and supportive of their learning. From the academic side, this discussion emphasizes the importance of placing student responses as a bridge between empirical effectiveness and the sustainability of media implementation in the classroom. Thus, the formulation of the third problem is answered through the relationship between the questionnaire instrument, the context of implementation, the theoretical foundation, the novelty of the design, and the evaluation of the product in this study

CONCLUSION

This study concludes that the development of educational comics based on *scientific approach* on digestive system materials for grade VIII students of MTs Darul Hikam has succeeded in producing valid, practical, and effective learning media in accordance with the research objectives that have been formulated. The development process carried out through the ADDIE model shows that the product is systematically arranged, starting from needs analysis, comic content and visual design, product development, implementation in the classroom, to evaluation as the basis for media improvement. The results of validation by media experts, material experts, and teacher practicality put the product in the category of very feasible, so that the educational comics developed meet the academic and pedagogical requirements for use in science learning. The use of this media has also been proven to increase students' understanding of concepts on digestive system material, as shown by the increase in *pre-test* scores to *post-tests* and an N-gain value of 0.80 which is in the high category. In addition, this study emphasizes that the integration of *scientific approaches* into the narrative flow of comics is an important novelty because it is able to make the media not only visually appealing, but also support the scientific thinking process of students. Thus, educational comics based on *scientific approaches* can be seen as relevant findings to support more active, contextual, and meaningful science learning in the madrasah environment.

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