

# Pengembangan *Structured Essay Diagnostic Test of Chemistry (SEDToC)* sebagai Instrumen Penilaian Hasil Belajar dan Identifikasi Miskonsepsi pada Materi Laju Reaksi.

## *Development of Structured Essay Diagnostic Test of Chemistry (SEDToC) as an Instrument for Assessment of Learning Outcomes and Identification of Misconceptions in Reaction Rate Materials.*

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### ABSTRACT

*The learning outcomes by learners are influenced by several factors, one of which is that learners have difficulty understanding the concepts because of misconceptions. The development of a structured essay diagnostic test of chemistry in reaction rate aims to identify misconceptions and learning barriers, assess learning outcomes that converge a good instrument criteria in terms of validity, reliability, difficulty index, and discrimination index. The research has three stages, namely determining the content, obtaining information about students' misconceptions, and developing diagnostic tests. The SEDToC instrument was validated by 5 validators. The results indicate that the SEDToC instrument is valid and reliable with an I-CVI value of 1 and Cronbach Alfa value of 0.84. In instrument difficulty index obtained 30% of questions with easy criteria, 60% medium and 10% difficult question. In addition, the discrimination index indicated that 10% of questions in the poor category, 20% sufficient, 40% good, and the rest were categorized as very good.*

### KEYWORDS

*Learning Outcomes, Misconceptions, Reaction Rate, SEDToC*

### ABSTRAK

Hasil belajar peserta didik dipengaruhi oleh beberapa faktor, salah satunya peserta didik mengalami kesulitan memahami konsep karena miskonsepsi. Pengembangan tes diagnostik esai terstruktur kimia laju reaksi bertujuan untuk mengidentifikasi miskonsepsi dan hambatan belajar, menilai hasil belajar yang memenuhi kriteria instrumen yang baik dari segi validitas, reliabilitas, indeks kesukaran, dan indeks diskriminasi. Penelitian ini memiliki tiga tahapan yaitu menentukan isi, memperoleh informasi tentang miskonsepsi siswa, dan mengembangkan tes diagnostik. Instrumen SEDToC divalidasi oleh 5 validator. Hasil menunjukkan bahwa instrumen SEDToC valid dan reliabel dengan nilai I-CVI 1 dan nilai Cronbach Alfa 0,84. Pada indeks kesukaran instrumen diperoleh 30% soal dengan kriteria mudah, 60% soal sedang dan 10% soal sukar. Selain itu, indeks daya pembeda menunjukkan bahwa 10% soal termasuk kategori kurang baik, 20% cukup, 40% baik, dan sisanya dikategorikan sangat baik.

### KATA KUNCI

*Hasil Belajar, Miskonsepsi, Laju Reaksi, SEDToC*



## 1. INTRODUCTION

One of the science that involves mastering concepts is chemistry. Chemical concept can be formed gradually, one of which is based on the experiences experienced by students<sup>[1]</sup>. Reaction rate is one of materials that is considered difficult by student. Reaction rate material is one of the more abstract chemical concepts, making it more difficult for students to understand the concept. In addition, the amount of subject matter that must be learned and calculations that require a thorough understanding also effect the understanding of the concept<sup>[2]</sup>.

Based on the result of the questionnaire, it was found that students had difficulties in understanding several material concepts of reaction rates such as factors affecting reaction rates, determining reaction orders, reaction rate equations and determining reaction rate constants. Several studies have also shown result that are relatively similar to the data above<sup>[3-7]</sup>.

The understanding of this concept plays an important role in the learning process, the understanding of the concept is an understanding that the participants have about the existing concepts<sup>[8]</sup>. If students do not understand the concept based on the concept presented by experts, it will lead to misconceptions in students which will cause learning outcomes to be low or not to reach the KKM<sup>[9]</sup>. As for students whose scores do not reach the KKM, they are required to participate in the remedial programme, which aims to identify concepts that students have misconceptions about. The implementation of the remedial programme can be carried out using various methods depending on the level of difficulty, namely by conducting individual tutorials, by giving assignments or using peer tutors, by implementing this remedial programme it is hoped that it will be able to improve student' learning outcomes<sup>[10]</sup>.

Diagnostic tests can be used as a test to see the level of understanding of students<sup>[11,12]</sup>. In addition, diagnostic tests are also carried out to assess the level of understanding of concepts in students before and after learning so that students' weaknesses towards certain concepts can be properly overcome<sup>[13]</sup>. However, in reality, educators in the field do not carry out diagnostic test, which is caused by several factors such as requiring a relatively long preparation time, students' freedom in choosing answers, which allows students to answer randomly and the analysis process is relatively difficult<sup>[14]</sup>.

