

# Integration-Interconnection with a Scientific Approach to the Rational and Irrational Inequality of One Variable Module

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ARTICLE INFO	ABSTRACT
<b>Article history</b> Received 23, 6, 2022 Revised 3, 4, 2022 Accepted 17, 12, 2021	In madrasah, the learning process tends to focus on concepts and materials related to a single branch of science alone, without paying attention to other sciences. Thus, there is a need for innovation in learning that can link various fields of science, one of which is by applying integration-interconnection-oriented learning. This research aims to develop an integrated-interconnected mathematical learning module with a scientific approach using one variable rational and irrational inequality materials. This study was categorized as research and development (R&D). This research was designed by following the steps of Richey and Klein's development, namely the PPE development model (Planning, Production, and Evaluation). For the instrument, this study used a product validation assessment sheet given to two expert validators. The results showed that the integrated-interconnection-oriented mathematics learning module with a scientific approach that had been developed got an average product validity score of 0.82, categorized as high. Thus, this learning module has met the valid criteria.
<b>Keywords</b> Integration-Interconnection Scientific Approach Modul Rational and Irrational Inequality of One Variable	

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## I. Introduction

Education has a vital role in human life. Education in Indonesia is held in an educational institution, one of which is the madrasah. As a formal institution based on the Islamic religion, the madrasah has an important role in shaping the personality of students. In accordance, (Kartika, 2018) states that through education in madrasah, parents expect their children to master two abilities at once, not only science and technology-based skills but also faith and piety. Directorate of Curriculum, Facilities, Institutions, and Madrasah Students of Islamic Education of Ministry of Religion (2013) states that holistic learning must be developed and implemented in education in madrasah. Thus, learning must focus on understanding information and relating it to other topics from various scientific fields, so that a framework of knowledge and student character is built (Sunusi, 2019).

Mathematics learning at regular school and in madrasah tends to teach concepts and materials related to science alone, without paying attention to another subject. Meanwhile, mathematics is general and comprehensive science that underlies and has a relationship with science and technology while also functioning to connect with other sciences (Kenedi, 2018). Thus, an innovation that

can link various fields of science is required, one of which is by applying integration interconnection-oriented learning.

Integration can be interpreted as connecting and uniting between two things, or more, while interconnection means bringing two or more things (Minhaji, 2007). According to Sugilar et al. (2019), A knowledge will be complete when there is an interconnection or integration of one with others and sometimes that knowledge develop through these two things, for example integrated mathematics will more contextual when integrated or interconnected with other fields such as math problems with physics context, biology, social humanities, religion, culture and etc. Integration-interconnection with Islam represents an effort to bring together and link the science of religion (Islam) with the general sciences, which include social humanities as well as natural science and technology (Nu'man, 2017). According to Zain & Vebrianto (2017), the learning that integrates various fields of science and religion science (Islam) can create a complete understanding through a subject learning, creating a generation of ulul albab. This is in accordance with Fitriyani & Kania (2019), who said that integrated learning can encourage students to actively receive meaningful learning, so that it can help

build personal character for good in the future. In its implementation, integrations attempt to connect and bring together various scientific fields, both general science, and religious knowledge. Integration-interconnection that links various scientific fields can be implemented in learning in schools, one of which is in mathematics learning.

Several studies (Khaira et al., 2021; Nu'man, 2017; Suparni, 2015) on integration-interconnection in mathematics learning have been carried out. Suparni (2015) states that learning by using integrated-interconnection-based teaching materials can improve critical thinking skills. In addition, Nu'man (2017) also shows that the integration-interconnection mathematics teaching materials can improve students' reasoning and problem-solving abilities while also transforming students to be more active and enthusiastic in learning activities. The same Khaira et al. (2021) the application of integrated mathematics learning can have a positive impact on student learning activities especially reducing boredom, as a variation of learning and building student morals and can improve learning outcomes student. Based on several studies that have been done previously, integration-interconnection in learning mathematics can improve students' mathematical abilities and create positive responses for students' mathematics learning.

Based on the results of interviews with mathematics teachers at Madrasah Aliyah in Jombang, integration-interconnection-based learning in mathematics lessons has not been implemented because there are no available mathematics teaching materials accompanied by integration-interconnection insights. Teaching materials are one of the supporting factors for the student learning process. The availability of teaching materials will support the achievement of the expected learning objectives. Good teaching materials are teaching materials that are able to accommodate students in understanding the subject matter and are able to improve student learning outcomes and help students to solve, provide solutions to problems that students find in their daily lives (Nilasari et al., 2016). One form of teaching material is a module. A module is a set of teaching materials that are systematically arranged with material content, methods of use, and learning evaluation materials that can be used independently to achieve the expected competencies and learning objectives (Triyono, 2021). From this definition, the use of the module is extensive, not only for classroom learning but can be used independently by students from anywhere and at any time.

