



Validity and Practicality of Reaction Rate Module Based on Problem Based Learning Integrated Socio-Scientific Issues for Phase F

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Abstract: This study aims to produce a Problem Based Learning-based reaction rate module integrated with the Socio-Scientific Issues approach for phase F students and analyze the validity and practicality of the developed module. The type of research used is Research and Development (R&D) with the 4D development model. The 4D development model consists of 4 stages, namely the define, design, develop, and disseminate stages. However, after the define and design stages, this research only focuses on the development stage, namely the validity and practicality tests. The research instruments used were validation questionnaires and practicality questionnaires for teachers and students. The validity test was carried out by 5 expert teams and the practicality test was carried out on two chemistry teachers and 34 phase F students. The results of construct and content validity tests were obtained at 0.89 and 0.93 with valid categories. The results of the module's practicality test conducted by teachers and students amounted to 92.92% and 87.45% with a very practical category. The results showed that a valid and practical PBL-based reaction rate module integrated with SSI was produced for phase F students.

Keywords: Module; Problem based learning; Reaction rate; Socio-scientific issues

Introduction

Chemistry is one of the branches of natural science (IPA) studied in high school (Andromeda et al., 2018). Chemistry not only emphasizes understanding of concepts, but focuses on mastering skills and reasoning abilities (Chang, 2010). Learners are required to be able to apply science concepts in solving problems related to everyday life (Afrianis & Nurhadi, 2022). Effective chemistry learning is expected to not only focus on understanding the theory, but also be able to encourage students to hone critical thinking skills, analytical skills, and the ability to solve problems (Handayani et al., 2024).

One of the chemistry materials that students learn in phase F is the reaction rate (Yerimadesi & Afendi,

2024; Handayani et al., 2021). This difficulty is caused by the tendency of students to memorize formulas without understanding the concepts deeply, so that their ability to apply this knowledge in everyday life is low (Antris & Andromeda, 2023; Musengimana et al., 2022). Whereas reaction rate material is closely related to everyday life, which contains concepts containing social science problems (Nurlatifah et al., 2018). This is in line with research by Driel (2002) which shows that students' understanding of reaction rate material is still relatively low because they have limited concept understanding in explaining concepts in reaction rate material.

Based on questionnaires given to 55 students at SMAN 1 Gunung Toar and SMAN 1 Kuantan Mudik showed that 67.3% of students felt that the material reaction rate was difficult to understand. Data from

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observations and interviews with two chemistry teachers show that one of the factors that cause students to have difficulty in understanding the reaction rate material is due to inadequate teaching materials. The learning resources used are only limited to books from the Ministry of Education and Culture without additional references to broaden students' horizons. In addition, the learning carried out by the teacher still focuses on achieving learning outcomes, without providing a deep learning experience. Innovative learning models are rarely applied, while the dominant method is the discussion method. As a result, students tend to be passive and less responsive during the learning process, especially when the teacher asks questions or explains the material.

So based on these problems, teaching materials are needed that can facilitate active and fun chemistry learning (Hanifah & Hidayah, 2024). One of the teaching materials that can be used is modules. Modules are one of the important elements in supporting quality learning (Fahmi et al., 2023). Module teaching materials can provide opportunities for students to learn based on their way of solving the problems faced (Nasution & Sutiani, 2022). Well-designed modules allow learners to learn actively, independently, and engage in problem solving that is relevant to everyday life (Sembiring & Sutiani, 2022). Modules can assist teachers in providing effective and interesting learning materials by designing appropriate learning models (Amryani et al., 2024).

The appropriate learning model to be applied in module teaching materials is the PBL Model (Simanjuntak et al., 2021). This model focuses on problem-solving activities that are very relevant to be applied in chemistry learning (Yulianti & Gunawan, 2019). Problem-based learning can build a close relationship between the concepts and facts learned (Rahayu et al., 2023). In the PBL model, students are actively involved in collaboration to find information, not just being passive students who only receive knowledge (Mustofa & Hidayah, 2020). In addition, the PBL model is considered a learning model that can encourage students to think creatively in analyzing real problems in order to find the right solution (Ulucinar, 2023). Therefore, this model is a learning strategy that can answer the challenges in understanding reaction rate material.

The use of modules with PBL models will be more maximized if integrated with innovative approaches. According to Lubis et al. (2022) the PBL model is very suitable when integrated with the Socio-Scientific Issues (SSI) approach which refers to social problem issues. SSI is a combination of science and social issues in creating relevant science education for students (Arifin et al., 024). SSI-contextualized modules not only

function as teaching materials, but can support meaningful learning because they train students to discuss, investigate, and find solutions to social problems in society independently (Setyaningsih et al., 2019). The implementation of SSI in the module has advantages that can stimulate the development of ethics, morals, and awareness between science and students' social lives (Rasyih et al., 2024). SSI integrated learning allows problem solving that is influenced by social aspects such as economy, culture, and environment (Azizah et al., 2021). In this study, the SSI aspects discussed include local community life phenomena such as in the cultural aspect, namely "Batik Nagori" and in the environmental aspect, namely issues related to household wastewater pollution.