The results of the distribution of the questionnaire to nine high schools (SMA) showed that educators had carried out an analysis of learning outcomes. The results will be used as a reference for the next process. As many as 33,3% of the educators have carried out an analysis of learning outcomes based on the acquisition of points based on the minimum criteria of completeness (KKM). As many as 33,3% of

teachers have carried out an analysis of students' answers, but how the process of analysing students' answers is carried out is not clear. Meanwhile, as many as 11.1% of teachers compared learning outcomes with the previous one, in addition, 11.1% of teachers compared questions based on the level of difficulty and 11.1% gave individual tasks to students. Thus, it can be said that the analysis process carried out by the educators was not able to identify the misconceptions of the students.

Therefore, in order to help educators to carry out the diagnostic test, an instrument has been developed in the form of a Structured Essay Diagnostic Test of Chemistry (SEDToC) on the subject, which has good response rate in terms of validity, reliability, difficulty index and discrimination index, and can measure learning outcomes, identify misconceptions and materials that hinder students' understanding. This is because, SEDToC is a structured essay test starting from basic material to more complex material and students' answers are more focused and limited, therefore with this SEDToC test it can be analysed on which concepts students experience misconceptions<sup>[15]</sup>.

## 2. METHOD

This research is developmental research or often referred to as research and development (R&D)[16]. SEDToC development stages for reaction rate materials refer to diagnostic test research developed by researchers where the development stages are:

### 1. *Define Content*

This stage consists of four steps, namely: a) Identifying propositional statements. This stage involves an analysis of the basic skills and supporting concepts in the reaction rate material on the rate of reaction based on the 2013 curriculum. b) Developing a concept map. The development of concept maps is based on the concepts listed in the propositional knowledge statement. c) Linking propositional knowledge to concept maps. This stage is carried out to see if the propositional knowledge fits with the concept map that has been created. d) Content validation. Propositional knowledge and concept maps are validated by chemists such as high school chemistry lecturers and teachers.

### 2. *Gathering information about student' misunderstandings of concepts*

The stage of obtaining information about students' misunderstanding of concepts is carried out by distributing questionnaires to high school chemistry teachers containing a list of questions related to learning outcomes and topics that are difficult for students to understand, especially on reaction rate material.

### 3. *Development of Diagnostic Tests*

This stage consists of three steps, namely: a) Create a Question Grid. The purpose of this step is to ensure that the developed instrument meets the criteria for propositional knowledge and concept maps. b) Development SEDToC. This test was developed on the topic of reaction rates where the previous question is a prerequisite for answering the next question. The questions are arranged according to a valid concept hierarchy. c) Making Improvements. In this phase, the reliability test, the difficulty index, validity and out.

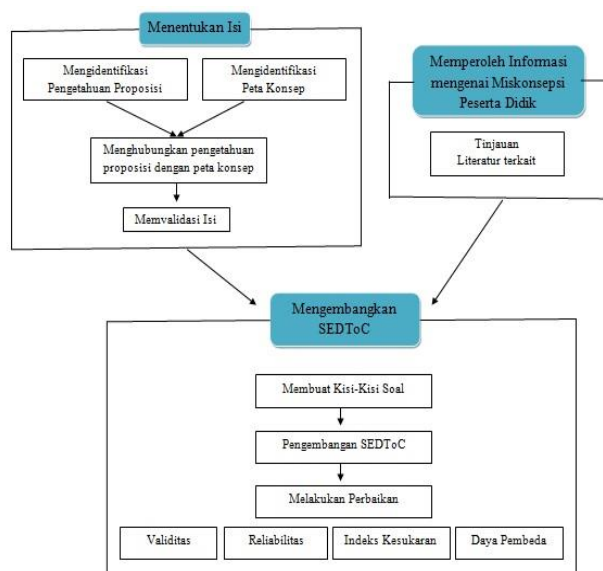


Figure 1. Research Methods

The subjects of this study were 30 students of Class XI at SMAN 1 Pantai Cermin who had studied the reaction rate material, 2 chemistry teachers and 3 chemistry lecturers at FMIPA, UNP. The object of this research is the Structured Essay Diagnostic Test of Chemistry (SEDToC) on reaction rate material.

### 3. RESULT AND DISCUSSION

#### 3.1. Definition of Content

The first step is to identify the propositional knowledge statement on reaction rates that refers to the 2013 revised 2018 curriculum. The content for reaction rates is listed in KD 3.6, namely explaining the factors that affect reaction rate using collision theory, and KD 3.7, determining the reaction order and rate constants from experimental data. At this stage concepts related to reaction rates are obtained, where these concepts come from source books. In the propositional knowledge statement table there are concepts, concept definitions and reaction rate prerequisite concepts. For reaction rate, the only prerequisite concept is stoichiometry. There are twelve concepts related to the matter of reaction rate, namely: reaction rate, concentration, surface area, catalyst, collision theory, reaction rate law/equation, reaction order and reaction rate constant (k). The above concepts are listed in Table

1

Table 1 Concepts in the Proposition Table

Reaction rate	Stoichiometry
1. Reaction rate	1. Molarity
2. Concentration	2. Chemical Reaction
3. Surface area	3. Chemical equation
4. Temperature	
5. Catalyst	
6. Collision Theory	
7. The Law/Equation of Reaction Rate	
8. Order of Reaction	
9. 0 order reaction	
10. 1st order reactions	
11. 2nd order reaction	
12. Reaction rate constant (k).	

