Development of Group Investigation (GI)-Orientated Interactive Worksheets to Improve Students' Problem-Solving Skills on Reaction Rate Material

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DOI: 10.29322/IJSRP.14.03.2024.p14719
https://dx.doi.org/10.29322/IJSRP.14.03.2024.p14719

Paper Received Date: 4th February 2024
Paper Acceptance Date: 7th March 2024
Paper Publication Date: 15th March 2024

***Abstract*-** The purpose of this research is to describe the feasibility of group investigation (GI)-oriented interactive worksheets to improve students' problem-solving skills on reaction rate material. This research uses the Research and Development (R&D) method adapted from Sugiyono (2015). This research was conducted at SMAN 1 Taman Sidoarjo on 36 students in class XI F-1. Feasibility is reviewed based on three aspects, namely validity, practicality, and effectiveness. Data on the validity of interactive worksheets is obtained from content validity and construct validity. Practicality data is obtained from the results of student response questionnaires, supported by student activity observation results. Effectiveness data is obtained from the pretest and posttest results of students' problem-solving skills. Based on the research results obtained, in terms of validity, a mode score of 5 was obtained on content validity and a mode score of 4 on construct validity, which was included in the very good and good categories. Practicality is shown by the results of the student response questionnaire, which has a percentage of 97%, so it is included in the very practical category. The effectiveness is obtained from the results of the n-gain score pretest and posttest of students' problem-solving skills in the medium and high categories and the sig. (2-tailed) of 0.000, which indicates a significant difference between the pretest and posttest of students' problem-solving skills. Based on these results, it can be concluded that group investigation (GI)-oriented interactive worksheets can improve students' problem-solving skills on reaction rate material.

***Index Terms*-** Interactive Worksheets, Group Investigation, Problem-Solving Skills, Reaction Rate

I. INTRODUCTION

Education can be said to be a human learning process to form better individual characters in terms of ethics, norms, and customs, where education is an important aspect of the life of the world community, including in Indonesia (Purwanti, 2021). One of the Graduate Competency Standards at the secondary education level is that students can demonstrate the ability to analyze complex problems and ideas, conclude the results, and present arguments that support their thinking based on accurate data (Kemendikbud Ristek, 2022). Therefore, to achieve the competency standards of graduates at the secondary education level, education should also be in line with the development of the education curriculum itself. The education curriculum implemented at this time is the Merdeka Curriculum. The Merdeka Curriculum carries the concept of "Merdeka Belajar," which is different from the 2013 curriculum. According to Sherly et al. (2020), this means giving freedom to schools, teachers, and students to be free to innovate, learn independently, and creatively, where this freedom starts with the teacher as the driving force. The implementation of learning in the Merdeka Curriculum emphasizes the achievement of attitude, knowledge, and skills competencies (Leny, 2022). Ismaya et al. (2021) state that the Merdeka Learning Curriculum comes as an answer to the tight competition for human resources globally in the 21st century. There are five skills that must be trained and developed in the 21st century, namely problem-solving skills, critical thinking skills, creative thinking skills, communication skills, and collaborative skills (Malik et al., 2020). This learning independence curriculum can be applied to every subject, including chemistry.

In the process of learning chemistry at school, students often find it difficult to digest the chemical material presented. One of the causes is that in the chemistry material taught at school, there are many abstract concepts (Nugrohadi & Chasanah, 2022). Based on Habibah's research (2019), students' low learning outcomes are caused by a lack of understanding of chemical concepts that are abstract or cannot be seen and felt with the five senses. The lack of students' understanding of chemical concepts will have fatal consequences because the understanding of concepts in chemistry is interrelated with each other. This is supported by facts obtained

from the pre-research questionnaire conducted at SMAN 1 Taman Sidoarjo. As many as 65.71% of students stated that chemistry is a difficult lesson to understand, especially the reaction rate material in the submaterial of factors that affect the reaction rate. This is because this submaterial requires concept-understanding skills, so students are still confused about how to solve problems in everyday life related to the concept of factors that affect the reaction rate. This is supported by research from Efliana and Azhar (2019), which states that the characteristics of reaction rate material are abstract and require the ability to understand, memorize, calculate, and analyze, as well as the activeness of students to practice so that students really understand the concept. Meanwhile, the learning outcomes of reaction rate material that must be achieved by students in the independent curriculum are that students are able to observe, investigate, and explain everyday phenomena according to the rules of scientific work in explaining chemical concepts in everyday life, apply mathematical operations in chemical calculations, and understand and explain aspects of reaction rates.

