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Development of Worksheets to Reduce Misconception with a Conceptual Change Text Stretegy on Reaction Rate Factors

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Abstract: The purpose of this study is to determine the feasibility of the students' worksheets that is developed to reduce misconceptions with the conceptual change text strategy on the material reaction rate factors. There are three aspects that review the feasibility of students' worksheets, (1) Validity is to find out the validity of the developed students' worksheets, (2) Practicality is to find out how practical the students' worksheets which developed in learning process, (3) Effectiveness is to find out how effective students' worksheets developed in reducing misconceptions. This research uses the Research and Development (R&D) method which has 10 stages (1) Potentials and problems, (2) Data collection, (3) Product design, (4) Design validation, (5) Design revision, (6) Product testing, (7) product revision, (8) usage trial, (9) product revision, and (10) mass production. The subjects in this study are 12 students who detected misconceptions in the material reaction rate factors in class XII MIA 1, and MIA 2 SMA PLUS AR RAHMAT (High School) Bojonegoro. The results of this study indicate that the students' worksheets developed are feasible to use to reduce misconceptions on the material reaction rate factors as evidenced by the acquisition of the results of the three aspects of feasibility as follow (1) Validity with the percentage of results 89.3% - 93.3% with Very valid category, (2) Practicality with a percentage of 90% - 93.75% with a very practical category, (3) Effectiveness with a percentage of 75% - 90.5% with an effective category.

Keywords: students' worksheets, misconceptions, conceptual change text, reaction rate factors

Abstrak: *Tujuan penelitian ini adalah untuk mengetahui kelayakan lembar kerja peserta didik yang dikembangkan untuk mereduksi miskonsepsi dengan strategi conceptual change text pada materi faktor-faktor laju reaksi. Aspek yang meninjau kelayakan lembar kerja peserta didik ada tiga, (1) Validitas untuk mengetahui kevalidan lembar kerja peserta didik yang dikembangkan, (2) Kepraktisan untuk mengetahui seberapa praktis lembar kerja peserta didik yang dikembangkan dalam pembelajaran, (3) Keefektifan untuk mengetahui seefektif apa lembar kerja peserta didik yang dikembangkan dalam mereduksi miskonsepsi. Penelitian ini menggunakan metode Research and Development (R&D) yang memiliki 10 tahap yakni, (1) Potensi dan masalah, (2) Pengumpulan data, (3) Desain produk, (4) Validasi desain, (5) Revisi desain, (6) Uji coba produk, (7) Revisi produk, (8) Uji coba pemakaian, (9) Revisi produk, dan (10) Produksi masal. Subyek dalam penelitian ini adalah 12 peserta didik yang terdeteksi miskonsepsi pada materi faktor-faktor laju reaksi di kelas XII MIA 1, dan MIA 2 SMA PLUS AR RAHMAT Bojonegoro. Hasil Penelitian ini menunjukan bahwa lembar kerja peserta didik yang dikembangkan layak digunakan untuk mereduksi miskonsepsi pada materi faktor-faktor laju reaksi yang dibuktikan berdasarkan perolehan hasil ketiga aspek kelayakan yakni, (1) Validitas dengan persentase hasil 89,3% - 93,3% dengan kategori sangat valid, (2) Kepraktisan dengan*

persentase hasil 90% – 93,75% dengan kategori sangat praktis, (3) Keefektifan dengan persentase hasil 75% - 90,5% dengan kategori efektif.

Kata kunci: *Lembar kerja peserta didik , miskonsepsi, conceptual change text, faktor-faktor laju reaksi*

▪ INTRODUCTION

In the world of education, efforts to realize learning objectives that have set graduate competency standards as stipulated in Permendikbud No. 21 of 2016 is an important thing to achieve to deliver students to meet their abilities in the 21st century (Permendikbud, 2016a). Judging from several learning principles determined by Indonesia from year to year have experienced significant changes. The standard of the primary and secondary education process shows that teachers are not the only source of learning as stipulated in Permendikbud No. 22/2016 (Permendikbud, 2016b). Then there is a change from students from being told to learners to find out and learning that emphasizes answers to multiple interpretations and several other principles.

