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USING STRUCTURED CLOCK REACTION DEMONSTRATION TO ASSESS STUDENTS UNDERSTANDING OF SOLUTION AND COLLOID CONCEPTS

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ABSTRACT

This study aims are to find out: 1) the profile of students understanding of solution and colloid concepts identification assessed by structured clock reaction demonstration (SCRD), 2) the pattern of student's misconceptions of solution and colloid concepts identification through structured clock reaction demonstration (SCRD).

This research is a descriptive research. There are ten SCRD implemented as assessment tools to explore student understanding. Each of SCRD was conducted in two stages, namely, anchoring demonstration (to give students chance doing fact observation and concept exploration) and core demonstration (including core question to explore student understanding). Rubric assessment was developed. Students' answers was analyzed qualitative descriptively.

The finding of this research shows that the students understanding of solution and colloid concepts identification assessed by structured clock reaction demonstration is low (less than 10%). The numbers are varied, depend on the concept accessed. Misconception which can be revealed by using structured demonstration clock reaction are categorized into three group: a) misconception on concept definition (e.g. solution is a mixture of a matter and water, colloid is a solid matter, Aluminium can change into brownish copper), b) misconception on characteristic level (e.g. water and milk mixture is a solution, solution volume is a factor of Ksp, solution molarity depend on limited reaction), and c) misconception on application level (e.g. volume of Al (s) and $CuCl_2$ (aq) can be calculated with gas volume formula = n x 22,4 L)..

Keywords: students' understanding, misconception, structured clock reaction demonstration, assessment

INTRODUCTION

Chemistry education paradigm in Indonesia has shifted from behaviorism into constructivism. This shift has some effect to all of the aspects inside. According to the last paradigm, knowledge has to be constructed by students themselves.

Knowledge construction is started with a phenomena or object observation based on their prior knowledge. Student gives a meaning to whatever phenomena they found. Construction process will run continuously, so cognitive structure will develop and become more detail. Concept is a proposition set that has a function to give a meaning on particular topic [1]. Concept consists of interrelated simple declarative statement (proposition) represent student knowledge construction.

Concept learning is a process happens naturally on all human age level. This process includes discovery the similarities of the objects on the world, category creating based on the similarity, and category abstraction. But it does not mean that it can happen automatically and easily. Even sometime, teacher efforts on helping this process make it more difficult [2].

Student undestanding divided of concept into six degree [3] as shown on the table here.

Table 1. Degree of understanding

Degree of understanding	Scoring criteria
No response	Blank I don't know I don't understand
No understanding	Repeats question Irrelevant or unclear response
Specific misconception	Responses that include illogical or incorrect Information
Partial understanding with specific misconception	Responses that show understanding of the concept but also make statements which demonstrate a misunderstanding
Partial understanding	Responses that include at least one of the components of the validated response,'but not all the components
Sound understanding	Responses that include all components of the validated response

Many studies taken a focus on misconception because it is not a simple problem and cannot be taken for granted. Misconception defined as a mental representation of a concept that does not correspond to a currently held scientific theory [4]. Numerous studies had indicated misconceptions concerning many aspects of chemical phenomena are prevalent among students and gives contribution on students learning outcome [5], [6], [7].

Misconception can raise from text book, teacher, students' daily life, and students their selves [8], [9], [10], [11] The constructivist views that on constructing the knowledge, the existing of misconception will lead to some difficulties on learning process and student does not make his learning succesfully.

For that case, student's understanding of chemistry concept must be identified with an assessment that can cover student understanding wider. Identification result can be used to improve teaching and learning process on chemistry.

There are some ways to identify student misconception of chemistry. To identify misconception, interview, paper and pencil based test such as multiple choice, concept map, word association test, or combination of these methods had been used [12]. Paper and pencil based test is the most popular among them due to the easiness of the preparation. But, paper and pencil based test give students chance on cheating or guessing the right answer. To identify student understanding of chemistry concept, it is necessary to develop a method that has chemistry characteristics. It always relate to matter and its change, and energy. Beside that, this method has to have sensitivity on student cognitive structure regulation and restructurisation.

Experienced has been reported as giving some contribution on misconception retention and elimination [13]. Some other methods has been reported to be used to reduce misconception for example teaching method variety [14], demonstration on challenging misconception [15], computer animation [16] and interactive software program [17].