One of the five 21st century skills that are very important in everyday life, especially in areas that demand critical thinking and innovative solutions, is problem-solving skills. Therefore, problem-solving skills are very important to be taught to students in learning reaction rate material, especially in the submaterial of factors that affect the reaction rate. Problem-solving skills are a series of thought processes to find the right way to get a solution to a problem (Widiasih et al., 2018). Problem-solving skills can also be defined as the skill of identifying problems that use non-automatic strategies so that students will be able to solve problems themselves and work more effectively (Nugroho, 2018). Indicators of problem-solving skills are: (1) understanding the problem; (2) planning problem-solving; (3) solving the problem; and (4) rechecking the steps of work (Mariam et al., 2018). According to Wulandari & Nana (2021), students who have problem-solving skills can understand the concepts learned and are also able to apply them in the real world.

In contrast to the importance of problem solving for students, various surveys and research that have been conducted show that students' problem-solving skills in Indonesia are still low (Hermaini & Nurdin, 2020; Indrawati & Wayan, 2021). According to the survey by the Programme for International Student Assessment (PISA), which shows that Indonesia has always ranked in the bottom 10 from 2012 to 2018, these results indicate that the competitiveness of Indonesian students at the international level is still low (Utama & Kristin, 2020). Based on the PISA results, it is also explained that the weakness of students in Indonesia is their inability to solve problems that require critical, creative, and higher-order thinking skills. This fact is in line with the research by Astuti, Rusilowati, Subali, and Marwoto (2020), which shows that 68.97% of students have not been able to solve problems and have difficulty solving them. According to Hidayatulloh et al. (2020), the factors that influence students' problem-solving skills are the lack of students' accuracy in working on problems, the fact that students rarely work on problems oriented towards problem-solving skills, and the lack of mastery of concepts in the material studied.

Based on the results of interviews conducted with one of the chemistry teachers at SMAN 1 Taman Sidoarjo, problem-solving skills have been taught to students, namely understanding the problem, planning problem solving, and solving problems in accordance with the plan. However, students at SMAN 1 Taman have not been trained to re-examine the results of problem solving that they have done. Pre-research at SMAN 1 Taman Sidoarjo was conducted on Wednesday, April 12, 2023, for students of class XI MIPA 5. Based on the pre-research that has been done, the results show that the ability of students to understand the problem is 40.71%, planning problem solving is 56.43%, solving problems according to the plan is 55%, and re-examining the results of problem solving is 44.29%. The results obtained are still relatively low, so it is necessary to improve problem-solving skills in students.

Based on the results of the pre-research questionnaire conducted at SMAN 1 Taman Sidoarjo, 91.43% of students stated that the learning experience during the learning of reaction rate material was only listening to the explanation of the teacher. Therefore, to improve problem-solving skills in reaction rate material, an appropriate learning model is needed. There is a relationship between problem-solving skills and the group investigation-type cooperative learning model. Based on the research by Tarigan and Irwan (2021), the group investigation learning model can improve students' problem-solving skills. In Navi's (2010) research, it was also found that the application of a cooperative learning model of group investigation type could improve students' problem-solving ability with a significant increase, namely problem-solving skills achieved classical completeness in cycles 1 of 48.28%, cycle 2 of 62.07%, and cycle 3 of 82.76%. Linuhung & Sudarman (2016) also stated that the learning process with the group investigation-type cooperative learning model will involve students actively in the process of investigating a problem, so this learning model is one of the learning models that can facilitate students to improve problem-solving skills through learning steps that require understanding of problems and solving problems in a planned manner. The steps of the group investigation cooperative learning model, according to Slavin (2018), are: (1) identifying topics and organizing them into groups; (2) planning tasks to be studied; (3) carrying out investigations; (4) preparing final reports; (5) presenting final reports; and (6) evaluation. Based on the pre-research questionnaire, learning in groups, where each group discusses a different topic and then each group presents it, has never been done on reaction rate material, and as many as 74.28% of students want to do learning using this learning model.

Learning objectives will be achieved in accordance with the learning orientation and the abilities to be trained if the learning tools used are also appropriate. One of the learning tools that need to be prepared to support learning is the worksheet, whose existence will involve students actively in learning. According to Katriani (2014), the worksheets provide a stimulus for students to carry out real studies or activities on an object or certain problems, both individually and in groups. In addition, worksheets can make it easier for teachers and students to achieve certain learning objectives. Along with the times, worksheets can also be innovated and integrated into the form of a presentation in the form of interactive worksheets (Adilla, 2017). Meanwhile, based on the results of the pre-research questionnaire, it shows that the learning resources used when learning chemistry reaction rate material only use package books and handbooks from schools and learning media such as Power Point and the Internet.

Based on the results of this analysis, the authors are interested in conducting research entitled "Development of Group Investigation (GI)-Orientated Interactive Worksheets To Improve Students' Problem Solving Skills On Reaction Rate Material."