Chemistry is a branch of science that is developed with the scientific method and scientific attitude to study various things from a material. Whereas a product of science is facts, concepts, principles, laws, and theories whose meaning is in harmony with chemistry as a scientific work process (Mulyasa, 2006). As a branch of science, chemistry is taught by connecting related concepts. Understanding a concept will affect the understanding of related concepts. The chemistry learning process is getting more complicated, because students must understand each concept correctly before other concepts are related. Understanding a concept often has the potential to be a misconception, because when students build their own understanding through the assimilation process, by the merging of old concepts with new concepts in cognitive or interrelated structures, they often experience difficulties or even failures (Suparno, 2013).

The subject matter in this case is the rate of reaction, chemical reactions are the process of changing reagents into reaction products (Syukri, 1999). Chemical reactions have a rate as a certain speed to reach a result or product, and there are several factors that affect the reaction rate that need to be controlled when we compare the reaction rates of various reactions (Masel, 2002). The factors that affect the rate of the reaction consist of temperature, reagent concentration, reagent properties, and catalyst (Syukri, 1999). The rate of reaction and the influencing factors can be determined by studying the chemical kinetics (Syukri, 1999). The method of designing factory equipment and reactor design in the production process by using the reaction rate constant information and the reaction order for this reagent is one example of using the reaction rate (Khairat, 2004).

One of the misconceptions is caused by the limitations of students in building or constructing an understanding of an accepted concept (Nakhleh, 1992). Misconceptions that last for a long time and are not immediately resolved can be integrated into the cognitive structures or subconscious of students, and interfere with further learning, so that these students will have difficulty linking a concept that has been learned with a new concept (Treagust, 2012).

One way to detect the occurrence of misconceptions to students is to use diagnostic test instruments given to students after the learning process is carried out,

students will build an understanding of a concept during the learning process. There are several types of diagnostic tests such as the one that will be used, one of which is a three-tier consisting of three-level questions. The first level is a question with several answer choices, then continues to the second level which contains three to five choices of reasons from the first level answer, the last is the third level of each item consisting of the confidence to answer the first level question.

Based on the study of several literature, the material for reaction rates, especially the topic of reaction rate factors, is a class XI material that is difficult to understand and learn by students, from the national exam data, the material achievement values of reaction rates and chemical equilibrium have decreased from year to year, according to (Malasari and Suyono, 2017) in their research successfully identified misconceptions of reaction rate material at Senior High School 22 Surabaya, there are only around 22.86% of students knew the concept, 50.59% of students are expressed in misconceptions, and 26.55% are stated in the category of not knowing the concept. The fact can be supported by the percentage of National Examination achievements in 2012 which was 87.04%, in 2013 this achievement decreased very drastically to 67.96%, as well as in subsequent years.

Therefore, misconceptions must be resolved immediately, in principle, misconceptions can be overcome with several concept change strategies. Experts have developed a variety of concept change strategies to overcome misconceptions, here are some examples of strategies developed by cognitive conflict (Niaz, 1995), Cause and Effects of Changes Model (CEC Model) (Pauen, 1999), Dual Situated Learning Model (DSLM)) (She, 2002), and Conceptual Change Text Model (CCT Model) (Çalik at al., 2007).

In this study, the Conceptual Change Text (CCT) strategy was used. CCT is a method in order to provide conceptual change (Aslan, 2014). The reason for using that CCT is one of the most effective strategies to use in remediating student misconceptions (Sendur and Toprak, 2013) can be proven in several previous studies by Chambers and Andre proved that CCT is more effective than ordinary text in understanding the conceptual circuit of electricity in research. Relationship between gander, interest, and experience in electricity. Çelebi found that ninth grade students in the Phase and Phase Change material experienced increased understanding by using the CCT strategy, so Çelebi stated that CCT was effective in the conceptual change of students. And there are many other examples (Çelebi, 2004). However, the development of CCT is still limited to certain materials including alkene (Sendur and Toprak, 2013), electro-chemistry (Önder, 2017), heat conduction (Anam at al., 2018), chemical equilibrium (Ramadhani at al., 2019).

