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Research Article

Development of an Acid-Base Supplement Book Oriented to Self Regulated Learning (SRL) to Improve Students Metacognitive Skills

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Abstract: Metacognitive skills in learning are an important indicator that can be measured. Based on the test of metacognitive skills when pre-study obtained the results that the metacognitive skills of learners are still relatively low. One of the learning strategies that can be used to improve the metacognitive skills of learners is a learning strategy oriented self regulated learning (SRL) by utilizing textbooks in the form of supplement books. Therefore, this study aims to describe the feasibility of self-regulated learning (SRL) oriented acid-base material supplement books to improve metacognitive skills of learners. This type of research is Research and Development (R&D) according to the Borg and Gall model. Validity Data obtained through validator assessment using validation questionnaire. Practicality Data obtained through the results of the questionnaire responses of students supported by the results of the observation sheet activities of students. Practicality Data were obtained through pretest and posttest of learners metacognitive skills supported by the results of metacognitive inventory questionnaire. The validation results showed that the content and construct validity criteria were declared valid with a median of 5. Practicality is stated to be practical in terms of the results of the questionnaire responses of students who showed a very strong category with the percentage of content criteria, language, presentation and graphics of 94,25%, 90,67%, 95% and 98,3% respectively with the results of the average percentage of observation sheet activity of students at 96,67%. Effectiveness is stated to be effective in terms of Paired Sample t-test results with sig. values ≤0.05 and N-gain pretest and posttest scores of metacognitive skills in the high category with the results of the metacognitive inventory questionnaire showed a very strong category with an average percentage of 90,8%. The results showed that the book supplement oriented material acid base self regulated learning (SRL) feasible to use as a solution to improve the metacognitive skills of learners.

Keywords: Acid-Base**;** Metacognitive Skills; Self Regulated Learning; Supplement Book;

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1. Introduction

In the independent curriculum, the main concept promoted in the learning process is freedom of thought [1]. In the concept of independent learning, the learning process involves independent conditions to fulfil the learning objectives, methods, materials and evaluations of both teachers and students [2]. The learning process is also more centred on the needs of learners (student-center) and no longer leads to the previous concept which is centred on the teacher or educator [3].

Learning independence or self-regulated learning is needed by students so that students are able to make learning targets, target learning outcomes, make learning plans, measure independent abilities, carry out learning activities properly, and evaluate learning outcomes until they achieve what has been determined [4]. The application of self-regulated learning to students needs to be done because it can affect students metacognitive skills [5].

Metacognitive skills in learning are important indicators that can be measured. The existence of metacognitive skills can play an important role in the success of students learning. Increasing students metacognitive skills causes students' learning outcomes to also increase [6] [7].

Chemistry is one of the branches of Mathematics and Natural Sciences that studies the nature, structure, and changes in matter [8]. The characteristics of chemistry material based on chemistry learning outcomes are learning about matter, the properties of matter, how and why substances combine or separate to form other substances, and the energy that accompanies their changes [9].

Some students consider that chemistry lessons are difficult to understand because many chemical concepts are abstract and complex [6]. The abstractness is caused because there are some sub-materials that cannot be observed by the eye so that it requires three levels of representation which include macroscopic, submicroscopic and symbolic levels to solve it [10]. This situation is supported by the results of the pre-research questionnaire, where as many as 94,4% of students stated that chemistry lessons are difficult lessons because of the many foreign terms and the delivery of material that is difficult to understand.

One of the chemical materials that are considered difficult by students is acid-base material [11]. This is because acid-base material is one of the chemical materials that has very complex characteristics that include 3 aspects, namely macroscopic, microscopic and symbolic aspects [12]. In addition, based on the results of interviews with chemistry teachers, when in class the teacher still uses a teacher-centred learning model, the teacher rarely uses problem-solving activities using the scientific method and the absence of evaluation and self-reflection activities can also make students still have difficulty in learning acid-base material.

The difficulty of students in acid-base material, based on Permendikbud No. 5 of 2022, students need to have a thinking process in their learning [13]. The thinking process of students can be pursued by improving students metacognitive skills [14].

Based on the results of the acid-base material metacognitive skills test, it was found that the metacognitive skills of students tended to be low, namely 31,25%, with the results on each component of metacognitive skills, namely planning skills of 42,19%; monitoring skills of 40,63% and evaluation skills of 10,94%. The low metacognitive skills of students so that students need to hone their metacognitive skills which include skills in planning, monitoring skills and evaluating skills so that appropriate learning strategies are needed [15].

The learning strategy that can be used is a learning strategy orientated to self-regulated learning. Through self-regulated learning strategies, students can direct their metacognitive processes, motivation and behaviour while learning [16]. In addition, through this learning strategy students will also be involved in analysing activities, planning activities, implementation activities, problem solving activities, evaluation activities and modification activities [17]. In order for the self-regulated learning strategy to be applied well to students, an innovation in the learning process is needed.

