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Development of STEAM-Based Integrative Learning Tools on The Topic of Islamic Mathematization

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ABSTRACT
Integrative learning that integrates spiritual and social attitudes with knowledge and skills has become an interesting discussion in the world of education. However, in the mathematics education study program the application of this learning is less familiar because it is difficult to find references on the integration of mathematics with spiritual and social values. The purpose of this study is to develop a STEAM-based integrative learning tool for effective Islamic Mathematization. This research is an R&D research using the 4 D model (Define, Design, Develop and Dessimenate) from Thiagarajan which is simplified to the develop stage. The test subjects were 31 students who took courses on the integration of Islam and science at the Mathematics Education Study Program, University of Muhammadiyah Purwokerto, Central Java, Indonesia for the 2020/2021 academic year. Data collection tools using expert validation sheets, student response questionnaires and Learning Outcomes Tests. The results showed that the validity of STEAM-based integrative learning tools was 83.5% (valid), 85% positive student responses, 84% learning completeness (completed), and the recommendations from the validator were 80% (feasible to use) so that the learning tools it's effective. Therefore, it can be used to enrich the treasures of holistic learning in mathematics education study programs.

Introduction

Spiritual and social drought is a major challenge in the era of global learning. Many people are physically close but feel far away and conversely many people are physically far away but feel close, because their closeness is only virtual. This is increasingly felt in the pandemic era which requires all learning activities to be carried out online, so that there is no physical contact between teachers and students and even students with other students. As a result, the teacher's control as an educator on the spiritual and social development of students has decreased drastically and has turned into the moral responsibility of parents. Meanwhile, parents also have difficulty dealing with this because of the gap in their ability to operate digital technology and their respective

activities. This problem is very urgent to find a way out so that the quality of education does not experience a significant decline.

In relation to these problems, Islamic-based universities have responded to this by introducing the Integration of Islam and science courses in all study programs as a form of holistic-integrative learning. Linda (2020) emphasized that holistic learning combines reasoning and value internalization simultaneously so that it will help accelerate the formation of a more complete personality because it includes aspects of attitudes, knowledge and skills. Previously Einstein, A (1982) stated that religion without science is blind and science without religion is lame. This statement reinforces the importance of integrating religious values with knowledge that can be developed in every aspect of life, including Islam

Some mathematicians in Islamic universities have begun to try to integrate them according to their respective points of view. For example, Masduki & Khotimah (2015) construct a model of integration of Islamic values in mathematics learning, through the stages of inculcation, implementation and reflection. This research has linked mathematics with Islamic values but has not touched the integration method, only in terms of the material. Maarif, (2015) recommends integrating mathematical concepts with Islamic values by linking Al-Quran verses with mathematics. (Abdussakir & Rosimanidar, 2017) reconstructed the integration model between mathematics and the Koran, namely (1) mathematics from the Koran (teaching mathematics from the Koran), (2) mathematics for the Koran (using mathematics to implement the Koran), (3) mathematics to quran (using mathematics to reveal the wonders of the Qur'an), and (4) mathematics with quran (using mathematics to explain the Qur'an). These findings theoretically only show that there is a functional relationship between mathematics and Islamic values and the Qur'an, but has not yet constructed this relationship so that mathematics becomes more meaningful and Islamic values become more rational (Ekowati, n.d.).

To answer the demands of the learning needs of this course, it is necessary to develop an integrative learning tool on Islamic Mathematization material. In Islamic Mathematization, symbolic facts, mathematical concepts/principles are seen as a source of inspiration for Islamic values that can build spiritual awareness through a process of analogy. Islamic mathematization places mathematics as a philosophical source of Islamic values, so that mathematics is referred to as value or mathematics as value. Thus learning mathematics will be a supplement in the formation of attitude values and at the same time developing reasoning.

The occurrence of cultural interactions with technology in the 21st century has implications for the process of character building, personality, ethics, law, criminology and media (Garba et al., 2015). The interaction between science, technology and culture has become a new trend (Pilliang, 2014) in global changes in general and in education in particular. In the world of education the changes are comprehensive and substantial. Comprehensive because there is a transformation in all aspects, and substantial because the changes are very basic. Significant changes in the world of education are marked by: (1) the use of information technology and computer (Sun & Chen, 2016) from offline learning to online through various platforms such as WA groups, zoom meetings, google meet, Learning Management System (LMS) and others, thereby opening up a wide public space, (2) changing the role of educators no longer as the only source of information, but as facilitators who serve students to learn optimally, (3) students are no longer objects of learning but become subjects of learning who can freely explore material through various

sources of information available on the internet, (4) the learning approach no longer only emphasizes student activities but must demand higher-order thinking processes , spiritual and social attitudes, and life skills needed in everyday life, (5) teaching materials are no longer content-based but context-based, materials are no longer constructed by the teacher and presented in finished form but are presented contextually in everyday life. which students must construct through investigation, reasoning, and discovery (White, 2014).