II. LITERATUR REVIEW

Students' Worksheet

The presentation of student worksheets, which is generally in the form of printed media, is now starting to be innovated by using electronic or digital media, known as electronic student worksheets. According to Trianto (2013), student electronic worksheets are a series of activities used by students to conduct investigations and solve problems. According to Putriyana et al. (2020) and Umriani (2020), student electronic worksheets are student work guides to make it easier for students to understand learning material in electronic form, which is applied using a computer desktop, notebook, smartphone, or mobile phone. Meanwhile, according to Mahtari et al. (2020), Syafitri & Tressyalina's (2020) electronic worksheet for students is one of the teaching materials that contains material for one meeting that is simple and practical to use in learning activities and allows students to be more effective in the learning process.

Liveworksheets

The development of group investigation-oriented interactive worksheets is supported by the liveworksheets platform. The liveworksheets platform has several advantages, including that student worksheets can be accessed via PC, laptop, or smartphone supported by visualization in the form of images and videos, and answers to questions are automatically sent (Zahroh & Yuliani, 2021). According to Wahyuni (2021), liveworksheets also have several types of features that can be utilized in student worksheets during the evaluation process.

Group Investigation (GI) Cooperative Learning Model

Group Investigation (GI) is a form of cooperative learning model that emphasizes the participation and activity of students to find their own material (information) lessons to be learned by using available study materials, for example, textbooks or the internet (Fauzi et al., 2021). The group investigation model can train students to foster independent thinking skills. The active involvement of student can be seen from the beginning to the end of learning (Supriatna, 2019). Various media and learning resources can be used to support the effectiveness of group investigation and cooperative learning. Therefore, teachers can use various learning resources, for example, handouts, student worksheets, and news summaries in newspapers, magazines, radio, television, the internet, and from the surrounding environment (Fauzi et al., 2021; Supriatna, 2019). In the Group Investigation cooperative learning model, students work through six stages (Slavin, 2018), namely (1) identifying topics and organizing into groups. (2) planning the tasks to be learned. (3) Carry out the investigation. (4) preparing the final report. (5) Presenting the final report; and (6) Evaluation. Meanwhile, according to Arends (2013), the syntax of cooperative learning type Group Investigation has six stages, namely (1) topic selection. (2) cooperative planning. (3) Implementation. (4) Analysis and synthesis. (5) Presentation of final results; and (6) Evaluation.

Problem-Solving Skills

According to Jayadiningrat & Ati (2018), problem-solving skills are a person's basic ability to solve a problem that involves critical, logical, and systematic thinking. Sari et al. (2020) also revealed that problem solving is the ability of student to select and/or predict, by inference, different possible consequences when the initial phenomenon contains one or more causes, and it is possible to determine how one or more of these causes can produce the selected effect or result. Indicators of problem solving ability based on the stages of problem solving by Polya (in Hamiyah and Jauhar, 2014: 121), namely (1) understanding the problem, (2) planning problem solving, (3) performing problem solving in accordance with the plan, and (4) re-examining the results obtained from problem solving.

Reaction rate material

Reaction rate is the change in concentration of reactants or products over time (M/s). The reaction rate can also be interpreted as the rate of decrease of reactants (reagents) or the rate of increase of products (reaction results). The speed of a reaction and its quantity are affected by its conditions. The rate of a chemical reaction is affected by: (1) concentration of reactants; (2) temperature; (3) surface area of the contact area; and (4) catalyst (Chang, 2005).

III. METHODS

The development of this interactive worksheet refers to the research and development (R&D) method adapted from Sugiyono (2015). However, this research is only limited to product trials because it aims to test the feasibility of the product. The adaptation of Sugiyono's R&D steps (2015) is shown in the following figure.