The innovation that can be done in order to create more efficient and effective learning is by developing an appropriate teaching book such as a supplementary book. Supplementary books are made as additional textbooks that are effective in increasing HOTS, learning motivation and critical thinking skills of students [18] [19] [20].

2. Preliminaries or Related Work or Literature Review

Supplementary book is one type of printed textbook that is used as a supporting book or companion book that contains a lack of material explanation in the main textbook, so that students can learn thoroughly about the learning material being studied [21].

Self-regulated learning oriented supplement books can help learners to set learning goals, control the learning process, and develop self-motivation and self-confidence, as well as determine or regulate aspects of the environment that support the learning process [22]. This is because through the phases in the self-regulated learning oriented learning strategy, which include the phases of analysing, planning, implementing, observing understanding, problem solving, evaluating, and modifying learners are able to be metacognitively, motivational and behaviourally active in learning process activities [17] [23].

Metacognitive skills of students cause learning success in students. Increasing students metacognitive skills causes students learning outcomes to also increase [6] [7]. Metacognitive skills are needed in chemistry learning so that students can easily represent the macroscopic,

submicroscopic, and symbolic levels in chemistry learning, especially in acid-base material. In acid-base material, the macroscopic aspect includes acid-base phenomena in everyday life, the microscopic aspect includes the properties, structure and interaction of particles in acid-base solutions, and the symbolic aspect includes mathematical operations in acid-base pH calculations [9].

Thus this supports that the development of a supplementary book of acid-base material oriented towards self-regulated learning as a chemical learning resource has the potential to facilitate students in improving their metacognitive skills.

3. Proposed Method

This study aims to determine the feasibility of a supplementary book of acid-base material oriented towards self-regulated learning developed based on aspects of validity, practicality and effectiveness [24]. This research was conducted on 30 IPIEMS Surabaya high school students by applying a Research and Development (R&D) approach that refers to the Borg and Gall draft model which is only carried out up to the 6th step, namely product trials as presented in the chart as follows:

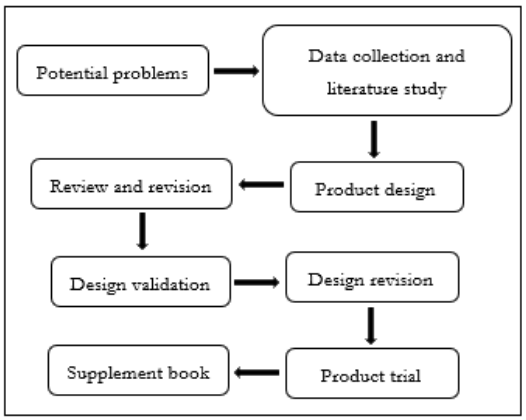

Figure 1 Steps of the Borg and Gall development method
(Adaptation of Sugiyono, 2011)

The following is a description of each step used in the research and development of a self-regulated learning-oriented acid-base material supplement book to improve metacognitive skills:

a. Identification of potential and problems
   The identification of potential and problems stage was carried out to identify the potential and problems of IPIEMS Surabaya high school students through a pre-research questionnaire and interviews with chemistry teachers.
b. Data collection and literature study
   The data collection and literature review stage was conducted to obtain information about the urgency of the research through journal reviews or related sources.
c. Product design
   In the product design stage, the researcher designed the initial draft of the acid-base material supplement book oriented towards self-regulated learning (SRL) to improve overall metacognitive skills.
d. Review and revisio
   The review stage aims to obtain feedback or suggestions regarding the first draft of the supplementary book. Based on the feedback or suggestions, revisions are made for improvement.
e. Design validation
   The design validation stage aims to determine the validity of the developed supplementary book based on content and construct validity assessed by validators.
f. Design Revision
   The design revision stage involves refining the supplementary book based on the validation results obtained.

g. Product trial
This stage involves testing the supplementary book with high school students at IPIEMS Surabaya using a pre-experimental design, specifically the One Group Pretest-Posttest Design. One Group Pretest-Posttest Design. To determine the feasibility of the supplementary book, the practicality of the supplementary book is reviewed through student response questionnaires, supported by observation sheets of student activities. Meanwhile, the effectiveness of the supplementary book is reviewed through pretest and posttest results, supported by the results of metacognitive inventory questionnaires.

4. Results and Discussion

Analysis of Potential Problems

Based on the results of a pre-research questionnaire that has been given to class XI at SMA IPIEMS Surabaya, it is known that as many as 94,4% of students state that chemistry is a difficult subject, as many as 36,1% of students state that the chemistry material delivered by the teacher is difficult to understand because of the many foreign terms and as many as 69,4% of students consider acid-base material as one of the materials in chemistry that is difficult to understand.

