Vol.12 (2), 2023, 263-272 DOI: 10.23960/jppk.v12.i2.2023.26
Jurnal Pendidikan dan Pembelajaran Kimia
e-ISSN: 2714-9595| p-ISSN 2302-1772
http://jurnal.fkip.unila.ac.id/index.php/JPK/index

Interactive e-Module with Conceptual Change Strategy to Reduce Misconceptions on Chemical Equilibrium Material

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Received: July 15th, 2023 Accepted: July 23th, 2023 Online Published: August 2nd, 2023

Abstract: Interactive E-Module with Conceptual Change Strategy to Reduce Misconceptions on Chemical Equilibrium Material. This study aims to describe the validity, practicality and effectiveness of interactive e-modules using conceptual change strategies in reducing students' misconceptions on chemical equilibrium material. The method used uses the development model by Borg and Gall with limitations only at the sixth stage, namely product trials. The research was conducted with the research subjects were grade XI students who experienced misconceptions. The data analysis technique used is to determine the mode of the validation results, calculate the percentage of the response questionnaire sheet, and through the calculation of misconception shifts. Based on the results of the study, it can be concluded that the interactive e-module developed is feasible to use because it meets the validity criteria with the mode on content and construct validity are 4 and 5 respectively so it is said to be valid, practicality with the percentage of student response questionnaire sheet with the percentage obtained is 95.65% so it is said to be practical and effectiveness with the misconception shift obtained is 88.89% which shows very effective to reduce misconceptions.
Keywords: interactive e-module, conceptual change, misconception. chemical equilibrium.

Abstrak: E-Modul Interaktif dengan Strategi Conceptual Change untuk Mereduksi Miskonsepsi pada Materi Kesetimbangan Kimia. *Penelitian ini bertujuan untuk mendeskripsikan validitas, kepraktisan dan keefektifan e-modul interaktif menggunakan strategi conceptual change dalam mereduksi miskonsepsi peserta didik pada materi kesetimbangan kimia. Metode yang digunakan menggunakan model pengembangan oleh Borg and Gall dengan batasan hanya pada tahap keenam yaitu uji coba produk. Penelitian dilaksanakan dengan subyek penelitian adalah peserta didik kelas XI yang mengalami miskonsepsi. Teknik analisis data yang digunakan adalah dengan menentukan modus dari hasil validasi, menghitung persentase dari lembar angket respon, serta melalui perhitungan pergeseran miskonsepsi. Berdasarkan hasil penelitian maka dapat disimpulkan bahwa e-modul interaktif yang dikembangan layak digunakan karena memenuhi kriteria validitas dengan modus pada validitas isi dan konstruk berturut-turut adalah 4 dan 5 sehingga dikatakan valid, kepraktisan dengan persentase lembar angket respon peserta didik dengan persentase yang diperoleh adalah 95,65% sehingga dikatakan praktis dan keefektifan dengan pergeseran miskonsepsi yang diperoleh adalah 88,89% yang menunjukkan sangat efektif untuk mereduksi miskonsepsi*

Kata kunci: *e-modul interaktif, conceptual change, miskonsepsi. kesetimbangan kimia*

▪ INTRODUCTION

Chemistry is one of the branches of science that studies matter and its changes, while what is meant by matter is everything that occupies space and has mass (Chang, 2003). Based on this definition, it can be interpreted that chemistry is a science that studies all about life, because of the broad scope of discussion sometimes chemistry seems more difficult even at the basic level. There are several reasons that make chemistry seem difficult, namely because the concept is abstract (Chang, 2003).

One of the difficult chemistry materials is chemical equilibrium. Chemical equilibrium is difficult material, due to the abstract nature of the material and supported by the need for mathematical ability and integration of previous material as a basis for chemical equilibrium material (Lukum et al., 2015). The statement is also supported by initial observation data which shows that 70.6% of students consider that chemical equilibrium material is difficult material due to abstract material and must connect with previous material.

