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THE NEED ANALYSIS OF MODULE DEVELOPMENT BASED ON SEARCH, SOLVE, CREATE, AND SHARE TO INCREASE GENERIC SCIENCE SKILLS IN CHEMISTRY

D. Nastiti*[1], S. B. Rahardjo[2], Elfi Susanti VH[3], R. Perdana[4]

[1,2,3]Post-graduate of Science Education in Sebelas Maret University, Surakarta, Indonesia
[4]Doctoral Program of Educational Science, Sebelas Maret University, Surakarta, Indonesia

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ABSTRACT

Science generic skill is very important for students to solve every problem in learning processes and daily life. The purpose of this research was to explore the students' needs of the chemistry module based on search, solve, create, and share (SSCS) to increase science generic skills. This research employed a descriptive qualitative method. There were 61 students in XI Grade from two Senior High Schools at Surakarta. The data were collected using questionnaires sheets, interviews, and materials analysis. The research revealed that the module and teaching materials used in the schools have not empowered the science generic skills maximally; also, the teachers remained to adopt discourse method which resulted in a teacher-centered learning. Such learning made the learning activities seemed monotonous, uninteresting, and less motivated the students in building concepts. Thus, the students required alternative teaching materials to increase their science generic skills. In sum, it is necessary to develop a chemistry module on the atomic structure which oriented to the SSCS.

Keywords: chemistry module, science generic skill, SSCS model

INTRODUCTION

A curriculum is, of course, a cultural product, and liable to shift in response to social trends and fashions (Taber, 2016). One of the Indonesian Government efforts to advance education is issuing the 2013 Curriculum. It is a student-centered learning which trained 3 aspects of knowledge, attitude, and skills. The 2013 curriculum is applied to all subjects in schools including the chemistry subject. Fin et al., (2008) defines chemistry as a branch of natural science (science), with regard to study the structure and composition of matters, changes that can be experienced by the materials and other phenomena which accompany material changes. The content of chemistry in the form of concepts, laws, theories, is basically the product of a series of processes using a scientific attitude. These three aspects of chemistry are equally important since there will be no chemical knowledge without a process involving chemists thinking and scientific attitude

The content of chemistry and 2013 curriculum has the same targets that must be possessed by students, namely aspects of knowledge, attitude, and skills. Studying chemistry can support the development of thinking skills, teamwork, communication skills, creativity, and metacognition (Taber, 2016). The success of increasing students' understanding of science can be assessed from their fundamental ability while they are in the learning process (National Research Coun-

*Correspondence Address
E-mail: deanitanastiti@gmail.com

cil, 2000). This initial ability is known as generic science skills. Generic science skills are intellectual abilities arising from the combination or complex interaction between science knowledge and skills (Tawil & Liliasari, 2014). Generic science skills emerge with the development of knowledge and skills within disciplinary areas of various sciences (Pitman & Broomhall, (2009). The generic science skills have an important role in supporting learning, especially in science learning to emphasize the aspects of the learning process (Agustina, 2016). The science generic skill indicators according to Brotosiswoyo in Tawil & Liliasari (2014) are shown in Table 1.

Table 1. Generic Science Skills Indicators According to Brotosiswoyo (2000)

Generic Science Skills	Indicators
Direct observation	Using as many senses as possible in observing natural experiments/phenomena Gathering the facts of the experiment or the natural phenomenon Searching for differences and similarities
Indirect observation	Using a measuring instrument as a sensing device in observing experiments or natural phenomena Collecting facts from experimental results of physics or natural phenomena Looking for differences and similarities
Awareness of the scale	Recognizing natural objects and high sensitivity to numerical scales as microscopic or macroscopic scales
Symbolic language	Understanding symbols, symbols, and terms Understanding the quantitative meaning of units and magnitudes of equations Using mathematical rules to solve problems or phenomena of natural phenomena Reading a diagram, table, and mathematical mark
Logical frame	Looking for a logical relationship between two rules
Logical consistency	Understanding the rules Rule-based arguments Describing the problem based on the rules Drawing the conclusions of a phenomenon based on rules or preceding laws
Cause and effect law	Expressing the relationship between two or more variables in a certain natural phenomenon Estimating the cause of natural phenomena Revealing phenomena or problems in the form of sketches of images or graphs Expressing phenomena in formulas Applying alternative problem solving
Mathematical modeler	Expressing the relationship between two or more variables in a certain natural phenomenon Estimating the cause of natural phenomena Revealing phenomena or problems in the form of sketches of images or graphs Expressing phenomena in formulas Applying alternative problem solving
Building concepts	Added a new concept
Abstraction (Sudarmin, 2007)	Describing or abstracting abstract concepts or events into the real-life everyday life Creating visual animations of abstract microscopic events

