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Development of Learning Model Tools STEAM-based SCT in Wetland Environment Theme

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Abstract

This study aimed to produce learning tools that meet the eligibility criteria based on the level of validity, practicality, and effectiveness. This study used methods of R&D with a 4D development model. The study was conducted with 5 students on individual trials, 9 students on small group trials, and 35 students on limited trials. The results showed: (1) Validity, expert validation results for lesson plans, and students' worksheets were obtained at 99.3% and 87.3% (accurate); (2) Practicality, from the results of students' responses to questionnaires on individual trials of 3.44 (good), small group trials of 4.29 (good), student response questionnaires of 3.93 (good), teacher's response questionnaires on learning and lesson plans of 4.70 and 4.30 (very good) and observations of the implementation of learning using lesson plans of 4.29 (excellent); (3) The effectiveness was seen in the average N-gain score for creative thinking abilities and self-efficacy of students, namely 0.54 (medium) and 0.73 (high). Overall the development of this learning device had met the eligibility criteria to train students' creative thinking skills and self-efficacy.

Keywords: creative thinking; SCT; self-efficacy; STEAM

Abstrak

Penelitian ini bertujuan untuk menghasilkan perangkat pembelajaran yang memenuhi kriteria kelayakan berdasarkan tingkat validitas, kepraktisan, dan keefektifan. Penelitian ini menggunakan metode R&D dengan model pengembangan 4D. Penelitian dilakukan dengan 5 siswa pada uji coba individu, 9 siswa pada uji coba kelompok kecil, dan 35 siswa pada uji coba terbatas. Hasil penelitian menunjukkan: (1) Validitas, hasil validasi ahli RPP, dan LKS diperoleh sebesar 99,3% dan 87,3% (akurat); (2) Kepraktisan, dari hasil angket respon siswa terhadap uji coba individu sebesar 3,44 (baik), uji coba kelompok kecil sebesar 4,29 (baik), angket respon siswa sebesar 3,93 (baik), angket respon guru terhadap pembelajaran dan RPP 4,70 dan 4,30 (sangat baik) dan observasi pelaksanaan pembelajaran menggunakan RPP sebesar 4,29 (sangat baik); (3) Keefektifan terlihat pada rata-rata skor N-gain kemampuan berpikir kreatif dan efikasi diri siswa yaitu 0,54 (sedang) dan 0,73 (tinggi). Secara keseluruhan pengembangan perangkat pembelajaran ini telah memenuhi kriteria kelayakan untuk melatih kemampuan berpikir kreatif dan efikasi diri siswa.

Kata kunci: berpikir kreatif; SCT; efikasi diri; STEAM

Introduction

Education is a process of learning knowledge, skills, and abilities to understand existing learning concepts. Education must be able to create and prepare students through meaningful learning in order to have competencies that can support them in competing in a global society (Shpeizer, 2018). The very rapid development of science, knowledge, and technology requires a fundamental change movement to create a generation of thinkers who can face challenges and life problems that are different from the past (Suryanti et al., 2018).

Educators can apply the Framework for 21st Century Learning so that students can solve life problems that continue to develop and are increasingly comprehensive (Anazifa & Djukri, 2017; Rachmawati et al., 2019). The framework itself is the basis of competence that students must master as a provision for future success in life and careers (Ariyana et al., 2018). The competencies considered less attention by most educators in the learning process are the ability to think creatively and the self-efficacy of students, especially in the fields of natural science and exact law, namely chemistry lessons.

The National Education Standards Agency suggests that there are two things related to chemistry: chemistry as a product in the form of facts, concepts, principles, laws, and theories and chemistry as a process or scientific work (BSNP, 2009). Herdiawan, Langitasari, & Solfarina (2019) stated that these characteristics are closely related to the facts and concepts of chemistry in everyday life (Herdiawan et al., 2019). Thus, we need something that can facilitate and train students' abilities in solving problems in the form of theories, concepts, laws, and facts from chemistry lessons.

