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Analysis of Student Conceptions and Conceptional Changes about Chemical Equilibrium Materials in Concentration Factors

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ABSTRACT

Objective: This study aims to determine the conception and changes in the conception of the concentration factor in chemical equilibrium material. **Method:** The method used in this study is a mixed method, which is a combination of qualitative and quantitative methods, namely the Concurrent Embedded Strategy, which is a combination of qualitative methods and quantitative methods carried out at the same time. **Results:** The test instruments provided can reduce the misconceptions that exist in students when viewed from a comparison of the number of students who experience misconceptions from 13.33% in the first stage to 7.00% in the last stage. Students understand enough about chemical equilibrium shifts but still need clarification, especially in writing down changes in reaction equations when chemical equilibrium is disturbed and analyzing phenomena using metacognitive examples of a concept in their surroundings. **Novelty:** This research reveals that students' misconceptions can be reduced using worksheets with five processing stages. This novelty can provide (1) solutions related to identifying students' misconceptions and (2) reducing students' misconceptions regarding chemical equilibrium concentration factors.

INTRODUCTION

Chemistry is one of the fields of science that is taught to students. Chemistry is the study of reactions to changes in matter in natural processes as well as in planned experiments (Landa, 2020), which are related to natural phenomena that contain the composition, properties, structure, reactions, dynamics, and energetics of a material (Juniar, 2022). Chemistry is often discussed and taught primarily regarding non-observable theoretical entities, such as molecules, electrons, and orbitals, which seem familiar and natural to a chemistry teacher (Taber, 2019).

Mastery of concepts in learning chemistry is significant (Avargil, 2019) as the concept is connected tightly to one another (Irawati, 2019). Therefore, science education must develop students' abilities, understand, and expand their ability to use theoretical knowledge and skills obtained resourcefully and originally. Chemistry is the science that studies the composition, structure, and behavior of substances or matter from the atomic (microscopic) to molecular scale, as well as their changes or transformations and interactions to form matter found in everyday life (Helsy & Andriyani, 2017). Chemistry has three levels, namely macroscopic, submicroscopic, and symbolic. Macroscopic levels can be obtained from direct observation (Ahmar et al., 2020; Gkitzia et al., 2020; Rizqiyyah & Novita, 2022; Sinaga, 2022). Examples of chemicals that can be seen directly are NaOH solution, magnesium ribbon, and rusty iron. At the same time, the submicroscopic level is a chemical level that cannot be observed directly. An example is the chemical reaction between ethanol and acetic acid. An example is a chemical reaction (Kusumaningrum, 2018). To help students understand these basic concepts, explaining equilibrium not only from a macroscopic viewpoint but also with a microscopic interpretation of the situation is recommended. The symbolic level is a qualitative and quantitative representation in the form of formulas, pictures, and diagrams. Many students preferred memorizing chemical concepts at the symbolic level to help understand the symbols' meaning. This situation leads to creating difficulty for students to experience construct explanations at the submicroscopic level related to the macroscopic level phenomena (Suja, 2021). learning should be with multiple representations since it is significant to improve students' learning of chemistry concepts, especially the role of visualization representations to explain the phenomenon of the sub-micro (Quilez, 2018).

Chemical reactions on chemical equilibrium can take place in both directions (forward and backward) or only in one direction. Those that go in both directions are known as reversible reactions and can be identified by arrows pointing in both directions (Novita, 2023). Variables that can be controlled experimentally are concentration, pressure, volume, and temperature. Students feel that chemistry is a complex subject, and students do not have a strong foundation before studying chemical equilibrium material, especially in the submatter of factors that affect chemical equilibrium (Belayneh & Belachew, 2023; Bernal-Ballen & Ladino-Ospina, 2019; Oladejo et al., 2023; Omilani & Elebute, 2020; Rahmawati et al., 2022). Chemical equilibrium matter is one of the abstract, defined, mathematical, and graphic complex matter. In addition, chemical equilibrium is a difficult material to understand because the reaction takes place microscopically, so it cannot be observed directly, especially in the submitter of factors that affect chemical equilibrium. This triggers the occurrence of misconceptions. In addition, chemical equilibrium is also a concept that requires mastery of several other chemical concepts, such as the concept of moles and stoichiometry (Quilez, 2018). The equilibrium problem is the most important and, at the same time, the most complex and challenging problem of general chemistry. So, it is unsurprising that many researchers have discussed it from several perspectives.