People realize that science generic skill is important, yet its implementation is not as expected (Faradilla et al., 2018; Ramlawati et al., 2014). The results of observations conducted at two high schools in Surakarta showed that teachers have not trained students' skills in learning activities. The questionnaires and interviews revealed that chemistry teachers knew that they lacked empowering students' generic science skills. The teachers only trained some indicators of generic science skills such as direct observation, indirect observation, symbolic language, and awareness of the scale (Nastiti et al., 2018). The interview with the chemistry teachers at both schools revealed that they had no idea what learning model/method s/he was using. However, the observation results made clear that the teachers applied the discourse methods which oriented to knowledge-transferring only without any students' involvement. Although the teachers have developed their own teaching materials and module, yet the analysis showed that those learning tools have not yet empowered students' skills maximally. Therefore, the teachers need an alternative module with learning method oriented to empower the students' generic science skills.

The efforts to support the teachers to maximally increase students' generic science skills inspired the researchers to develop a module based on the SSCS model (Search, Solve, Create, and Share) for the atomic structure and the periodic table of elements. The SSCS model is one of the learning models that can increase students' skills, especially generic science skills. A handbook by Pizzini (1991) describes the sense of the four stages of SSCS, and the 'search, was a fact-finding process in discovering who, what, where, and how. 'Solve' means finding the alternative sorting out the will used in solving a problem as well as planning the problem-solving steps. Next, 'Create' is the implementation of plans determined on the 'solve', i.e. by using use creative thinking and analytical skills. The last stage is 'Share' that is communicating solutions of the problem with colleagues (Pizzini, 1991). The adaptation of the four SSCS model in the learning process was expected to increase the students' interest, vivacity, creativity, and communication skills; also, affect the students' generic science skills. This corresponds to some research indicating that there was an improvement of students' skills and conceptual understanding after joining a learning using the SSCS model (Kurniawati & Siti, 2014; Rosawati & Dwiningsih, 2016; Yusnaeni et al., 2017). Based on the problems above, this research intended to make an early analysis of the students' need for an SSCS-based chemistry module.

METHODS

This research employed a descriptive qualitative method. The purpose of this research was to explore the students' needs of the chemistry module to increase generic science skills. The purposive sampling technique was applied to select the participants (Sugiyono, 2013). The participants of this study consisted of 61 students from two senior high schools in Surakarta, Indonesia. They were XI grader who learned the atomic structure and periodic table of elements. Furthermore, seven chemistry teachers involved in the interview stage to ensure the validity of data. The data were analyzed with the percentage calculation by the following formula (Ali & Asrori, 2014).

$$P = \frac{n}{N} x \ 100\%$$

Description :
P = Percentage score (%); n = Number of scores obtained; N = Maximum score

The instruments used in this research were questionnaires, interview guidelines, and materials analysis. The questionnaires were handed out to the students and teachers. The validity test adopted Aiken's formula resulted in the value of 0,87 -1,00 and the average value of 0,89. Hence, the contents were declared valid by five validators (Aiken, 1985). The students' questionnaires consisted of 13 questions (4 questions about learning method, 5 questions about learning materials, 2 questions about teachers' method in the learning process, and 2 questions about students' needs).

The students' interview guideline covered 9 open-ended questions to find out their reasons for giving yes or no answer for each question. The interview aimed at finding out information about the process of learning activities and problems faced during learning. The teachers' interview guidelines comprised 19 open-ended questions about teaching-learning processes, teaching materials, students' skills, teachers' needs, and outcomes from the learning process. The analysis of teaching materials and module was adapted from BSNP 2016 assessment textbook which integrated the aspects of generic science skills. The analysis results of the adopted teaching materials and module intended to know the extent of fulfillment of each generic science skill indicator in two Senior High Schools at Surakarta.