The active role of students' involvement is closely related to the ability to think creatively, allowing them to obtain many ways or alternative solutions to a problem. Although sometimes too many ways will make it difficult to get to the final result, many choices will allow students to get to the goal compared to students who really do not have a way to get to the solution of the problem. Therefore, creative thinking is very important for a student (de Bono, 2017). Students do not escape the experience of failure or setbacks, with self-efficacy will make them more confident. High self-efficacy will make students feel calm in approaching difficult tasks, and activities experienced students. Conversely, people who doubt their abilities can believe that something is more difficult than it really is (Mukhid, 2009).

The realization of students who can practice creative thinking skills and self-efficacy in chemistry lessons are actively involved in the learning process. It can be done through the learning tools used. Through the learning tools, it is possible for educators and students to carry out the process of learning activities so that learning objectives can be achieved. It is in line with research conducted by Wati et al. (2017) that these students' abilities can be improved through problem-solving.

Learning chemistry, creative thinking skills and self-efficacy tools are inseparable. It is because chemistry material can be understood through learning tools in order to train students' creative thinking skills and self-efficacy. Likewise, creative thinking skills and self-efficacy can be trained through learning chemistry. Based on this, it can be seen that the ability to think creatively is very important is owned by students.

In order to build the students' knowledge to understand the learning concept through involvement in the learning process and in order to be able to develop their abilities, it is necessary to have a solution that can train students' creative thinking skills and self-efficacy. It is by using chemistry learning tools with a learning model relevant to the students' living environment.

According to the research conducted by Khairunnisa & Salamah (2018), environmental-based education is an educational program to foster students to have rational and responsible understanding, awareness, attitude, and

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behaviour regarding the mutual influence between the population and the environment in various aspects of human life.

The right learning model for the self-development of students in facing 21st-century life is a learning model that is more student-centred so that students will be actively involved in the learning process. One of the learning models that actively involve students in their learning is the Scientific Critical Thinking (SCT) model.

The SCT model is one of the constructivist learning models that was developed specifically from the Problem Based Learning (PBL) model and the Inquiry model (Rusmansyah et al., 2019). This model can be applied in an effort to train students' creative thinking skills and self-efficacy, which involves the process of understanding concepts and applying them in experimental activities to prove the truth of the concepts being studied. Supporting the realization of concepts that are more meaningful learning and can be applied in everyday life by students can be created through approaches that can train students' abilities. The approach in question is a STEAM-based approach (Science, Technology, Engineering, Art, and Mathematics) that is integrated with the surrounding environment.

The STEAM approach that is relevant to the students' living environment, students could interact actively and explore in their groups so that together they could observe the phenomena that occurred around them in the form of facts (Hadinugrahaningsih, et al., 2017). It is in line with research that showed the use of learning tools with realistic PBL models, or realistic learning that is in line with the environment of students in learning can empower and train students' creative thinking skills and self-efficacy (Masitoh & Hartono, 2017; Siregar et al., 2020).

Based on the description above, this research was conducted as an effort to develop learning tools with an integrated STEAM-based SCT model in the wetland environment to improve creative thinking skills and self-efficacy of students with online learning using google classroom and zoom meetings during the pandemic.

Method

This research was R&D, using a 4D model based on Thiagarajan, Semmel & Semmel (1974); namely, the stages are to define, design, develop, and disseminate (Sugiyono, 2016). The experimental subjects that were engaged in this study were students of Grade XI in the science program, in one public school in Banjarmasin City, in 2020/2021 academic year and 5 validators, namely four lecturers of FKIP Chemistry Education and one teacher of chemistry subjects at MAN 2 Banjarmasin City who is experts in their fields. The object of this research is learning tools, namely lesson plans and students' worksheets with model SCT based on STEAM integrated into the wetland environment to train students' creative thinking skills and self-efficacy. Research data collection started from April to May 2021.

Based on the characteristics of class XI MIPA 6 MAN 2 Banjarmasin students, the average age is 16-17 years. If it is associated with the stage of cognitive development according to Piaget, then the students of class XI are at the stage of formal operational development. The main characteristic of development at this stage is that children can think abstractly and logically using "possible" thinking patterns. Through interviews with Mrs Rini Amini Sholeha, S.Pd., M.Pd. As a chemistry teacher for class XI MIPA 6 MAN 2 Banjarmasin, the information was obtained that students in class XI MIPA were heterogeneous students in terms of students' cognitive abilities. Judging from students' academic ability, they had never participated in realistic approach-based learning such as integrated STEAM learning in a wetland environment. Thus, this learning is relatively new for students.

