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# Design of Submicroscopic Book and Improving of Students Learning Outcomes for Remedial Program in Class XI for Buffer Solution

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**Abstract**

This study aims to develop the submicroscopic book and improving of students learning outcomes for remedial programs. A remedial program is one of the lessons used to improve student understanding and learning outcomes. The results of a survey conducted by researchers at 10 SMA/ MA in Cirebon that the implementation of remedial program rarely carried out remedial teaching activities due to time constraints. This research used R & D method with 4-D model which consists of 4 stages, that were define, design, develop, and dessimination. The results of a small scale test that there was an inproving in students learning outcomes after participating in the remedial program, from 17.14% to 58.62%. The results of a large scale test were carried out in two classes with an increase in student learning outcomes from 12.50% to 71.43% and 17.50% to 78.79%. Students gave the positive responses for remedial learning used submicroscopic book. The response of students in the small-scale test was 78.02% (good) and the results of a large-scale test were 80.50% (good) and 81.17% (very good). The teachers also gave a positive response for use of the submicroscopic book and that was 86.67% (very good). The use of this submicroscopic book can be the one of solutions for implementing remedial teaching.



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## INTRODUCTION

Purwanto (2002) learning outcomes are students' abilities after learning. These abilities can change behavior in knowledge, attitudes, and skills so their personality can be better than before. Learning outcomes are usually marked with a pass or not pass on a subject matter called completeness of learning outcomes. The completeness of student learning, especially in the material of the buffer solution based on the results of interviews at 10 SMA/MA in Cirebon was quite low at around 12.5% to 25%.

Similar research was carried out by Vitria et al. (2014) and the results of the interviews found that in one of high school in Karanganyar, the value of students' completeness in the subject matter of the buffer solution was still very low at 40.0%. The results of the daily chemical test of the material of the buffer solution in one of the high schools in Surakarta showed that as much as 57.98% of students had grades below the minimum completeness criteria (KKM) (Ma'rifatun et al., 2014). The incompleteness of student learning outcomes in the buffer solution material in one of the high schools in Sukoharjo was 53.33% (Santhiy et al., 2015).

Buffer solutions had low results due to the buffer solution according to Sanubari et al. (2014) had the character of book that was abstract (in the acid-base reaction section), understanding the concept (in the nature of the buffer solution), mathematical (in the pH calculation section of the buffer solution), and applicable (in the buffer solution function) so that many students who experienced difficulties in studying the material. The results of research conducted by Yunitasari et al. (2013) also stated that students experience misconceptions on the concepts of the subject matter of buffer solutions, especially on the concept of the character, composition, working principle, pH, and the role of buffer solutions carried out by diagnostic tests accompanied by interviews at one of the high schools in Sragen.

One way to overcome student incompleteness and improve students' understanding of buffer solutions is remedial learning. Prayitno (2008) explains that remedial is a form of assistance given to a person or group of students who face learning problems with the intention of correcting errors in their learning process and results. Remedial programs could help students to achieve learning goals optimally.

This was also supported by the results of research conducted by Alvina et al. (2015) that remedial learning on solubility and solubility results could improve learning completeness by 52.17%. Bukhari (2017) states that remedial learning could be used to improve the learning outcomes of chemistry in the material of chemical bonding seen from the increase in completeness of learning outcomes before and after remedial learning by 31% . Another study was conducted by Dewi et al. (2017) that remedial learning using peer tutoring methods on atomic structure material could improve learning completeness by 22.7%. The remedial program wasvery effective to improve students' understanding that could be seen from the increase in learning outcomes, so that the remedial program was one way to overcome the problems of inadequacy experienced by students.