According to Nuryana & Aprismayanti (2013), the use of modules in learning can increase students' motivation, activity, and learning outcomes in mathematics subjects. In line with previous research, Putri et al. (2021) reveals that the use of modules in mathematics learning can make students more active and enhance students' conceptual understanding of concepts. In addition, Kurniati (2016) shows that their developed module is valid and practical to use. Likewise, the student's response to the developed

module is categorized as very good, and the response shows that the developed learning module has a good and attractive physical appearance and can facilitate students learning process. Thus, using modules in mathematics learning can improve students' mathematics learning outcomes, create a good learning environment, and create motivation and positive responses in learning mathematics.

On the other hand, learning management in the current Indonesian Curriculum 2013 is an example of good integration-interconnection practices, where the learning integrates three domains of competence, namely attitudes, knowledge, and skills. One of the rules in implementing the Curriculum 2013 is to carry out learning using a scientific approach. The scientific approach generates a learning process that is designed in such a way to facilitate students to actively construct concepts, laws, or principles through the stages of observing, asking questions, gathering information, reasoning, and communicating (Mahmudi, 2015). The characteristics of scientific approach learning are student-centered; involve scientific process skills in constructing concepts, laws, or principles; involve potential cognitive processes in stimulating intellectual development, especially students' higher-order thinking skills; and can develop student character (Hosnan, 2014). According to Machali (2015), the practice of learning with a scientific approach, as demanded by the 2013 Curriculum, is believed to narrow the dichotomy space and integrate-interconnect various subjects.

Several studies on the scientific approach have been carried out (Maryani et al., 2020; Tjiptiany et al., 2016). Maryani et al. (2020) stated that students' mathematics learning outcomes increased by using a scientific approach. On the other hand, Tjiptiany et al. (2016) state that learning using a scientific approach has a significant influence on student learning outcomes. Learning experiences using a scientific approach aid students to think scientifically, think reasonably, gain a much higher understanding, and help students learn more effectively.

One variable irrational rational inequality is one of the compulsory mathematics materials taught in the tenth grade of school semester 1 based on the 2013 Curriculum that is considered difficult by students. The difficulty is marked by students' number of errors in solving the problem. Based on research conducted by Shantika (2017), students' errors in solving problems on the material are categorized as high, which is ranked 2nd out of all mathematics materials in the tenth grade of high school semester 1 with a percentage of 73%. The error is because many students still do not understand the use of inequality signs, determine the members of the complete set, and interpret the language of the problem in the form of rational/irrational inequalities. Also, Setiyaningsih (2018) explains that in the one variable rational and irrational inequalities material, students usually only worked on procedural problems following the examples given by the teacher

without a good understanding of the principles of solving rational and irrational inequalities and their application in problem-solving. Moreover, the material is not contained in the textbook published by the government or the 2017 revision of the Ministry of Education and Culture, while the book is mostly used as the primary teaching material in the learning process in madrasah. Consequently, in studying the material, students must use other textbooks as learning resources or even only rely on explanations from the teacher.

Based on the explanation and problems, the development of integrated-interconnected teaching materials is required. Therefore, we developed a mathematics teaching material in the form of a mathematics learning module accompanied by integration-interconnection insights using a scientific approach. Insights of integration-interconnection will be applied in the realm of material and strategy. The realm of material is a process of integrating mathematics material with other sciences and vice versa. Meanwhile, for the domain of design, this module used a scientific learning approach. The integrations applied in the developed modules were not only related to Islamic material but also to a broader context, namely linking and connecting one variable rational and irrational inequalities with other mathematics materials, religious studies (Islamic), general knowledge, and everyday life using a scientific approach. The developed module focused on the material of rational and irrational inequalities of one variable. Thus, this research aims to construct a mathematical learning module with integration-interconnection insight and a scientific approach on the material of one variable rational and irrational inequality.

## II. Method

This Research and Development (R&D) research used a procedural development model, namely a descriptive development model that outlined the steps to produce a product. The steps were based on the Richey and Klein development steps, the PPE development steps, consisting of planning, production, and evaluation (Sugiono, 2015).

The first step consisted of several stages, namely needs analysis, curriculum analysis, and analysis of the selection of teaching materials. In the second step, the production contained material and exercise development as well as developing module designs and making validation assessment instruments. Furthermore, in the last step, the evaluation, the developed product was assessed by expert validators.

The data collection instrument used in this study was the validation assessment sheet. The instrument was used to measure the value of the module validity, which was developed based on four aspects of the assessment, namely the content feasibility aspect, the integration-interconnection aspect, the linguistic aspect, and the media and presentation aspect.