The learning process does not only involve teachers and students, but also involves learning media as an intermediary. Learning media aims to make it easier for teachers to deliver messages or material optimally. There are three characteristics of learning media, like audio, visual, and audiovisual. Student activity sheets (student**s'** worksheets) are a visual learning medium that is not projected. Student**s'** worksheets are sheets containing tasks that must be done. Student**s'** worksheets is usually in the form of instructions, steps to complete a task. The advantage of having a student**s'** worksheets for teachers is that it makes it easier for teachers to carry out learning, while for students they will learn independently and learn to understand and carry out a written assignment (Depdiknas, 2008).

Therefore, it is necessary to develop student**s'** worksheets that can train students to work scientifically and can develop students' thinking skills so that they can find the correct concept, build their own knowledge, and play an active role in the learning process (Wahyuningsih and Saputro, 2014). Students experience misconceptions on several materials, one of which is the reaction rate. To remediate a student's misconception, a strategy is needed, one of which is CCT, and in a learning process the need for media, one of the visual media, is student**s'** worksheets. - Reaction rate factor which discusses 4 reaction rate factors, like the surface area of the touch area, temperature or temperature, concentration, and catalyst. Therefore, the authors are interested in conducting a research entitled "Development of student**s'** worksheets to Reduce Misconceptions with CCT Strategies on the Material of Reaction Rate Factors".

▪ METHOD

The Research and Development (R&D) method is a method used in research. In the R&D method there are 10 research procedures as follows: (1) Potentials and problems, (2) Data collection, (3) Product design, (4) Design validation, (5) Design revision, (6) Product testing, (7)) Product revision, (8) Trial use, (9) Product revision, and (10) Mass production (Sugiyono, 2017).

In the 10-step research procedure, the R&D method is divided into 2 research stages, as follows: 1) Preliminary study stage and 2) Development stage. At the preliminary study stage covering potentials and problems, data collection. The development stage includes product design, design validation, design revision, product testing, product revision, usage testing, product revision, and mass production. However, this research was only carried out until the use trial.

Research Objectives

The target of this study is a student worksheet developed to reduce misconceptions in the sub-material of reaction rate factors through the conceptual change text strategy. The research subjects are 12 students of SMA Plus Ar Rahmat (High School) Bojonegoro from class XII MIA 1 and 2 who are selected homogeneously with criteria that experienced misconceptions and did not know the concept.

Research Instruments

This study uses an instrument consisting of data collection instruments that will be arranged in order to obtain valid and reliable instruments, including: study sheets, validation sheets, observation sheets, student response sheets, and test sheets. The data analysis method used is the analysis of the student**s'** worksheets review data which is used to provide an overview of the input or suggestions that have been given by chemistry lecturers and chemistry teachers so that it is known that the deficiencies of the student**s'** worksheets are developed and assessed descriptively quantitatively. Which is presented using the linkert scale in table 1 (Riduwan, 2015). An assessment of validation can be obtained from a Likertscale based on the table.

Table 1. Validation of Scale Value

Assessment	Scale Value
Not good	1
Less good	2
Enough	3
Good	4
Very good	5

Table 2. Criteria for the Validity of Student Worksheets

Percentage (%)	**Criteria**
0 – 20	Not valid
21 – 40	Less valid
41 – 60	Quite valid
61 – 80	Valid
81 – 100	Very valid

Based on the criteria in table 2, students' worksheets are declared valid if ≥ 61% (Riduwan, 2015). The formula for calculating the validation results to get the percentage of validity is:

$$P(\%) = \frac{\sum \text{score obtained}}{\text{maximum score of each criterion}} x100\%$$

(Kumalaningtias and Sukarmin, 2019)

Data analysis of the student response questionnaire results was used to determine the practicality of the student worksheets developed using the linkert criteria score in table 3 (Riduwan, 2015).

Table 3. Practical criteria for student worksheets

Percentage (%)	**Criteria**
0 – 20	Not practical
21 – 40	Less practical
41 – 60	Quite practical
61 – 80	Practical
81 – 100	Very practical

(Riduwan, 2015)

Based on the criteria in table 3, student worksheets are declared practical if ≥ 61%.

