The development of an instruments diagnostic two-tier multiple choice assisted smartphone on salt hydrolysis

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Abstract. Research has been conducted instruments diagnostic two-tier multiple choice assisted smartphone on salt hydrolysis, or called Smartphone Tes Diagnostik Miskonsepsi Hidrolisis Garam (S-TDM-HG). In this study using descriptive methods that are part of research and development (R & D). The procedure of research is carried out through several stages of work, namely: (1) determination of subject matter; (2) study of core competencies, basic competencies, syllabus and material to determine concept labels, (3) concept map making, (4) identification of student misconceptions based on concept labels made in concept maps, (5) designing questions and answers (6) collection of existing multimedia, (7) making scripts and storyboards, (8) making S-TDM-HG. The development of the items adapted the stages developed by Treagust and McIntire. The concept map developed is used to identify what concepts will be developed in the process of making S-TDM-HG questions. Based on the essay test data given to 34 students in one of the high schools in Sumedang, the initial identification of misconceptions from students was generated to develop the S-TDM-HG problem in the first tier (tier 1) and second tier (tier 2). Based on the 16 response patterns obtained there are six possible answers to misconceptions, one possible answer understands the concept and nine possible answers that do not understand. 22 items developed, 20 questions are said to be valid with a CVI value of 0.9385. Based on 20 valid questions, which meet the content validation criteria as many as 18 items.

1. Introduction
Misconception can be a barrier to understanding the next chemical material in chemistry subjects. Many abstract chemical materials are interconnected with other material so that misconceptions in one concept cause misconceptions in another concept [1]. That is, the misconceptions that arise continuously will disrupt the learning process [2], the formation of scientific concepts of students [3], logical thinking wrong [4] and lead to interpretation when studying concepts [5]. Misconceptions that occur in students need to be corrected immediately because they can become obstacles for students in the process of learning chemistry.

Until now, misconception diagnostic tests identified using two-tier multiple choice tests have been studied including chemical structure material [6], acid base [7], Solution [8], salt hydrolysis [9], chemical equilibrium [10], Acid-base titration [1]. The identification results above are reinforced by a statement [8], where effective multiple-choice multiple layers are used to identify misconceptions in chemical matter.

In response to technological advancements, Smartphones are secondary and even primary needs for students. Smartphones have been widely used in various tools to facilitate chemical analysis [11],
stimulating student creativity [12], as a tool to practice in facing tests [13], assisted test tools images, animation [14,15], tools for communicating online [16]. This can provide an opportunity for researchers in the field of chemical assessment to develop two-tier and smartphone-assisted multiple choice misconception diagnostic tests.

2. Method
This research is part of research and development (R & D). In implementing this R & D descriptive method was used. Descriptive methods are used in initial research in collecting data about existing conditions [17].

The procedure of the research carried out refers to the Far West Laboratory experiments. According to Borg and Gall there are ten steps in implementing a research and development strategy [17]. But in this study the preparation and development / manufacture stages were carried out.

At the preparation stage is carried out:

2.1. Research and research and information collecting
In this step the subject matter is determined, the study of KI and KD is based on the label of material concepts, existing collection, concept mapping, identification of student misconceptions based on concept labels made in concept maps, designing questions and answers, existing multimedia collection, preparation of test items, writing instructions for administering the test.

2.2. Planning (planning)
In this step, script and storyboard are created.

At the stage of manufacture / development, S-TDM-HG is made. From the stages of planning and making above the items developed the stages of Treagust and McIntire.

3. Result and discussion
From the research and development that has been carried out, the results obtained at each stage are in accordance with the research and development procedures described as follows:

3.1. Determination of subject matter
This determination is done because basically all chemical material can be developed into the form of smartphone media. The subject matter determined in this study was hydrolysis of salt. There are several misconceptions found based on literature review. Therefore the study of this material is very necessary.

3.2. KI Study, KD, syllabus and material to determine concept labels
Based on the results of the study 13 concept labels were obtained in the salt hydrolysis material in semester XI 2. The label concepts found in the literature review were as follows: salt, hydrolysis of salt, total hydrolysis, partial hydrolysis (partially), partial hydrolysis of cations, partial anion hydrolysis, hydrolysis constant, acid ionization constant (Ka), alkaline ionization constant (Kb), solution pH, Acid salt properties, alkaline salt properties, neutral salt properties. This material is a prerequisite material for studying the next material. Therefore, the development of concept maps based on concept labels was obtained based on literature review.

3.3. Making concept maps
The development of concept maps is based on Croasdell's theory in Uyulgan, Akkuzu, and Alpat [18], which defines concept maps as part of an image or which describes a matter that contains concepts represented by words associated with one another with others use lines or hyphens. After a theoretical study of concept maps was made, the concept maps were developed as follows:
3.4. Identify student misconceptions
Based on the concept label made in the concept map made, according to Treagust to identify students' initial misconceptions. Then students are given 11 essay tests. The following is an example of the initial identification of student misconceptions.
"PROBLEMS OF SALT HYDROLYSIS MATERIALS"

*) Questions about the concept of salt. c. What do you know about Salt?