The results of interviews with chemistry teachers at SMA IPIEMS Surabaya stated that students were lacking in learning the basic concepts of chemistry material, causing students understanding to be lacking. The use of teacher centred learning models and the absence of supporting textbooks in the learning process causes students to be less facilitated during the learning process. Thus making students metacognitive skills tend to be low at 31,25% with planning skills of 42,19%; monitoring skills of 40,63% and evaluation skills of 10,94%.

Data Collection and Literature Study

This stage aims to obtain information that will be used as material in developing supplement books and overcoming problems in research. At this stage, theories based on books and research journals regarding the development of supplement books, self-regulated learning (SRL) oriented learning strategies, metacognitive skills and acid-base materials are sought as reference sources.

Product Design

The product design stage aims to design the initial design of the supplement book developed. The supplement book was developed based on the elaboration of the contents of the current curriculum, namely the independent curriculum which includes the components of the preface, table of contents, instructions for using the book, an overview of self-regulated learning and metacognitive skills, concept maps, and learner learning activities which include phases of analysing, planning, implementing, observing understanding, problem solving, evaluating and modifying [17] [25].

Review and Revision

The design of the supplementary book that has been developed is then reviewed by the reviewer with the aim of obtaining suggestions and comments. The review aims to find out whether the supplement book is appropriate or there are still deficiencies that need to be revised. The results of suggestions and comments that have been obtained from the reviewer are used as material for improvement in revising the supplement book to be more perfect.

Design Validation

The supplementary book that has been reviewed by the reviewer and revised by the researcher is then validated by 3 validators, namely 2 chemistry lecturers at Surabaya State University and one chemistry teacher at IPIEMS Surabaya High School which includes content and construct validity. The results of content and construct validity are presented in the following table:

Table 1 Supplement Book Validation Results

Eligibility Criteria	Validator			Median	Criteria
	1	2	3		
Content validity	4	5	5	5	Very good
Construct validity					
Language	4	4	5	4	Good
Presentation	4	5	5	5	Very good
Graphics	4	5	5	5	Very good

In the table above, the content validity criteria obtained a median of 5 so that it was declared very good. In construct validity, it obtained a median of 5 so that the supplement book was declared valid for use in a limited trial on students. In line with research (Khoiroh & Azizah, 2021) which explains that the content and construct validity of problem solving based supplement books to train students metacognitive skills get an average score of 91,6% with very good criteria and the results of construct validity get an average score of 84,9% with very good criteria so that they can be declared suitable for use.

Design Revision

Suggestions or comments obtained from validators are used as improvement materials for the perfection of the supplement book developed so that the supplement book can be declared feasible before being tested on a limited basis to students.

Product Trial

The supplementary book of acid-base material oriented to self-regulated learning (SRL) was tested on 30 students of class XI SMA IPIEMS Surabaya. The research design used was the One Group Pretest-Posttes Design research design. This research design has pretest activities before the treatment is given then given treatment in the form of giving textbooks, namely acid-base material supplement books oriented to self-regulated learning (SRL) then given a posttest after treatment [26].

Table 2 One Group Pretest-Posttest Design Scheme

Pretest	*Treatment*	*Posttest*
O_1	X	O_2

The results of the supplement book trial will be described as follows:

Practicality Results

The results of practicality obtained in the form of the results of students responses after using the supplement book supported by the results of observations of students activities while using the supplement book. The results of students responses are presented in the following table:

Table 3 The Results of the Student's Response

Criteria	Results (%)	Categories
Contents	94,25	Very strong
Language	90,67	Very strong
Presentation	95	Very strong
Graphics	98,3	Very strong

Based on the table above, it can be seen that the percentage obtained is ≥61% in the category of very strong, so that the acid base material supplement book oriented to self regulated learning can be declared practical. In line with the results of the study (Laili & Azizah, 2024) which explained that the results of the e-LKPD learners response questionnaire to train students metacognititf skills with an average of 95,29% were declared practical to be used as teaching materials [28].

The results of observation of students activities carried out by three observers are presented in the following table:

Table 4 Results of the Activity of Learners

Activity Of Learners	Activity Percentage (%)		
	P1	P2	P3
Relevant Activities	96,7	97,2	96,1
Irrelevant Activity	3,3	2,8	3,9

Based on the table above, it can be seen that the percentage of relevant activities obtained is greater than irrelevant activities. This shows that the activities of students are carried out well according to the self-regulated learning learning strategy. With the percentage of average activity of students obtained as a whole that is equal to 96,67% with a very strong category so that the book supplements the asam basa-oriented self-regulated learning material can be declared practical.