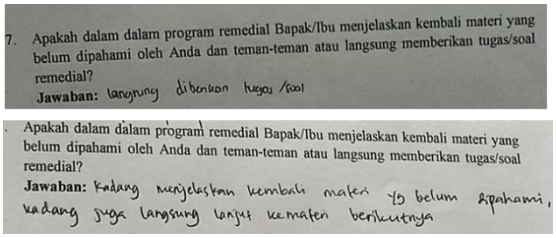
Based on the results of a field study conducted by researchers to teachers in 10 SMA/MA in Cirebon, it was found that the implementation of the remedial program had some problems, especially time problems. The remedial implementation that should be carried out outside of class hours was difficult to implement because all high schools in Cirebon had already carried out full days following Permendikbud No. 23 of 2017 concerning School Day. MA even though did not do full day but the number of MA study hours was more than in high school. so that the learning activities at MA ended in the afternoon and held for 6 days.

This caused some teachers to carry out direct remedial programs by asking children to did the questions without being given the remedial teaching. The same thing was obtained from the interview results of 80 students from 8

SMA/MA in Cirebon that the implementation of remedial was usually not accompanied by remedial teaching or directly working on questions. The results of interviews with students can be seen in Figure 1.

Remedial teaching that was not done by the teacher was very unfortunate. Sugihartono (2007) states that remedial teaching is a very important activity in the entire learning program. Through remedial teaching programs, the teacher can help students to achieve learning goals optimally. Juliyanti et al. (2017) state that the remedial activities that had been carried out by the teacher were by giving homeworker or test according to the subject matter that had not been completed without teaching efforts from the teacher to help students understand material that was not yet understood. This method was not effective in helping students' learning difficulties and students' learning interest becomes less because there was no effort to help students in understanding material that had not been mastered.

The results of research conducted by Hafid et al. (2016) stated that Remedial teaching could overcome learning difficulties by 89%, so it could be said that remedial teaching was effective in overcoming student learning difficulties in mathematical problem solving abilities (Hafid et al., 2016). Remedial teaching was effective in overcoming mathematics learning difficulties of students in class XI IPS 1 of SMA 1 Bobotsari on material composition and inverse composition and 83% of the total number of students declared cured (get scores above the KKM) in the material part which becomes learning difficulties (Saputra & Suhito, 2015).


7. Apakah dalam dalam program remedial Bapak/Ibu menjelaskan kembali materi yang belum dipahami oleh Anda dan teman-teman atau langsung memberikan tugas/soal remedial?
**Jawaban:** langsung diberikan tugas /soal

Apakah dalam dalam program remedial Bapak/Ibu menjelaskan kembali materi yang belum dipahami oleh Anda dan teman-teman atau langsung memberikan tugas/soal remedial?
**Jawaban:** kadang menjelaskan kembali materi yg belum dipahami, kadang juga langsung lanjut kemateri berikutnya

**Figure 1.** The results of interviews with students regarding the implementation of remedial teaching

Problems in implementing remedial teaching can be overcome one of the ways by using book as a substitute for teachers in re-teaching material that was not yet understood by students. The Book used can be made by the teacher using language that was easily understood by students. The book used in this study were submicroscopic book. Based on interviews conducted by researchers, teachers did not have book for remedial programs and book used by teachers in SMA / MA had not used submicroscopic book and were more likely to discuss at the level of macroscopic and symbolic representation. The chemistry material was abstract and material would be easier to learn if it involves submicroscopic representation and was not limited to macroscopic and symbolic representations.

This was in line with the findings of Tasker & Dalton (2006) that many conceptual errors that occur in chemistry come from the inability to visualize structures and processes at the submicroscopic level. The importance of using three levels of representation in chemistry learning was to help students learn chemistry more meaningfully and remember chemical concepts more easily (Tuysuz et al., 2011).

The results of research conducted by Sunyono et al. (2015), multiple representation based learning models were more effective in building students' mental models in understanding the concept of atomic structure compared to conventional learning models. Learning with multiple representations was also suitable for learning in classrooms that had students with low levels of ability to match the level of middle and high ability. The results of the research by Irsyad et al. (2018) that learning with a multiple representation models using the 7E learning cycle becomes effective in reducing students 'misconceptions on heat material that was the percentage of students' misconceptions decreased in the experimental class 18.72% higher than the control class which was only 9.68%. Based on the problems that have been revealed, this study was intended to overcome the problem of the implementation of remedial teaching, improve the completeness of student

learning outcomes, and improve students' understanding of buffer solution material.