#### 3.2. Gathering information about students' misunderstanding of concepts

The next step is to gather information about the students' misunderstanding of concepts. This aims of this stage is to obtain information about the misunderstanding of concepts experienced by students. Misunderstanding of this concept occurs when the understanding of the concept mastered by students is inversely proportional to the concept expressed by experts. Misunderstanding of the concept experienced by students in the reaction rate material obtained from a literature review and distribution of questionnaires to nine high school chemistry teachers in West Sumatra. The results showed that students had difficulties determining the order of the reaction and the formula for determining the reaction rate equation, which is the determination of the reaction rate constant (k). Regarding the factors that affect the rate of reaction, students have misconceptions about the concept of surface area, the effect of temperature and catalysts. In addition, the teachers was unable to identify the causes of the students' misconceptions through the results of the interviews conducted [7].

#### 3.3. Development of Diagnostic Tests

The activity carried out at this stage is to create a grid of questions based on the stage of identifying the misunderstandings of concepts experienced by the students. The steps carried out earlier aim to make the SEDToC instrument include the concepts in propositional knowledge statements and concept maps<sup>[1]</sup>. The development of the SEDToC instrument is based on a grid of questions, the design of the questions created is in the form of structured essay questions whose answers are limited so that the answers to the previous questions are related to the next ones, the questions developed total 5 questions where out of 5 questions there are several sub-questions so that the total number of questions as many as 10 questions. The prepared questions are then corrected through validity, discriminatory and reliability, difficulty index tests. The tests are carried out so that the resulting instrument meets

the criteria for a good instrument <sup>[15]</sup> .

### 3.3.1 Validity and Reliability

The validity of the item is derived from the results of validation carried out by five validators. Validation was carried out with a validation sheet using the Guttman scale for each item with a 'yes' and 'no' answer. The validation results were then obtained and analysed using the Content Validity Index (CVI) approach <sup>[18]</sup>. Validation is performed only once, as all items were declared valid by the validator with the acquisition of S-CVI = 1. Suggestions and input obtained from the validator include the use of language and conjunctions in the questions and writing the correct chemical reactions. An instrument can be said to be valid if 80% of the validators agree or the I-CVI value obtained is 0.8 <sup>[17,19]</sup> .

Reliability is a measure of a test's ability to remain consistent after repeated administration. The reliability test in this test refers to the Cronbach Alpha formula, because the questions developed are in the form of essay questions (description), the reliability value obtained is more than 0.6 with high criteria. When testing the reliability of this test, the results obtained were 0.84 <sup>[12]</sup> . Therefore, it can be concluded that the developed SEDToC instrument for the reaction rate material developed has a high reliability value <sup>[12]</sup> . In order to obtain the Cronbach Alpha value, the formula is used:

$$r_{ac} = \left( \frac{k}{k-1} \right) \left( 1 - \frac{\sum \sigma_i^2}{\sigma_t^2} \right)$$

Keterangan :

$r_{ac}$  = Reliabilitas Cronbach Alpha

$k$  = Banyak soal esai

$\sum \sigma_i^2$  = Jumlah varians skor tiap item

$\sigma_t^2$  = Varians skor total

### 3.3.2 Difficulty Index and Discrimination Index

The level of difficulty of the questions can be seen from the results of the students' answers to the questions made. Questions can be categorised as good if the questions are in the easy to difficult range <sup>[21]</sup> . Based on the results of the analysis of the difficulty index of the SEDToC instrument for the reaction rate material, it was found that 30% of the questions were included in the easy category, especially in the molarity sub-material. Factors that affect the rate of reaction include the influence of concentration, surface area, temperature and the 10% difficult category in the sub-material under the influence of the catalyst.

Analysis of the discrimination index of the items obtained as much as 10% of the items in the poor category and 20% of the items in the sufficient category in the sub-material of molarity determination, 40% in the good category in the

sub-material of factors affecting the rate of reaction and 30% in the very good category in the sub-material for determining the order of the reaction, the reaction rate equation and the determination of the reaction rate constant (k). 10% of the item items in the poor category are prerequisite questions that students have ideally understood, these items can be retained because the cause of these items is classified as poor because students make errors in the calculation process. There are 4 items on the sub material factors affecting the rate of reaction, 3 items on the sub-material molarity, 1 item on determining the order of the reaction, 1 question on the equation of the rate of reaction and 1 question is on determining the rate constant of the reaction.