Figure 2. Student answer 1.

Figure 3. Student answer 2.

Figure 4. Student answer 3.

Figure 5. Student answer 4.

Figure 6. Student answer 5.

After identifying misconceptions for the development of the first and second tier. Then from the results of identification for the concept label of salt are as follows:

Label concept : Salt
Target concept : Salt is a strong electrolyte which decomposes completely in water and in a few cases react with water [19].

Misconception :
Student 1: salt is ions formed from positive ions (cations) and negative ions (anion) so as to form a neutral compound (not formed).
Student 2: salt is a substance found in NaCl. Salt has a salty taste, and is acidic / can be broken down in water.
Student 3: salt is an acidic / basic substance that can dissolve with water. Student 4: salt is a solution that can be dissolved by water.
Student 5: salt is an acidic / alkaline substance, it feels salty can dissolve with water. The colour is white, some are in the form of brick.

Based on the answers of the five students, the researcher can develop the students' thinking patterns regarding the definition of salt:

- Students assume that salt formed from a mixture of positive and negative ions is neutral.
- Students assume that NaCl salt can decompose water. The salt makes acidic or basic properties in the salt.
- Students assume that all salt can break down water. And only has acidic or basic properties.
- Students assume salt is a solution. All salts can break down water and can dissolve in water.
- Students assume that all salt can break down water. And only has acidic or basic properties.

3.5. Designing questions and answers
From identification through the essay test, a double-layer multiple choice arrangement with the answer key is performed. There is a development of the first and second tier adopted from Treagust which was modified in the first tier there are four answer choices and the second tier is four choices. The description of the problem structure is as follows:
Figure 7. The two-choice multiple choice structure developed.

The examples of questions that have been developed from the results of previous essay tests are as follows:

Label concept : Salt
Target concept : Salt is a strong electrolyte which decomposes completely in water and in a few cases react with water [19].

Two-layer multiple choice questions developed:

Below is some salt:

I. \( \text{NH}_4\text{CN} \)  III. \( \text{NH}_2\text{SO}_4 \)
II. \( \text{KCN} \)  IV. \( \text{NaCl} \)

From the salt above. Which salt does not undergo hydrolysis...
A. Salt I  
B. Salt II  
C. Salt III  
D. Salt IV  
The reason:

i. \( \text{NH}_4^+ \) from weak bases that are stronger than water so they cannot be hydrolyzed

ii. \( \text{NH}_4^+ \) & \( \text{CN}^- \) from weak bases or acids which are stronger than water so they cannot be hydrolyzed

iii. \( \text{SO}_4^{2-} \) from weak acids which are weaker than water so they cannot be hydrolyzed

iv. \( \text{Na}^+ \) & \( \text{Cl}^- \) from weak bases or acids which are weaker than water so they cannot be hydrolyzed.

Answer: D.iv

3.6. Existing multimedia collection
At the multimedia collection stage in the form of images, animations, graphics, tables, videos are used for questions developed for smartphone multiple-assisted multiple-choice misconception diagnostic tests. The following are examples of images collected and made to complete and visualize questions from the concept label salt.

3.7. Making scripts and storyboards
The script is a narrative that explains the description of multimedia S-TDM-HG questions that will be made based on aspects that have been studied. The script and storyboard that have been made are then validated in terms of aspects of pedagogy and the content by the validator. Validation is used as a repair of Script and Storyboard as well as consideration in making S-TDM-HG questions.

3.8. Making S-TDM-HG
Development of items about Smartphone Diagnostic Tests for Misconception and Salt Hydrolysis. Based on the script and storyboard that was compiled in the previous stage in the form of adobe annime, which consisted of 18 screens consisting of 13 items which included questions in the form of animations,
videos, images recorded and researchers developed in adobe anime, corel chem draw, chemsketch, chemLab, macromediaFlash. From the videos, images and animations selected from the recordings and multimedia exiting according to the needs of the S-TDM-HG items developed by the researcher. The following is an overview of the question media developed in the smartphone.

Figure 8. Display of smartphones that have S-TDM-HG applications.

Figure 9. Display of the S-TDM-HG application logo for 10 seconds.

Figure 10. Display menu options in the S-TDM-HG application.

Figure 11. Display of student logins before the S-TDM-HG test.

Figure 12. Display of item 1.

Figure 13. Display of item 2.

Figure 14. Display of item 3.

Figure 15. Maker profile view.

Of the eighteen screens developed in the application of the S-TDM-HG problem, there are several functions including: when students choose the application logo that has been shared offline by the researcher, a display will appear on the next screen shown in figure 9. From the image about ten seconds, the application will automatically enter the main menu display of the application that contains read instructions, S-TDM-HG questions and profiles or shown in picture 10.

4. Conclusion
Based on the results of the research that has been conducted, of the 13 questions developed, 11 items of S-TDM-HG questions are valid with a CVI value of 0.9385. In addition, from the 16 response patterns the possibility of misconceptions experienced by students was more than the development patterns carried out by previous researchers, resulting in 6 key patterns of determination of misconceptions, 1 pattern of key comprehension answers and 9 key patterns of answers that did not understand the concept.
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