The data was collected by distributing the module and validation assessment sheets to the validator. Qualitative data in the form of suggestions and input from validators were used as a reference for product improvement or revision. In comparison, the data in the form of letters obtained through the module validation assessment sheet by the validator was converted into qualitative values. Qualitative data in the form of letters garnered from the expert validator's assessment using a Likert scale was converted into a quantitative score with a classification. The score of 4, 3, 2, and 1 were classified as very good (VG), good (G), less (L), and very less (VL). The attained quantitative data was analysed using the following Aiken's formula (1) (Aiken, 1980).

$$V = \sum s / (n(c-1))$$

where:

- V = module validity
- S = r-Lo
- Lo = lowest score
- R = validator assessment
- N = number of validators
- C = highest score

The results of the calculations using formula (1) were converted into qualitative values in the form of validity criteria. The obtained validity was categorized using the categorization of Aiken's validity criteria proposed by Retnawati (2016), in which  $V \leq 0.40$ ,  $0.40 < V \leq 0.80$ , and  $0.80 < V \leq 1.00$  represented the low, medium, and high validity. The learning module developed was declared valid in this study if the average validity interval was at a high criterion.

## III. Results and Discussion

The development of the learning module in this study was carried out based on Richey and Klein's development steps (PPE model), which includes three steps, namely planning, production, and evaluation.

### A. Planning

The planning stage contained product-planning activities carried out based on previous analysis results, consisting of needs analysis, curriculum analysis, and analysis of the selection of teaching materials.

#### 1) Needs Analysis.

The needs analysis was carried out by conducting a literature study and unstructured interviews with mathematics teachers at Madrasah Aliyah Unggulan Darul 'Ulum Jombang, East Java, Indonesia. This needs analysis was conducted to identify the problems in learning mathematics and possible alternative solutions. The analysis results indicate the need for mathematics teaching materials with an integration-interconnection perspective using a scientific approach in the material of one variable rational and irrational inequalities.

2) Curriculum Analysis

Curriculum analysis was carried out by examining core competencies and basic competencies on the one variable rational and irrational inequalities material. This analysis was used as a basis for determining indicators of competency achievement and expected learning objectives.

3) Analysis of the Selection of Teaching Materials

The analysis of teaching materials selection in this study was carried out by conducting a literature study related to teaching materials in mathematics learning. The analysis results show that the teaching materials have often been used in mathematics learning, but teaching materials that can be used independently by students remain rare. One form of teaching material that students can use independently is a module. Several studies have also been carried out related to the use of modules in mathematics learning. Based on these studies, the use of modules as teaching materials in mathematics learning carries a good influence on learning. Therefore, the module was chosen as a form of teaching material developed in this study. The learning module development in this study was carried out based on the PPE model from Richey and Klein, including three steps of planning, production, and evaluation.

B. Production

The module was developed based on the results of the analysis carried out in the planning stage.

1) Develop materials and exercises

In this stage, several relevant references used in developing materials and exercises were reviewed. The references used were in the form of books and articles related to the material as well as integration-interconnection insights. The material of one variable rational and irrational inequality is divided into three sub-module topics, namely the concept of rational and irrational numbers, one variable rational inequality, and one variable irrational inequality. The material is presented by attempting to provide integration-interconnection insight, such as linking the material and practice questions with other mathematical material, material in other subjects, religious knowledge (Islam), general knowledge, and students' daily life. The module is also presented using the steps of a scientific approach summarized in the five main activities in the module. The activities consist of let's observe, let's ask questions, let's dig up information, let's reason, and let's share activities. The example of material presentations in the developed module is illustrated in Figure 1.