The concept of chemical equilibrium which is interrelated with other concepts makes it difficult for students to integrate new information, if students' knowledge is lacking to process new information, students will become confused and inaccurate so that misconceptions are formed (Bilgin et al., 2003). Misconception is a concept that is not in accordance with scientific explanations or explanations accepted by experts in the field (Suparno, 2013). Based on a literature study research on students in Sleman Regency showed that 63.42% experienced misconceptions in chemical equilibrium material (Salirawati, 2011). This is also supported by initial observations made by researchers in one of Surabaya's high schools that 79.4% of students experienced misconceptions in chemical equilibrium material, especially in the sub-material of factors that affect the direction of chemical equilibrium shifts. Based on this data, there are many students who are not aware of having misconceptions, so it is necessary to take steps to identify misconceptions contained by students.

Misconception identification can be detected in various ways, namely through interview instruments, open-ended tests, multiple-choice tests, and two-tier diagnostic, three-tier diagnostic, and four-tier diagnostic (Gurel et al., 2015). Each instrument to identify misconceptions has its own advantages and disadvantages, but the four-tier diagnostic has better sensitivity than the others. That is because this test can identify variations in content knowledge, explanatory knowledge, as well as the beliefs and strengths of students' understanding, therefore in this study using four-tier diagnostic to identify misconceptions in students (Caleon & Subramaniam, 2009).

Misconceptions that exist in students must be reduced, because the presence of misconceptions can interfere with further learning, so that students will find it difficult to associate new concepts with old concepts that have been built in their cognitive structure (Suparno, 2013). Reducing misconceptions there are various strategies, such as Conceptual Change, Cognitive Conflict, Predict-Observe-explain, predict-discuss-explain-observe-discuss-explain, think aloud protocol (Ibrahim, 2012). The conceptual change strategy is a strategy that is quite effective in reducing misconceptions, because this strategy has phases to foster inductive and deductive thinking skills (Rohmah & Fadly, 2021).

Misconceptions that occur can be caused by various things, apart from abstract chemical materials, misconceptions can also come from the use of teaching materials and textbooks. Misconceptions that occur due to the use of teaching materials occur because of errors in the concepts written in teaching materials so that they will make

misconceptions in students. Errors in the concept are very fatal because the teaching material is useful as a source of guidance in the learning process (Nurulwati et al., 2014). Based on this, it is necessary to have teaching materials in the form of modules that are correct in the presentation of concepts as an appropriate source of guidance.

Module development can be carried out according to needs such as tailored to the interests, attention, abilities, characteristics, and needs of students. Module development must be in accordance with the needs, because if there are errors in module development, it can result in less than optimal understanding of students in learning (Yulaika et al., 2020). One of the innovations that can be used as a development is in the field of information technology, namely through a digital module product which is a module published in digital format, containing text, images, which can be read through a computer or other digital device (Yulaika et al., 2020). Digital modules or commonly called E-Modules have various advantages such as being easy to access and easy to share via social media (Yulaika et al., 2020).

The use of this interactive E-Module is supported by Government Regulation No. 19 Article 19 (1) of 2005 concerning National Education Standards which states that learning in schools is carried out interactively, inspiring, fun, challenging, motivating students to actively participate, so it is hoped that misconceptions in students will be reduced. Based on this description, the author is interested in developing a learning media in the form of an E-Module that is suitable for reducing misconceptions in students.

▪ METHOD

The method used in this research is development or reseacrh and development (R&D) proposed by Borg and Gall. There are 10 stages in its implementation, namely (1) potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product trial, (7) product revision, (8) usage trial, (9) product revision, and (10) mass production (Sugiyono, 2013). In this study only at the sixth stage, namely product trials. This is due to the limited time and the lack of ability of researchers in carrying out the next stage.

In this study, the population applied was students of class XI MIPA 7 SMA Negeri 16 Surabaya in the academic year 2022/2023 which amounted to 35 students. The samples needed in this study are students who experience misconceptions which are determined based on the pretest results. It was found that 18 students had misconceptions and continued with the trial of the interactive e-module that had been developed.

The data collection technique in this study was carried out using a questionnaire method, observation method and test method with the instruments used were media validation sheets, student response questionnaires, student activity observations, and pretest and posttest sheets.

In this study, the data analysis techniques used were validity, practicality and effectiveness data analysis. In the validity data analysis, the data used were the results of validation by three validators consisting of two chemistry education lecturers and one chemistry teacher. The three validators conducted validation assessments using a Likert scale with rules such as Table 1.