## METHODS

The method used in this study was R & D. Sugiyono (2015) development research is defined as a scientific way to research, design, produce, and test the validity of products that have been produced. Product development in this study adapted the 4D model (four-D model) from Thiagarajan et al. (1974) which consists of four stages. Those the stages were define, design, develop, and disseminate. In the define phase, a field study was conducted. Field studies conducted by researchers were interviews with teachers from 10 SMA/MA in Cirebon about the completeness of student learning outcomes in buffer solutions, student difficulties in learning buffer solutions, and remedial implementation. Interviews were also conducted with 80 students in 8 SMA / MA in Cirebon by filling out the questionnaire questionnaires

## RESULTS AND DISCUSSION

The results of the field study in the define stage can be seen in the introduction to this article. The book developed in this study had the characteristics of submicroscopic submission of buffer solution material. One example of the concept of a buffer solution that was described in a submicroscopic manner in this book was the concept of a component that can form a buffer solution by learning in advance what species were in a solution.

Students who had understood what species were contained in a solution will easily learn which species form a buffer solution. Figure 2. was an example of submicroscopic learning on this developed book. Learners had introduced what species were in a solution that can form a buffer solution. Species can be found provided. At the design stage, researchers design the book, questions, student and teacher response questionnaires that will be used in data collection in this study.

In the develop phase, the products and instruments that had been previously designed were validated by 4 validators consisting of 2 UNNES lecturers and 2 high school teachers who teach chemistry. The implementation of remedial learning in this study was conducted in SMAN 1 Dukupuntang. Data was taken from students of class XII who were not yet complete in the buffer solution when they were in class XI and had not been remedial because of time constraints. The trial in this study was divided into two, small-scale test and large-scale test. The small-scale test was carried out in class XII IPA 5 with 29 respondents. The large-scale test was conducted twice, those were class XII IPA 1 with 33 students and XII IPA 2 with 35 students. The deployment stage was carried out by publishing research results with articles in journals.

in the reaction results as shown in Figure 2. Students could see in the results of the reaction there are any species and students can determine which species could form a buffer solution, in this case, was CH3COOH/CH3COO−.

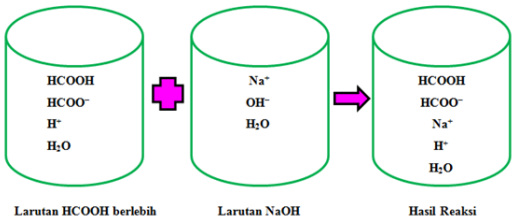



**Figure 2**. One of the discussion of submicroscopic buffer solution material in the developed book

Validation results from 4 validators stated that the products and instruments developed in this study were valid. Validation results in this study can be seen in Table 1.

**Table 1.** The results of validation of book, questions, and instruments

| Validated instrument | score | | | | Total score | Average score | criteria |
|---|---|---|---|---|---|---|---|
| | V 1 | V2 | V3 | V4 | | | |
| Book | 4,00 | 3,65 | 4,00 | 3,33 | 14,95 | 3,74 | Valid |
| question | 4,00 | 3,00 | 3,71 | 3,57 | 14,29 | 3,57 | Valid |
| Student Response Questionnaire | 4,00 | 3,43 | 4,00 | 3,43 | 14,86 | 3,70 | Valid |
| Teacher Response Questionnaire | 4,00 | 4,00 | 4,00 | 3,71 | 15,71 | 3,93 | Valid |

Validators not only provide value to the products and instruments developed but also provide recommendations for improvements to the product and instruments can be used in the test. The advice given by the validator can be seen in Table 2.