The development of a PBL-based reaction rate module integrated with SSI is one of the most effective teaching materials to be developed. This is in line with previous research conducted by Sariningrum et al. (2018) showing that the PBL model with the context of SSI in learning can sharpen the ability of students to develop their knowledge to solve problems. Then research by Amdayani et al. (2022) showed that SSI-based teaching materials can encourage students to analyze problems and make decisions based on scientific facts and social impacts.

This research is important to do so that students can understand chemical concepts in solving problems that are relevant to students' social lives (Hisyam & Handayani, 2024). The novelty of this research lies in the development of PBL-based modules that are specifically integrated with the SSI approach for reaction rate material. In contrast to previous studies that only used PBL or SSI approaches separately, this study unites the two approaches to create more meaningful learning. Therefore, this research contributes to the development of innovative teaching materials that have not been widely applied in schools. By integrating PBL and SSI into teaching materials, it is expected to make a significant contribution in adding insight to students, especially in complex reaction rate material. In addition, the results of this study can be a reference for the development of other innovative teaching materials in various chemical materials. Thus, this study aims to develop a PBL-based module integrated with SSI that is not only valid and practical, but also able to overcome learning difficulties in reaction rate material.

Method

The type of research conducted was Research and Development (R&D) with the 4-D development model developed by Thiagarajan (1974) and adapted by Sugiyono (2019). The 4D model consists of four stages,

namely defining, designing, developing, and disseminating. However, this research only focused on the development stage, namely on testing the validity and practicality of the module. The deployment stage is planned for further research.

The first stage is the defining stage which is carried out by identifying problems found in teachers and students in the learning process and analyzing the teaching materials used (Ulfana et al., 2023). Activities at this stage include front end analysis, learner analysis, task analysis, concept analysis and formulation of learning objectives. Front end analysis was conducted by interviewing chemistry teachers at SMAN 1 Gunung Toar and SMAN 1 Kuantan Mudik. The instrument used was an interview sheet to find out the problems related to learning and teaching materials used in the reaction rate material. Furthermore, learner analysis was conducted to find out how the characteristics of students. The instrument used was a questionnaire. Then, task analysis is carried out to identify competencies that must be achieved by students in order to master the material to be studied. While concept analysis aims to identify important concepts and prerequisite material contained in the reaction rate material. And the last step of this stage is to formulate learning objectives by reducing learning outcomes into learning objectives.

The second stage is the design of the reaction rate module based on problem-based learning integrated Socio-Scientific Issues (SSI). At this stage there are four activities carried out, namely compiling criteria tests, selecting teaching materials, selecting formats and initial designs (Febrilla et al., 2024). Then the third stage is development. The development stage is carried out by testing the validity and practicality of the module.

The validity test consists of construct and content validity. The validity test was conducted by three chemistry lecturers of FMIPA UNP and two chemistry teachers of SMAN 1 Kuantan Mudik. Data from the validity questionnaire used as an instrument were analyzed using Aikens's v formula. The formula proposed by Aikens's is shown in equation 1.

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Description:

- r = the score given by the validator
- c = highest validity score
- lo = lowest validity value
- s = r - lo
- n = number of validators

The practicality test was conducted by 34 students of SMAN 1 Kuantan Mudik. Data from the practicality

test analysis can be calculated using the formula shown in equation 2 (Arikunto, 2021).

$$p = \frac{f}{N} \times 100\% \quad (2)$$

Description:

- p = posttest score
- f = score obtained
- N = maximum score

The scores from the validity questionnaire that have been analyzed using Aiken's V formula are converted into validity criteria. Meanwhile, the scores from the practicality test refer to the Likert scale assessment criteria (Isnaini et al., 2022). The validity and practicality criteria are shown in Tables 1 and 2.

Table 1. Validity Criteria (Aikens, 1985)

Interval	Validity Category
$V < 0.87$	Medium
$V \geq 0.87$	Valid

Table 2. Practicality Categories (Elisyah et al., 2024)

Practicality Percentage	Practicality Category
81% - 100%	Very Practical
61% - 80%	Practical
41% - 60%	Practical enough
21% - 40%	Less Practical
0% - 20%	Not Practical

Results and Discussion

The result of this research is a PBL-based reaction rate module integrated with SSI for Phase F students. There are four stages carried out, namely the defining, designing, developing and disseminating stages. However, after the design stage, this research will focus on the development stage. The details of the results and discussion of product development that have been carried out are as follows.