RESULTS AND DISCUSSION

The observation was done for collecting information directly about the learning process in two Senior High Schools in Surakarta. It revealed during the observation that the teachers remained to apply the discourse method in learning process. The students were given handouts of learning materials developed by the teachers. However, the teachers' were more active than the students, which did not give tangible impacts on the increase of students' potentials. Such method led to the lack of students' activity. Instead, they only listened and recorded information obtained from the teachers' long explanation.

Questionnaires were given to the students to seek information about their needs of chemistry module. The questionnaires pertained to the students' learning style, needs, learning materials, and teachers' the teaching methods. The results of the questionnaire analysis were reinforced with the results of interviews with the students. As many as 95% of the students were enthusiastic about following the chemistry lesson though they considered it one of the most difficult subjects requiring high-level of intention. This corresponds with Ardiansah (2016) who agreed that chemistry is a misconception-prone subject as there are a dozen analogies for students to be understood. 73% of the students stated chemistry subject is difficult because of many materials and abstract formulas contained in it. Moreover, previous studies have revealed that students only completed general chemistry yet lacked a conceptual understanding of several fundamental topics (Cracolice et al., 2008; Burrows & Mooring, 2015). Learners may have difficulties in differentiating between key aspects of different atomic models; for example, confusing electron shells and clouds (Ruengtam, 2013).

The students, through the questionnaires, stated that they performed practicums in chemistry classes. The availability of laboratory and library have helped them to understand the chemistry concepts (73%), the students used textbooks or other handbooks to learn about chemistry concepts (65%) such as student worksheets (45%) and textbooks available on bookstores (34%). The students (67%) had difficulties in studying the chemistry concepts from books due to its elusive comprehensiveness and explanatory techniques. Most of them (96%) said that although the teachers have employed special teaching materials in learning chemistry concepts such as module, student worksheets, and power points, it did not give many contributions to their comprehension of the atomic structure and the periodic table of elements (83%). The students (63%) declared that the atomic structure and the periodic table of elements were elusive, abstract materials.

Below is presented in Table 2 the data of the National Examination analysis at both upper secondary schools in Surakarta during the last 3 years (BSNP, 2016).

Table 2. The Percentage of National Examination on Questions of Atomic Structure and Periodic Table of Elements in Two Schools in Surakarta

Indicators of Subject	Academic Year	Sch	Cit/Reg	Prov	Nat
Determine the element notation and its relation to atomic structure, electron configuration, chemical bonding type, molecular formula, molecular form, and the nature of the compound it produces, and the location of elements in the periodic table.	2013/2014	55,73 54,00	63,30 63,30	60,09 60,09	65,09 65,09
Determine the element notation and its relation to atomic structure, electron configuration, chemical bonding type, molecular formula, molecular form, and the nature of the compound it produces, and the location of elements in the periodic table.	2014/2015	57,93 36,96	62,74 62,74	50,59 50,59	59,60 59,60
Given an elemental notation from 2 different classes, learners can choose the most appropriate statement about the different properties of the two elements appropriately.	2015/2016	55,90 41,11	51,60 51,60	53,54 53,54	43,89 43,89
Given a picture of the periodic system of elements with elemental notation, learners can determine the exact configuration of electrons, atomic numbers, and atomic numbers.		68,94 54,74	74,43 74,43	72,37 72,37	67,94 67,94
Given the following elemental notation of the atomic number, learners can define the graphic that indicates the specified nature of the specificity correctly.		73,29 50,53	71,91 71,91	63,94 63,94	58,77 58,77

Description:
Sch= School; Cit/Reg= City/Regency; Prov= Province; Nat= National

A central concern in chemistry education is students' understanding and knowledge (Taber, 2014). The students' knowledge of the atomic structure is built in schools while their understanding of scientific terms might be supported by the learning sources used both inside and outside the class (Zarkadis et al., 2017). Nevertheless, the National Examination analysis showed that the atomic structure and the periodic table of elements materials at two senior high schools in Surakarta were not able to achieve the city/regency, province, and national average value. This means that chemistry learning in the school was not run well. In addition, the result of an interview with some students suggested that the students found it difficult to comprehend such abstract matters like protons, electrons, neutron, isotope, and theories of atom, determining of quantum numbers, configuring electrons of several atoms, determining periods and classes of an atom by atomic number and quantum number.

