Using module based on search, solve, create, and share effective to increase students’ science generic skills

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Abstract. This research aimed to determine the effectiveness of chemistry module based on Search, Solve, Create, and Share (SSCS) to increase science generic skills. The module developed used SSCS stage that was integrated with six aspects of science generic skills which divided into six chapters of atomic structure and the periodic table of elements. The research was conducted at one of Senior High School in Surakarta. This research method was quasi-experiment with pre- and posttest design. The control and experimental class group at school were used in this research. The control class used instructional material that teachers developed in school experimental class was used module based on SSCS and the experimental class was used module based on SSCS. The control and experimental class groups were given science generic skills test before (pre-test) and after learning (post-test). Quantitative data analysis was calculated using an inferential statistic. The result of this research indicated that the experimental class was used module based on SSCS better than the control class was used teaching material from teacher developed in school. Student’s science generic skills increase with used the module based on SSCS in the learning process. Chemistry module based on SSCS was effective to increase science generic skills and can be one of the materials teaching used by the teacher as a reference to increasing aspects of indirect observations, symbolic language, scale awareness, logical consistency, logical frame, and concept constructing.

1. Introduction
The twenty-first century skills were skill include being able to solve complex problems and acquire new skills [1]. Science generic skills is an intellectual skill that results in a complex mixture of interactions between science and skill knowledge [2]. Science generic capability is a result of a combination of intellectual abilities and the complex interaction of knowledge and skills [3]. The science generic skills indicator according to Brotoisiswoyo in Tawil [2] i.e. (1) direct observation; (2) indirect observation; (3) scale awareness; (4) the symbolic language; (5) logical frame; (6) logical consistency; (7) the law of cause and effect; (8) mathematical modeling; (9) concept construction.

National Research Council or NRC [4] stated that the skill need of future is a variety of science generic skills. The generic skills are expected to be developed through the acquisition of knowledge and concepts [5]. Generic skills are also conceptualized as skills that help them understand their strengths and weaknesses and to help them learn on their own [6]. This shows that science generic skills are very important to be training to the student. The importance of science generic skills is procured to students’ chemistry and developing science generic skills through chemistry learning [7].
The result of the data national exam’s in one of the senior high schools at Surakarta show that the score atomic structure and the periodic table of elements subject have not been able to achieve the average value at the level of city/regency, province, and national [8]. The percentage score gets in senior high school for three academic years (2014 to 2016), which amounted to 54.00% in 2014; 36.96% in 2015; 48.79% in 2016. The result of an interview with some students in an analysis of the needs conducted that the chemistry subject is difficult to understanding. Students stated that the atomic structure and the periodic table of elements is one of the subjects which difficulty to understanding such as atomic theories, determining quantum numbers, configuring electrons, and determining classes and periods of an atom by atomic number or quantum number. The difficulties of learning science are related to the nature of science itself and to the methods by which science is customarily taught without regard to what is known about children’s learning [9].

Some studies indicate that students have misconceptions and learning difficulties concerning atomic structure, chemical bonding and matter [10][11]. Many problems that learners have in chemistry, where there are several kinds of acids or oxidation, or of atomic structure, being presented to students there is clear that the subject has much confusion [12]. This is particularly so when most learners have a very limited notion of the role of models in science [13]. Learners may have difficulty differentiating between key aspects of different atomic models, for example confusing electron shells and clouds [14].

There are many problems in the learning process in the classrooms of the theoretical subjects such as the low effectiveness of student learning, a period of study more than one hour/period, physical environment within the classrooms where were one-way teachings by an instructor [15]. Based on observations and questionnaire in this research, conducted that teachers still used the method of discussion, frequently asked questions, even though still used discourse method [16]. Although teachers have developed a module and their own teaching materials, the results of the analysis also show that teacher modules and teaching materials do not increase students' skills. The teachers still felt their module and teaching material can’t increase science generic skills maximally, so they need an alternative teaching material can increase student's science generic skills. The students (85%) stated that they felt difficult to understand the structure atom and the table periodic of elements used teaching methods and teaching material from their teacher and 96% students need alternative teaching methods and teaching material makes them more than interest to learn and understand this subject. Teaching methods and teaching materials can’t increase student’s skills affect student’s learning outcome.

Teaching material is tool and media that provide opportunities for students to gain learning experience. The students’ used module can learn independently so that more efficient allocation of instructional hours [17]. The availability of modules can assist students in obtaining information about learning materials. The result of a research indicated that students who were given the module had a high post-test score compared to students who did not use the module in the lesson [18].

