

Strengthening the Basic Competence of Sciences for Master Students of Science Education Program

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ABSTRACT

Based on Indonesian National Qualification Framework (known as, KKNI), master student in science education alumnus is targeting to well understanding about materials or concepts that rely on memorization will impact on students' inability to construct relationships between concepts, integrate new concepts with previous concepts to create imagination in understanding concepts. In order to achieve the specific target, the research used explorative research design with writing test data, then for triangulation data, the test result is followed up with in-depth interview. In-depth interviews were conducted through clinical interviews and individual demonstration interviews. The results showed that the initial ability of science S2 students in science subjects is low. On a scale of 0-100 the profiles of basic competence in science of the students is 35.4 for Physics, 43.7 for Biology and 49.7 for Chemistry. Interviews indicate that unfavorable learning materials are complex materials and a lot of discussion on work mechanism, abstract material and many scientific terms and materials that require a high level of understanding. Based on these results need to be developed student-centered learning that is learning that activate and cause high curiosity. Implementable learning is a learning model with experiment / practice, problem solving, assignment or project, invention and simulation so that students find their own concept or material to be learned. The results of this learning will be more memorable and not easy to forget.

KEYWORDS

Basic concept, Science education

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Introduction

As an effort to achieve a qualification of graduates in accordance with the Indonesian National Qualification Framework (known as, KKNI) Master's study program in science education has developed and implemented the Curriculum of 2015. In addition to compliance with the KKNI, the graduate qualifications of the program are also combined with efforts to strengthen the science teacher profession. Based on these matters, it is hoped that the Magister program in

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science education will produce graduates who meet the qualifications of KKNI for professions related to education in science, including to strengthening science teacher competence.

The development and application of curricula that support teacher competence will be more effective if based on the initial state of the student. The result of the research on the initial condition of the students shows that the ability of the basic mastery of the subject matter of science of Science Education Program, which covers the basic mastery of physics, chemistry, and biology matter is low. The early capabilities of basic mastery of physics, chemistry, and biology are not closely related to the diverse backgrounds of the students. On a scale of 0-100, profiles the basic mastery of physics is 37.85, the Biology 28.10 and 44.30 for the basics chemistry.

Mastery in scientific subject matter related to one of the competence that must be mastered by the teacher, that is professional competence. Mastery in scientific subject matter is important, because teachers who are less mastering the field of science is believed will not be able to conduct teaching in field as well. In addition, the mastery of science is important when viewed from the direction of world developments that tend to go to research-based education in the field of science, which is often called discipline-based education research (McDermott, 2013), which results are then implemented in the learning is often called research-based learning (Cochran & Heron, 2006).

Understanding materials or concepts that rely on memorization will impact on students' inability to construct relationships between concepts, integrate new concepts with previous concepts to create imagination in understanding concepts. These things may result an impact on the error of the concept. Misunderstanding concepts will have an impact on delivering wrong information.

Based on the results of the studies that have been described, the difficulty of understanding the basic materials of the field of science could be took into consideration to analyze the difficulties of the students. Therefore, on this occasion that will be examined is the ability of Magister science education students in understanding the material on the field of science. The research is emphasized on the mastery of the basic skills of scientific subject matter, the problem that caused the low level of the ability of the basic skill of science in the students of Science Education Program of Universitas Negeri Semarang (UNNES).

Research methods

The research was conducted by explorative research design using written test technique to reveal the basic capability of scientific subject matter. For the purpose of data triangulation, the test result was followed up with in-depth interview (Shaffer & McDermott, 2005). In-depth interviews were conducted through clinical interviews (Jones 2010) and individual demonstration interviews (McDermott, 2013). The results of the tests and interviews are then analyzed and patterned so as to acquire the basic skills of scientific subject matter from the students of the Magister science education program of the Postgraduate of UNNES.

The research begins with the provision of written tests on all students of Science Education class of 2017/2018, which consist of students concentration of

Science Education and Biology concentration. The test given in the form of multiple choice, aims to reveal the mastery of basic skills in the field of science. Topics or concepts used as test materials are obtained from the analysis of initial ability tests that are considered difficult by the respondents (students). Students of science education concentration program are given tests on physics, biology, and chemistry.