Data collection in the development of 4D learning tools began with the define stage, which aims to collect various information related to the development of learning tools. The following design was the design of the content framework and the

outline of learning tools with an integrated STEAM-based SCT model in the wetland environment. Develop was in the form of product testing in the form of activities to assess the feasibility of being developed. Finally, dissemination is the dissemination or promotion of developing products with the aim of knowing the effectiveness of using learning tools in the learning process. This stage was carried out with products that had been tested in the research class and would be tested again by comparing the developed learning tools (experimental class) with the usual tools used by teachers in chemistry subjects at MAN 2 Banjarmasin City (control class). However, this stage was not carried out by researchers due to time constraints, so this stage was not discussed in depth.

The research instrument to determine the feasibility of learning devices with an integrated STEAM-based SCT model in the wetland environment in this development research was in the form of test and non-test instruments. The instruments used for the feasibility test were based on the validity, practicality, and effectiveness of the learning tools developed. The test instrument used was in the form of essay questions given at the beginning and the end of the lesson (pre-test and post-test). The test used by students is in the form of a description test consisting of 4 items that were adjusted to the indicators of creative thinking.

The non-test instrument was used in the validity test in the form of a validation sheet for the validator's assessment results before all instruments were tested. Other non-test instruments are readability test questionnaires, students' responses questionnaires, teachers' responses questionnaires, and learning implementation observation sheets using learning tools with the SCT model used in the practical feasibility test and last, the questionnaire self-efficacy used in the effectiveness feasibility test. This self-efficacy questionnaire was a modification of the results of research conducted by Hayati (2021), which contained 15 statements divided into 2 aspects; positive and negative. Questionnaire sheets Self-efficacy and students' responses were made using a scale Likert. The self-efficacy questionnaire contained 15 statement items, and the response questionnaire contained 10 statement items.

The data analysis technique in this study used descriptive data analysis techniques to analyze the use of learning tools with an integrated STEAM-based SCT model in a wetland environment based on creative thinking skills, questionnaire self-efficacy, and response questionnaire.

Results and Discussion

The research data were obtained from students' answers to the HOTS-based test instrument on the Chemical Bonding materials at MAN Binjai. Three expert validators revised and validated the instrument before being used to determine students' higher-order thinking skills. It consisted of 30 multiple-choice questions, distributed into 6 C4 questions, 14 C5 questions, and 10 C6 questions. Afterward, based on the test conducted on students through small classes to determine the instrument's validity, 25 questions were declared valid.

The development products produced in this study were learning tools in the form of lesson plans and students' worksheets using the SCT-based STEAM model integrated into the wetland environment to train creative thinking skills and self-efficacy students on colloidal system material. The advantage of this product was that it could help teachers develop learning tools which were in line with the 2013 curriculum. Also, it helped students interpret learning and trained students' creative thinking skills and self-efficacy on colloidal system materials that were suitable for their environment, namely the wetland environment.

Based on the development of the 4D model that had been carried out at the Define stage, several analysis results were obtained. They included curriculum analysis, needs analysis, student analysis, concept analysis, task analysis, and formulation of learning objectives that had been adapted to the problems that exist in MAN 2 Banjarmasin

City with the demands of the Framework in the 2013 Curriculum. In the phase design was, obtained draft in the form of students' worksheets and lesson plans for 3 meetings on colloid system material. Furthermore, at the stage develop, the data obtained from the feasibility test results were based on validity, practicality, and effectiveness.

1. Validity

The feasibility assessment based on the validity of the learning tools was assessed by the validator through a validation assessment sheet containing assessment items that were adapted to the assessment of the STEAM-based integrated SCT model of the wetland environment. The validators who validated the learning tools developed consisted of 4 lecturers of FKIP Chemistry Education ULM and a teacher of chemistry lessons from MAN 2 Banjarmasin City. Based on the value of the validity of the developed lesson plan and student's worksheet learning tools, the results are shown in Table 1 and Table 2.

