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Development of Interactive E-Modules Using Conceptual Change Text Strategies to Reduce Student Misconceptions on Solution Colligative Properties

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Abstract: Development of Interactive E-Modules Using Conceptual Change Text Strategies to Reduce Student Misconceptions on The Material Colligative Properties of Solutions. *The purpose of this study is to obtain interactive e-module products using conceptual change text strategies to reduce student misconceptions on the material colligative properties of solutions that are suitable for use. The colligative nature of solutions is a chemical material that is considered difficult because it is abstract and complex, causing students to find it difficult to understand the material. Learners who have difficulty in understanding the material's colligative properties of solutions can lead to misconceptions. To reduce misconceptions, an effort is needed, namely using a conceptual change text strategy packaged in the form of electronic learning media such as interactive e-modules. This study was prepared using research and development (R&D) research methods development model by Borg and Gall with descriptive analysis based on mode and shift misconceptions. Interactive e-module using conceptual change text strategy to reduce students' misconceptions on the material colligative properties of solutions are declared feasible based on content validity and construct, practicality and effectiveness. The validity of the content and construct obtained 4 or valid modes, practicality with a percentage of response questionnaire sheets of 95.8% or very practical and the percentage of observation sheets of student activities of 92.94% or very practical, and effectiveness in terms of the results of shifting misconceptions obtained by 87.36%. The results showed that the interactive e-module using the conceptual change text strategy to reduce students' misconceptions on the material colligative properties of the solution was declared feasible for use.*

Keywords: Interactive E-module, Conceptual Change Text, Misconceptions, Colligative Properties of Solutions.

Abstrak: Pengembangan E-Modul Interaktif dengan Menggunakan Strategi Conceptual Change Text untuk Mereduksi Miskonsepsi Peserta Didik pada Materi Sifat Koligatif Larutan. *Tujuan dari penelitian ini adalah untuk memperoleh produk e-modul interaktif dengan menggunakan strategi conceptual change text untuk mereduksi miskonsepsi peserta didik pada materi sifat koligatif larutan yang layak digunakan. Sifat koligatif larutan merupakan materi kimia yang dianggap sulit karena bersifat abstrak dan kompleks sehingga menyebabkan peserta didik sulit memahami materi. Peserta didik yang mengalami kesulitan dalam memahami materi sifat koligatif larutan dapat menyebabkan miskonsepsi. Untuk mereduksi miskonsepsi diperlukan suatu upaya yaitu menggunakan strategi conceptual change text yang dikemas dalam bentuk media belajar elektronik seperti e-modul interaktif. Penelitian ini disusun menggunakan metode penelitian research and development (R&D) model pengembangan oleh Borg and Gall dengan analisis deskriptif berdasarkan modus dan pergeseran miskonsepsi. E-modul interaktif dengan menggunakan strategi conceptual change text untuk mereduksi miskonsepsi peserta didik pada*

materi sifat koligatif larutan dinyatakan layak berdasarkan validitas isi dan konstruk, kepraktisan dan keefektifan. Validitas isi dan konstruk didapatkan modus masing-masing 4 atau valid, kepraktisan dengan persentase lembar angket respon 95,8% atau sangat praktis dan persentase lembar observasi aktivitas peserta didik 92,94% atau sangat praktis, serta keefektifan ditinjau dari hasil pergeseran miskonsepsi yang diperoleh sebesar 87,36%. Hasil penelitian menunjukkan bahwa e-modul interaktif dengan menggunakan strategi conceptual change text untuk mereduksi miskonsepsi peserta didik pada materi sifat koligatif larutan dinyatakan layak digunakan.

Kata kunci: *E-modul Interaktif, Conceptual Change Text, Miskonsepsi, Sifat Koligatif Larutan*.

▪ INTRODUCTION

According to Chang (2005), chemistry is a science that studies matter and its changes, including elements and compounds. According to Kartini (2019), chemistry is abstract and complex. It is abstract because there are many formulas and calculations in it, so students consider chemistry as a difficult subject that requires high reasoning in the learning process (Ikhwan, 2020). Complex means that in chemistry, it is not just understanding theory but also needs to be studied through macroscopic, microscopic, and symbolic aspects (Kartini, 2019). These three aspects of chemical representation must be mastered by students in order to understand chemistry deeply and thoroughly. However, many students experience misconceptions due to difficulties in understanding these three aspects of representation (Alfiyanti & Sukarmin, 2020).