In addition to teaching materials, learning models also have a role in the learning process. One of the learning models can be applied in a module is the problem-solving approach. The ultimate success of problem-solving based on learning model resulted from the emphasis on instruction in problem-solving strategies, including logical thinking skills and the skills of other processes. Students have a treatment of opportunity to observe, hypothesize, record, predict, think, analyze and create conclusions [19]. One of the models in the problem-solving approach was being developed specifically for science instruction is Search, Solve, Create, and Share (SSCS) [20]. This model teaches a problem-solving process and gives students ample opportunity to practice and refine their problem-solving skills. Creative thinking as a positive action was an important factor in stimulating brain function that can be a good learning style [21]. Therefore, learning should be carried out using the student-centered learning model, and one of which is SSCS learning model [22]. SSCS model helped students to develop advanced cognitive abilities [23] such as creative thinking, problem solving, communication skills, and generic skills.

The efforts to support the teacher to increase student’s science generic skills and make the students more be active-inspired the researchers to using a module based on SSCS at the atomic structure and
the periodic table of elements in the learning process. The developed module is expected to increase the science generic skills in students according to the demands of the 21st century. The purpose of this research to determine the effectiveness of chemistry module based on SSCS to increase science generic skills.

2. Methods
2.1. Research design and samples
This research involved two (10th grade) classes that consisted of 28 and 30 students in each class. The classes were selected by using purposive sampling technique. This research method was quasi-experimental with pre- and post-test design [24].

2.2. Instrument
Science generic skills test given to the students which consist of 20 multiple-choice questions. It involves questions assessing science generic skills aspects developed by Brotosiswoyo in Tawil [2] that conducted six aspects. There were indirect observations, scale awareness, symbolic language, logical frame, logical consistency, and concept constructing. The validity of the science generic skill test gets score 0.87 by using the Aiken formula [25] which means the content of validity was good. The coefficient reliability (α) of the science generic test gets score 0.73 with Anates 4.0, this shows that the science generic skills test was reliability cause gets score more than 0.70. A correct and wrong answer has been scored respectively as 1 and 0 for the evaluation of science generic skills test.

2.3. Intervention
The control and experimental class groups were given science generic skills test before (pre-test) and after learning (post-test). The control class used instructional material that teachers developed in school while the experimental class was used module based on SSCS. Module based on SSCS of atomic structure and the periodic table of elements to increase science generic skills have conducted the activities using SSCS stage by Pizzini [20]. The validity of the module which value 0.91 by using Aiken formula [25], that means the content of module valid based on the average score of validation by nine experts. There were nine experts in chemistry, teaching and learning, module development, linguist, and education practitioners. Therefore, module SSCS on atomic structure and the periodic table of elements to increase science generic skills were interpreted as valid and it was implemented to the experimental class group.

The analysis was performed on the pre- and post-test values of the control and experimental classes. The pre- and post-test values were used to determine the n-Gain of each class. Furthermore, the prerequisite test (normality test and homogeneity test) for effectiveness test using SPSS 18. The effectiveness test used to find out whether there was a significant difference between the control class and the experimental class.

3. Result and discussion
The module developed used SSCS stage that was integrated with six aspects of science generic skills which divided into six chapters of atomic structure and the periodic table of elements. There were atomic structure, atomic number and mass number, Bohr’s atomic theory, the theory of quantum mechanics, electron configuration and the periodic table. The reached score of science generic skills in the control and the experimental class group presented in Figure 1.
Note:
• Aspect 1: Indirect observation
• Aspect 2: Symbolic language
• Aspect 3: Scale awareness
• Aspect 4: Logical consistency
• Aspect 5: Logical frame
• Aspect 6: Concept constructing

The aspect of indirect observation gets score pre- and post-test were respectively 38.27 and 68.88 in control class and get score pre- and post-test were respectively 31.90 and 73.81 in experimental class. Score pre- and post-test were respectively 26.79 and 66.43 was got by control class and score pre- and post-test were respectively 24.67 and 70.33 was got by experimental class for an aspect of symbolic language. The aspect of scale awareness gets score pre- and post-test were respectively 31.55 and 69.64 in control class and get score pre- and post-test were respectively 36.11 and 73.33 in experimental class.

The aspect of logical consistency gets score pre-test 25.00 and post-test 73.70 in control class and get score pre-test 23.33 and post-test 70.30 in experimental class. The control class gets score 25.71 (pre-test) and 70.00 (post-test) for an aspect of the logical frame, and experimental class get score 21.67 (pre-test) and 69.67 (post-test). The score for aspect concept constructing, control class gets score pre- and post-test were respectively 32.65 and 70.48 and experimental class gets score pre- and post-test were respectively 30.48 and 70.48.

Based on reached a score of science generic skills control and in experimental class group presented in Figure 1, show that science generic skills in the experimental class were higher than control class, that was 43.29 for an average of reached a score in experimental class and 40.27 for the control class. The control class used material developed by the teacher used discourse method and frequently asked questions make the activity of the student to be low, the student only listens and record an explanation of the teacher, so the learning process is teacher-centered, not student-centered. This affects to learning the outcome, the student's science generic skills in control class more less than the experimental class. The experimental class used module based on SSCS integrated with some aspect of science generic skills. The result of pre- and post-test score in control and the experimental class group presented in Figure 2.