The basic skills test is a multiple-choice test, consisting of 60 items, and for each basic skill (physics, chemistry and biology) consists of 20 questions. Questions 1-20 are basic components on Physics, question number 21 to question number 40 is a matter of basic Biology and 41-60 is a matter of basic Chemistry. Prior to use, the basic skills test questions are tested for validity and difficulty based on expert considerations (content and construct validity). Respondents in this research are 50 new students of Magister Science Education Program.

Students of Science and Biology Education concentration are given science material tests which include physics materials, biology materials and chemistry materials. The data of the written test results were analyzed and then trended by the difficulties in solving the problem of all questions

The study continued by validating the difficulties of students' ability by following up the written test results by interviewing several students in depth. The purpose of this interview to diagnose in detail the parts of the scientific field materials based on the results of written tests identified tend to be understood / not understood by students. Therefore, the interview is done with a clinical interview technique, i.e. one person interviewer faced with one student. There are several pieces of material to be interviewed with the help of media / demonstration tools.

The result of the written test which is harnessed by the result of in-depth interviews yielded the acquisition of basic capability, the problem causing the result of mastery and misconceptions of the second year student of Magister student of Science Education of UNNES. Furthermore, the mastery of basic skills, problems that cause mastery and error concept is expected to be utilized for the development of strategies to achieve superior and competitive graduates learning outcomes.

The test result data was analyzed using Classical Test Theory approach by using Test Analysis Program (TAP) application. The TAP program used in this study is a version 14.7.4 developed by Gordon P Brooks of Ohio University. The program by default runs on a Windows-based Operating System computer, but can also run on a Linux-based computer using a Wine emulator.

Research results

Based on the result of the test with the instrument of basic skill of scientific subject matter, the result recapitulation as revealed in Table 1 and Table 2

Table 1. Recapitulation result of mastery test on basic ability of science for Integrated Science Concentration

Result	Integrated Science	Physics	Biology	Chemistry
The highest score	41	12	15	15



The lowest score	10	2	3	4
Average score (N = 50)	25,94	7,08	8,74	9,94

Table 1 show that the initial proficiency profile of basic skills of scientific subject matter from each basic component that became the basis of the success of S2 education in Science Education Study Program, Integrated Science concentration is low. This is based on the initial profile score of the mastery of the basic skills of the scientific subject matter of each component score reached below 30.

Table 2. Result of recapitulation of basic capability test in biology material for Biology concentration

Result	Biology
The highest score	12
The lowest score	3
Average score (N = 17)	9

Table 2 shows that the initial profile of mastery of the basic skills of Biological science subject matter which became the foundation of successful Master education in Science Education Program, Biology concentration is low. This is based on the score of the initial profiling profile of the basic skills of the scientific subject matter of each component of the score achieved under ten.

Based on the results of a written test to validate the initial profile of student ability followed up with in-depth interviews conducted with clinical interview techniques. Interviews were conducted on several students of Integrated Science concentration and Biology concentration on the basic material of the scientific field understood or not understood. In the execution of the interview there are several basic material sections of the field of science that are interviewed with the help of media or demonstration tools. Interview results as revealed in Table 3.

Table 3. Results of interview recapitulation mastery of basic skills of science subject matter

Component	Integrated Science Concentration	Biology Concentration
Unpopular materials	<p>Physics: Electricity, Light, Motion, Magnetism, Optics, Sound</p> <p>Biology: Genetics, Biochemistry, Anatomy and Physiology of living things, Classification of living things, Biology cell and metabolism</p>	<p>Genetics, Classification of Living Beings, Micro-Biology, Biochemistry, Immune System, Coordination System, Anatomy and Histology of Plants and Animals, Plant and Animal Physiology,</p>