One of the chemical materials that allows misconceptions to arise in the understanding of students is the material of the colligative properties of solutions (Wulandari, et al., 2019). Abstract concepts in this material include inter-particle forces, phase changes and the conditions that liquids must have at vapor pressure (Wulandari, 2019). Auliyani, et al. (2017) stated in their research that as many as 33.94% of students experienced misconceptions about the material colligative properties of solutions. This is supported by the results of initial observations made by researchers at SMA Negeri 16 Surabaya, which found that 52% of students experienced misconceptions about the material colligative properties of the solution.

A misconception is a view of a concept that is contrary to expert beliefs (Alifiyanti & Sukarmin, 2020). Students' understanding of a concept can be grouped into 3 groups, namely students who understand the concept (TK), students who do not understand the concept (TTK), and misconception (M) (Parniyanda & Sukarmin, 2022). Diagnostic tests can be used to identify misconceptions (Zainab & Sukarmin, 2020). Researchers detect misconceptions in students using a four-tier diagnostic test (Zainab &; Sukarmin, 2020).

Students who experience misconceptions and are not immediately followed up on can have difficulty learning chemical concepts at the next level (Hastutidkk., 2014). One of the efforts to reduce the occurrence of misconceptions is by using the conceptual change text strategy (Zainab & Sukarmin, 2020). Conceptual change text is a learning strategy based on constructivism and thinking skills (Parniyanda & Sukarmin, 2022). In addition to the right strategy, learning media are also very important to use in the learning process (Mandasari &; Sukarmin, 2020).

Conceptual change texts can be packaged in the form of electronic and print learning media (Sukmawati, et al., 2020). According to the results of an interview with chemistry teachers at SMA Negeri 16 Surabaya, it is known that in chemistry learning, the use of learning media is still very limited and the use of technological developments is relatively low. The right learning media can be developed by utilizing technological

developments so that student misconceptions can be reduced such as by developing electronic modules.

According to Rahmatsyah & Dwiningsih (2021), e-modules are systematic digital learning media that students can use to solving problems independently. Based on the results of previous research, it shows that the use of e-modules in the learning process can reduce student misconceptions (Imaningtyas, 2016; Erna, et al., 2021; Prastyo, et al., 2021). E-modules can be redeveloped into interactive e-modules so that students will be actively involved in the learning process and effective learning can be created. To enhance learners' understanding of chemistry, this interactive e-module to be developed may include three representations of chemistry. Three chemical representations can help learners understand chemical concepts (Apriani, 2021).

With the help of professional PDF flip software, this interactive e-module will be developed. Flip PDF Professional Software is an application that can be used to convert PDF publications into digital flipping pages. This allows you to create interactive learning content with many supporting features (Rindaryati, 2021).

Based on the above background, researchers are encouraged to conduct research entitled: "Development of Interactive E-Modules Using Conceptual Change Text Strategies to Reduce Student Misconceptions on the Colligative Properties of Solution Material".

▪ METHOD

This research method uses the Research and Development (R&D) development model by Borg and Gall. The R&D method, according to Sugiyono (2013) has 10 steps of research and development: (1) Potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product trial, (7) product revision, (8) use trial, (9) product revision, (10) mass product manufacturing. This R&D research is limited to stage 6, which is the product trial stage.

The stage of potential and problems is where researchers collect information related to problems that often occur in schools by means of field studies and literature studies. At this stage, it was found that the potential of teachers and students has supported the implementation of interactive e-module development research using conceptual change text strategies to reduce student misconceptions about the colligative nature of the solution.

Data collection stage, data collection obtained through pre-research that has been conducted at SMA Negeri 16 Surabaya. Pre-research was conducted to determine the level of understanding of students towards the material colligative properties of solutions. The pre-research results showed that 52% of students experienced misconceptions about the colligative properties of the solution, so researchers could develop teaching materials in the form of interactive e-modules using conceptual change text strategies to reduce student misconceptions on the colligative properties of the solution.

At the product design stage, carry out a rough draft of the e-module design with Microsoft Office Word, refine it with additional decorations, layouts, and covers, and then insert the draft e-module in the flipbook application.

Design revision stage, at the design revision stage is carried out after validation, and improvements are made based on suggestions and comments from validators.