Learning tools consisting of Learning Plans, Textbooks, Media and Evaluation Instruments on Islamic Mathematics materials need to be developed in an integrative way across domains of knowledge and learning outcomes. Cross-disciplinary because it integrates several fields of science simultaneously and across domains because it contains the domains of knowledge, attitudes and skills. In the aspect of knowledge, learning is needed to trigger higher-order thinking processes, especially analytical, critical, argumentative and creative (Karakoc, 2016). In the attitude aspect, learning is needed to trigger students to have a balanced sense of spiritual and social values ((Chowdhury, 2018). In the aspect of skills, learning is required to be able to provide encouragement and real experience faced in social life. Integrative learning is needed to help develop a deep understanding of systematic knowledge building (Akbar, Sebayang, N: 2015), which constructs facts, concepts, generalizations, and relationships between them (Eggen and Kauchak, 2010), which requires thinking skills. critical and emotional sensitivity. Integrative learning tools are expected to facilitate students in formulating hypotheses, compiling generalizations, making analogies, encouraging evidence, demanding arguments, exploring, collecting data by involving students' participation through exploratory questions, analyzing factual data by utilizing information technology. and communication. Integrative learning is expected to encourage students to think critically ((Sari et al., 2021), be communicative and collaborative in solving real problems in everyday life.

In the development of Islamic Mathematization tools, the study material is derived from the phenomenon of the functional relationship between the humanities, mathematics and Islamic values to be achieved. Humanities function as a stimulus that tells a person's behavior because of his achievements in incising moral values in his life. A person's behavior narrated in the stimulus is a form of example for the practice of Islamic values that can be imitated in everyday life. Mathematics functions as a kauniah verse (Kusno & Marsigit, 2018) which provides a philosophical basis for delivering spiritual messages through an analogy process. The analogy is a form of similarity or similarity in nature (Kristayulita, As'ari A, R & Sa'dijah Cholis: 2017). Analogy is a thinking process to get a conclusion or new knowledge by comparing the object of analogy with existing knowledge (Amir-Mofidi et al., 2012). Analogies are used for the formation of Islamic values through taking the existing substance in common from the social reality that occurs, previous knowledge that already exists in the minds of students or the beliefs they have. The analogy further develops the metaphorical meaning of concepts or principles in mathematics into a philosophy of Islamic life as a material to provide spiritual messages.

One of the recommended learning approaches in the 21st century is the Science, Technology, Engineering, Art and Mathematics (STEAM) approach which is able to integrate the use of science, technology, engineering, artistic values and mathematics in human life (Wahyuni, 2018). There are several variations in STEAM integration, first examine each discipline within STEAM by focusing on one or two of these disciplines. The second integrates all disciplines within STEAM but needs to take into account

materials, media and other factors. Third, combine all disciplines in STEAM and teach it as an integrated subject. The emergence of the STEAM approach is motivated by various problems and social upheavals in society that require the unification of various disciplines or expertise simultaneously (Hoachlander, G., & Yanofsky, D: 2011). The STEAM approach creates a new phase for educational reform and research in the field of integrative learning theory. The presence of STEAM overcomes the isolation of knowledge towards the integration of knowledge that is useful for solving life's problems. The STEAM approach in recent years has become a central issue in the development of learning in the present and the future (Bybee, 2013).

The term science emphasizes the use of the scientific method in the study of complex human relationships. The systematic process of understanding these properties is called scientific inquiry. The scientific process requires students' ability to observe, ask questions, explore, formulate hypotheses, conduct experiments, solve problems, reflect and revise (Tresnawati et al., 2020). Technology is the application of science and mathematics to construct structures, products, machines, equipment or other components that can help solve the problems of everyday life. For example, information and communication technology, which reduces barriers to human interaction, helps create a new sub-culture, namely the emergence of a virtual world culture based on the development of the internet. Art is an activity that can evoke imagination, values, culture, outlook on life, which are believed and practiced in everyday human life. It should be noted that the estuary of science and engineering is a practice of human life which is the embodiment of the values, beliefs, and culture of a society. At Muhammadiyah universities, art is emphasized on Islamic values. Islamic values include the values of faith, morals, worship and muamalah. Science can be extracted from life and conversely the way of life of a life can reflect the development of science, including mathematics.