Table 1
Lesson Plan Validation Results

No	Aspects of assessment	Assessment results (%)	Category
1	Lesson plan identity	100	Accurate
2	Formulation of learning objectives	99.33	Accurate
3	The content presented	98.67	Accurate
	Average	99.33	Accurate

Based on Table 1 above, the average value was 99.33%, which is in the accurate category. The developed lesson plan was declared very feasible to be used by educators in the teaching and learning process. The lesson plan developed was adjusted to the circular letter of the Ministry of Education and Culture regarding the simplification of the lesson plan so that the lesson plan could be said to be valid and suitable for use. It is in line with research by Khomsiatun & Retnawati (2015) which states that learning tools are determined to be suitable for use if the validation results of each component show a minimum category of "valid" after repairs were made based on suggestions from the validator (Khomsiatun & Retnawati, 2015).

Table 2
Students' woksheet Validation Results

No	Aspects of assessment	Assessment results (%)	Category
1	Based on didactic requirements	70.89	Valid
2	In accordance with construction requirements	95	Accurate
3	In accordance with technical requirements	96	Accurate
	Average	87.29	Accurate

Based on Table 2, it was obtained an average value of 87.29%, which was in the accurate category. The students' worksheet with the SCT-based STEAM model integrated into the developed wetland environment was declared very feasible to be used by students in the teaching and learning process. The students' worksheet developed was adjusted to the learning objectives to be achieved, the learning model used, and the student's living environment so that the worksheet can be said to be valid. Rajabi et al. (2015) stated that learning tools that reflect the consistency between the parts of

the learning tools that are compiled and the suitability between learning objectives, learning models, learning materials and assessments that will be given have valid criteria or are suitable for use (Rajabi et al., 2015).

2. Implementation

The purpose of assessing the practicality of learning devices was to find out that the devices developed could be implemented in the field in line with the assessment given by the validator. Purboningsih (2015) states that learning tools are said to be practical if teachers and students consider learning tools to be easy to use and in accordance with the researcher's plan (Purboningsih, 2015).

The analysis of the practicality of learning devices in this study was measured through a questionnaire on the readability of the students' worksheets in individual and small group trials, a questionnaire on the responses of students to the students' worksheets, a questionnaire on the teacher's response to learning and the lesson plan, and a questionnaire for observing the implementation of the lesson plan which is presented as follows.

Figure 1
The Results of the Readability Test of Individual Students' Worksheets for Each Question

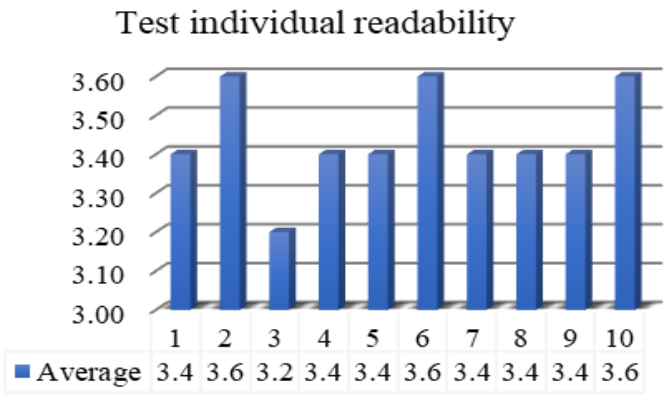
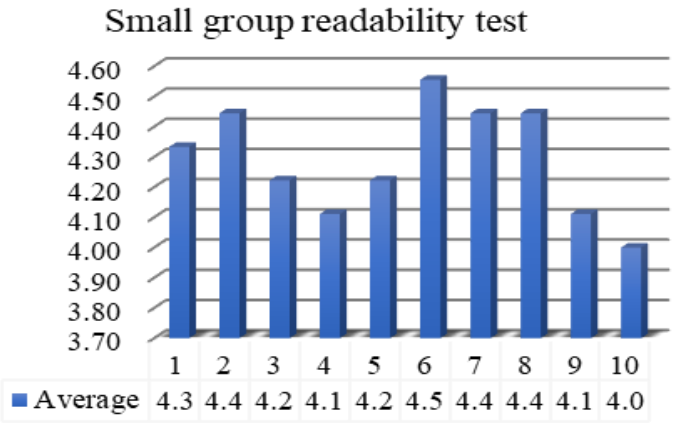