Table 1. Likert scale description

Scale	Category
1	Very unfavorable

Scale	Category
2	Not good
3	Good enough
4	Good
5	Very good

(Riduwan, 2015)

The validation data is in the form of ordinal data which makes it unable to be operated by mathematics, so that the validation data can be processed using the mode. The use of mode is a decision for each aspect determined by the highest number provided that each aspect has a minimum score of 3 (Lutfi, 2021). Analysis of validity data if the score ≥ 3 is found, it can be declared valid, while if the score < 3 is found, it is declared invalid and must make revisions until it reaches the predetermined criteria, namely score ≥ 3.

In the practicality data analysis, the data used is the results of the learner response questionnaire which is supported by the results of the observation of learner activities. The results of the assessment of the learner response questionnaire and the results of the observation of learner activities are both analyzed using the practicality percentage formula, which is as follows.

$$P\ (\%) = \frac{total\ score}{score\ maximum}\ x\ 100\%$$

The percentage of the results of the learner response questionnaire and the results of the observation of learner activities are then interpreted in accordance with the criteria for practicality in accordance with Table 2.

Table 2. Practically level classification

Scale	Category
0 – 20	Very inpractical
21 – 40	Impractical
41 – 60	Practical enough
61 – 80	Practical
81 – 100	Very practical

(Riduwan, 2015)

In the effectiveness data analysis, the data used are the results of the pretest and posttest. The pretest and posttest questions were developed according to identify misconceptions with the four-tier diagnostic test method. In each question there will be four levels, consisting of questions, confidence in the answer to the question, the reason for the answer to the first question, and confidence in the answer to the reason (Hesti, 2022). In this method, students' answers can also be classified according to Table 3.

Table 3. Combination Answers four-tier diagnostic test

No.	Category	Combination of Answer			
		Answer	Confidence level	Reason	Confidence level
1.	Know the Concept (TK)	True	Sure	True	Sure
2.	Does not know the concept (TTK)	True	Not Sure	True	Not Sure
		True	Sure	True	Not Sure

No.	Category	Combination of Answer			
		Answer	Confidence level	Reason	Confidence level
		True	Not Sure	True	Sure
		True	Not Sure	False	Not Sure
		False	Not Sure	True	Not Sure
		False	Not Sure	False	Not Sure
		True	Sure	False	Not Sure
		False	Not Sure	True	Sure
3.	Misconception 1 (M1)	True	Not Sure	False	Sure
	Misconception 2 (M2)	True	Sure	False	Sure
	Misconception 3 (M3)	False	Sure	True	Not Sure
	Misconception 4 (M4)	False	Sure	True	Sure
	Misconception 5 (M5)	False	Sure	False	Not Sure
	Misconception 6 (M6)	False	Not Sure	False	Sure
	Misconception 7 (M7)	False	Sure	False	Sure

(Fariyani et al., 2015)

The pretest and posttest data obtained can be entered into the conception shift formula with the following formula.

$$concept\ shift(\%) = \frac{\sum initial\ misconceptions - know\ the\ concept\ (M - TK)}{\sum initial\ misconceptions\ (M)}\ x\ 100\%$$

(Fariki & Novita, 2021)

Interactive e-modules can be declared effective when the percent of concept shift is ≥ 61%.

▪ RESULT AND DISCUSSION

The e-module developed using the conceptual change strategy, the development of the e-module is then tested for feasibility based on validity, practicality and effectiveness. The results of this study are as follows

Product Design

At this stage begins with designing the module through Microsoft Office Word which is then decorated using an attractive layout and cover. The ready module is then uploaded in the flipbook application to give an interactive impression. Here's a look at the finished interactive e-module.

Figure 1. E-Module cover

This E-Module has a cover that can represent the content. This E-module also contains information before using, such as learning indicators, description of chemical equilibrium material, conceptual change strategy, instructions for use, knowledge of features in the e-module.