Mathematics is a human activity in the form of tracing patterns and relationships that require investigation, discovery, initiative, thinking differently, asking questions, refuting, estimating, finding structures, and thinking reflexively. Mathematics is problem solving to stimulate, develop and solve problems in their own way, help find information to solve problems, encourage logical, consistent, systematic thinking and develop documentation systems, help use media / teaching aids effectively. Mathematics is also a communication that encourages students to recognize, create and explain examples of the nature of mathematics, give reasons for the need for mathematical activities, read, write, and appreciate mathematics, and the mother tongue used in discussing mathematical problems in context. from students. This activity requires a rational and objective way of thinking and an attitude of integrity which is the embodiment of mathematical values. Therefore, Istiqlal & Jumadi, (2017) suggest that mathematics has excellent potential to elaborate Islamic values in particular or spiritual and social values in general. For this reason, it is necessary to develop a module that integrates mathematics with Islamic values in order to make it easier for prospective mathematics teachers, especially at Muhammadiyah universities, to study integrated Islamic mathematics.

Research Methods

The type of research used in this research is Research & Development with a 4D model (Define, Design, Develop and Desseminate) from Thiagarajan which is simplified to Develop. The reason is because this research is only intended to obtain effective development results. Furthermore, the stages of development are described in Figure 1 below:

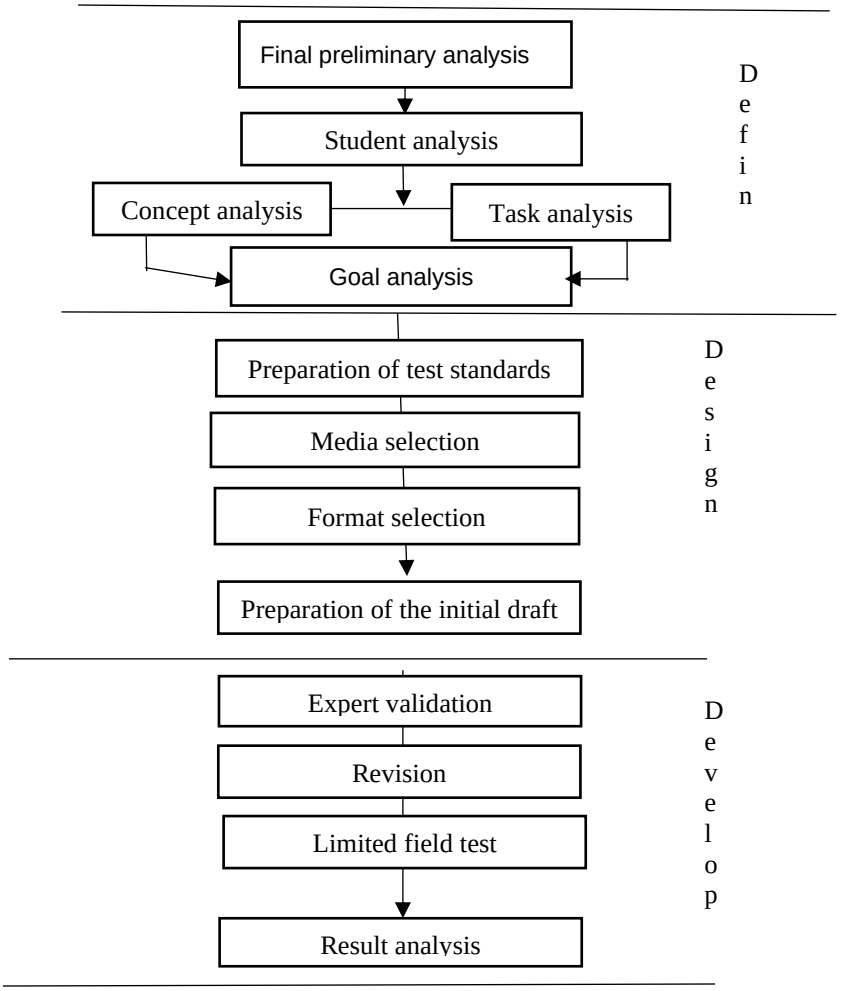

Figure 1. Four D development procedure (adapted from Thiagarajan: 1979)