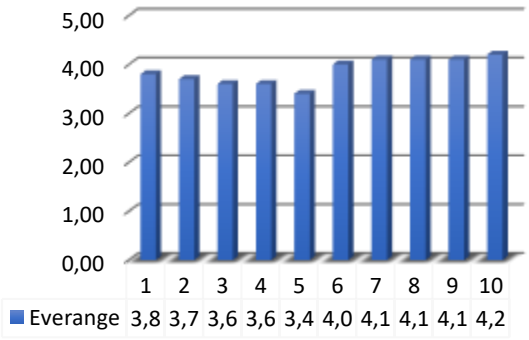
Figure 2
The Results of the Readability Test of the Small Group Students' Worksheet for Each Question



Based on the data in Figure 1 and Figure 2 the readability test assessment of the 10 questions given regarding learning tools in the form of students' worksheets with an integrated STEAM-based SCT model in the land environment wet on the colloid system material obtained the average overall score of the individual students' worksheet

readability test of 3.44 (excellent) and a small group of 4.29 (excellent).

Figure 3
Student Response Results



Based on Figure 3 about the results of students' responses to the 10 questions given, it was obtained data on the assessment of student responses to the students' worksheet, which was developed with an integrated STEAM-based SCT model of the wetland environment on colloid system material with good categories with an average value overall score of 3.93. These criteria were obtained based on the qualifications of Widoyoko (2018). Thus, it can be concluded that the learning tools in the form of students' worksheets with the SCT-based STEAM model integrated into the wetland environment can be used easily by students as a learning resource.

Figures 4 and 5 show the teacher's response assessment data from 10 questions given to learning, and the lesson plans used obtained an average value of both 4.7 and 4.3 in the same category, which is excellent. These criteria were obtained based on the qualifications of Widoyoko (2018). A positive response was given by the chemistry teacher at MAN 2 Banjarmasin City. Thus, it can be concluded that the STEAM-based SCT model of learning tools integrated with the wetland environment can be used practically by educators.

Figure 4
Teacher's Response to Learning for Each Question

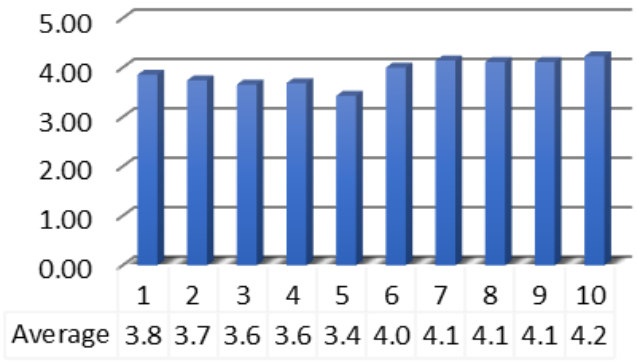


Figure 5
Teacher's Response to Lesson Plans for Each Question

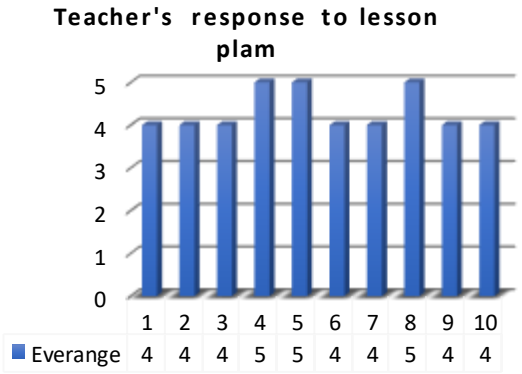


Table 3
Observations on the Implementation of the Lesson Plan

Meeting	Average	Assessment Criteria
I	3.67	Good
II	4.33	Excellent
III	4.87	Excellent
Average	4,29	Excellent