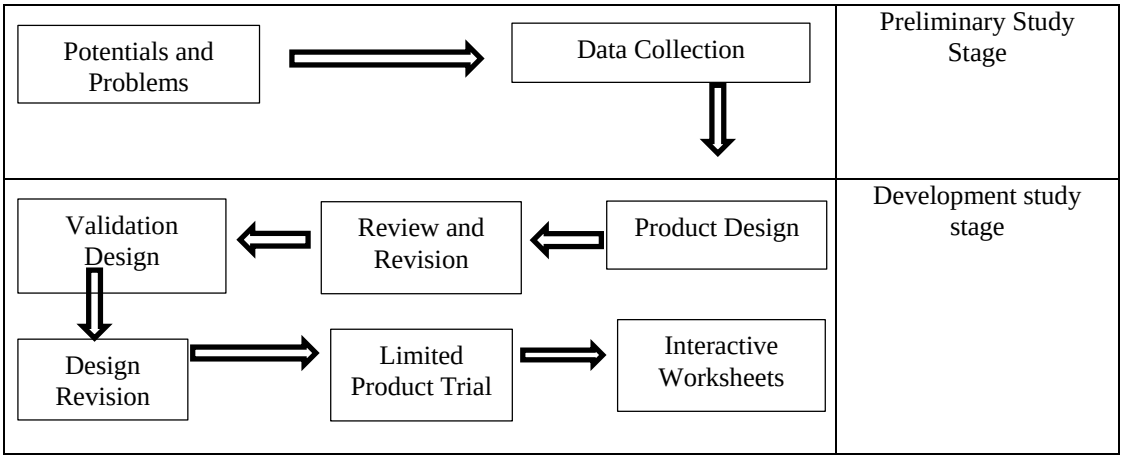

Figure 1. Development Research Procedure, or Research and Development (R&D) adaptation of Sugiyono (2015)

The product trial was conducted on 36 students in class XI F-1 SMAN 1 Taman Sidoarjo. The product trial used the One Group Pretest Posttest Design, which is research conducted in one group without a comparison group. This design can be described as follows.

Table 1. One-Group Pretest-Posttest Research Design

Pretest	**Treatment**	***Posttest***
O_1	X	O_2

Description :
O_1 = Pretest score
O_2 = Posttest score
X = Given a group investigation-oriented interactive worksheets

Data analysis included analysis of validation sheets, response questionnaires, observation of students' activities, and tests of students' problem-solving skills. The validation data was analyzed through the assessment given by three validators by filling out the validation sheet provided. Validators give an assessment based on a Likert scale.

Table 2. Likert Scale Rating Score

Assessment Category	**Scale Score**
Not Good	1
Less Good	2
Simply	3
Good	4
Very Good	5

Data from validation results can be analyzed by determining the mode for each aspect or indicator. If the aspects scored by the validator have a mode score ≥ 4, then the aspect is declared valid (Lutfi, 2021).

Practical data analysis was obtained from a response questionnaire for students and supported by observations of the students' activities. The response questionnaire will be filled out by students after the research is conducted to measure the practicality of the development of group investigation (GI)-oriented interactive worksheets based on a guttman scale with the answer options "yes" and "no".

Table 3. Guttman Scale for Students' Response Questionnaire

Answer	**Positive Answer Score**	**Negative Answer Score**
Yes	1	0
No	0	1

(Riduwan, 2015)

The score obtained will determine the percentage of practicality of group investigation (GI)-oriented interactive worksheets as learning media with the following formula:

$$\text{Practicality percentage (\%)} = \frac{amount\ of\ scores\ obtained}{maximum\ amount\ of\ scores} \text{ x } 100\%$$

The percentage results were used to determine practicality using the following categories:

Table 4. Practicality Category

Percentage (%)	**Category**
0-20	Very less practical
21- 40	Less practical
41-60	Practical enough
61-80	Practical
81-100	Very Practical

(Riduwan, 2015)

Based on these categories, interactive worksheets are said to be practical if the percentage results obtained are ≥ 61%. The response questionnaire data is also supported by the student activity observation data. The student activity observation sheet will be filled in by the observer based on the activities of the student when using the developed interactive worksheets. The data obtained will then be analyzed by calculating the percentage of participant activities carried out by students with the following formula:

$$\text{Activity percentage (\%)} = \frac{\Sigma \text{ frequency of activities appear}}{\Sigma \text{ overall activity frequency}} \text{ x } 100\%$$

The results of the percentage assessment of students' activities obtained from the formula are interpreted in Table 4. Student activities can support the practicality of the interactive worksheets developed if the percentage of relevant student activities is ≥ 61% in the practical or very practical category.

Effectiveness can be analyzed based on pretest and posttest data on students' problem-solving skills. The problem-solving skills data obtained in the form of pretest and posttest results will be analyzed and calculated using the n-gain score with the following formula:

$$n - gain\ score = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score}$$

The results that have been obtained will be classified according to the N-Gain Score criteria as below:

Tabel 5. Criteria for the n-gain score

N-Gain Score	Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	Medium
g < 0,3	Low

(Hake, 2002)

Students' problem-solving skills can be stated to increase, and the learning media developed is categorized as effective if the n-gain score (<g>) ≥ 0,3 or in the medium and high categories.

The pretest and posttest data obtained were also analyzed using the paired sample T-test. Before being analyzed using the paired sample T-test, the data obtained was tested for normality using the Kolmogorov-Smirnov test. If the significance value is > 0.05, then the data is declared normally distributed. If the data is normally distributed, then it can continue to test the data with the paired sample T-test. The paired sample T-test was conducted using SPSS. If the Sig. (2-tailed) value is <0.05, then H0 is rejected and H1 is accepted, while if the Sig. (2-tailed) value is >0.05, then H0 is accepted and H1 is rejected.