Definition

Based on the results of the analysis of front end, it is obtained that the module used by teachers in learning chemistry, especially reaction rate material, has not implemented the use of a problem-based model integrated with SSI. The learning module used is still lacking in depth so that in the implementation of the learning process students are still unable to link the scientific knowledge they learn with phenomena that occur in real life. The material described in the module has not linked chemistry material with social-science issues related to the lives of surrounding communities. Teachers feel that the learning modules currently available are not optimal in supporting quality learning. This is because the modules used are inadequate in

providing relevant real-world contexts in helping students connect chemical concepts with relevant issues in society. Implementing Socio Scientific Issues (SSI) in the module can make learning more meaningful because SSI is able to stimulate students to realize the analysis of social problems related to science (Febriana et al., 2023).

The next step is to analyze the learners. The goal is to find out the character of the learners to fit the module developed. The results of the analysis of students' questionnaires showed that 67.3% of students found it difficult to learn reaction rate material and 74% of students did not know learning with PBL-based modules with SSI context. As many as 19.8% of students feel that the teaching materials used now are not sufficient to help understand chemistry learning because there are only a few references. The obstacle encountered by students during the chemistry learning process on reaction rate material is when students have difficulty in connecting theory with practice. For example, when discussing the reaction rate, they can memorize the formula but when asked to analyze how changes in conditions affect the reaction rate in real situations, they are often confused and cannot provide an in-depth explanation.

The next stage is task analysis and concept analysis. This stage is carried out to analyze the learning outcomes and objectives on reaction rate material that refers to the independent curriculum. The learning achievement in this material is that phase F students are required to be able to explain aspects of reaction rates in everyday life. For concept analysis, it is compiled into a concept map. Structured learning mapping can make it easier for students to organize all the information needed during the learning process (Darnella et al., 2020).

Planning

This stage consists of three stages, namely media selection, format selection and initial design. The first stage begins with media selection based on the results of the analysis and adjusted to the independent curriculum. The module is made with the help of the Canva application media and is equipped with a QR code to be able to display video and audio related to reaction rate material. The format selection stage is carried out by determining the learning model to be used. The developed module is designed based on the PBL model which consists of five stages. PBL as a learning model has the aim of helping students to solve complex and unstructured real-world problems collaboratively (Rotgans & Smith, 2019).

The initial design of the reaction rate module refers to the module components which include cover, preface, table of contents, instructions for using the module,

learning outcomes and learning objectives, concept maps, learning activities, formative tests and evaluation. In the learning activities section there are scientific activities made based on the syntax of the PBL model which consists of the first stage of problem orientation, containing problems on reaction rate material integrated with the SSI approach. Second, organizing students to learn, students are directed to gather information related to reaction rate material from various sources. Third, guiding individual and group investigations, students are guided to find further information to solve problems by answering questions. Fourth, develop and present the results of the work, students present the results of the discussion by presenting the results obtained in front of the class. Finally, analyzing and evaluating the results of problem solving, students evaluate the results of problem solving made. Each stage of the PBL model is able to encourage students collaboratively to dare to try to identify the knowledge they have in finding a solution or a problem (Ulucinar, 2020).

Development Validity Test

Validity test was conducted as an improvement to perfect the developed module (Carolina et al., 2024). The validator's assessment of the PBL-based reaction rate module integrated with SSI produced data on the results of the construct validity test and content validation. The overall recapitulation of the validity results by the expert team lecturers can be shown in Table 3 and Table 4.

Table 3. Results of Construct Validity Analysis

Assessed Aspect	Value V	Category of Validity
Content Component	0.90	Valid
Language Component	0.90	Valid
Presentation Component	0.88	Valid
Graphics Component	0.92	Valid
Average V value	0.89	Valid

Table 4. Results of Content Validity Analysis

Assessed Aspect	Value V	Category of Validity
Content conformity with PBL syntax	0.92	Valid
Suitability of module content with chemistry	0.94	Valid
Average V value	0.93	Valid

Based on the data in Table 3, the overall average value of the construct aspect is 0.89 with a valid category. In the "content component" aspect, the validity of 0.90 was obtained. These results indicate that the material content of the developed module is in accordance with everyday life. This is in line with previous research which states that the material or content contained in the module can facilitate students

in making observations and analyzing problems if it is relevant to everyday life (Nurkhasanah & Rohaeti, 2024). According to a statement from Jasmi (2024), the suitability of the content of the material is useful in increasing learning motivation, interest in learning, and willingness to learn learning material.