The Ministry of Education and Culture (Kemdikbud, 2020) states that 21st-century learning emphasizes students' ability to find out from various sources, formulate problems, think analytically, and work together to solve problems. However, more than the learning process that has taken place is needed to make students actively involved in it. So that the knowledge gained needs to be stronger and can lead to misconceptions. Differences in the concepts that students experience about a phenomenon that occurs in the real world are called misconceptions. Misconceptions usually occur because students' perceptions of phenomena in everyday life are inconsistent with scientific explanations of phenomena, so students' understanding of a concept becomes different (Modell et al., 2017). This can have a negative impact because the concepts that are owned will continue to be used in subsequent learning. When students connect the new information to a cognitive structure with inappropriate knowledge, this misconception interferes with further learning. Thus, a weak understanding of concepts or misconceptions will occur because new information cannot properly relate to their cognitive structure. The analysis needs to show a better understanding of the level of balance, prediction of balance conditions, and application of the principle of balance in everyday life.

Not all mistakes in solving a problem or problem are considered misconceptions because there are differences between misconceptions and ignorance experienced by students. One way to analyze misconceptions is to look at students' mental models. The term mental model was introduced to explain how students form a model of understanding a process by integrating new information with existing knowledge. Misconceptions can be detected by identifying students' initial conceptions. In this way, students' initial conceptions can be identified. If there is a misconception among students, it is necessary to formulate an appropriate strategy to help identify and develop more scientifically acceptable views (Chandrasegaran et al., 2017). Understanding the concept is one of the bases for further learning processes to formulate principles and generalizations of a material.

Knowledge is not just a concept, facts, and principles ready to be understood and remembered. Students must reconstruct this knowledge and give meaning through real-life experiences. Students who are involved in activities related to the analysis of phenomena in real life to acquire concepts will help overcome misconceptions. In particular, research on educational development can make a significant contribution to our understanding of how students acquire and process scientific knowledge, overcome misunderstandings, study the discourse of scientists, learn to think and reason like a scientist, evaluate sources of scientific information, and justify personal beliefs with scientific content. Identifying students' misconceptions and learning difficulties and finding effective ways to overcome them has become one of the main concerns in chemistry education. Understanding the concept is one of the bases for further learning processes to formulate principles and generalizations of a material. Misconceptions about chemical equilibrium are influenced by students' prior knowledge that all reactions take place at an end (Rizqiyah et al., 2020; Üce & Ceyhan, 2019).

Student worksheets are one instrument that can be used to minimize misconceptions of learners. According to research by Wityanita et al. (2019), worksheets are usually equipped with instructions for use, steps, and commands to complete a task systematically. The advantage of using worksheets is that it makes it easier for educators to carry out learning because students will learn independently and learn to understand and carry out written assignments. Student worksheets can guide the development of all aspects of learning through experimental guides or demonstrations that can reduce misconceptions. Based on the background above, the researcher is motivated to develop worksheets with five stages of processing to identify students' misconceptions and reduce them. This research hoped to identify and reduce misconceptions among students.

RESEARCH METHOD

The method used in this study is a mixed method, a combination of qualitative and quantitative methods, namely the Concurrent Embedded Strategy, which is a combination of qualitative methods and quantitative methods carried out simultaneously. One method is the primary method, which is more dominant, and the secondary method will be embedded into the primary method. Participants in this study were chemistry students at Surabaya State University in three different classes. The instrument used is a worksheet with five stages of processing. The instrument used is a worksheet developed based on the representation-metacognitive reinforcement conceptual change model (R-MR CCM). The R-MR CCM model was developed to correct misconceptions that occur by using a thought self-monitoring process. The self-monitoring process carried out is associated with an understanding of chemical representations in the study of scientific questions. The R-MR CCM model is appropriate and includes several things by enriching the existing conceptual change remediation models.