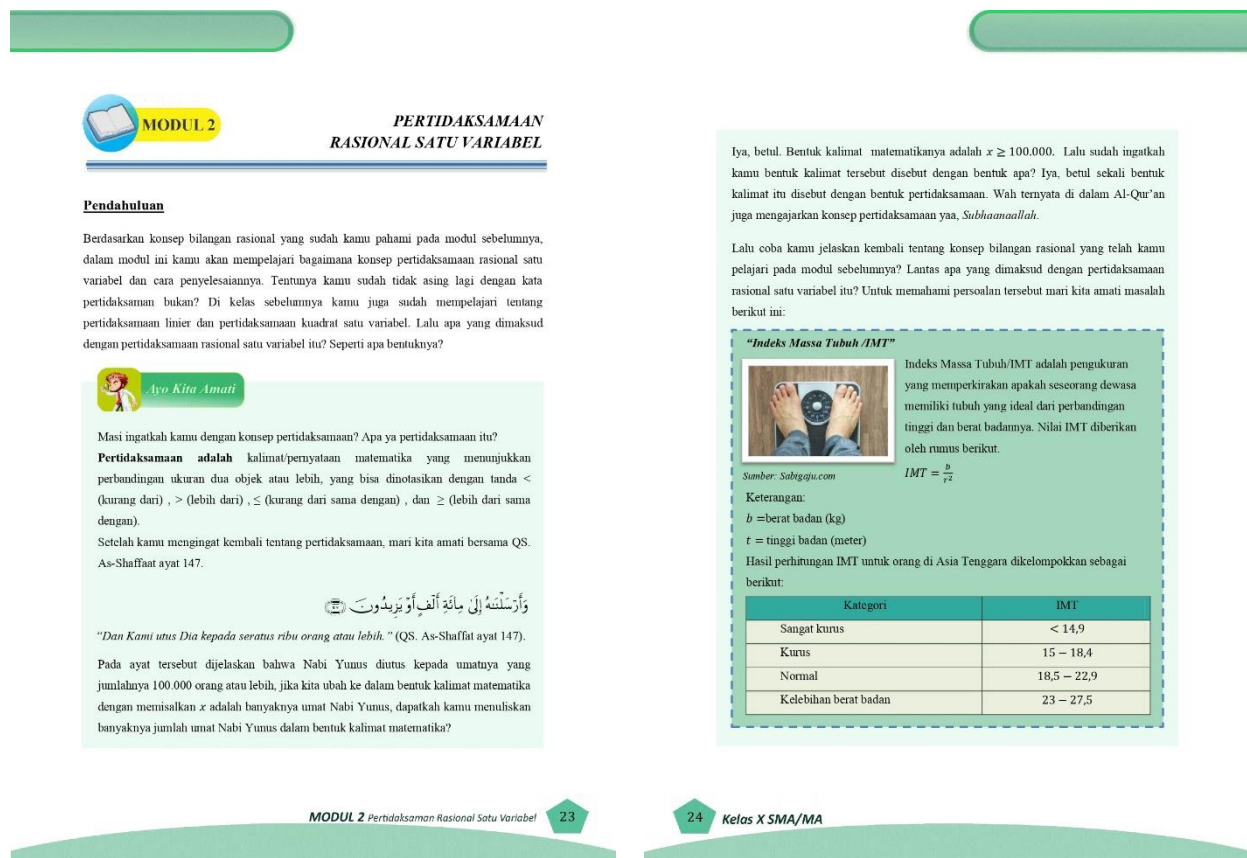


Fig. 1. Let's Observe Activities Accompanied by Integration-Interconnection Insights

2) Develop module design

The module design was developed using Microsoft Word, Coreldraw X7, and Paint. At this stage, a temporary module was generated. The module is divided into three

parts, namely introduction, content, and closing. The introductory part consists of several components, namely cover, identity, introduction, table of contents, instruction of usage, prerequisite test, and narrative of inspirational

figures. The content section consists of introductory material, basic competencies, indicators of competency achievement, concept maps, and basic materials. Meanwhile, the closing section consists of a bibliography, a

glossary, a profile of the authors, and guidelines for alternative solutions. The display of the developed module's cover is shown in Figure 2.



Fig. 2. Module Cover Design

### 3) Creating an assessment instrument

After constructing the module, the assessment instrument was developed. The module assessment instrument was an instrument used to assess the validity of the developed learning module. The assessment instrument consists of various aspects, namely aspects of content feasibility, integration-interconnection, language, media, and presentation.

### C. Evaluation

The evaluation stage in this study was in the form of product assessment activities carried out by expert validators. This assessment was carried out to determine the validity of the developed product. The results of the assessments, suggestions, and comments from experts were used as a reference in revising the product to produce a valid product. There were some suggestions and input from the validator on the developed module, which were 1) some sentence structures were still not quite right, 2) the concept map in the module should be reviewed, 3) examples of problems that trigger misconceptions on rational and irrational inequalities need to be provided, 4) reviewed the suitability of the concept of irrational numbers with the level of knowledge of class X students, 5) some definitions needed to be improved, 6) questions related to positive and

negative definitions should be given, and 7) the wording needed to be improved.

Based on suggestions and input from the validator, several revisions were made. The revision consisted of 1) correcting the incorrect sentence structure in the module, 2) reviewing and improving the appearance of the concept map, 3) adding exercises that triggered misconceptions about the one variable rational and irrational inequality, 4) reviewing the presentation of the concept of rational numbers and replacing the concept with the knowledge that was more in line with the level of knowledge of class X high school students, 5) redefining some of the concepts in the module, 6) adding some questions and information related to positive and negative definitions, and 7) fixing a spelling error contained in the module.

After the validation and revision process, the validator assessed the validity of the developed learning module. The results of the assessment of the validity of the module in each aspect are discussed below.

#### 1) Content Feasibility Aspect

The assessment of the feasibility aspect of the content consisted of several components, which are material coverage, material accuracy, scientific approach, logic, and

facts. The results of the validator's assessment of the feasibility aspect of the content in the developed module are shown in Table 1. The results of the validator's assessment of the content feasibility aspect are included in the medium category with an average value of 0.79.