IV. RESULT AND DISCUSSION

The first stage is based on the R&D development method adapted by Sugiyono (2015); before conducting a development study, a preliminary study is carried out first. The preliminary study stage includes the potential and problem stage, or literature study, and the data collection or field study stage. The potential and problem stage aims to provide an overview of the potential and problems of students with reaction rate material. The potential and problem stages are carried out by collecting relevant journal articles and books containing theories that support the research. At the data collection stage, pre-research data were collected directly at the research location, namely at SMAN 1 Taman Sidoarjo, by giving questionnaires and questions to test students' problem-solving skills and conducting interviews with chemistry teachers at SMAN 1 Taman Sidoarjo.

The research questionnaire given to students contains information on their difficulties in understanding reaction rate material, the learning tools used during the learning process on reaction rate material, and their' opinions regarding the presentation of reaction rate material that has been obtained at school. The interview asked about the learning model that is often used by teachers during chemistry learning, students' problem-solving skills, and learning tools used during chemistry learning. The results of the analysis needed a group investigation (GI)-oriented interactive worksheet to improve students' problem-solving skills on the material of reaction rate.

The second stage is a development study, which includes product design, design review, design revision, design validation, and limited trials. The following describes the development study stage in this research:

Product Design

In the design stage, the interactive worksheet design was produced in the form of draft 1. There are four interactive worksheets designed according to the factors that affect the reaction rate. The stages used in the development of interactive worksheets use the cooperative learning stages of group investigation according to Slavin combined with Arends, namely, topic identification, planning tasks, conducting investigations, preparing final reports, presenting final reports, and evaluation. At each stage, the interactive worksheets aim to improve problem-solving skills, which include four indicators according to Polya: understanding the problem, planning to solve the problem, solving the problem according to plan, and re-examining the results of problem-solving. The interactive worksheets developed use the LiveWorksheets website so that students can access and answer questions on the interactive worksheets directly using a cellphone or laptop. In this study, the interactive worksheets developed also have interactive features that make it easier for students to work on existing problems and help students understand the material presented. These features include a text field, single choice, play MP3, link, listening, and YouTube Player experimental videos that can be observed by students, as well as virtual labs that

students can try directly by simply pressing the available virtual lab icon. The following is the design of the interactive worksheets developed:

Figure 1. Interactive Worksheets Cover Display: Main Cover (Left) and Sub Material Cover (Right)

The main interactive worksheet cover contains images that support chemistry learning, namely images of tools and chemicals in the laboratory. The cover design of the submaterial interactive worksheets is divided into 4 designs, each of which presents the phenomenon of factors that affect the reaction rate, namely: 1) concentration factor depicted through murky water; 2) temperature factor depicted through soap; 3) surface area factor depicted through campfire; and 4) catalyst factor depicted through butter. Both the main interactive worksheets and the sub-materials also add a wall clock image that represents time, where the reaction rate material is always related to the reaction time.

Figure 2. Display of GI Stages in an Interactive Worksheet

Figures 1 and 2 are fragments of the prototype made at the interactive worksheet design stage, according to the results of the previously conducted analysis. Interactive Worksheets draft 1 after being designed, are then reviewed by experts and lecturers of the chemistry education study program to provide suggestions and comments for improving interactive worksheets. The results of the review were revised, and the revised results were in the form of draft 2, which would be validated by 2 experts/lecturers of chemistry education and 1 chemistry teacher.

Design Validation

The revised interactive worksheet in the form of draft 2 was validated by 2 lecturers of the Unesa Chemistry Education Study Program and 1 chemistry teacher of SMAN 1 Taman Sidoarjo, in order to produce an interactive worksheet that is valid and feasible to be tested. The validation criteria follow the validity criteria by Nieveen, which include content validity and construct validity. Content validity includes suitability with learning outcomes and materials, suitability of interactive worksheet content with group investigation learning steps, and suitability of interactive worksheet content with problem-solving skills indicators. The results of the validation of the developed interactive worksheet are shown in the table below.

Table 6. Validation Result

Validity Criteria	Mode			
	Worksheet 1	Worksheet 2	Worksheet 3	Worksheet 3
Content Validity	5	5	5	5
Construct Validity	4	4	4	4

Table 6 above shows the content validity of interactive worksheets 1-4 obtained in mode 5 with a very good category. This indicates that the interactive worksheets developed are in accordance with the learning outcomes and reaction rate material, group investigation learning steps, and problem-solving skills indicators, so that the interactive worksheets can be said to be valid or worthy of being tested on students. These results are in accordance with Ibrahim (2010), who says that good teaching materials are teaching materials that are in accordance with the learning objectives and materials used. These results are also in accordance with the standards of teaching materials according to the National Education Standards Agency (BSNP) (2012), namely that one indicator of the feasibility of a worksheet is the suitability of the presentation of material with the syntax of the learning model.