The define stage consists of five activities, as follows: (1) early-late analysis to find out the basic problems faced by educators and the solutions to be taken, (2) student analysis to identify student characteristics as the basis for determining the development design, (3) task analysis to identify the main skills needed, (4) analysis concepts to identify the main concepts to be taught, and (5) formulation of learning objectives to project the results obtained in task analysis and concept analysis steps into specific objectives.

The design stage consists of four activities, namely (1) preparation of test standards to measure success in achieving goals, (2) selection of media to be used in learning, (3) selection of formats to be used in the development, (4) preparation of initial draft.

The development stage consists of two activities, namely (1) expert validation to get suggestions for improvement, determination of validation scores and feasibility assessment from related experts. Aspects of teaching materials that are validated are integrative aspects, didactic aspects, readability aspects and technical aspects. (2) Limited field trials, to get responses from users in this case students. In relation to the characteristics of the material, the items that students respond to as users are aspects of novelty, touching spiritual awareness, readability, interest in reading, meaningfulness,

contextuality, analogy, science, integration with values and science. To measure cognitive abilities, students are asked to construct Islamic values (aqidah, worship and morals) from mathematical facts, concepts, principles or procedures that are selected through the process of material analysis, analogies and generalizations in order to obtain a philosophy of mathematics-based values that is beneficial for life. The data collection and analysis techniques were carried out respectively as follows: First for the quality of the development material using an expert validation sheet with an alternative Likert scale of 5, namely: 5 very good, 4 for good category, 3 for quite good category, 2 for poor category and 1 for bad category. From expert validation, the sum of all question points is determined and converted into a percentage scale, as Table 1 below:

Table 1: Expert Validation Criteria

Percentage (%)	Validity Criteria
80≤ X ≤100	Very Valid/ Eligible
60≤ X <80	Valid/ Eligible
50≤ X <60	Not enough valid/ Eligible
0≤ X <50	Not valid/ Eligible

For the rating criteria using 4 scales, namely 4 very suitable for use, 3 suitable for use, 2 less suitable for use, and 1 not suitable for use. Furthermore, the results are converted into a presentation scale and consulted with Table 1 above. Second, for student responses, a Likert scale is used with four alternatives, namely 4 good, 3 quite good, 2 not good and 1 not good. Then the sum of all question points is determined and converted into a percentage scale. The description is divided into 4 categories as shown in table 2 below:

Table 2. User Response Criteria

Pesentasi (%)	Criteria Respon Pengguna
80≤ X ≤100	Good
60≤ X <80	Pretty Good
50≤ X <60	Not enough good
0≤ X <50	Not Good

Third, to find out whether the learning tools can be completely understood by students during learning, a test of learning outcomes is carried out using the prepared instruments. Furthermore, the test results were analyzed to determine the level of complete learning. If the number of test takers who get a total score of at least 75 is more than or equal to 80%, it is said that the learning has been completed and vice versa..

Results and Discussions

The product resulting from development research is in the form of STEAM-based integrative learning tools on Islamic Mathematization material in the form of Learning Plans, Textbooks and Evaluation Instruments. The resulting textbook is expected to be one of the learning resources for students of the Mathematics Study Program for Islamic and Science subjects, especially those related to integration with Islamic values. The research results are summarized in the define, design and development stages which are described as follows: The define stage consists of 5 analyzes, namely:

(1) Early-late analysis.

Starting from the difficulty of finding references to integrate Islamic values with mathematics, there are no integrated teaching materials. Furthermore, it is definitely necessary to develop learning tools that are integrated between science, technology, engineering art, and mathematics.

(2) Student analysis.

From the results of this analysis, it is found that the level of thinking of students according to Paget's theory is at the stage of formal operations so that they have the potential to be critical, collaborative, communicative, and creative which will be developed in learning tools,

(3) Task analysis

Skills mapped the main skills to be designed, namely downloading teaching materials, making mind mapping materials, videos or animated PPT from stories integrated with mathematics, conducting presentations and discussions and answering questions related to metacognitive, value awareness and 4C skills.