The formula for calculating the results of students' responses to get a percentage of practicality is:

$$P(\%) = \frac{\sum \text{the total score of all responses}}{\text{maximum score}} x100\%$$

(Kumalaningtias and Sukarmin, 2019)

Analysis of the data from the observation of student activity is used to support the data from the student response questionnaires, using the Guttman scale with **Yes** and **No** scale, as in table 4.

Table 4. Guttman scale

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

(Riduwan, 2015)

Based on the criteria of the Guttman scale (Riduwan, 2015) in table 4 student worksheets are declared practical if ≥ 61%, and are calculated using the following calculation formula:

$$P(\%) = \frac{\Sigma\ Answer\ Yes}{\Sigma\ Maximum\ Yes}\ x100\%$$

(Kumalaningtias and Sukarmin, 2019)

The data analysis of the results of the students' conceptual shift was used to determine the shift in conceptions that occurred in students after using the student worksheets that were developed. The shift in the students' conception that is calculated is from misconception (MK) to knowing the concept (TK). The formula in calculating the shift in the conception of students to obtain the percentage of effectiveness is:

$$P(\%) = \frac{\Sigma MK\ -\ TK}{\Sigma MK}\ x100\%$$

(Kumalaningtias and Sukarmin, 2019)

The results of the data analysis on the shift in students' conceptions were used to determine the effectiveness of the student worksheets developed using the Likert score interpretation in table 5 (Riduwan, 2015).

Table 5. Criteria for the effectiveness of student worksheets

Percentage (%)	Criteria
0 – 20	Not effective
21 – 40	Less effective
41 – 60	Quite effective
61 – 80	Effective
81 – 100	Very effective

Based on the criteria, the student worksheets developed are said to be effective if the percentage is ≥ 61%.

The way of assessing this diagnostic test is by using several categories, the students' conception categories based on the data on the results of the conception test with a three tier format are shown in Table 6 (Arslan dkk., 2012).

Table 6. Conception categories of students based on the three tier test data

First tier	*Second tier*	*Third tier*	Category
Correct	Correct	Sure	Know the Concept
Correct	Wrong	Sure	Misconception 1 (M1)
Wrong	Correct	Sure	Misconception 2 (M2)
Wrong	Wrong	Sure	Misconception 3 (M3)
Correct	Correct	Not sure	Don't Know the Concept (TTK)
Correct	Wrong	Not sure	Don't Know the Concept (TTK)
Wrong	Correct	Not sure	Don't Know the Concept (TTK)
Wrong	Wrong	Not sure	Don't Know the Concept (TTK)

▪ RESULT AND DISCUSSION

This research is entitled "Development of student worksheets to Reduce Misconceptions with Conceptual Change Text Strategies on Material Reaction Rate Factors". Aims to develop proper student worksheets as a learning medium. Feasibility is viewed from 3 aspects like validity, practicality, and effectiveness. The developed

student worksheets were tried out on 12 students of class XII MIA 1 and MIA 2 to find out how effectively the student worksheets were used.

Product Design Stage

The product design stage is necessary to compile an initial design in making student worksheets which will later be developed, at this stage it begins with compiling the material to be used as content that must be in accordance with the conceptual change text strategy stages such as the example in Figure 2 and the rate factors. reaction, then the arrangement was carried out with a more attractive design and making a good cover to make it memorable as a student worksheet that was easy to understand with the design in Figure 1

Figure 1. Front Cover and Back Cover

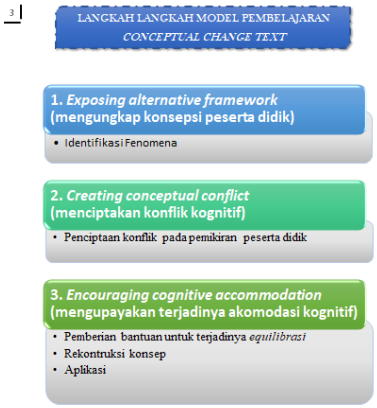

Figure 2. Example of Conceptual Change Text Stages

Figures 1 and 2 are the results of the product design stage in accordance with the results of the analysis at the product design stage.