There are five stages in the R-MR CCM model. Students are asked to write down their initial conception in the first stage. They are given a video demonstration to detect the tendency for misconceptions to occur in chemical equilibrium at the temperature factor. In the second stage, students are asked to contrast their initial conceptions after being presented with the scientist's conception. In the next stage, students are asked to simulate in a virtual laboratory to be directed to a conception by the scientist's conception. In the fourth stage, the phenomenon of dynamic equilibrium disturbance is presented for analysis. In the final stage, students are asked to find examples of other phenomena regarding shifts in the equilibrium system due to the temperature factor from the concepts that have been formed in the previous stage.

RESULTS AND DISCUSSION

Results

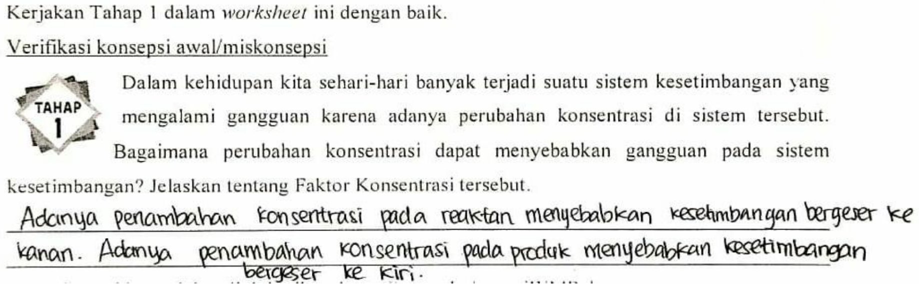
This research was tested on 25 students of the Surabaya State University Chemistry Education Study Program to find out the students' conceptions and changes in the concentration factor on chemical equilibrium material. There are five stages in the worksheet to determine the conception and changes in student conceptions after completing all the given stages. The first stage is related to verifying the initial conception, namely explaining disturbances in the equilibrium system due to concentration factors and analyzing video demonstrations regarding the conditions of the equilibrium system experiencing disturbances due to concentration factors.

Table 1. The distribution of student understanding in stage 1.

Indicator	Understanding (%)		
	U	M	DU
Initial conception verification	84.00	12.00	4.00
Analysis of the phenomenon of equilibrium Shift 1	84.00	16.00	0.00
Analysis of the phenomenon of shifting Equilibrium 2	80.00	12.00	8.00
Average	82.67	13.33	4.00

Note : U = Understood; M = Misconceptions; DU = Do not understand

Based on Table 1, it was found that an average of 82.67% of students understood the questions in the first stage. Besides that, there is an average of 13.33% of students who experience misconceptions and 4.00% of students who need help understanding the questions given in the first stage.



Kerjakan Tahap 1 dalam *worksheet* ini dengan baik.

Verifikasi konsepsi awal/miskonsepsi

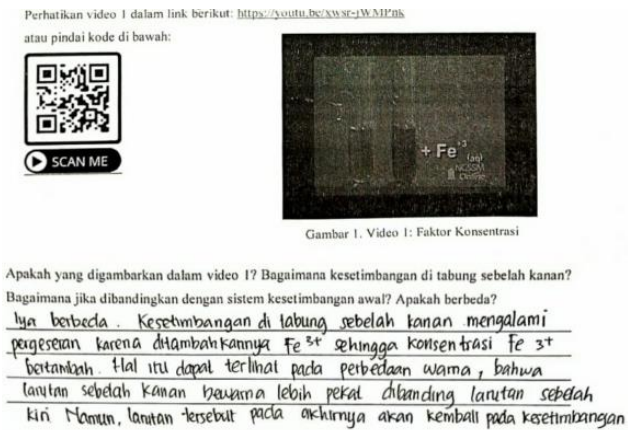
TAHAP 1

Dalam kehidupan kita sehari-hari banyak terjadi suatu sistem kesetimbangan yang mengalami gangguan karena adanya perubahan konsentrasi di sistem tersebut. Bagaimana perubahan konsentrasi dapat menyebabkan gangguan pada sistem kesetimbangan? Jelaskan tentang Faktor Konsentrasi tersebut.

Adanya penambahan konsentrasi pada reaktan menyebabkan kesetimbangan bergeser ke kanan. Adanya penambahan konsentrasi pada produk menyebabkan kesetimbangan bergeser ke kiri.

Figure 1. Items about stage 1 part 1.