## 4. CONCLUSION

The conclusion from the research results is that the developed SEDToC instrument is valid. With a reliability of 0.84. Difficulty index of 30% questions at easy level, 60% questions at medium level and 10% questions at difficult level. While the discrimination index of 10% is classified as poor, 20% is classified as sufficient, 40% is classified as good and 30% is classified as very good. The discrimination index of the questions classified as poor can be maintained because they are classified as prerequisite concepts, this is because students make errors in calculations.

## REFERENSI

1. Faridah. Miskonsepsi dalam Topik Elektrolisis dikalangan Pelajar Tingkatan Empat Di Daerah Tanah Merah, Kelantan. Tesis. In Johor Bahru: Universiti Teknologi Malaysia. Malaysia; 2004.
2. Effendy. Upaya Untuk Mengatasi Kesalahan Konsep dalam Pengajaran Kimia dengan Menggunakan Strategi Konflik Kognitif. *J Media Komun Kim.* 2002;2(6).
3. Kaya, E.E dan Geban O. Facilitating Conceptual Change In Rate of Reaction Concepts Using Conceptual Change Oriented Instruction. *J Educ Sci.* 2013;Vol.37,(No.163).
4. Sari NKE. Pengembangan Tes Diagnostik Two-Tier Sebagai Instrumen Alternatif untuk Mendeteksi Miskonsepsi Siswa SMA pada Materi Laju Reaksi. Skripsi: UPI; 2013.
5. Fahmi & Irhasyurna Y. Misconceptions of Reaction Rates on High School Level in Banjarmasin. *IOSR J Res Method Educ (IOSR-JRME).* 2017;7(54-61).
6. Qurbaniah WW dan M. Deskripsi Kemampuan Multirepresentasi pada Materi Laju Reaksi Siswa Kelas XI IPA SMA Muhammadiyah 1 Ketapang. *Ar-Razi J.* 2018;Vol. 6, No(ISSN: 2503-4448, pp: 144-155):hlm 146.
7. Nazar, Muhammad., Sulastri., Winarni, Sri., Fitriana R. Identifikasi Miskonsepsi Siswa SMA pada Konsep Faktor-faktor yang Mempengaruhi Laju Reaksi. *J Biol Edukasi Progr Stud Pendidik Biol FKIP Unsyiah.* 2010;vol 2(no 2).

8. Suprijono A. Cooperative Learning : Teori dan Aplikasi PAIKEM. Yogyakarta: Pusaka Pelajar; 2010.
9. Suparno P. Miskonsepsi & perubahan konsep pendidikan fisika. Jakarta: Grasindo; 2005.
10. Pembinaan D, Menengah S, Jenderal D, Dasar P, Menengah DAN, Pendidikan K, et al. Panduan Penilaian oleh Pendidik dan Satuan Pendidikan Sekolah Menengah Atas. 2017;
11. Tuysuz. Development of Two-tier Diagnostic Instrument and Assess Students' Understanding in Chemistry. Acad J. 2009;4(6).(626-631).
12. Treagust DF. Development and use of diagnostic tests to evaluate students ' misconceptions in science. 2014;(December).
13. Arikunto S. Dasar-dasar Evaluasi Pendidikan. Jakarta: Bumi Aksara; 2013.
14. Suwanto. Pengembangan Tes Diagnostik dalam Pembelajaran. Jakarta: Pustaka Pelajar; 2013.
15. Gurel DK, Eryilmaz A, McDermott LC. A review and comparison of diagnostic instruments to identify students' misconceptions in science. Eurasia J Math Sci Technol Educ. 2015;11(5):989–1008.
16. Fitriza, Zonalia; Aini, Q.R;Handayani, P;Munira I. Development of structured essay diagnostic test of chemistry ( SEDToC ) to investigate senior high school student ' s conception of buffer solution Student ' s Conception of Buffer Solution. 3rd Int Semin Chem Educ. 2020;020012.
17. Nasional DP, Jenderal D, Pendidikan M, Dan D, Pembinaan D, Menengah S. Tes diagnostik. 2007;
18. Davis LL. Instrument review: Getting the most from a panel of experts. Appl Nurs Res. 1992;5(4):194–7.
19. Taherdoost H. Validity and Reliability of the Research Instrument: How to Test the Validation of Questionnaire/Survey in Research. Int J Acad Res Manag (IJARM),. 2016;5(3),.(28–36).
20. Polit DF, Beck CT, Owen S V. Focus on research methods: Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Res Nurs Heal. 2007;30(4):459–67.
21. Sulistyorini. Evaluasi Pendidikan dalam Meningkatkan Mutu Pendidikan. Yogyakarta: Teras; 2009. 174 p.