(4) Concept analysis

In the form of the main concepts of the interaction of mathematics with Islamic values which include the geometry of faith, geometry of worship, geometry of morality, algebra of faith, algebra of worship and algebra of morality.

(5) Objective analysis

In the form of mapping of learning objectives that recommend learning experiences as specified on the task map to construct character values as referred to in the concept map.

The design stage consists of 4 activity stages, namely the preparation of test standards, media selection, format selection, and initial design, each of which is explained as follows:

(1) Preparation of test and assessment standards to measure success in goals. The standard of the test is prepared based on the CRT (Criteria References Test) which is taken from the material of aqidah geometry, worship geometry, moral geometry, creed algebra, worship algebra and moral algebra. There are three objectives of learning outcomes, namely (a) metacognition which requires students to regulate their way of thinking on what they do on their own so that it can improve the learning process and memory. (b) value awareness, which is a situation where an individual knows, understands, and understands the norms that are considered good by each individual and have the guts to get them, (c) life skills, namely the ability to adapt and show positive behavior that makes individuals face challenges and challenges of daily life effectively,

(2) The selection of media used in the development of teaching materials is graphic, image and color.

(3) The selection of the format used in the development of teaching materials is in the form of a textbook whose content structure is the first part in the form of an introduction containing rational, integrative mathematics learning and Islamic values, and the STEAM approach in integrative learning, the second part is an integration guide containing the structure guide, integration method, concept map and integrative learning guide, the third part is the core of integrative learning which contains learning objectives, stimulus, working instructions, questions and alternative answers.

Learning objectives contain components of audience, behavior, condition and degree (ABCD). Stimulus in the form of narratives that are contextual and interesting in the form of natural events, history and inspirational stories that serve as a foothold in understanding or constructing learning outcomes. Instructions and questions are part of the structure of teaching materials that function to demand and direct students to think in accordance with learning outcomes. This section is equipped with examples of alternative answers to find different answer alternatives.

(4) The initial design for the preparation of integrative learning tools based on the STEAM approach by considering the integrative, didactic, legibility, and technical aspects and graphics. The design of the integration of development tools follows the flow of Islamic mathematization which views mathematical concepts and principles as an inseparable part of the verses of the Kauniyah. In this case the meaning of mathematical characters is carried out denotatively to produce mathematical concepts and metaphorical meanings produce the concept of life as shown in figure 2 below.

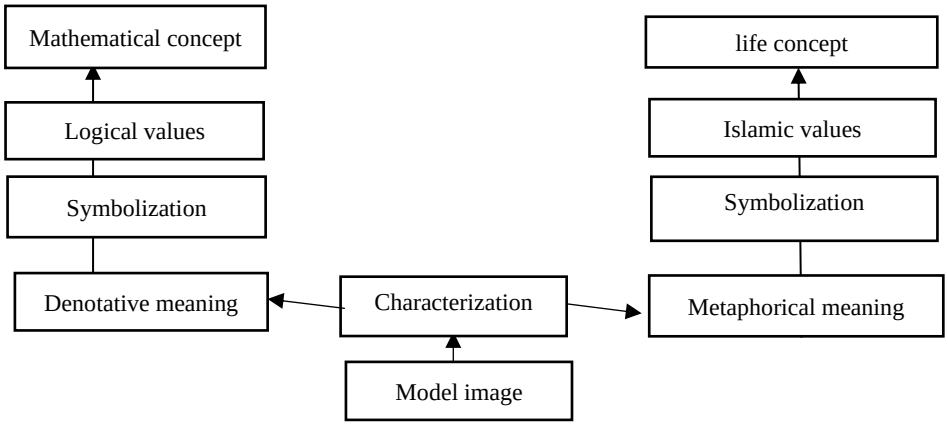

Figure 2. Islamic Mathematization Integration Model

The development of Islamic mathematization teaching materials is based on 7 development indicators as follows: (1) Teaching materials have a dual function, namely providing mathematical messages and spiritual messages, (2) Equipped with exemplary stories to build spiritual awareness as a stimulus in developing hots questions, (3) Demanding students to do literacy reading and compiling mind mapping,(4) Has an important meaning in human life,(5) Connecting life problems that have spiritual values and solving mathematical problems, (6) Demanding students to do high-level reasoning,(7) Demands the ability to elaborate with science and information technology Lesson Plans are prepared by accommodating the syntax of the integrative learning model. The syntax of the integrative learning model consists of 5 phases of learning activities as follows:

a. Data presentation phase. Students explore the information presented in the stimulus section in the form of inspirational stories, and then present it again in their own language by utilizing learning media in the form of video, macro media flash or power point.
b. The phase of examining the relationship in the unity of information. Students examine the relationship between information in the metacognition section in the form of philosophy, analogy, or modeling built from mathematical objects with Islamic values presented in the stimulus section in the form of mind mapping.