Figure 1 shows an instrument of questions and sample answers from respondents in stage one that are by the scientist's concept. It can be seen in the early stages that students can correctly describe shifts in equilibrium due to changes in concentration.


Perhatikan video 1 dalam link berikut: https://youtu.be/xwsr-jWMPnk

atau pindai kode di bawah:

SCAN ME

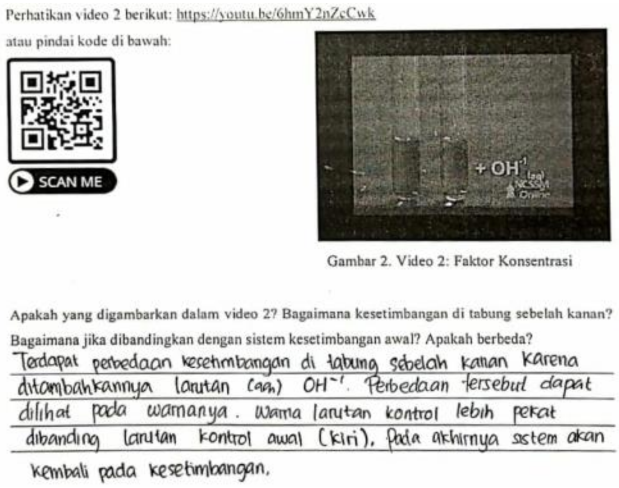
Gambar 1. Video 1: Faktor Konsentrasi

Apakah yang digambarkan dalam video 1? Bagaimana kesetimbangan di tabung sebelah kanan? Bagaimana jika dibandingkan dengan sistem kesetimbangan awal? Apakah berbeda?

Iya berbeda. Kesetimbangan di tabung sebelah kanan mengalami pergeseran karena ditambahkannya Fe^{3+} sehingga konsentrasi Fe^{3+} bertambah. Hal itu dapat terlihat pada perbedaan warna, bahwa larutan sebelah kanan berwarna lebih pekat dibanding larutan sebelah kiri Namun, larutan tersebut pada akhirnya akan kembali pada kesetimbangan

Figure 2. Items for stage 1 part 2 questions.

Figure 2 shows an instrument of questions and sample answers from respondents in stage one that are by the scientist's concept. It can be seen in the early stages that students can explain the meaning of the first videos that have been observed.


Perhatikan video 2 berikut: https://youtu.be/6hmY2nZcCwk

atau pindai kode di bawah:

SCAN ME

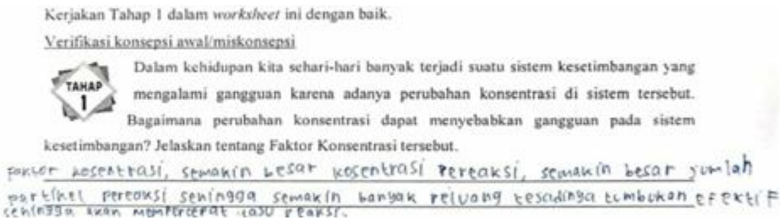
Gambar 2. Video 2: Faktor Konsentrasi

Apakah yang digambarkan dalam video 2? Bagaimana kesetimbangan di tabung sebelah kanan? Bagaimana jika dibandingkan dengan sistem kesetimbangan awal? Apakah berbeda?

Terdapat perbedaan kesetimbangan di tabung sebelah kanan karena ditambahkannya larutan (aq) OH^{-1}. Perbedaan tersebut dapat dilihat pada warnanya. Warna larutan kontrol lebih pekat dibanding larutan kontrol awal (kiri). Pada akhirnya sistem akan kembali pada kesetimbangan.

Figure 3. Items for stage 1 part 3 questions.

Figure 3 shows an instrument of questions and sample answers from respondents in stage one that are by the scientist's concept. In the early stages, students can explain the meaning of the second video that has been observed. In this initial conception, even though most students had no misconceptions, students only explained about shifts in equilibrium if the concentrations of reactants/products were changed so that students still had the potential to experience misconceptions. The following is an instrument of questions and sample answers from respondents at stage one who are different from scientists' concepts or need clarification.


Kerjakan Tahap 1 dalam *worksheet* ini dengan baik.