### 2) Integration-interconnection aspects

The assessment of the integration-interconnection aspect consisted of several components, namely the

presentation of the material, connecting various scientific fields, and the proportion of the material. The results of the validator's assessment of the integration-interconnection aspect of the content in the developed module are shown in Table 1. The integration-interconnection aspect is categorized as high, with an average value of 0.83.

Table 1. Content Feasibility Aspect Assessment

Aspect	No	Component	r1	r2	V	Average	Category
Content Feasibility	1.	Material coverage	7	7	0.83	0.79	Medium
	2.	Material accuracy	12	13	0.71		
	3.	Scientific approach	16	17	0.77		
	4.	Logical and factual	8	8	1.00		
Integration-interconnection	1.	Material presentation	8	8	1.00	0.83	High
	2.	Connecting material with various scientific fields	13	14	0.79		
	3.	Material proportion	3	3	0.67		
Linguistic	1.	Conformity to the level of development of students	3	4	0.83	0.73	Medium
	2.	Communicative	3	4	0.83		
	3.	Coherence and coherence in the flow of thinking	3	3	0.67		
	4.	Suitability with good and correct Indonesian language	3	3	0.67		
	5.	Use of terms and symbols	3	3	0.67		
Media and presentation	1.	Physical appearance	12	12	1.00	0.93	High
	2.	Presentation technique	3	3	0.67		
	3.	Module completeness	4	4	1.00		
					Average	0.82	High

### 3) Linguistic aspect

Assessment of linguistic aspects consisted of several components, namely conformity with the level of student development, communicativeness, coherence, and coherence of the plot, accordance with good and correct Indonesian language rules, and the use of terms and symbols. The results of the validator's assessment of the content linguistic aspect in the developed module are shown in Table 1. The linguistic aspect is classified as medium, with an average value of 0.73.

### 4) Media and presentation aspects

Assessment in media and presentation aspects consisted of several components, namely physical appearance, presentation techniques, and module completeness. The results of the validator's evaluation of the media and presentation aspect of the content in the developed module are shown in Table 1. The media and presentation aspects are included in the high category with an average value of 0.93.

According to Table 1, the highest validity value was observed in the media and presentation aspects, with a 0.93 score, while the lowest value was in the linguistic aspect, with a 0.73 score. The value of the validity of the developed module was classified in the high category, with an average validity score of 0.82. Thus, the integration-

interconnection-oriented mathematics-learning module with a scientific approach on the material of one variable rational and irrational inequalities is categorized as valid. In the developed learning module, there are aspects of integration-interconnection insight that are adjusted to the indicators of integration-interconnection insight, including the following aspects.

#### a) The relationship of the material with other mathematical material

One of the links between mathematical material and other mathematical material in the developed module lies in the concept of irrational numbers. In explaining this material, this module provides information and relates the material to the value of phi, where the idea of the value of phi has been studied previously in mathematics lessons at the elementary school level. The integration is illustrated in Figure 3.

#### b) The linkage of the material with other subjects

In the developed module, one of the examples of the relationship between mathematics material and other subjects lies in the one variable irrational inequalities material. In explaining this material, this module provides information and links the material of irrational inequalities with the material in physics subjects, namely vertical upward motion, as shown in Figure 4.