The validity of student worksheets and Diagnostic Test Instruments

The validation assessment which was assessed by 2 lecturers and 1 chemistry teacher was used to determine the validity of the student worksheets and the Diagnostic Test Instrument which was developed until it was said to be valid if the validation assessment had a result of ≥ 61%. The results of the validation of student worksheets and diagnostic test instruments can be detailed in table 7 and table 8.

Table 7. Validation Results of student worksheets

Assessment criteria	Percentage (%)	Criteria
Conformity with KI and KD curriculum 2013	91,1	Very valid
Accuracy of material	90	Very valid
The suitability of the material with conceptual change text	93,3	Very valid
Compliance with the conceptual phase of change text	91,1	Very valid
Video accuracy	93,3	Very valid
Conformity with the correct Indonesian language rules	93,3	Very valid
Use of communicative language	90	Very valid
Use of terms and symbols / symbols properly	90	Very valid
Serving Criteria	93,3	Very valid
Completeness of the components presented in the Student worksheets	93,3	Very valid
Graphics	89,3	Very valid
Average	92	Very valid

Table 8. Validation Results of Diagnostic Test Instruments

Assessment criteria	Percentage (%)	Criteria
The correctness of the material in the three-tier multiple choice diagnostic test instrument on the concept of reaction rate	91,1	Very valid
The suitability of the three-tier multiple choice diagnostic test instrument with the identification of students' misconceptions on the concept of reaction rate	90	Very valid
The suitability of the three-tier multiple choice diagnostic test instrument with the language used	93,3	Very valid
Average	91,467	Very valid

Based on tables 2 and 3, it is known that the validity of student worksheets and diagnostic test instruments consisting of several criteria, from all these data it can be seen that the percentage is between 91.467% - 92% and can be categorized as valid according to the Linkert scale with results ≥ 61% is a valid criterion. (Riduwan, 2015), means that the student worksheets developed are valid for use in learning on the material of reaction rate factors.

Practicality of student worksheets

The way to find out the practicality of the student worksheets being developed is by looking at the data on the response of students and observer data. Student response data were obtained from a questionnaire given to 12 students who had used the student worksheets that were developed. Observer data were obtained from observational data that had been assessed by the observer when using the developed student worksheets so that they could help the student's response data to obtain data on the practicality of student worksheets, which can be detailed as follows.

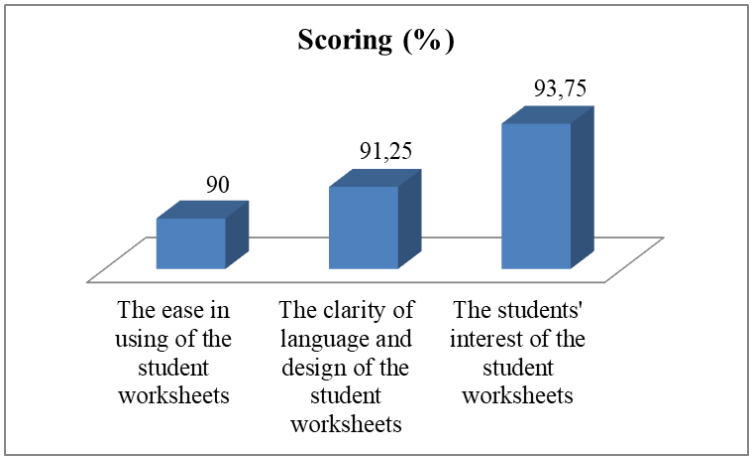

Figure 3. Student Response Results

Based on the detailed data, it gets a score of 90% - 93.75% when categorized on a linkert scale, then it is included in the category ≥ 61%, so the student worksheet developed can be categorized as practical, the following is also supported by data observers who state that 100% of learning activities are carried out by very good, meaning that student worksheets are developed practically to be used anywhere and anytime (Riduwan, 2015).

The effectiveness of student worksheets

The effectiveness of the developed student worksheets can be proven by the data resulting from the shift in students' understanding in terms of shifting misconceptions to knowing concepts. The data on the results of the shift were obtained through the shift in the conception of students after working on the pretest and posttest. The pretest function is to identify the conceptions experienced by students after being given learning by the chemistry teacher, whether they experience knowing concepts (TK), misconceptions (MK), or not knowing concepts (TTK). While the posttest function is to identify the shift in the conception of students after using the developed student worksheet, especially the shift from MK to Kindergarten.