Verifikasi konsepsi awal/miskonsepsi

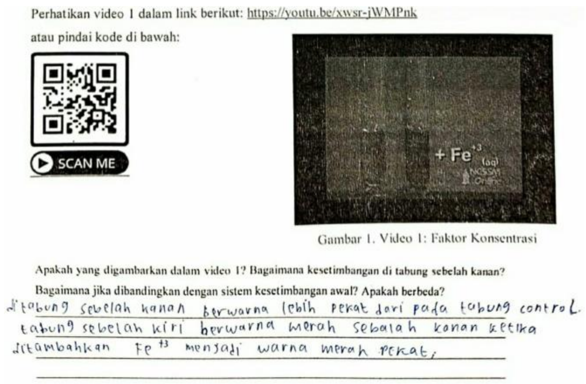
TAHAP 1

Dalam kehidupan kita sehari-hari banyak terjadi suatu sistem kesetimbangan yang mengalami gangguan karena adanya perubahan konsentrasi di sistem tersebut. Bagaimana perubahan konsentrasi dapat menyebabkan gangguan pada sistem kesetimbangan? Jelaskan tentang Faktor Konsentrasi tersebut.

faktor kosentrasi, semakin besar kosentrasi pereaksi, semakin besar jumlah partikel pereaksi sehingga semakin banyak peluang terjadinya tumbukan efektif sehingga akan mempercepat laju reaksi.

Figure 4. Items about stage 1 part 1.

Figure 4 shows an instrument of questions and sample answers from respondents in stage one, where there are misconceptions. It can be seen that students are still unable to describe changes in equilibrium due to concentration factors correctly or by scientific concepts.


Perhatikan video 1 dalam link berikut: https://youtu.be/xwsr-jWMPnk

atau pindai kode di bawah:

SCAN ME

+ $Fe^{+3}_{(aq)}$

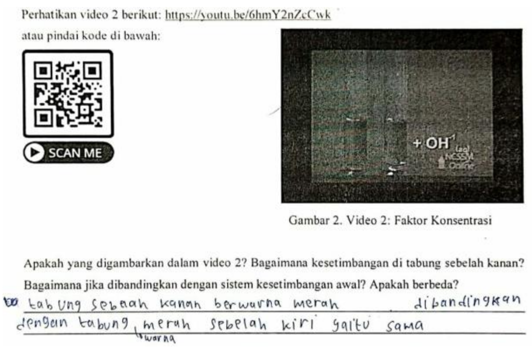
Gambar 1. Video 1: Faktor Konsentrasi

Apakah yang digambarkan dalam video 1? Bagaimana kesetimbangan di tabung sebelah kanan? Bagaimana jika dibandingkan dengan sistem kesetimbangan awal? Apakah berbeda?

di tabung sebelah kanan berwarna lebih pekat dari pada tabung control. tabung sebelah kiri berwarna merah sebalah kanan ketika ditambahkan Fe^{+3} menjadi warna merah pekat.

Figure 5. Items for stage 1 part 2 questions.

Figure 5 shows an instrument of questions and sample answers from respondents in stage one, where there are misconceptions. It can be seen in the early stages that students need help explaining the meaning of the first videos that have been observed.


Perhatikan video 2 berikut: https://youtu.be/6hmY2nZcCwk

atau pindai kode di bawah:

SCAN ME

+ $OH^{-1}_{(aq)}$

Gambar 2. Video 2: Faktor Konsentrasi

Apakah yang digambarkan dalam video 2? Bagaimana kesetimbangan di tabung sebelah kanan? Bagaimana jika dibandingkan dengan sistem kesetimbangan awal? Apakah berbeda?

tabung sebaah kanan berwarna merah dibandingkan dengan tabung, warna merah sebelah kiri yaitu sama

Figure 6. Items for stage 1 part 3 questions.