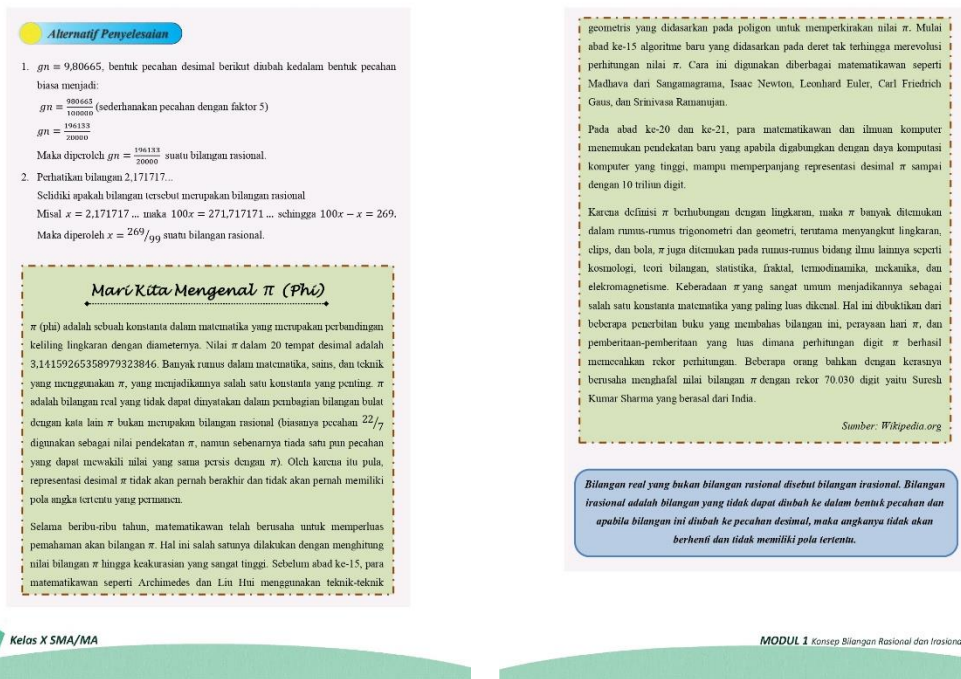


Fig. 3. Relation of Materials with Other Mathematical Materials

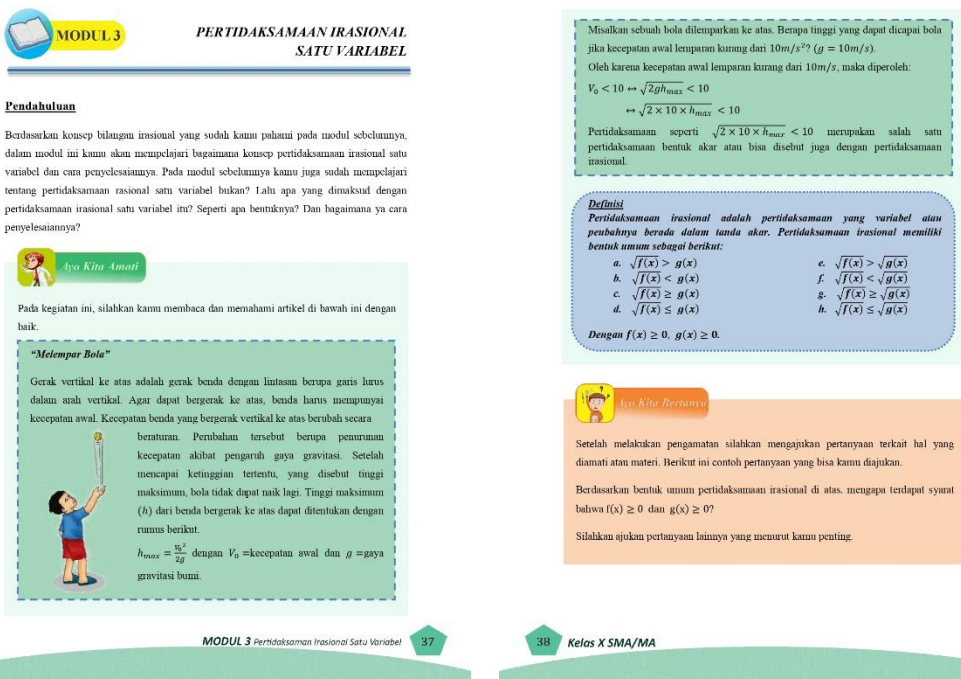


Fig. 4. Relation of Materials with Other Subjects

c) The relationship of the material with the science of religion (Islam)

The linkage of the material with the science of religion (Islam) in the module was developed by providing information and linking the material with verses of the Qur'an,

hadith, and Islamic values. One of them is in module 2 on the one-variable rational inequalities topic. In explaining the concept of inequality, this module relates to the verse of the Qur'an, namely the letter As-Shaffat, verse 147, as presented in Figure 5.