Demonstration assessment becomes an interesting choice. Demonstration has been implemented in chemistry classroom to attract student attention, and it can nurture student understanding effectively. Teacher can show phenomena illustration happened in their day life to stimulate student mind, nurture the curiosity and aptitude toward chemistry. Demonstration gives student chance to observe the change on reaction, analyze data, make a conclusion to propose some hypothesis [18], and make a relationship between macroscopic, microscopic, and symbolic world [19]. Using demonstration as an assessment tool is a useful technique on exploring students understanding of scientific process [19], [20].

We implemented a demonstration assessment that called structured clock reaction demonstration (SCRD). Demonstration clock reaction is reaksi kimia yang memberikan tanda yang mudah dikenali pada periode awal induksi sebelum konsentrasi produk spesi kimia yang terlibat tercapai secara signifikan. (Shakhashiri, 1984; Billingham & Needham, 1992).

Structured clock reaction demonstration (SCRD) is modified from this definition. The stuctured term is chosen refer to

EXPERIMENTAL

This is a descriptive study with the following steps.

1. Identifying and analising the demonstration that will be implemented to assess student understanding of chemistry concept. The following is the demontration and concept related to be implemented on this study (Tabel 2).

Tabel 2. Demonstration and the concept identified

No	Demonstration title	Concept
1	What's that	Colloid
2	Magic Milk	Emulsifier
3	Magic Drop	Solubility and solubility product
4	Twin Act	Solubility and solubility product

2. Make demonstration worksheet and assessment guide. Score range of every understanding degree on each demonstration are different. It fits to number of requirements and explanation. Score range shown here.

Tabel 3. Score range on understanding level for every category

No	Cat.	Score range			
		WT	MM	MD	TA
1.	NR	0	0	0	0
2.	NU	1-2	1-2	1-4	1-4
3.	SM	3-8	3-6	5-14	5-14
4.	UM	9-10	7-10	15-20	15-20
5.	PU	11-14	11-14	21-24	21-24
6.	SU	15	15	25	25

Where

NR : No response
NU : No understanding
SM : Specific misconception
UM : Partial understanding with specific misconception
PU : Partial understanding
SU : Sound understanding
WT : What's that
MM : Magic Milk
MD : Magic Drop
TA : Twin Act

3. Make two student worksheets.
   First worksheet, this worksheet is filled after they observe on the first stage demonstration but before they know the result of the last stage.
   Second worksheet, this worksheet is filled after they know the result and they have to explain the similarities and diffeerences between their prediction and demonstration result.
4. Do demonstration to assess student understanding. Structured demonstration was divided into two stage. First, observation stage. This stage led student attention to the concept will be assessed. They make an observasion note, integrate their observation to the theory they get in the class. It will be used to make a prediction on the next stage. Demonstration was done with the following steps:
5. Give students direction and worksheets.
6. Introduce all equipments used on the demonstration.
7. Do SCRD for observation stage.
8. Give student time to make a note on their observation.
9. Do the beggining of the main assessment demonstration
10. Ask a question as writen on the worksheet and demonstration guide.
11. Give student time to write down the answer of question and make a prediction what going to happen, on worksheet (max 5 minutes)
12. Collect students answer sheet.
13. Continue the main demonstration to show the fact.
14. Give students time to explain if their prediction fit to the fact or their explanation of the fact, compare with their prediction.
15. Collect their explanation.
16. Prepare the next demonstration
17. Score student answer and clasify them into degree of understanding.
18. Analyze students answer to find some misconception

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RESULTS AND DISCUSSION

Student understanding of concept profile explored with structured clock reaction demonstration

On attracting student attention to the new concept, sometime teachers use single demonstration only. Teacher gives some comment or explanation, then, to enforce concept to understand. It cannot work on assessment, because a demonstration can be viewed from different ways and we do not give students explanation. Student can think different concept we mean, and it will make them confuse when they face the question we serve. May be, they can answer what they think, but it will give us a wide range concept to analyze.