Based on Table 3, the data obtained from the assessment of the results of observing the implementation of learning devices through the developed lesson plan with the SCT model based on STEAM integrated wetland environment on the colloid system material from the 15 questions given a score of 4.29 with an excellent category. It is due to the activities of students who cannot be separated from the teacher's influence. Student activities will increase if teacher activities are carried out effectively and efficiently during learning (Ariani et al., 2015). Effectiveness

The effectiveness analysis was intended to determine the effectiveness of the developed learning tools previously validated by experts. An effort can be said to be effective if the effort reaches its goal. The effectiveness of the development of learning tools in this study was known through the analysis of creative thinking skills and self-efficacy, namely the N-Gain, in a limited trial of 35 students of Grade XI in the science program in one public school in Banjarmasin City, South Borneo. which changed before learning was carried out (pre-test) and after learning (post-test).

1) Creative thinking ability

The creative thinking test was ability conducted twice, namely before learning and after learning. The test was given as many as 4 description questions under the indicators of creative thinking, which are filled out online by students via a google form.

Based on Figure 6, the value of creative thinking skills during the post-test was higher than in the pre-test, from 38.57% to 72.14%. This difference in values indicates that the device with the model SCT based on STEAM integrated wetland environment used is influential and able to train students' thinking skills. The results of the pre-test and post-test of creative thinking skills for each indicator can be seen in Figure 7.

The difference between the pre-test and post-test the ability to creative thinking can be seen clearly in Figure 7, which shows the value of each indicator of the ability to think creatively is fluency, elaboration, originality, and flexibility. It is due to the students' ability which continues to be trained through the learning tools used. In addition, using a learning model that involves an active role and orientation to the wetland environment makes students

motivated to participate in learning. Sustanto et al. (2018) state that the learning carried out must provide many opportunities for students to develop their creative thinking skills, create a meaningful learning atmosphere, and make them active and independent in finding existing problems (Sustanto et al., 2018).

Figure 6
Data on Pre-Test and Post-Test Results of Creative Thinking Skills

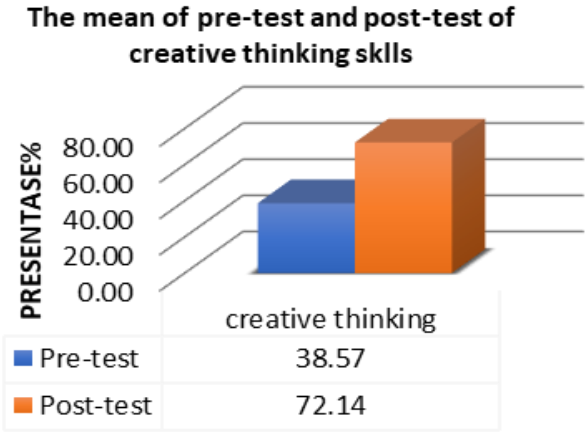
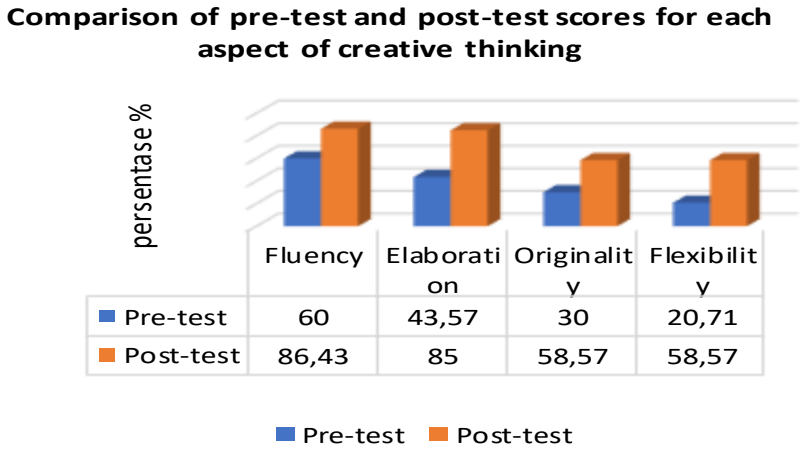


Figure 7
Comparison of the Pre-Test and Post-Test of Every Aspect of the Creative Thinking



Comparison of developments to determine whether learning devices can be trained using the STEAM-based SCT model integrated into the wetland environment on students' creative thinking ability through the N-gain value of the pre-test and post-test scores. Based on the study's results, the average N-gain was 0.54 and included in the moderate category.