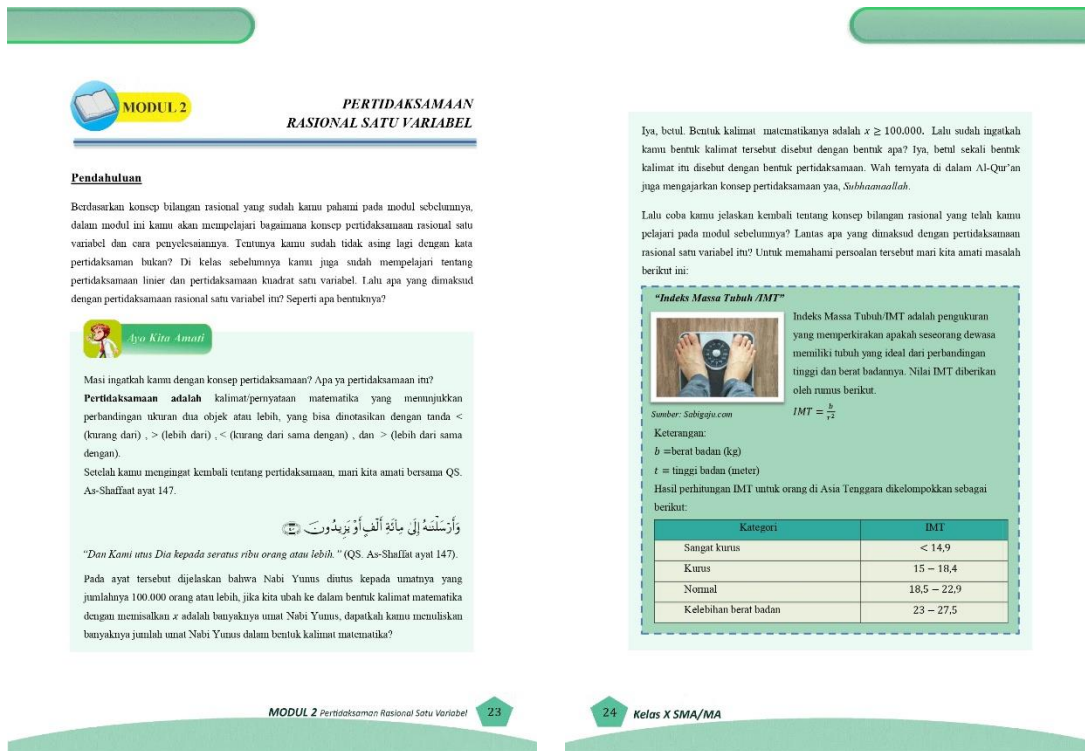


Fig. 5. Relation of Material with Religious Science (Islam)

d) Relevance of the material with general knowledge

In the developed module, the presentation of the relationship between material and general knowledge is in

module 2 with the topic of rational inequalities of one variable. In explaining the concept of rational inequality, this module relates the material to information and body mass index (BMI) problems, as shown in Figure 6.

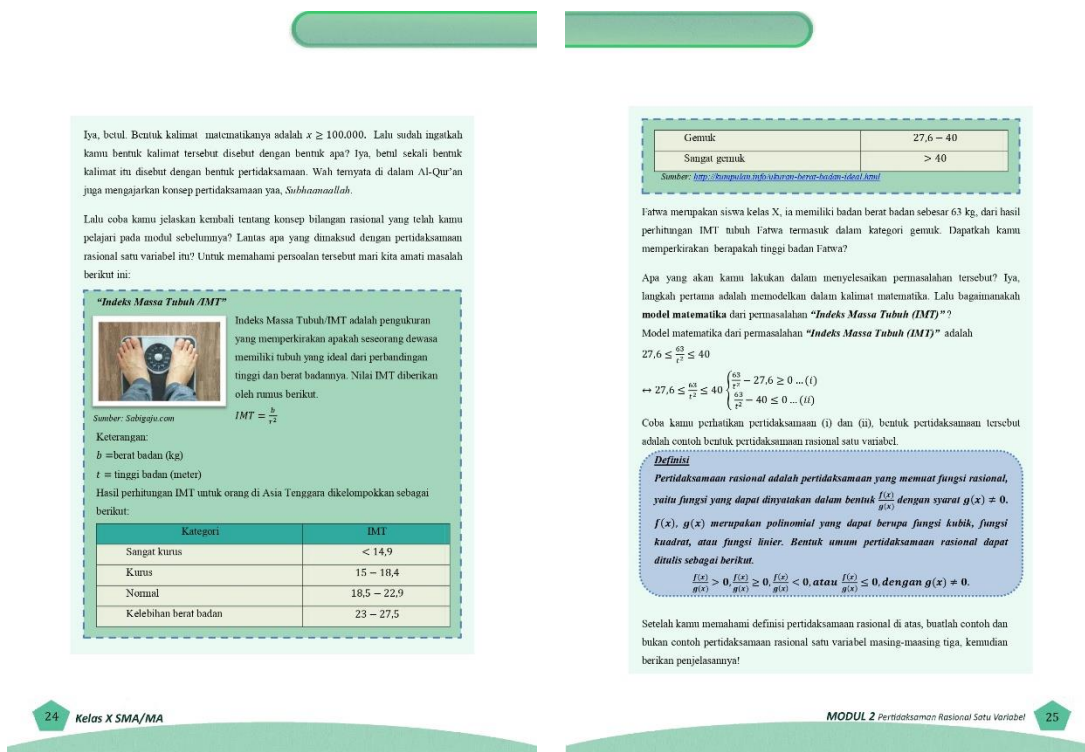


Fig. 6. Relation of Material with General Knowledge

e) *Relevance of the material to the daily life of students*

The relevance of the material to everyday life in this module is presented in the material and exercises. One of them is contained in module 1 in the Let's Dig for

Information activity. In this activity, the module explains the characteristics of rational numbers presented by providing problems related to students' daily lives, namely sponge cake recipes, as shown in Figure 7.

**Let's Dig for Information**  
Kelas X SMA/MA

Setelah melakukan pengamatan silakan mengajukan pertanyaan terkait hal yang diamati atau materi. Kemudian kamu bisa mendiskusikan pertanyaanmu bersama guru maupun temanmu. Berikut ini contoh pertanyaan yang bisa untuk diajukan:  
Apakah perbedaan antara bilangan pecahan dengan bilangan rasional?  
Silahkan ajukan pertanyaan lainnya yang menurut kamu penting.