Effectiveness Results

The results of the effectiveness of the supplement book can be reviewed through the results of the students metacognitive skills test before and after using the supplement book supported by the metacognitive inventory questionnaire. The results of the students metacognitive skills test obtained were then subjected to statistical tests. Before that, a normality test was carried out first to determine whether the data was normally distributed or not. The normality test used is the Shapiro Wilk test because the data sample is less than 50 samples (N < 50) [27].

Table 5 Normality Test Results

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Pretest	.945	30	.122
Posttest	.944	30	.113

Based on the above, the significance value of pretest data and posttest data >0,05, then both data are normally distributed. Thus, a parametric statistical test was carried out, namely the paired sample t-test.

Table 6 Test Results of Paired Samples T-Test

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 Pretest - Postest	-5.42222E1	6.30838	1.15175	-56.57781	-51.86663	-47.078	29	.000

Based on the results of the Paired Sample t-test above, a significance value (2-tailed)< 0.05 was obtained. The sig. (2-tailed) value obtained was then divided by 2 to produce a sig. (1-tailed) value. Thus, the sig. (1-tailed) value obtained was 0.000 ≤ 0.05, so H_0 was rejected and H_1 was accepted. Based on the results of the paired sample t-test, it can be concluded that there is an effect of the application of the acid-base material supplement book oriented towards self-regulated learning (SRL) in improving students' metacognitive skills. This means that there is a significant improvement in the pretest and posttest scores of students' metacognitive skills, so the acid-base material supplement book oriented towards self-regulated learning (SRL) can be considered effective in improving students metacognitive skills. In line with research (Azizah & Nasrudin, 2021) which states that the metacognitive skills variable has a significant effect on self-regulated learning (SRL) [30]. Thus it can be said that the supplementary book of acid-base material oriented towards self-regulated learning is effective for improving students metacognitive skills.

After the paired sample t-test test was conducted, the data was then tested using N-gain to determine the improvement of students metacognitive skills through pretest and posttest scores. The N-gain value data is presented in the following diagram:

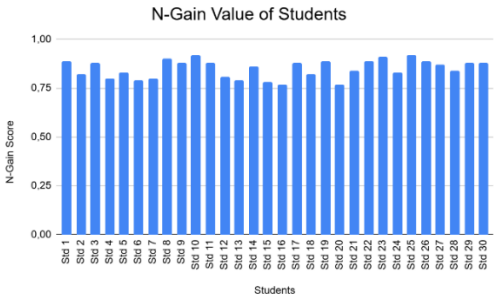

Figure 2 The Value of N-Gain Learners

Based on the diagram above, it can be seen that 30 students obtained N-gain scores in the "high" category and the average N-gain score was 0,85 in the "high" category. A high N-gain score indicates that students have high metacognitive skills so that they can perform well at school [31].

The results of the metacognitive inventory questionnaire for each component of students metacognitive skills are presented in the following table:

Table 7 Metacognitive Inventory Questionnaire Results

Components of Metacognitive Skills	Results (%)	Categories
Planning skills	93,54	Very strong
Monitoring skills	90,67	Very strong

Components of Metacognitive Skills	Results (%)	Categories
Evaluating skills	87,85	Very strong
Average	90,8	Very strong

Based on the table above, it can be seen that the average percentage of metacognitive inventory obtained is 90,8% with a very strong category so that the supplementary book of acid-base material oriented to self-regulated learning can be declared effective for use in learning.

5. Comparison

Similar research was conducted by (Khoiroh & Azizah, 2021) regarding the development of a problem solving-based supplement book that can train students metacognitive skills on thermochemical material with the results of content validity getting an average score of 91.6% with very good criteria and the results of construct validity getting an average score of 84.9% with very good criteria so that it can be declared suitable for use. Other research was also conducted by (Aji, 2024) regarding the development of effective local wisdom-based science supplement books to improve the critical thinking skills of grade IV elementary school students obtained a P-value in the experimental class I and control class groups of 0.021, while in the experimental class II and control class groups of 0.043. The p-value in both groups shows that both scores are smaller than 0.05 so that it can be declared effective to improve critical thinking skills **[20] [28]**.

Conclusions

Based on the results of the research and discussion that has been described, it can be concluded that the validity of the acid-base material supplement book oriented to self regulated learning to improve students metacognitive skills in terms of content and construct validity obtained a median of 5 with a very good category, so it can be declared valid. The practicality of the supplementary book of acid-base material oriented towards self-regulated learning to improve students metacognitive skills is declared practical in terms of the results of the response questionnaire and the results of the student activity observation sheet. The effectiveness of the supplementary book of acid-base material oriented towards self-regulated learning to improve students metacognitive skills is declared practical in terms of the results of improving students metacognitive skills and the results of the metacognitive inventory questionnaire.

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