**Tabel 2.** Validator notes on book, questions and instruments

| No | Instrument | Validator notes | Revisions made |
|---|---|---|---|
| 1 | Book | The picture must had reliationship with chemistry<br>Error writing in some words | Pictures on book were replaced with those related to chemistry<br>Some words that are wrong in writing were fixed |
| 2 | questions | The sentence was corrected because there were some ambiguous questions.<br>On the validation sheet there was an assessment related to the indicator but the indicator was not available<br>There was a problem that was changed that was 0.41 grams of HNO2 in the reaction results were changed to 0.01 mol because in fact it was difficult to determine 0.41 grams of HNO2 in the mixture in the form of solution. | The sentence was fixed<br>Indicators added to book<br>The problem was changed from 0.41 grams to 0.01 moles |
| 4 | Student Response Questionnaire | There were errors in numbering | Numbering was corrected |
| 5 | teacher Response Questionnaire | - | - |

In the small-scale test, there were 29 students who took remedial programs, 17 people passed and 12 people did not pass with a pass percentage of 58.62%. Before remedial the percentage of passing was 17.14%, that was, from 35 students only 6 students passed. Increasing student learning completeness can be seen in Figure 3. The results of the validity based

on the results of the students' answers in working on the questions obtained results that all questions were valid. The reliability of the question was 0.892 which was included in the very high category based on the interpretation criteria according to Arikunto (2013). Difficulty level criteria indicate that all questions had a moderate level of difficulty. The distinguishing power of categorizing questions was categorized as sufficient and good.

The results of the first limited trial were analyzed. Based on the results of the analysis, it was found that many answered incorrectly in problem number 4, namely 17 students answered incorrectly and 12 students answered correctly and the problem number 5 was 13 people answered incorrectly and 16 people answered correctly. Problem number 4 was determining what species are in the reaction results between 25 mL of 0.2 M CH3COOH solution mixed with 25 mL of 0.1 M KOH solution. This was because students had not understood what species were in a solution and the reaction results. Researchers look for ways to overcome this by giving examples of book related to the species that were in a solution in the form of images.

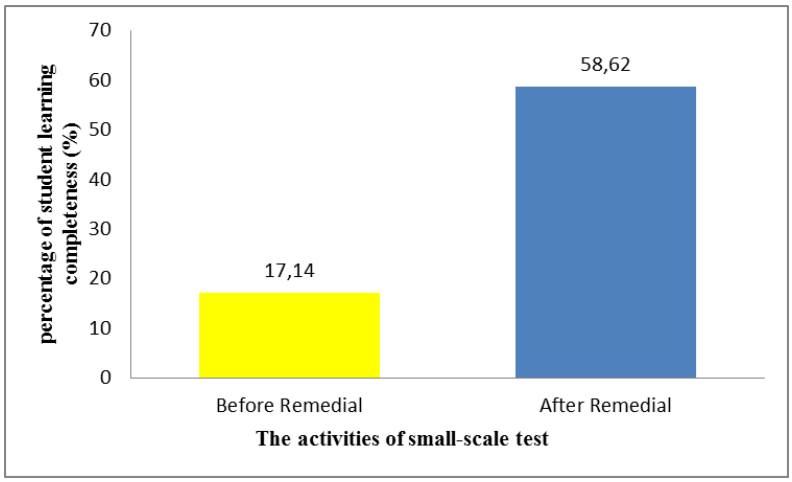



**Figure 3.** The students' completeness charts for small-scale test

The problem for number 5 relates to the ability of the buffer solution to maintain pH when added a little acid or a little base. One of the reasons for this was that students had not understood acid-base according to Bronsted-Lowry. This can be seen from the interview results in Figure 4 that some children did not understand the conjugate acids and bases. The results of research conducted by Drastisianti et al. (2018) based on the analysis of the answers to written tests and interviews shows that students had not been able to distinguish between conjugate acid and bases because students were used to memorizing the names of weak acids, strong acids, weak bases, and strong acids so that students were less able to distinguish the components of the buffer solution.

This understanding of acid-base according to Bronsted-Lowry was very important in learning how the buffer solution works in maintaining pH because it was associated with the added ion H+ which reacts with the base or conjugate base and the added ion $OH^-$ reacts with acid or acid-base conjugation. This makes students had to understand which were conjugate acids/acids and which were conjugate bases from the species that make up a buffer solution. Researchers added Bronsted-Lowry acid-base material to book so students could remember and understand the material again.