In bold 6 above, it also shows the construct validity of interactive worksheets 1-4 obtained in mode 4 with a good category. This indicates that the interactive worksheets developed have met the criteria of language, graphics, and presentation. This is in accordance

with Sihafudin & Trimulyono (2020), who state that the language and terms used must also be clear, easy to understand, and not double-meaning because the function of language is as an intermediary for students to be able to understand the meaning of the information contained in the interactive worksheets. Prastowo (2014) also emphasizes that interactive interactive worksheets are interactive worksheets that are combined from several interactive learning media to control something that will occur in the relationship between teaching materials and users that can provide learning experiences directly to students so that learning is active and interacts with each other.

Limited Trial

Interactive worksheets that have gone through the validation stage and have been declared valid were tested on 36 students in class XI F-1 SMAN 1 Taman Sidoarjo. Learning is divided into two meetings, where the first meeting involves the use of worksheets 1 concentration factor and worksheets 2 temperature factor. During the second meeting, the use of worksheets 3 surface area factors and 4 catalyst factors. In this limited trial stage, data were obtained to determine the practicality and effectiveness of the interactive worksheets developed.

Practicality

The practicality of the interactive worksheets developed is reviewed in the response questionnaire. The intended student response is the response after using the interactive worksheets. The response data is supported by observations of students' activities while using the interactive worksheet. Practicality aims to find out that interactive worksheets can be used in real learning with the GI stages.

Student Response

The interactive worksheets developed obtained a percentage of responses from students of 97%, so it can be concluded that the interactive worksheets developed are very practical because the percentage of students' responses obtained a value of ≥61% (Riduwan 2015). The response questionnaire given to students consists of 22 aspects, where students can choose the answer "yes" or "no" according to their opinion. All of these aspects are considered to represent the interactive worksheets that have been developed, both in content, appearance, language, and presentation. These results are in accordance with Azizah & Nasrudin's (2018) research, where students gave a good assessment of group investigation-oriented chemistry teaching materials with a percentage of 81.1%–91.7%.

Student Activity

Activities were observed by six observers who referred to the implementation of the group investigation (GI) stages on the interactive worksheet. One observer observed student activities in one group. The application of GI-type cooperative learning involves forming small groups with heterogeneous abilities to learn together and solve a problem or investigation. The percentage of relevant activities of students at meetings 1 and 2 amounted to 86.67% and 87.22%, respectively, while irrelevant activities obtained a percentage of 13.33%. And 12.78%. Therefore, the interactive worksheet developed can be categorized as very practical because the percentage of relevant activities carried out by students obtained a value of ≥ 61% (Riduwan, 2015). These results show that students follow the learning very well, so they can understand the concept of material on factors that affect the reaction rate through the developed group investigation-oriented interactive worksheets. The results obtained are in accordance with the results of research by Azizah & Nasrudin (2018), which found that the implementation of group investigation-oriented teaching materials can make most students accustomed to conducting investigations (theory/observation/experiment), analyzing and evaluating the results of investigations, compiling reports, and presenting investigation reports. These activities can develop abstract thinking skills, provide opportunities for students to interact with friends in investigations for concept discovery, and facilitate interaction between students and teachers in expressing ideas and asking and answering questions (Azizah & Nasrudin, 2018). This is also in accordance with Linuhung & Sudarman (2016), which state that the learning process with the group investigation-type cooperative learning model will involve students actively in the process of investigating a problem, so this learning model is one of the learning models that can facilitate students to improve problem-solving skills through learning steps that require understanding of problems and solving problems in a planned manner.

Effectiveness

The results of the effectiveness of interactive worksheets are obtained from the pretest and posttest results of students' problem-solving skills. The questions used in measuring problem-solving skills are questions that require students to carry out a thinking process based on indicators of problem-solving skills (Azizah & Nasrudin, 2022). The problem-solving skills pretest questions were given to students before the limited trial, which was held on January 24, 2024. While the problem-solving skills posttest questions were given to students after a limited trial on January 31, 2024.

To find out if there is a significant difference between students' problem-solving skills before and after the limited trial of developing group investigation-oriented worksheets, a hypothesis test is carried out on the data obtained. The data obtained was tested for normality using the SPSS application, with the results presented in the following figure.

One-Sample Kolmogorov-Smirnov			
		pretest	posttest
N		36	36
Normal Parameters[a,b]	Mean	26.53	75.89
	Std. Deviation	11.049	10.452
Most Extreme Differences	Absolute	0.138	0.137
	Positive	0.138	0.137
	Negative	-0.110	-0.065
Test Statistic		0.138	0.137
Asymp. Sig. (2-tailed)		,079[c]	,087[c]
a. Test distribution is Normal.			
b. Calculated from data.			
c. Lilliefors Significance Correction.			