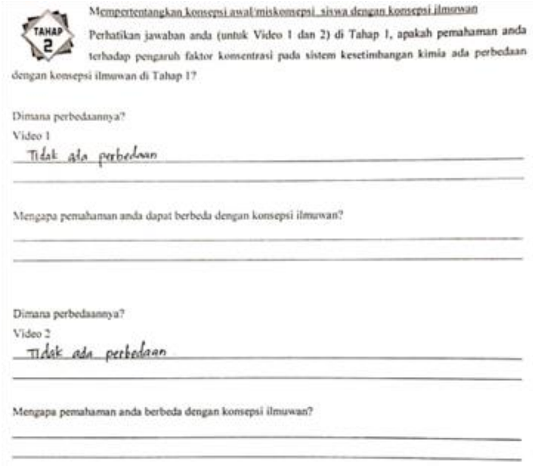
Figure 6 shows an instrument of questions and sample answers from respondents in stage one, where there are misconceptions. In the early stages, students cannot explain the meaning of the second video that has been observed. After showing the scientific conception that is by the theory, students are allowed to contrast their initial conception with the scientist's conception if there are differences in concepts and understanding. Four questions in stage two related to video demonstrations 1 and 2 in the previous stage.

Table 2. The distribution of student understanding in stage 2.

Indicator	Understanding (%)		
	WV	VC	IV
Video verification 1	72.00	0.00	28.00
Video verification 2	72.00	8.00	20.00
Average	72.00	4.00	24.00

Note: WV = Without Verification; VC = Verify Compliant; IV = Invalid Verification

As many as 72% of students did not contest their answers because the initial answers were based on the scientist's concept, so no further opinion was needed. Whereas 4% of students were able to explain the differences and understanding of scientific concepts correctly, the other 24.00% could not explain the reasons for their differences and understanding of scientific concepts. This is an example of answers from student worksheets on stage two.


TAHAP 2

Mempertentangkan konsepsi awal/miskonsepsi siswa dengan konsepsi ilmuwan

Perhatikan jawaban anda (untuk Video 1 dan 2) di Tahap 1, apakah pemahaman anda terhadap pengaruh faktor konsentrasi pada sistem kesetimbangan kimia ada perbedaan dengan konsepsi ilmuwan di Tahap 1?

Dimana perbedaannya?
Video 1
Tidak ada perbedaan

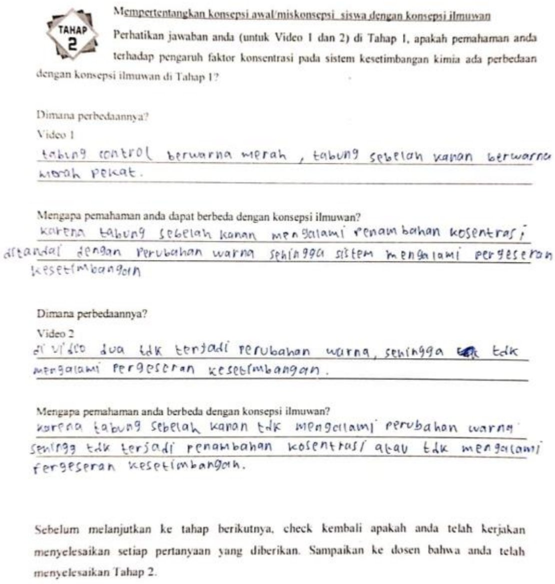
Mengapa pemahaman anda dapat berbeda dengan konsepsi ilmuwan?

Dimana perbedaannya?
Video 2
Tidak ada perbedaan

Mengapa pemahaman anda berbeda dengan konsepsi ilmuwan?

Figure 7. Items about stage 2.

Figure 7 shows an instrument of questions and sample answers from respondents in stage two, followed by the instructions. Students who have misconceptions about the concept of scientists are allowed to provide reinforcement that their concepts are similar to those of scientists.


TAHAP 2

Mempertentangkan konsepsi awal/miskonsepsi siswa dengan konsepsi ilmuwan

Perhatikan jawaban anda (untuk Video 1 dan 2) di Tahap 1, apakah pemahaman anda terhadap pengaruh faktor konsentrasi pada sistem kesetimbangan kimia ada perbedaan dengan konsepsi ilmuwan di Tahap 1?

Dimana perbedaannya?
Video 1
tabung control berwarna merah, tabung sebelah kanan berwarna merah pekat.

Mengapa pemahaman anda dapat berbeda dengan konsepsi ilmuwan?
karena tabung sebelah kanan mengalami penambahan kosentrasi ditandai dengan perubahan warna sehingga sistem mengalami pergeseran kesetimbangan

Dimana perbedaannya?
Video 2
di video dua tdk terjadi perubahan warna, sehingga tdk mengalami pergeseran kesetimbangan.