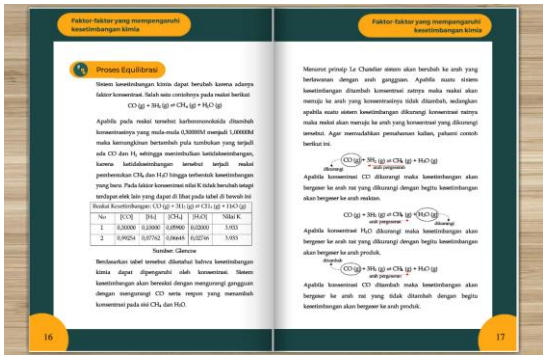

Figure 2. Stages of conceptual change

This e-module has also been in accordance with the stages of conceptual change, namely 1) showing the status of misconceptions, 2) creating conceptual conflicts, 3) the process of equilibration, 4) concept reconstruction (Davis, 2001). The e-module designed to reduce misconceptions also contains evaluation questions that have been combined using the four tier diagnostic test.

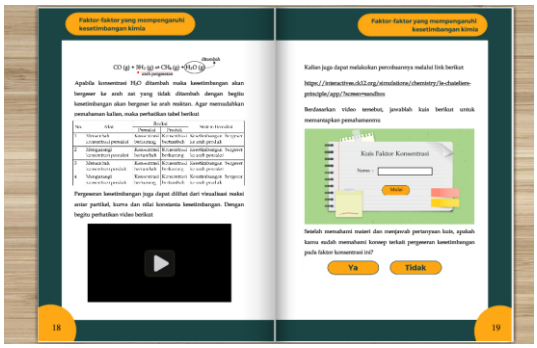

Figure 3. Features in e-module

The interactive e-module has various features that can support learning such as images that can be enlarged, quizzes that can show the results of the work, and videos in the form of laboratory experiments and videos that have been linked to chemical representations on microscopic visualization.

Design Validation

Validation of the interactive e-module design using the conceptual change strategy was carried out by two chemistry education lecturers and one chemistry teacher. Validators will validate the interactive e-module that has been revised after being reviewed with assessment criteria based on a Likert scale. The assessment is carried out by selecting a number from 1-5 according to the assessment that represents each aspect, then the assessment of the three validators will be calculated using the mode to determine the validity of each aspect. The interactive e-module is said to be valid if each aspect gets a mode ≥ 3 (Lutfi, 2021).

Table 4. Result of e-module validation

No	Validity	Score Mode	Category
1	Content Validity	4	Good
2	Construct Validity	5	Very Good

In content validity, it gets mode 4 with the good category, that is because the content in the e-module is in accordance with the learning objectives to be achieved and the concept is correct, besides that the conceptual change stage in the e-module is appropriate. While in construct validity, it gets mode 5 with a very good category, that is because aspects of language, presentation, media interactivity and graphics are appropriate and comfortable to use. Based on the results of this mode, it can be stated that the e-module developed is valid and can be used.

Design Revision

The next stage after obtaining the validation results is to revise the product according to the input by the validators, some suggestions from validators such as, improving writing in accordance with appropriate language rules, adding translations to videos that use English to make it easier for students to understand the video, and adding images to readings that contain phenomena to attract students to learn more.

Product Trial

The trial was conducted a one group pretest-posttest design by comparing the pretest results when before using the interactive e-module with conceptual change strategy with the posttest results, namely after using the interactive e-module with conceptual change strategy. From the trial, a result of practicality and effectiveness was obtained which will be discussed as follows:

Practicality

Practicality data analysis is reviewed from the results of the student response questionnaire, the following data are the results of student response questionnaires

Table 5. The results of the student response questionnaire

No.	Criteria	Percentage	Category
1.	Ease of use	89%	Very practical
2.	Learning motivation	94,33%	Very practical
3.	Language	98%	Very practical
4.	Media features	97%	Very practical

Based on the table, there are four criteria, namely ease of using interactive e-modules, learning motivation, language, and media features with a total of 9 questions.

In the criteria for ease of use, there is only one question item with a percentage obtained of 89% which indicates that the e-module is very easy to use. This is in accordance with the characteristics of the module that a module must be easy to use. (Suwartaya et al., 2020).