In the product trial phase, after the interactive e-module developed is declared valid by validators, the product will be tested.

▪ RESULT AND DISCUSSION

The feasibility of the developed product is reviewed based on the validity of the content and construct, the practicality of the media based on the response questionnaire and observation of student activities, and the effectiveness of the media based on the results of shifting student misconceptions. The following is a description of the three feasibility aspects of this interactive e-module.

a) Validity

The validation of this interactive e-module is carried out to determine the validity of the content and the validity of the construct as part of the four media eligibility criteria. The validation process uses two instruments, namely content validation sheets and construct validation with the assessment scale of each aspect is 1 to 5. Likert Scale scores can be seen in Table 1 below.

Table 1. Likert Scale

Score	Category
1	Very unfavorable
2	Not good
3	Good enough
4	Good
5	Very good

(Riduwan, 2015)

The assessment obtained will be calculated using mode to determine validity in each aspect. The interactive e-module developed can be declared valid if it gets a mode score ≥ 3 (Lutfi, 2021). The results of the validation of the interactive e-module developed are as follows.

Table 2. Validation Results Data

No	Validity	Score Mode	Category
1	Content validity	4	Good
2	Construct validity	4	Good

Based on table 2, the developed interactive e-module obtains a mode score of 4, which can be categorized as indicating that this interactive e-module is valid. Content validation consists of several aspects, which include the suitability of the material with learning objectives, the correctness of concepts in the material in the e-module, and the suitability of the content of the e-module to reduce misconceptions using the conceptual change text strategy. While construct validation consists of several aspects, which include the use of language in e-modules, presentation in e-modules, interactivity in e-modules, and graphical display in e-modules.

b) Practicality

The practicality of the products developed is reviewed based on the results of student response questionnaires supported by observations of student activities. The

student response questionnaire contains 10 questions regarding the feasibility of presenting the e-module display, language clarity and ease of operation of the e-module, as well as the level of student motivation to learn using the e-module. The results of the questionnaire response and observation of student activities were calculated using the Guttman Scale as follows.

Table 3. Guttman Scale Score for Positive Statements

Statement	Score
Yes	1
No	0

Table 4. Guttman Scale Score for Negative Statements

Statement	Score
Yes	0
No	1

The percentage of student response results to the use of the product can be known through the following formula:

$$Persentase\ (\%) = \frac{number\ of\ answers}{maximum\ total\ score} \times 100\%$$

The results of the percentages obtained are interpreted into the following score criteria:

Table 5. Media Practicality Score Interpretation Criteria

Persentase (%)	Category
0-20	Very poor
21-40	Poor
41-60	Fair
61-80	Good/practical
81-100	Excellent/ Very practical

The results of the student response questionnaire were obtained by 95.8% and the results of observations of student activities by 92.94%. The e-module developed is included in the very practical category if the percentage obtained in the response questionnaire and the results of observations of student activities ≥ 61%.

c) Effectiveness

Effectiveness is obtained based on the results of shifting student conceptions obtained after students test the product. The interactive e-module developed can be said to be effective if it can be understood well when operated by students and can shift students' understanding from misconceptions to concepts. The initial concept understanding of students is obtained based on the results of the student *pretest* which will then be measured again through *the posttest* to determine the shift in student understanding. Pretest *and* posttest *questions given to students use* a four-tier diagnostic test *to detect student misconceptions.* In the *four-tier test*, there is a classification of student concept understanding categories shown in Table 6 below.

Table 6. Four-tier Test Answer Combination

Answer	Confidence Level of Answers	Reason	Reason Confidence Level	Criteria
True	Sure	True	Sure	Understand the concept (PK)
True	Not Sure	True	Not Sure	Does not understand the concept (TPK)
True	Sure	True	Not Sure	
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	
True	Not Sure	False	Sure	Misconception 1 (M1)
True	Sure	False	Sure	Misconception 2 (M2)
False	Sure	True	Not Sure	Misconception 3 (M3)
False	Sure	True	Sure	Misconception 4 (M4)
False	Sure	False	Not Sure	Misconception 5 (M5)
False	Not Sure	False	Sure	Misconception 6 (M6)
False	Sure	False	Sure	Misconception 7 (M7)

(Fariyani dkk., 2015)