To get our focus, we done the demonstration as assessment in structured manner. That means that we had a structured answer sheet to help student focus what they need to answer the question to come and a set of demonstration contain observation and main demonstration. We did demonstration(s) on the observation stage to help student get the data they need. We had student to write certain data on the answer sheet. It does not mean they cannot take other data, they still have a chance to take a note as demonstration goes on

Here are the results, after we analysed all of students' answers carefully.

Tabel 4. Profile of student understanding of concept explored with structured clock reaction demonstration

No	Demo	Percentage					
		NR	NU	SM	UM	PU	SU
1	WT	0	3,23	70,97	12,9	12,9	0
2	MM	0	19,35	80,65	0	0	0
3	MD	0	29,03	70,97	0	0	0
4	TA	0	19,35	74,19	6,45	0	0

Students' understanding of chemistry concept degree assessed by SDCR shows that they can not explain the chemistry phenomena they faced. They cannot use the data or even do not know what to be observed. This founding is interesting, because it seems that they had learnt all of the concepts on the classroom. This condition shows that there are still so many misconception experienced by student. They cannot apply their concept to a 'real' world like demonstration. We used to say that our student had understood because they can do the final exam or get a good mark. We cannot imagine that our student make a wrong construction about chemistry.

Terms of Student Misconceptions Explored with SCRD

Students' worksheets were analysed further to find any sentences that had possibility to lead to misconception. We began with student answer sheet that had been categorized into misconception level. From this it will take time to present all of student misconception sentences. We classified them into three groups of concept components, namely definition, attribution, and application. Here is the list of student misconceptions.

Tabel 5. Misconceptions type explored with clock reaction demonstration

a.	Misconception on definition level
	1. solution is a mixture of matter and water
	2. Ksp is product of reactan mol
b.	Misconception on attribution level
	1. colloid precipitate
	2. colloid is solid
	3. solution is always dilute
	4. when $PbCl_2$ is reacted with acid, it will produce precipitation
	5. volume contribute on Ksp
c.	Misconception on application level
	1. soap help milk to disolve color agent
	2. soap addition will make color agent dropped on milk mixed easily because soap is slippery, can move easily
	3. when Ksp value of solution and product are equal, solution has not reach the saturated state
	4. the precipitation produced on HCl addition into $PbNO_3$ is Pb, because H+ can shift Pb.

Every concept has definition. Concept definition can be a limitation for the concept it self. Sometime, a definition come from student daily life last longer than the one explained by teacher. Students seem to try to explain the phenomena they observe but, they use their own definition on explaining the phenomena. The statement of " solution is a mixture of matter and water" is an example of misconception on definition level. It can be raised from the fact that they always work with water solution (aqueous) so student is hard to accept non water-solution. Another example of misconception on this level is "*Solution Ksp is multiplied product of number of reactant mol.* It cannot be raised from daily life. It could be raised from an expression of solubility unit, mol/L or g/L. Student seem to fail to transfer this understanding when he faced solubility product (Ksp).

Some students wrote that mixture of water and milk produce solution. This sentence shows that students do not use the information of colloid characteristic to explain the matter they faced. Students seem to choose their conception that milk they know is always liquid. This knowledge leads them to assume that milk is a solution. The statement "solution volume contribute on Ksp value" is interested to be discussed. This sentence shows that there is a blunder on students mind, they fail to differ their understanding of solubility, concentration quotient product (Q), and Ksp.

Misconception on application level shown on this sentence: "soap addition will make color agent dropped on milk mixed easily because soap is slippery, can move easily". This sentence is far from "understand concept" state. Student does not see the chemistry concept at all.

CONCLUSION

This result showed that misconceptions case is so complex. This can resist student to understand the concept. This study proves that paper and pencil based test is not enough to explore student misconception. It needs an alternative assessment like this demonstration assessment to do that. This structured demonstration help student to think scientifically, and help them to revise their concept understanding

All misconceptions above show that student may be give the right answer on theoretical test. Paper-pencil based test make them to rote the concept without understanding. If we always make the paper and pencil based test as a measurement of achievement we will find student pass the exam without understand the concept, and of course the science process included. On doing SCRD test, student has to know the concept conclude on the demonstration, combine their theory understanding and data from the observation, and predict the future happen. This test is an instrument of assessment that has chemistry characteristic. This test give student chance to do self assessment

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