Table 9. Shift in Students' Conception Understanding

A Shift in Students' Conception	Concentration			Temperature			Surface area			Catalyst		
	Task Number-			Task Number-			Task Number-			Task Number-		
	1	2	3	1	2	3	1	2	3	1	2	3
TK-TK	5	9	5	7	2	1	1	4	2	1	0	0
TK-MK	0	0	0	0	0	0	0	0	0	0	0	0
TK-TTK	0	0	0	0	0	0	0	0	0	0	0	0
MK- TK	5	2	3	3	5	7	9	6	4	6	5	6
MK- MK	1	0	2	1	2	2	0	0	2	2	2	1
MK - TTK	0	0	0	0	0	0	0	0	0	0	0	0
TTK - TK	1	1	2	1	3	2	1	2	4	3	5	5
TTK - MK	0	0	0	0	0	0	1	0	0	0	0	0
TTK - TTK	0	0	0	0	0	0	0	0	0	0	0	0

From the data table 4, it can be presented the shift of students from MK to TK for each concept so that the following data are obtained:

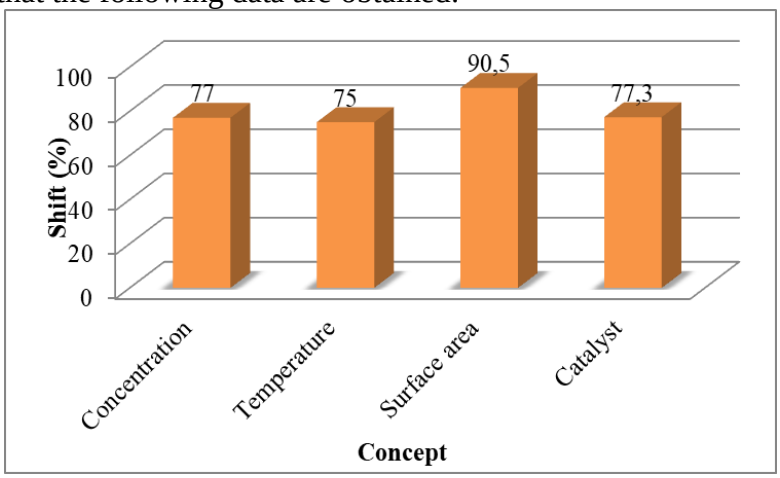

Figure 4. Results of MK-TK Shift for Each Concept

Based on Figure 4, the results of the MK-TK shift for each concept include concentration with a shift percentage of 77%, temperature with a shift percentage of 75%, surface area with a shift percentage of 90.5%, and catalyst with a shift percentage of 77.3% so that the percentage of departure was obtained an average of 79.95%. Student worksheets can be said to be effective if the results of shifting the percentage of students from misconceptions to knowing concepts reach ≥ 61% (Riduwan, 2015). So it can be concluded that the student worksheet developed is categorized as effective in reducing misconceptions on the material reaction rate factors.

▪ CONCLUSION

Based on the data that has been analyzed, the conclusion drawn is that the student worksheet developed is suitable for use in reducing misconceptions on the material of reaction rate factors, with the following details: **Validity** Based on the results of the discussion on the validity of the student worksheet, the conclusion is that the student worksheet developed has a value of 89.3% - 93.3%, which means that it is on a linkert scale ≥ 61%, which is the valid category, meaning that the student worksheet developed is valid for use in learning on the material reaction rate factors. **Practicality** Based on the results of the discussion on the practicality of the student worksheet, the conclusion is that the student worksheet developed has a value of 90% - 93.75%, which means that it is on a linkert scale ≥ 61%, which is the practical category, meaning that the student worksheet developed is practically used anywhere, and anytime. **Effectiveness** Based on the results of the discussion on the practicality of the student worksheet, the conclusion is that the developed student worksheet has a value of 75% - 90.5%, which means that it is on a linkert scale ≥ 61%, which is the effective category, meaning that the student worksheet developed is effective in reducing student misconceptions on the material the reaction rate factors.

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