Based on Table 6, the results of the shift in the conception of students will be obtained. The analysis technique used to measure shift in through the following formula:

$$P(\%) = \frac{\sum Misconception - Understand\ the\ concept}{\sum Initial\ misconceptions} \times 100\%$$

(Fariki & Novita, 2021)

Interactive e-modules can be said to be feasible if the effectiveness of the percentage shift of misconceptions reaches .$\geq 61\%$

Misconceptions can be reduced using *the conceptual change text strategy*. According to Yulianing &; Sukarmin (2020), *conceptual change text* strategy is the process of replacing concepts owned by students with new concepts. Based on this, interactive e-modules using the *conceptual change text* strategy developed are very suitable for replacing concepts owned by students with new concepts. This interactive e-module is arranged based on the *stages of conceptual change text*, namely stages (1) showing the conception of students, (2) creating conceptual conflicts, (3) equilibrium processes, (4) concept reconstruction.

Interactive e-modules using the *conceptual change text strategy* are considered suitable for reducing misconceptions in the colligative properties of solutions. This can be seen in the results of the shift in students' conceptions obtained on the concept of decreasing the vapor pressure of the solution, increasing the boiling point of the solution. decrease in freezing point of solution and osmosis pressure.

The shift in students' conception of the concept of decreasing the vapor pressure of the solution can be seen in Table 7.

Table 7. The Results of Shifting Misconceptions of Students on the Concept of Decreasing Vapor Pressure

Student	Question Number	
	3	6
PD01	M-PK	M-TPK
PD02	PK-M	M-PK
PD03	M-PK	M-PK
PD04	M-PK	PK-PK
PD05	M-PK	TPK-PK
PD06	PK-PK	PK-PK
PD07	PK-PK	PK-PK
PD08	M-PK	PK-PK
PD09	PK-PK	PK-PK
PD10	PK-PK	M-PK
PD11	M-PK	M-PK
PD12	M-TPK	TPK-PK
PD13	M-M	M-PK
PD14	M-PK	M-PK
PD15	M-PK	PK-PK
PD16	M-PK	M-TPK
PD17	M-PK	M-PK
Initial misconceptions count	12	9
Number of M-PK	10	7
Persentase	83,33%	77,78%

In question number 3, 10 students experienced a shift in conception from misconception (M) to concept understanding (PK), 1 student was detected experiencing a shift in conception from misconception (M) to not understanding the concept (TPK), 1 student still experienced misconception (M), and 1 student was detected experiencing a shift in conception from concept understanding (PK) to misconception (M). The percentage of the shift in the misconception of the first concept in question number 3 is 83.33%, because there are students who do not experience a shift in conception to understand the concept in *their posttest*.

Based on Table 2 of question number 6, there were 7 students who experienced a shift in conception from misconception (M) to understanding the concept (PK), 2 students who experienced a shift in conception from not understanding the concept (TPK) to understanding the concept (PK), and 2 students who experienced a shift in conception from misconception (M) to not understanding the concept (TPK). The percentage of the shift in the misconception of the first concept in question number 6 is 77.78%, because there are students who misconception (M) experience a shift in the concept to not understand the concept (TPK) in *their posttest*. Many students assume that the presence of solutes in the solution does not affect the magnitude of the decrease in the vapor pressure of the solution so that many students experience misconceptions. According to Barr (2005) which states that the greater the number of solute particles in a solution, the lower the vapor pressure produced.

The shift in learners' conception on the concept of increasing the boiling point of the solution can be seen in Table 8.

Table 8. Results of Shifting Misconceptions of Students on the Concept of Increasing the Boiling Point of Solutions

Student	Question Number	
	4	5
PD01	M-PK	M-PK
PD02	M-PK	M-PK
PD03	TPK-PK	PK-PK
PD04	M-PK	PK-PK
PD05	TPK-PK	TPK-PK
PD06	PK-PK	M-PK
PD07	M-PK	PK-PK
PD08	PK-PK	TPK-PK
PD09	PK-PK	PK-PK
PD10	TPK-PK	TPK-PK
PD11	M-PK	PK-PK
PD12	PK-PK	PK-PK
PD13	M-PK	M-PK
PD14	M-M	PK-PK
PD15	PK-PK	PK-PK
PD16	PK-TPK	M-PK
PD17	M-PK	M-PK
Initial misconceptions count	8	6
Number of M-PK	7	6
Persentase	87,5%	100%

In question number 4, 7 students experienced a shift in conception from misconception (M) to understanding concept (PK), 3 students were detected to have a shift in conception from not understanding the concept (TPK) to understanding the concept (PK), and 1 student still experiencing misconception (M). The percentage of shifting misconceptions of the second concept in question number 4 is 87.5%, because there are students who still experience misconceptions in *their posttest*.