**Contoh 1.1**

**Resep kue bolu sederhana:**  
2 ons tepung terigu  
3 butir telur  
1/4 sdm baking powder  
1/5 liter susu cair  
1/3 kg gula pasir  
2/3 sdt garam

Sebutkan semua bilangan rasional pada resep kue bolu di atas, kemudian nyatakan bilangan rasional tersebut ke dalam bentuk pecahan desimal!

**Alternatif Penyelesaian**

Semua bilangan rasional di atas jika dinyatakan dalam bentuk desimal, diperoleh

2 = 2,000... dapat ditulis 2,00...0...  
3 = 3,000... dapat ditulis 3,00...0...  
 $\frac{1}{4}$  = 0,250... dapat ditulis 0,250...0...

$\frac{1}{2}$  = 0,500... dapat ditulis 0,500...0...  
 $\frac{1}{3}$  = 0,333... dapat ditulis 0,33...3...  
 $\frac{2}{3}$  = 0,666... dapat ditulis 0,666...6...

Terlihat bahwa pada setiap bilangan rasional di atas, bentuk desimalnya memuat pengulangan angka atau deretan angka tertentu secara terus menerus. Pada 2, 3,  $\frac{1}{4}$  dan  $\frac{1}{5}$  memuat pengulangan angka nol. Akan tetapi, biasanya pengulangan angka nol tidak perlu dituliskan. Pada  $\frac{1}{3}$  terdapat pengulangan angka 3 dan pada  $\frac{2}{3}$  terdapat pengulangan angka 6.

**Coba selidiki:**

1. Apakah setiap bentuk bilangan rasional jika dinyatakan dalam bentuk desimal pasti memiliki angka atau deretan angka yang berulang?
2. Apakah berlaku sebaliknya, yaitu setiap bilangan dalam bentuk desimal yang memiliki angka atau deretan angka yang berulang pasti merupakan bilangan rasional?

**Contoh 1.2**

1. Dalam pelajaran Fisika, kita mengenal percepatan rata-rata gravitasi bumi yang disimbolkan sebagai "g" menunjukkan rata-rata percepatan yang dihasilkan medan gravitasi pada permukaan bumi (permukaan laut). Nilai sebenarnya percepatan gravitasi berbeda dari satu tempat ke tempat lain tergantung ketinggian dan kondisi geologi. Dalam fisika, nilai percepatan gravitasi standar (gn) didefinisikan sebagai 9,80665 m/s<sup>2</sup>. Coba selidiki apakah nilai gravitasi standar yang didefinisikan sebagai gn = 9,80665 m/s<sup>2</sup> merupakan bilangan rasional!
2. Perhatikan bilangan 2,171717...  
Selidiki apakah bilangan tersebut merupakan bilangan rasional!

Fig. 7. The Relation of Matter to Daily Life

The mathematics learning module using a scientific approach on the material of one variable rational and irrational inequalities, offers several advantages, including:

- it can be used as teaching materials for students and teachers in conveying learning using the material of one variable rational and irrational inequalities with the integration-interconnection insights.
- it is designed to be used independently by students with or without a facilitator or teacher.
- it can be used online via fliphtml5.com.

On the other hand, the weaknesses of this developed module include:

- it is limited to the material of one variable rational and irrational inequalities.
- it contains insights on integration-interconnection, one of which links and relates the material to religious knowledge (Islam) to be more suitable for use in madrasah or Islamic-based schools.

The results of this study are like the results of (Nu'man, 2017; Suparni, 2015) in constructing valid integration interconnection-oriented mathematics teaching materials. This learning module is designed to facilitate students in learning the material on one variable rational and irrational inequalities, independently both at school and home.

According to Suparni (2015), integration-interconnection is applied by linking the material with other subject matter, everyday life, and Islam. Meanwhile, Nu'man (2017) explains that integration-interconnection is used by linking contextual and Islamic insight material. As for this module, the integration-interconnection is in the form of linkages between the material and other mathematics materials, other subjects, religious knowledge (Islam), general knowledge, and students' daily lives so that it is expected to provide new knowledge and experiences for students. This learning module also has an attractive appearance which is expected to make students more interested in learning. At the same time, the weakness of this module is that it is limited to the material of one variable rational and irrational inequalities. This developed learning module has been declared valid, but its effectiveness and practicality in classroom learning have not been examined.

#### IV. Conclusion

These integrated-interconnected mathematical learning modules with a scientific approach have been developed using Richey and Klein development steps, consisting of planning, production, and evaluation. The developed learning module has undergone the assessment and revision stage following the assessment results from two expert validators. It attained a high criteria assessment with an average value validity score of 0.82. Therefore, the

developed integrated-interconnected mathematical learning module with a scientific approach has met the validity criteria.

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