The students (98%) stated that they had been given teaching materials in the form of modules to study the atomic structure and the periodic table of elements. One of the teachers of the two senior high schools has developed a chemical module on atomic structure materials and the periodic table of elements, but the module has not been model-specific to train students' generic science skills (Tawil & Liliasari, 2014). The highest percentage of generic science indicators achievement was 66.6% for the two from the ten indicators of atomic structure and the periodic table of elements, while the other material indicators were below 50%. However, more than 50% of the students stated that the module was enough to help in understanding the atom structure and the periodic table of elements but 83% of students stated that they remained to have difficulties in understanding the atomic structure and the periodic table of elements through teaching materials and methods applied by the teachers. Moreover, languages seemed to be another burdensome as they mostly did not understand the terms used in the textbook.

The students (95%) said they had never been taught using Search, Solve, Create, and Share (SSCS) learning model. Most of the teachers still used direct instruction strategy and discourse method when teaching their students. The teacher assumed that with these strateges, the subject-transfer would be fast and match with the estimated time. Therefore, according to the 2013 Curriculum, learning should be carried out using the student-centred learning model, and one of which is the Search Solve Create and Share (SSCS) learning model. The SSCS model helped the students to develop advanced cognitive abilities (Chen, 2013), such as creative thinking and generic science skills. The use of SSCS model has proven to give students' positive responses in the learning process and increase students skills (Mulyono & Lestari, 2016).

Most of the students (91%) stated that they need alternative teaching materials that can help the remaining materials of atomic structures and the periodic table of elements. The students (85%) agreed if there should be developed materials in the form of chemistry modules based on Search, Solve, Create, and Share (SSCS) makes it easier to understand the atomic structure and the periodic table of elements. Parmin & Peniati (2012) stated that modules are components that have an important role in the learning process. The availability of modules can assist students in obtaining information about learning materials. The research done by Burmeister & Eilks (2013) indicated that students who were given the module had a high post-test score compared to students who did not use any module in the lesson. Moreover, they also revealed that: (1) students were interested in using and reading the module; (2) module made students active in the learning process such as reading and understanding modules, asking and discussing with group friends, also, solving problems exist in the modules; and (3) students' problem solving skills increased after using metacognitive-based mathematics modules.

Based on the interview with seven chemistry teachers, it was known that the teacher used discourse method, question and answer method, and discussions as a method to transfer knowledge. All of the teachers have developed their own lesson plan, but science generic skills have not been included in the lesson plan. The schools did not yet support chemistry learning to increase students' generic science skills. On the other hand, the teachers stated that students' generic science skills belong to the low-moderate category (Nastiti et al., 2018). Some of the teachers (71%) developed teaching materials and module on atomic structure and the periodic table of elements, yet the material teaching and the module did not integrate with specific teaching method aimed at increasing students' skills. All of the teachers stated that the needed an alternative teaching materials which can increase the students' skills especially the generic science skills.

The development of SSCS-based module is necessarily done to improve the students' generic science skills. It is essential to enhance generic science skills since they can be applied across a variety of subject domains yet take longer to acquire than the domain-dependent (Lim in Anwar, 2014). Generic science skills are the combination of knowledge and skills related to cognitive, affective, and psychomotor (Wahyuni, 2016). Generic skills define as the set of skills or abilities essential to fulfilling the three potential outcomes of higher education, namely the needs and requirements of employers in the marketplace, lifelong learning, and good citizenship (Hadiyanto & Ibrahim, 2013).

Overall, based on the analysis results, the students need an SSCS-based Chemistry Module oriented to the increase of generic science skills. The learning process with SSCS method has proven to have a great influence on the students' roles in establishing their own competence and knowledge through search, solve, create and share stage (Rahayu et al., 2018; Khabibah et al., 2017).

CONCLUSION

The need analysis indicated that the school materials have not empowered science generic skills maximally. Further, the teachers remained to use discourse method which resulted in a teacher-centered, monotonous, uninteresting learning. Such method has proven to be unable to contribute to the students' generic science skills improvement seen from the last three-year National Examination results. Therefore, an SSCS-based chemistry module is greatly needed. It is expected that this new kind of module could foster the students' generic science skills with its strengths to meet the demand of the 21st-century.

This research plays a role as a reference for future research to develop the SSCS-based chemistry module oriented to the improvement of generic science skills. The developed module is expected to pay attention to subject indicators, generic science skills, and SSCS model.

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