2) Self-efficacy

Self-efficacy tests were carried out twice, namely before learning and after learning. Tests were carried out by giving a questionnaire divided into four aspects with the number of 15 questions that were filled online by learners through a google form.

Figure 8 shows that there are differences in the value of self-efficacy of students at the time of pre-test and post-test. The average value of students' self-efficacy at the time of the post-test was 62.63, while at the time of the pre-test was 89.94. The level of students' self-efficacy can be seen from the graph of the results of the comparison of the answer choices for each aspect at the time of the pre-test and post-test presented in Figure 9.

Figure 8
The Average Pre-Test and Post-Test Self-Efficacy of Students

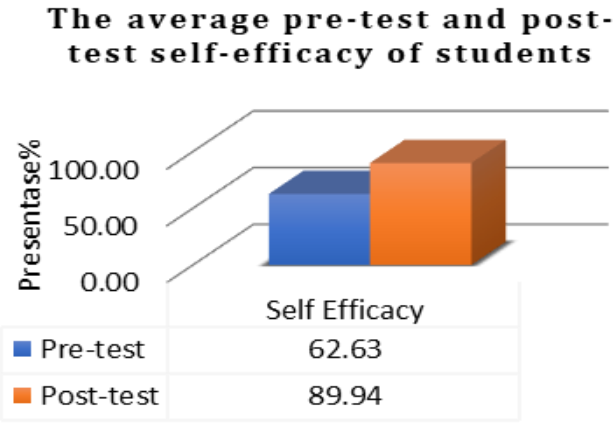
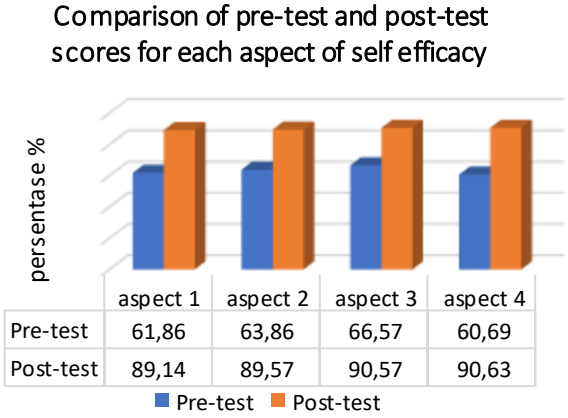


Figure 9
The Average Pre-Test and Post-Test of Each Aspect of Self-Efficacy



Description indicators self-efficacy :
1 = Aspects of belief in the ability to deal with uncertain situations that contain elements of ambiguity, unpredictable and stressful
2 = Aspects of belief in the ability to drive motivation, cognitive abilities and take the necessary actions to achieve a result
3 = Aspects of confidence in achieving the predetermined target
4 = Aspect of confidence in the ability to overcome problems that arise

Based on Figure 9, it can be seen that the level of achievement of each aspect of self-efficacy before learning and after learning has increased. The application of learning tools with model SCT integrated STEAM-based in the developed wetland environment makes students more active in participating, thus leading to the development of self-efficacy in the learning process.

The students' self-efficacy training in the limited trial can be determined using the N-gain value of the scores pre-test and post-test. Based on the study results, the average N-gain was 0.73 and included in the high category. This learning makes students more actively participate so that it can affect the value achieved. It is in line with the research of Rusmansyah et al. (2018), which shows

that there is a development of self-efficacy (Rusmansyah et al., 2018).

Conclusion

Based on the data above, it can be concluded that the development of this learning device had met the criteria of validity, practicality, and effectiveness. Positive response to the use of SCT-based learning tools based on STEAM integrated wetland environment on colloidal system material because it can make students active in the learning process, train students' discipline in collecting assignments, and make it easier for teachers and students to interact in the teaching and learning process. Chemistry teachers should consider the application of learning tools with the STEAM-based SCT model integrated into the wetland environment that was developed to optimize creative thinking skills and self-efficacy of students'.

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