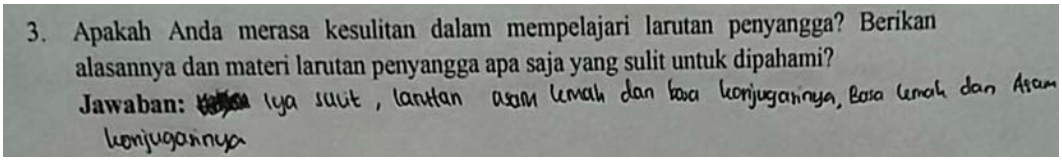



**Figure 4.** The results of student interviews regarding buffer solution material

Revised book in the small-scale test was used in large-scale test. The large-scale test were conducted twice. The first large-scale test was conducted with 33 students. The results after attending a remedial program found that 26 people passed and 7 people did not pass with a passing percentage of 78.79%. Before remedial the percentage of passing was 17.50%, that was, from 40 students only 7 students passed. The second large-scale test was conducted with 35 students. The results of remedial learning found that 25 people passed and 10 people did not pass with a passing percentage of 71,43%. Before remedial the percentage of passing was 12.05%, that was, from 40 students only 5 students passed. Graphs of the increase in graduation in a wide scale trial can be seen in Figure 5.

Based on the results of research that obtained the used of the submicroscopic book in remedial learning could improve students' understanding of buffer solutions which could be seen from the increasing completeness of student learning outcomes after using the book. This result was in line with the results of the research on the development of chemical learning devices based on multiple representations conducted by Susanto et al. (2014) stated that there was an increase in student learning outcomes of 0.79 or 79%. All students show the completeness of learning outcomes, meaning that no students get grades under the KKM after the learning. Another study was carried out by Herawati et al. (2013) that student learning achievement in multiple representations learning on material reaction rate was higher than conventional learning.

Students provide a positive response to the used of this submicroscopic book. The results of students response questionnaires can show in Table 3.

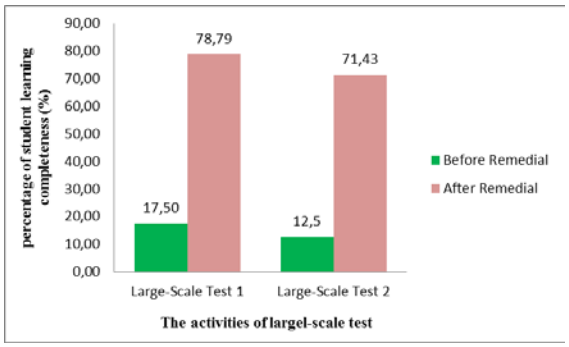



**Figure 5.** The students' completeness charts for large-scale-test

**Table 3.** The results of student response questionnaires

| student response questionnaires | Score (%) | | |
|---|---|---|---|
| | S1 | L1 | L2 |
| Use of submicroscopic book | 78,02 (good) | 80,50 (good) | 81,17 (very good) |

Information: S = Small-scale test; L = Large-scale test

The same results were given by the teacher. The results of the teacher response questionnaire provide positive results. The teacher response was given by 10 teachers from 10 different SMA / MA in Cirebon. The average value of the use of the book was 86.67% which included in the excellent category. This showed that the teachers provide a positive response to the use of the submicroscopic book in remedial programs and the teachers believe that this book can improve students' understanding of the buffer solution material.

## CONCLUSION

Based on the results and discussion, this study had the following conclusions:

The submicroscopic book developed in this study were effective to improve student learning outcomes. This Submicroscopic book was also able to increase students' understanding of buffer solution material as evidenced by the increased learning outcomes of students after taking remedial programs using this book.

Students gave a positive response to remedial learning using this submicroscopic book. The response of students in the small-scale test was 78.02% (good) and the results of large-scale tests were 80.50% (good) and 81.17% (very good).

The teacher gave a positive response to the use of the submicroscopic book that was 86.67% included in the very good category.

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