In question number 5, 6 students were detected who experienced misconceptions, 3 students were detected not understanding concepts, and 8 students were detected understanding concepts (PK). Based on Table 4.9 question number 5, there were 6 students who experienced a shift in conception from misconception (M) to understanding the concept (PK), and 3 students who experienced a shift in conception from not understanding the concept (TPK) to understanding the concept (PK). The percentage of the shift in misconceptions of the second concept in question number 5 is 100%, because all students who experience misconceptions (M*) on the pretest* experience a shift in concepts to understand concepts (PK) on *their posttest*. Many students assume that the presence of solutes in a solution can reduce the boiling point of a solution, so many students experience misconceptions on this concept. According to Barr (2005), The increase in boiling point of the solution is directly proportional to the molality of the solute, the greater the number of solute particles in the solution, the greater the increase in the boiling point of the solution.

The shift in learners' conception of the concept of decreasing the freezing point of the solution can be seen in Table 4.

Table 9. Results of Shifting Misconceptions of Students on the Concept of Decreasing the Freezing Point of Solutions

Student	Question Number	
	2	8
PD01	TPK-PK	M-PK
PD02	M-M	M-TPK
PD03	M-PK	M-PK
PD04	M-PK	M-PK
PD05	M-PK	PK-PK
PD06	M-PK	PK-PK
PD07	M-PK	PK-PK
PD08	M-PK	M-PK
PD09	PK-PK	M-PK
PD10	TPK-PK	M-PK
PD11	M-PK	M-PK
PD12	PK-PK	TPK-PK
PD13	M-PK	M-PK
PD14	M-PK	M-PK
PD15	M-PK	PK-PK
PD16	M-TPK	M-PK
PD17	M-PK	M-PK
Initial misconceptions count	13	12
Number of M-PK	11	11
Persentase	84,61%	91,67%

In question number 2, 11 students experienced a shift in conception from misconception (M) to understanding concept (PK), 1 student was detected experiencing a shift in conception from misconception (M) to not understanding the concept (TPK), 2 students experienced a shift in conception from not understanding the concept (TPK) to understanding the concept (PK), and 1 student still experiencing misconception (M). The percentage shift in misconceptions of the third concept in question number 2 is 84.61%, because PD16 does not understand the concept and PD02 is still detected misconceptions.

In question number 8, 12 students were detected who experienced misconceptions, 1 student was detected not understanding the concept (TPK), and 4 students were detected understanding the concept (PK). Based on Table 4.11 question number 8, there were 11 students who experienced a shift in conception from misconception (M) to understanding the concept (PK), 1 student who experienced a shift in conception from not understanding the concept (TPK) to understanding the concept (PK), and 1 student who experienced a shift in misconception from misconception (M) to not understanding the concept (TPK). The percentage of the shift in misconception of the third concept in question number 8 is 91.67%, because there is 1 student who detected a shift in misconception (M) to not understanding the concept (TPK) in posttest.

Many students assume that the presence of solutes in a solution can raise the freezing point of a solution, so many students experience misconceptions on this concept. Though according to Tro (2014) states that a solution that has a solute in it has a lower

freezing point than a pure solvent (water). This means that the presence of solutes in a solution causes a decrease in the freezing point of the solution.

The shift in students' conception of the concept of osmosis pressure can be seen in Table 10.

Table 10. Results of Shifting Misconceptions of Students on the Pressure Concept of Osmosis Solution

Student	Question Number	
	1	7
PD01	M-PK	PK-PK
PD02	M-PK	M-PK
PD03	M-TPK	TPK-PK
PD04	M-PK	M-PK
PD05	TPK-PK	TPK-PK
PD06	PK-PK	M-PK
PD07	TPK-PK	M-PK
PD08	M-PK	M-PK
PD09	M-PK	M-PK
PD10	M-TPK	M-TPK
PD11	M-PK	M-PK
PD12	M-PK	TPK-PK
PD13	M-PK	M-PK
PD14	M-PK	M-PK
PD15	M-PK	M-PK
PD16	M-PK	M-PK
PD17	M-PK	M-PK
Initial misconceptions count	14	13
Number of M-PK	12	12
Persentase	85,71%	92,31%