Figure 3. Normality Test Results of Problem-Solving Skills

Based on the data obtained in Figure 3 above with a pretest Sig value of 0.079 and a posttest Sig value of 0.087, which means that the Sig value> 0.05, the data is normally distributed. After knowing that the data obtained is normally distributed, it is continued with the paired sample t-test based on the pretest and posttest values. The paired sample t-test is carried out with the hypothesis:

a.) H0 = There is no increase in students' problem-solving skills in reaction rate material after the use of interactive worksheets oriented to group investigation.

b.) H1 = There is an increase in students' problem-solving skills in reaction rate material after the use of interactive worksheets oriented to group investigation.

The data obtained were tested for a paired sample t-test using the SPSS application, with the results as presented in Figure 5 below.

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Interval of the Difference Lower	Interval of the Difference Upper			
Pair 1	pretest - posttest	-49.361	10.635	1.772	-52.959	-45.763	-27.849	35	0.000

Figure 4. Paired Sample T-test Results of Problem-Solving Skills

Based on Figure 4 above, the sig. (2-tailed) value is 0.000, which means that the sig. (2-tailed) <0.05, then H0 is rejected and H1 is accepted, which shows that there is a significant difference between the pretest and posttest scores of students' problem-solving skills. Based on the results that have been obtained, it can be said that the interactive worksheets developed can be said to be effective. The improvement of each indicator of problem-solving skills is presented in Table 7 below.

Table 7. Improvement of Problem-Solving Skill Indicators

Skill Indicator Problem Solving	Pretest	Posttest	N Gain Score	Category
Understanding the Problem	33,56	74,31	0.61	Medium
Planning Problem Solving	30,32	79,63	0.71	High
Doing Problem Solving	19,91	68,75	0.61	Medium
Rechecking the Result	21,76	80,56	0.75	High

Each indicator of problem-solving skills has increased with high and medium n-gain score criteria, as shown in Table 7 above. The following also gives a comparison of the pretest and posttest results of students on each indicator of problem-solving skills.

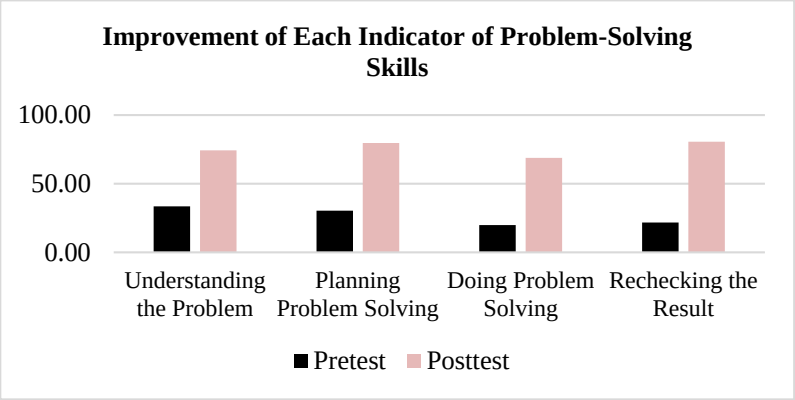

Figure 5. Improvement of Each Indicator of Problem-Solving Skills

Figure 5 shows that each indicator of students' problem-solving skills has increased after the limited test of the developed interactive worksheets. The learning process that occurs in each problem-solving cycle always begins with the presentation of problems in the context of students (Azizah et al., 2019). In the test questions to measure the ability to understand the problem, students are asked to determine the focus of the problem to be solved and information that can support problem solving based on the phenomenon presented. This is in accordance with Hidayatulloh et al. (2020), which state that the indicator of understanding the problem includes the ability to accurately understand the problem at hand and identify related information available. The average value of understanding the problem of students at the time of the pretest was 33.56, and at the time of the posttest, it increased by getting an average value of 74.31, and the n-gain score obtained was 0.61, which was included in the medium category. This is due to the acquisition of pretest scores on the indicator of understanding problems that get higher scores than other indicators of problem-solving skills, even though they are still in the low category, so that when calculated with the n-gain score to determine the increase, the results are obtained in the moderate category. Students' skills in understanding the problem before the limited trial was carried out were still relatively low, which showed that students had not been able to understand the problem from the phenomenon presented. However, the results of the posttest of problem-solving skills on the indicator of understanding the problem of students have increased in value from the pretest results. This shows that students have been able to understand the problem from the phenomenon presented. These results also show that the indicator of understanding the problem is an indicator that can be mastered by students in problem-solving thinking skills, such as the results of research conducted by Azizah & Nasrudin (2022). Students who can understand problems well will tend to be able to analyze problems and connect various information obtained well (Azizah & Nasrudin, 2022).