Figure 1. The reached score of science generic skills in control and in experimental class groups.

| Aspect    | Control Class | Post test | Experimental Class | Post test | n-Gain |
|-----------|---------------|-----------|---------------------|-----------|-------|
| Aspect 1  | 31.60         | 69.64     |                     | 72.16     | 0.55  |
| Aspect 2  | 30.33         | 70.00     |                     | 70.30     | 0.60  |

Figure 2. The reached score of science generic skills in control and in experimental class group.
Figure 2 showed that n-Gain in experimental class is higher than control class that was .60 for experimental class. These n-Gain scores were used for normality test and homogeneity test. The result of normality test showed in Table 1.

**Table 1. The result of normality test**

| Significance Different | Criteria Test | Result          |
|------------------------|---------------|-----------------|
| Control Class          | 0.200         | Sig. Different > 0.05 | Normal |
| Experimental Class     | 0.058         |                 |       |

Based on Table 1, normality obtained significance level of 0.200 for control class and 0.058 for experiment class. The result shows that the level of significance is more than 0.05, meaning the data was normally distributed.

Homogeneity test obtained the level of significance equal to 0.027. These results indicate that the significance level is less than 0.05, meaning that the sample has unequal variation (not homogeneous). The effectiveness test used non-parametric test, that was Mann Whitney because the data have been a normal distribution and not homogeneous. The result of effectiveness test showed in Table 2.

**Table 2. The result of effectiveness test**

| Z_{count} | Z_{table} | Criteria Test               | Decision Test |
|-----------|-----------|-----------------------------|---------------|
| 2.225     | 1.64      | Z_{count} > Z_{table}       | Accept H1     |

Based on Table 2, the effectiveness test obtained z_{count} > z_{table} it means the learning process with using module based on SSCS better than the learning process without used module based on SSCS. Module based on SSCS at the atomic structure and the periodic table of elements to increase student’s science generic skills significantly. The effectiveness of module was known from the test results of the non-parametric test (Mann Whitney). The students’ science generic skill in the experimental class was used module based on SSCS better than the students’ science generic skill in the control class was used teaching material from teacher developed in school.

The result of a study about using module indicated that module based on discovery learning in the learning process is effective to increase science generic skills [26]. Science generic skills are common thinking skills of science learning [27]. Science generic skill necessary for success in all jobs as it includes cognitive ability, personal, and interpersonal. Generic skills are the ability of a combination of knowledge and skills related to cognitive, affective, and psychomotor [28].

Module based on SSCS used in the learning process can increase student’s science generic skills because module presented SSCS stage where integrated with science generic skills aspect. SSCS stages are search, solve, create, and share gives freedom for the student to increase their skill and ability. At the search stage students do a search and investigate the topic of they were studied, though this stage students will get questions related to the topic. There was a link to a website for students to search deeper about the topic. The aspect of indirect observation and scale awareness increased in search stage. In the solve stage, students make the group as a team to encourage inquiry plan to find answers of the questions on the module. The aspect of the symbolic language and logical frame were increased in solve stage. The aspect of symbolic language is an essential skill needed in learning chemistry [7].

After performing the inquiry plan, the students try to continue to create stage. At this stage, students create their findings, which are can data interpretation, data analysis, or conclusion. The last stages are share stage, the students share and communicate the findings to other fellow students and teachers to obtain feedback. The aspect of logical consistency and concept constructing were increased in create and share stage. Learning process with the module integrated with SSCS, make the students
have more motivation, students have more active, students interesting to solve every problem, and the students have more understanding the subject. From the research about using module in the learning process known that students were interested in using and reading the module, and using the module make student more active in the learning process such as reading and understanding modules, ask and discuss with group friends and solve problems that exist in modules [29].

Overall based on the results have shown that module based on SSCS at the atomic structure and periodic table of elements has more effective to increase student's science generic skills. Learning materials with Search-Solve-Create-Share effective improve the pre-service teachers' basic skills of teaching mathematics [30]. SSCS model is a model that can increase students' skills, especially science generic skills of students. The used of SSCS model gave positive responses to the students in the learning process and can increase student's skills [31].

4. Conclusion
Science generic skills are important to train the student. Module based on SSCS effective to increase science generic skills. The module integrated with aspects of science generic skills can be one of the materials teaching used by the teacher as a reference to increasing aspects of indirect observations, symbolic language, scale awareness, logical consistency, logical frame, and concept constructing. The module has a more detailed on lesson plan with practical activities make the students understand the subject easily, the students enjoy and felt easy to follow the learning process to increase student's science generic skills.

In the implementation of module based on SSCS learning model, teachers should guide students in module activities because the students need more period to finish SSCS stage, especially in solve and create stage. This module only integrated with six aspects of science generic skills, so the module which is developed can be used as the reference for teachers to develop module in another aspect of science generic skills.

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