Mengapa pemahaman anda berbeda dengan konsepsi ilmuwan?
karena tabung sebelah kanan tdk mengalami perubahan warna sehingg tdk terjadi penambahan kosentrasi atau tdk mengalami pergeseran kesetimbangan.

Sebelum melanjutkan ke tahap berikutnya, check kembali apakah anda telah kerjakan menyelesaikan setiap pertanyaan yang diberikan. Sampaikan ke dosen bahwa anda telah menyelesaikan Tahap 2.

Figure 8. Items about stage 2.

Figure 8 shows a question instrument and sample answers from respondents in stage two who do not follow the instructions given. The answer given by the respondent above is an example of an answer that does not follow the order given. In the next stage, students are directed to a conception that is the scientist's conception by analyzing simulated data in the virtual laboratory that has been provided.

Table 3. The distribution of student understanding in stage 3.

Phenomenon	Indicator	Understanding (%)	
		True	False
1	Changes in the reaction equation	56.00	44.00
	Graphic changes	100.00	0.00
	Meaning of changes in reaction equations and graphs	96.00	4.00
	Data writing	80.00	20.00
2	Changes in the reaction equation	56.00	44.00
	Graphic changes	96.00	4.00
	Meaning of changes in reaction equations and graphs	92.00	8.00
	Data writing	80.00	20.00
	Average	91.63	18.37

Based on Table 3, the percentage of each item is averaged, and an average percentage of 91.63% of students can provide arguments and analyze data correctly. At the same time, 18.37% of students still need help to analyze data according to the scientist's conception. In the fourth stage, students are directed to solve dynamic equilibrium questions using metacognitive examples of concepts in their surroundings. The given phenomenon concerns the buffer system in human blood.

Table 4. The distribution of student understanding in stage 4.

Indicator	Understanding (%)		
	U	M	DU
Initial balance	76.00	8.00	16.00
Balance disorder	68.00	12.00	20.00
The reaction happened	76.00	4.00	20.00
Final balance	92.00	4.00	4.00
Average	78.00	7.00	15.00

Note : U = Understood; M = Misconceptions; DU = Do not understand

Based on Table 4, it was found that an average of 78.00% of students understood the questions in the fourth stage. Besides that, there is an average of 7.00% of students who experience misconceptions and 15.00% of students who need help understanding the questions given in the fourth stage. In the last stage, students are directed to find examples of other phenomena regarding shifts in the equilibrium system due to the concentration factor of the concepts formed in the previous stage.

Table 5. The distribution of student understanding in stage 5.

Indicator	Understanding (%)	
	True	False
Examples of phenomena related to shifts in the equilibrium factor concentrations	100.00	0.00

Indicator	Understanding (%)	
	True	False
Explanation of phenomena with the concept of equilibrium	100.00	0.00
Relation of phenomena with other concepts	72.00	28.00
Average	90.67	9.33

Based on Table 5, the percentage of each item is averaged, and an average percentage of 90.67% of students can present examples, explanations, and relations of phenomena in the equilibrium concept. At the same time, 9.33% of students still need help to provide examples, explanations, and relations of phenomena in the concept of equilibrium.

Discussion

The first stage aims to find out the initial concept of students. Most students only explained shifting the equilibrium if the concentration of the reactants/products was changed. In addition, some relate the concept of Le Chatelier's principle with a more detailed explanation. In this initial conception, even though most students had no misconceptions, students only explained about shifts in equilibrium if the concentrations of reactants/products were changed so that students still had the potential to experience misconceptions (Quílez, 2021; Sotáková & Ganajová, 2023).

The first stage verifies initial conceptions/misconceptions by presenting two videos about dynamic equilibrium. Students are asked whether the student's initial conception is by the scientist's conception. The reaction in the video presented in the first stage shows a shift in equilibrium due to the concentration factor (Turns, 2020). In the first stage, there is a minority of answers given by students, which tend not to be by the questions asked, so the desired concept is not achieved. In addition, some students interpreted the change in solution clearly as an effect of reducing OH^-, even though the video clearly shows the process of adding OH^- (Schmal & Pinto, 2021). This can happen due to the students' need for initial conceptual power.