In the learning motivation criteria, there are three questions with an average percentage obtained of 94.33%, which indicates that the e-module can motivate students to learn. This is in accordance with the conceptual change stage which must motivate students to want to change their wrong conceptions so that the misconceptions that exist in students can be reduced (Mandasari & Sukarmin, 2020).

In the language criteria, there are three questions with an average percentage obtained of 98% which indicates that the e-module has appropriate language so that it is easy to understand, It is appropriate that a module must use good language and be easy to understand. (Depdiknas, 2008).

In the media features criteria, there are two questions related to videos, images and material related to everyday life which get an average percentage of 97%, indicating that the e-module has features that support its use. This is appropriate because the use of media features can correct misconceptions that occur (Hidayat et al., 2015) and linking material in everyday life can make learning more meaningful and easy to understand (Hindasah, 2010).

Apart from the results of the students' response questionnaire, practicality is also supported by the results of observations of students' activities whose data are as follows

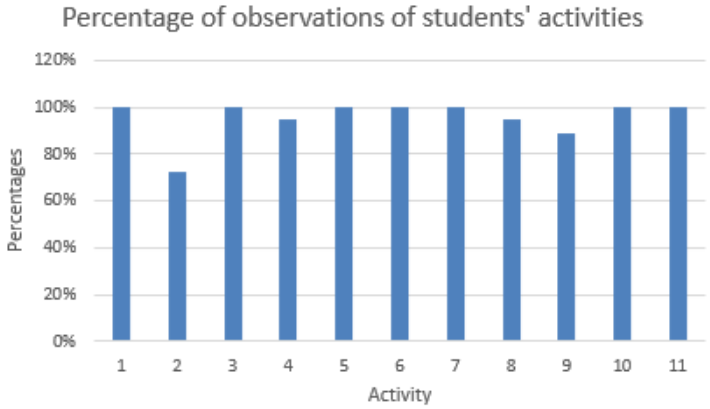

Figure 4. Percentage of observation of student' activities

Based on the average of the results of the learner response questionnaire and the results of the learner activity observation, it can be seen that it has a percentage of 95.68% and 95.96% respectively, which indicates that the e-module is very practical.

Effectiveness

In this effectiveness is reviewed from the shift in the conception of students who initially misconceptions to know the concept. This conception shift can be seen from the comparison of pretest and posttest results. The following is a table of the overall results of students' conceptions

Table 6. conception shift results

No	Concept shift	Percentage of concentration factor	Percentage of pressure and volume factors	Percentage of temperature factors	Percentage of catalyst factors
1	M - M	9,5%	6,1%	3,3%	9,1%
2	M - TK	90,5%	87,9%	93,3%	84,8%
3	M - TTK	0,0%	6,1%	3,3%	6,1%

Based on the table above, it can be seen that many students whose misconceptions are reduced are indicated by a shift in the conception of students who were initially misconceptions to know the concept. This happens because the interactive e-module uses a conceptual change strategy that can help students to reduce their misconceptions (Yani et al., 2018). In line with that, the reduction of misconceptions is also supported by the

interactivity of the e-module which contains an image and video that can make it easier for students to understand the material (Hidayat et al., 2015).

Based on the Table 6, it can be seen that almost all students have been able to reduce their misconceptions by shifting students' misconceptions to know the concept. But there are also students who were initially misconceptions and still experience misconceptions, this can happen because students have difficulty understanding abstract concepts, this is because based on Piaget's developmental theory when students are unable to pass the formal operational stage, students will have difficulty understanding abstract material (Mandasari & Sukarmin, 2020).

Based on this description, the overall shift in the conception of students who were initially misconceptions to know the concept (M-TK) was 88.89% so that it could be said that the e-module developed was very effective for reducing misconceptions.

▪ CONCLUSION

Based on the results of the study obtained the results of content and construct validation successively get mode 4 and 5 so that it can be said to be valid, the results of practicality in terms of student response questionnaires and supported by the results of observations of student activities obtained percentages respectively are 95.68% and 95.96% so that it can be said to be practical, and the results of effectiveness in terms of shifting misconceptions obtained 88.89% experienced a shift in concepts from misconceptions to understanding concepts so that it can be said to be effective. So it can be concluded that the e-module developed is said to be feasible.

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