c. Information analysis phase and hypothetical submission. Students analyze, formulate a causal relationship hypothesis or functional relationship based on the similarity of substance. In this case, the roles of mathematical reasoning and the humanities are used. For example, to carry out the analysis, alternative answers are given for the metacognition and value awareness sections, while in the skills section they are submitted as discussion material.
d. Generalization phase. Simultaneously integrate all information between science, technology, values and mathematics so that it becomes comprehensive information.

The develop stage consists of two stages: first, expert validation-1 provides input as follows:

Table 3. Input from Validator

Page	Before Revision	After Revision
13	Success point: Start from yourself, start small, start from now	Success point: Start with yourself, start small and start now, and spread it to the community so that knowledge is increasingly widespread.
19	The positive and negative gradient	The positive gradient shows the right group, namely the group of Allah SWT and the left group is the shaytan group.
27	Human sustenance puzzle	To obtain sustenance from Allah SWT, humans must pray, strive and be grateful.
39	Fate turn	Everyone must try so that they can change their fate for the better
45	Success dilation	Achieve great success in this world and in the hereafter

As for the input from validator 2 regarding the cover, it must be symmetrical and capitalize the Nik abbreviation to become NIK. Furthermore, a quality assessment is carried out by the validator whose results are described as Table 4 follows:

Table 4. Validator assessment

No	Indicator	V-1	V-2	M(%)
01	Integration Aspect	90	80	85
02	Didactic Aspect	86	82	84
03	Language Aspect	90	90	90
04	Graphic Aspect	80	70	75

From table 4 it can be concluded that the average validation value is 83.5 with valid criteria. The highest validity value was in the linguistic aspect, followed by integration, didactic and the lowest was in the graphic aspect. And from the ranking results, the two validators gave status to the validation results that integrative learning tools are based on STEAM learning. From the results of a limited field trial to users of 31 students, the results are as contained in Table 5 below:

Table 5. User Response

No	Indicator	M(%)
01	Novelty	80
02	Touching spiritual consciousness	90
03	Interesting reading	76
04	Meaning in life	91
05	Contextual	88
06	Demands analogy skills	86
07	Integration with values, science and technology	84

From the results of student responses as users, it can be seen in Table 5 above that Islamic Mathematization teaching materials have a novelty of 80% (good), can touch spiritual awareness well (90%), quite interesting (76%), meaningful in life (91%) , contextual to student life (88%), good for developing skills (86%) and integrating values, knowledge and technology well (84%). The highest score on the meaningfulness indicator in life followed by touching spiritual awareness and the lowest was reading interest (only 76). Based on the implementation of the learning outcomes test using the given evaluation instrument, it is known that the average value of knowledge is 81, the number of test participants who experience learning mastery is 84%. Overall, the development of an integrative learning model based on the STEAM approach on the topic of Islamic Mathematics is (1) Valid, (2) User response is good (3) Appropriate for use after going through revision, (4) Meets learning mastery achievement. Thus, the development of an integrative learning model based on the STEAM approach on the topic of Islamic Mathematization is effective.

Conclusion

The STEAM-based integrative learning tool developed is valid based on expert judgment, namely the integration aspect is 85%, the didactic aspect is 84%, the linguistic aspect is 90% and the graphic aspect is 75% with an average overall device validity of 83.5%. Judging from the user's response to the STEAM-based integrative learning tool that was developed, it had 80% novelty, 90% spiritual awareness, 76% interest in reading, 91% meaning in life, 88% contextual thinking, 86% demanding analogy thinking. , has integration with values, science, and technology of 84% with an average of 86.4% so that user responses meet the criteria well. Completeness of student learning using the developed tools reached 84% with complete criteria. Because the feasibility level of the learning tools obtained is 80%, valid, the user response is good with 84% learning completeness, and visible to use it means that the STEAM-based integrative learning tool is effective. Therefore, it can be used to enrich the treasures of holistic learning in mathematics education study programs.

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