Based on the assessment of the "language" aspect, it obtained a validity of 0.90. These results indicate that the module has used communicative language and is easy to understand and consistent in the use of chemical symbols or symbols (Indah et al., 2022). This is in accordance with the opinion of Wardhana et al. (2022) that the use of language in the module should be simple sentences and not have double meanings to make it easier for students to understand the material presented. In addition, the components in the language aspect also review the accuracy of the sentences in the module representing the delivery of simple information and adapted to the ability of students. The terms used are in accordance with the KBBI, and the use of punctuation marks is appropriate. According to Sukirman's statement (2020) the application of the use of punctuation and vocabulary needs to be considered correctly so that the meaning of the sentence or writing can be conveyed.

In the aspect of "presentation component" obtained a validity of 0.88. These results indicate that the presentation of the developed reaction rate module has been systematically organized based on the objectives to be achieved and in accordance with the syntax of the PBL model. The presentation of PBL syntax integrated with SSI content adds to the added value of the developed module. In line with previous research that the material presented systematically can help students to understand and understand the material presented (Larasati et al., 2018). Then according to a statement from Fauziah et al. (2023) material that is presented systematically and in detail with clear material concepts is a reflection of the feasibility of the content of teaching materials.

Furthermore, the "graphical component" aspect obtained a validity of 0.92. This component is reviewed from several indicators such as the color of an attractive display, the cover on the module that must describe the contents of the module, the spacing between lines, and the combination of font type and size. The results obtained from this aspect conclude that the developed module has a clear and attractive design, layout, image, size and typeface as a whole. The suitability of layout fonts, font sizes that suit your needs and color harmony can affect the appearance of teaching materials when used (Sa'diah et al., 2022). This is also in line with research from Asri et al. (2022) which states that the

combination of background and color used in the module can affect students' reading interest.

Then based on the data in Table 4, the overall result of the content aspect is obtained with a percentage of 0.93 with a valid category. Based on the results of this analysis, it can be concluded that the validity of the module content for the suitability of the module content with PBL syntax and the correctness of the module content with chemical science is valid.

The revision stage is carried out based on the input provided by the validator which aims to improve the developed module. There are several suggestions and input given by the validator to the developed module, namely the size of the letters that must be enlarged in the table of contents, then the color design that is too striking, the concept map that is not clear, the images on each material are not clear, the error in writing the formula, and the discourse section in the problem orientation syntax to make it clearer where the problem of the discourse content is.

Practicality Test

The practicality test stage involved 2 chemistry teachers and 34 students who had studied reaction rate material at SMAN 1 Kuantan Mudik. The practicality test was carried out through filling out a response questionnaire consisting of aspects of ease of use, efficiency of learning time and benefits. Based on Table 5, the average value of module practicality by teachers and students is 92.92% and 87.45% respectively with a very practical category.

The recapitulation of the practicality of the reaction rate module based on PBL integrated with SSI is shown in Table 5.

Table 5. Results of Module Practicality Analysis by Teachers and Learners

Rate Aspect	Teacher	Learners	Practicality Category
Ease of Use	95.00%	89.14%	Very Practical
Study Time	87.50%	86.00%	Very Practical
Efficiency			
Benefits	96.25%	87.22%	Very Practical
Average Value	92.92%	87.45%	Very Practical

The results of the data analysis of teacher practicality in the aspect of ease of use of the module were 95.00% and 89.14% with very practical criteria, respectively. This shows that the material content, language, and sample questions contained in the module are easy to understand (Haspen et al., 2021). In the aspect of learning time efficiency, the percentage obtained was 87.50% and 86.00% with very practical criteria. This shows that learning activities with this module can make learning time more efficient. Structured learning resources can save learning time

(Gultom & Amdayani, 2023). The utilization aspect also has very practical criteria, meaning that the developed module has many benefits for students in helping them learn independently and increase the curiosity of students. This is in line with previous research that learning with the SSI approach can make students have a high curiosity about an issue or problem faced in everyday life (Priyanka & Selamat, 2021). Based on the validity and practicality analysis data, the reaction rate module based on problem-based learning integrated with SSI for phase F high school students can be declared valid and practical. This is in line with previous research which shows that PBL-based teaching modules in chemistry learning are valid and practical (Nurhamidan & Andromeda, 2023).

Conclusion

The PBL-based reaction rate module integrated with SSI for Phase F students has been developed through research and development with the 4-D development model. The developed module has been valid in terms of construct and content with an average value of 0.89 and 0.93. The results of the module practicality test conducted by teachers and students obtained an average value of 92.92% and 87.45%, respectively. The results showed that the PBL-based reaction rate module integrated with SSI was valid and practical. This module can help students in adding insights related to social-science issues in the aspects of the environment, culture and the state. It is hoped that future researchers can continue this research at the effectiveness stage in improving students' science literacy skills.

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Author Contributions

Making research instruments, guiding the research process and writing articles, F.F.F and A.; module validation, A. and D.K.

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Conflicts of Interest

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