The phenomenon of misconceptions in preconceptions is that students' preconceptions experience errors because preconceptions are formed before they receive formal lessons about the concept in question (Rizqiyyah & Novita, 2022). Students associate a state of balance with familiar phenomena in everyday life (Khairunnisa & Prodjosantoso, 2020). For example, students have constructed their own that a balanced reaction has the same mass. This can be seen from the students' answers in the analysis of the video demonstration regarding the condition of the equilibrium system, which is disturbed due to concentration factors. Students tend to associate equilibrium states that have the same mass, not constant mass. Therefore, it is necessary to proceed later to strengthen students' conceptions of shifting equilibrium due to concentration factors. After demonstrating previously understood conceptions, students can contrast their initial conceptions with those of scientists if there are differences in concepts and understandings. Four questions in stage two related to video demonstrations 1 and 2 in the previous stage.

In the second stage, as many as 72.00% of students did not challenge the answer because the initial answer was based on the scientist's concept, so no further opinion was needed. While 4.00% of students could explain their differences and understanding of scientific concepts correctly, another 24.00% could not explain the reasons for their differences and understanding of scientific concepts. This can happen due to the students' need for initial conceptual power. If the students' answers at the previous stage are by the scientist's concept, then at the second stage, no further explanation is needed because at the previous stage, there were no misconceptions. However, if at the previous stage, it turns out that there are differences and understandings with scientific concepts, students are allowed to contrast the differences in understanding that occur (Hand et al., 2021; Nicol, 2021; Rach & Ufer, 2020; Siry & Gorges, 2020; Vosniadou, 2019). Item part 1 discusses the differences in the concepts of respondents and scientists in the previous stage, but several respondents answered about the differences in treatment in the demonstration video. The points in section 2 discuss the reasons for these differences, and the answers given are to the instructions given.

In the third stage, students are directed to a conception that is the scientist's conception by analyzing simulated data in the virtual laboratory that has been provided. Using a virtual laboratory can improve students' memory because students can see a direct visualization of a chemical reaction (Ramadhani, 2019). The percentage of each item is averaged, and an average percentage of 91.63% of students can provide arguments and analyze data correctly. At the same time, 18.37% of students still need help to analyze data according to the scientist's conception. Most of the respondents were still having trouble writing the change in the reaction equation, where when there should be a disturbance in the equilibrium, the length of the arrow also changes according to the speed of the reaction that occurs until it reaches equilibrium again.

In the fourth stage, students are directed to solve dynamic equilibrium questions using metacognitive examples of concepts in their surroundings. The given phenomenon concerns the buffer system in human blood (Luscombe, 2018). It was found that an average of 78.00% of students understood the questions in the fourth stage. Besides that, there is an average of 7.00% of students who experience misconceptions and 15.00% of students who need help understanding the questions given in the fourth stage.

In the fifth stage, students are directed to find examples of other phenomena regarding shifts in the equilibrium system due to the concentration factor of the concepts formed in the previous stage. The percentage of each item is averaged, and an average percentage of 90.67% of students can present examples, explanations, and relations of phenomena in the concept of equilibrium. At the same time, 9.33% of students still need help to provide examples, explanations, and relations of phenomena in the concept of equilibrium. In the last stage, most students could give examples of other phenomena related to chemical equilibrium in the concentration factor. Indeed, some students still need help to answer appropriately because there are still misconceptions or questions that students have not answered, so they cannot be identified.

CONCLUSION

Fundamental Finding: Based on the data obtained, it can be seen from the students' conception of the shift in chemical equilibrium in the concentration factor. Students understand enough about chemical equilibrium shifts but still need clarification, especially in writing down changes in reaction equations when chemical equilibrium is disturbed and analyzing phenomena using metacognitive examples of a concept in their surroundings. **Implication:** Based on the data obtained, the test instruments can reduce the misconceptions that exist in students when viewed from a comparison of the number of students who experience misconceptions from 13.33% in the first stage to

7.00% in the last stage. **Limitation:** One of the factors constraining this research is time constraints and the difficulty of determining an attractive virtual laboratory scale experiment. **Future Research:** For future research, the misconception information in this study can be used as a basis for overcoming misconceptions correctly. Researchers in this study suggest that further research can be further deepened with the case study method and trials in a broader range of respondents so that the results obtained are more valid and reliable.

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