In question number 1, 12 students experienced a shift in conception from misconception (M) to understanding the concept (PK), 2 students were detected experiencing a shift in conception from not understanding the concept (TPK) to understanding the concept (PK), and 2 students experiencing a shift in concept from misconception (M) to not understanding the concept (TPK). The percentage of the fourth concept misconception shift in question number 1 is 85.71% because there are students who are detected misconceptions (M) experiencing a shift in conception to not understanding the concept (TPK) in the *posttest*.

In question number 7, 13 students were detected who experienced misconceptions, 3 students were detected not understanding concepts, and 1 student was detected understanding concepts (PK). Based on Table 4.13 question number 7, there were 12 students who experienced a shift in conception from misconception (M) to understanding the concept (PK), 3 students who experienced a shift in conception from not understanding the concept (TPK) to understanding the concept (PK), and 1 student who experienced a shift in conception from misconception (M) to not understanding the concept (TPK). The percentage of misconception shift in the fourth concept in question number 7 is 92.31%, because there are students who experience misconceptions (M) in

the pretest experience a shift in concepts to not understand the concept (TPK) on the *posttest*.

Many students assume that solvent particles move from areas with high solute concentrations to areas with low solute concentrations through semipermeable membranes, so many students misconception this concept. Though according to Barr (2005) states that osmosis is a solvent particle passing through a semipermeable membrane from an area with a high solvent concentration to an area with a low solvent concentration

The shift of misconceptions in the four concepts in the colligative properties of the solution can be seen through the graph in figure 1.

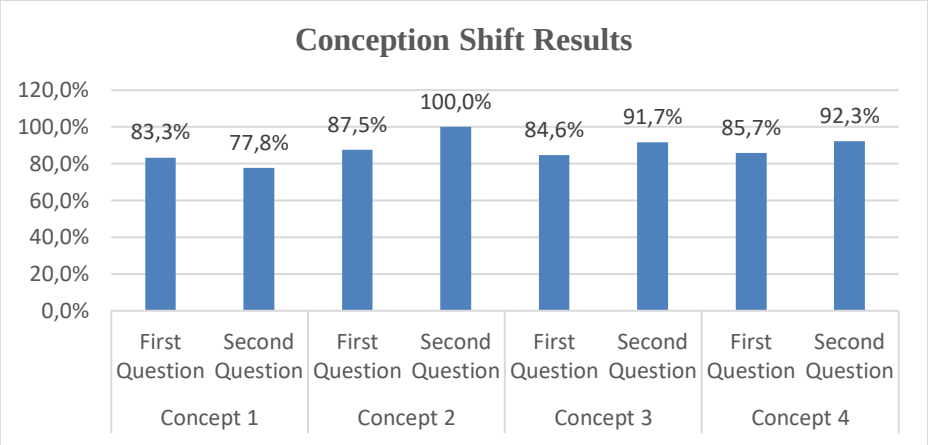

Figure 1. Shifting Students' Conception on the Material Colligative Properties of Solutions

It can be seen that the average percentage of the overall conception shift in the whole concept was obtained at 87.36%. Based on this, it shows that interactive e-modules using conceptual *change text strategies* can be said to be effectively used to reduce student misconceptions on the material colligative properties of solutions.

▪ CONCLUSION

Based on the results of the study, it can be concluded that interactive e-modules using conceptual change text strategies are feasible to be used as a medium to reduce student misconceptions on the material colligative properties of solutions in terms of validity, practicality and effectiveness with the following details:

1. Interactive e-modules using the *conceptual change text* strategy are declared valid in terms of content and construct aspects, each of which obtains a mode value of 4 with a valid category.
2. Interactive e-modules using *conceptual change text strategies* are declared practical to review based on student responses and activities. In the results of the questionnaire, student responses obtained a percentage of 95.8% with a very practical category and the results of observations of student activities obtained a percentage of 92.94% with a very practical category.
3. Interactive e-modules using the *conceptual change text* strategy were declared effective in terms of decreasing student misconceptions, with the average result of the percentage shift in student conceptions from misconceptions to understanding concepts of 87.36% with a very effective category

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