The next indicator is the indicator of planning problem solving. In the test questions to measure the ability to plan problem solving, students are asked to provide problem-solving solutions based on the phenomena presented using the concept of reaction rate factors. By writing strategies, various alternative solutions and solution schemes designed for students will be identified, from which we can find out the extent to which students understand the problem (Aziah & Nasrudin, 2022). This is in line with Hidayatulloh et al. (2020), who state that the indicator of planning problem solving is the ability to plan approaches and strategies to solve problems and draw links between knowledge possessed and alternatives that will be designed for problem solving. The average value of planning problem solving during the pretest was 0.32, and during the posttest it increased by getting an average value of 79.63 and getting an n-gain score of 0.71 and being included in the high category. The skills of planning problem solving from students before the limited trial was carried out were still relatively low and proved that students had not been able to plan problem solving from an existing phenomenon. However, the results of the posttest indicator of planning problem solving have increased in value from the pretest results. This proves that students have been able to plan problem-solving based on the phenomena presented.

The next indicator is the indicator of doing problem solving. In the test questions to measure problem-solving ability, students are asked to solve problems based on the phenomenon based on the solutions that have been given previously by connecting them to the experimental data presented. Applying problem-solving strategies through exploration of concepts and facts is the basis for formulating problems, formulating hypotheses, carrying out experimental procedures, making observations, analyzing data, and making conclusions (Azizah & Nasrudin, 2022). This is in accordance with Hidayatulloh et al. (2020), who stated that the indicator of doing problem solving is the skill in implementing the planned problem solving plan. The average value of the indicator of doing problem solving during the pretest was 19.91, and during the posttest it increased by getting an average value of 68.75 and an n-gain score of 0.61, which is included in the moderate category. The problem-solving skills of students before the limited trial were still relatively low, which proved that students had not been able to solve existing problems based on the problem-solving plan by connecting to the experimental data. However, the results of the problem-solving skills posttest on the indicator of doing problem-solving, which increased the score from the previous pretest results, showed that these interactive worksheets could help students improve problem-solving skills. This proves that students have been able to connect the experimental data presented and solve existing problems based on the problem-solving plan.

The last indicator is the indicator of re-examining the problem-solving results obtained. In accordance with the research of Azizah & Nasrudin (2022), at the end of learning to solve problems, students evaluate the performance that has been done in constructing concepts. In the test questions to measure the ability to re-examine the results obtained, students are asked to connect problem solving to the phenomenon with the concept of reaction rate factors. This is in accordance with Hidayatulloh et al. (2020),

which state that the indicator of re-checking the results obtained is the ability to evaluate the effectiveness of various solutions applied in problem solving and respond to changes in plans. The average value of re-examining the results of problem solving obtained by students at the pretest was 21.76, and at the posttest it increased by getting an average value of 80.56 and getting an n-gain score of 0.75, which is included in the high category. The skill of re-examining the results obtained by students before the limited trial was still relatively low and showed that they could not connect problem solving to the phenomenon with the concept of reaction rate factors. The posttest results of problem-solving skills on the indicator of checking back the results obtained increased the score from the previous pretest results, proving that these interactive worksheets can help students improve problem-solving skills. This shows that students have been able to re-examine the results of problem solving on the phenomenon by connecting it to the concept of reaction rate factors.

These results are relevant to the research of Navi's (2010), which found that the application of the cooperative learning model type Group Investigation can improve students' problem-solving skills with a significant increase, namely the ability to solve problems in cycle 1 experienced a classical completeness of 48.28%, cycle 2 62.07%, and cycle 3 82.76%.

V. CONCLUSION

Based on the results and discussion of the research discussed earlier, it can be concluded that the interactive worksheets developed can improve students' problem-solving skills and are suitable for use. This is reviewed from the aspect of validity, which gets a mode score of 5 on content validity and a mode score of 4 on construct validity, which is included in the good and very good categories. For practicality, the results of student response questionnaires were obtained with a percentage of 97% and supported by student activity observation, which obtained a percentage of relevant activities of 86.67% at meeting 1 and 87.22% at meeting 2. So the interactive worksheets developed can be said to be practical. Effectiveness is reviewed based on the results of pretests and posttests of students' problem-solving skills, which get n-gain scores in the medium and high categories. The results of the paired sample T-test test on problem-solving skills and learning outcomes got a Sig. (2-tailed) value <0.05, which means that there is a significant difference between the pretest and posttest of problem-solving skills. So that the interactive work developed can be said to be effective.

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