	Chemistry: Chemical Reaction, Chemical Equilibrium	Sensory System and Molecular Biology
Favored materials	Physics: Magnitude and Unit Biology: Ecosystems, growth and development Chemistry: Chemical elements, Acid and Bases, Chemical Reactions	Digestive system, Respiratory system, Reproduction system, Microbiology, Biotechnology, and Motion System
Characteristic of Unfavored Materials	Complex and abstract material, many foreign terms or scientific terms, and demands a high level of understanding and not easily memorized	Complex material, many mechanisms and processes discussed, many scientific terms, and demands a high level of understanding and not easily memorized but must be understood
Characteristic of Favored Materials	the material relating to daily life, the material discussed is not much, simple or not complex and easy to memorize The material is related to daily life and is discussed is not much, simple or not complex and easy to memorize	the material relating to daily life, and the material discussed is not much, simple or not complex and easy to memorize The material is related to daily life and is discussed is not much, simple or not complex and easy to memorize
Learning Habits	Implementation of learning is generally theoretical and teacher-centered. Not all learning is conducted with experiments / tempo-cum that are challenging or increasing curiosity. So the learning rely on rote only.	Implementation of learning is generally theoretical and teacher-centered / lecturers. Not all learning is conducted with experiments / tempo-cum that are challenging or increasing curiosity. So that learning only rely on rote.
Expected Learning process	Learning centered on students who activate and cause high curiosity. Learning is done by experiment / practice, assignment or project, so the students find their own concepts / materials to be studied. Learning outcomes will be more memorable and not easy to forget	Learning centered on students who activate and cause high curiosity. Learning is done by experiment / practice, problem solving, assignment or project, so students find their own concepts or materials to be learned Learning outcomes will be more memorable and not easy to forget

Discussion

Physics components. In the field of physics, there are 3 items that are answered less than 10 respondents, that is item number 6, 11 and 20. The items



are only answered correctly by respondents 0, 9 and 6. Respondents' inability to answer question number 6 seems to be caused by an incomprehension of the true and virtual image concept in the mirror. The results of this study are in accordance with the results of Heron and Mc Dermott (1998). Problems related to the concept of this shadow is actually easy to understand if the learning ever done a simple experiment with a flat mirror. The inability of respondents to answer the number 11 relating to speed and mathematical operations (Shaffer & McDermott, 2005). While the inability of respondents to answer the number 20 associated with light, apparently caused by difficulties often caused by the misconception (Hazelton et al., 2012; Shaffer & McDermott, 2005).

The fact of the difficulty in correctly answering questions related to the basic skills of the subject of physics science shows that respondents do not understand the basic concept correctly. This is because respondents only memorize the basic concept, do not understand the basic concept as a whole. So when respondents have to think with high-level thinking (HOTS) they just guess the answer. By simply memorizing, at least the respondent is only capable of working on standard questions, unable to explain the phenomenon by applying reasoning (Hazelton et al., 2012). For example almost all (44 out of 50) can answer correctly about the number 55 but none of them answer correctly about number 6.

Biology components. In the field of biological sciences, there are 2 items, which answered less than 10 the number of respondents, namely the number 28 and 36. The item is only answered correctly in succession by respondents as much as 9 and 7. Inability of respondents answered about the number 28 and 36 caused by the lack of understanding of the mechanism of the heart's work, the guidance of evolution. Questions relating to the mechanism of the heart's work and evolutionary guidance are easy to understand if the respondent can reason properly. The reality of the results of this study proves the truth of the findings stating that students often fail in doing reasoning (Hazelton et al., 2012).

Problems related to chemical reactions related to metabolic mechanisms, processes in microbiology and requiring biochemical understanding by most respondents are an obstacle to answering correctly. Likewise with the questions that the material many and many scientific terms. This is supported by interviews stating that chemical reactions associated with metabolic mechanisms, microbiological processes, scientific terms, nomenclature in both plant and animal classification become the burden for respondents, both with Biology education background and non-educational background Biology.

Chemistry components. In component of chemistry field, there is only 1 item that answered less than 10 respondents, that item 47 is only answered correctly by 5 respondents. The inability of respondents to answer number 47 is caused by the lack of understanding of the number of ions in the molecule, the difficulty often caused by misconceptions (Hazelton et al., 2012; Shaffer & McDermott, 2005).

Difficulties in understanding and reasoning in chemistry concepts from written tests are almost non-existent. However, according to interviews, respondents stated that writing chemical reactions and chemical equilibrium is a constraint in understanding basic materials of chemical science. The difficulty in understanding and reasoning in basic concepts of chemistry is in line with what

has been revealed by Moon et al. (2016). The solution that can be done to overcome this is the need to develop a clear and planned learning strategy (McDermott, 2013).

Difficulties in understanding basic concepts cannot be overcome with the application of traditional learning (lectures and questioning) but with student-centered learning such as what is expected by the respondents is learning that activates and raises high curiosity. Some learning models that can be used include Project Based Learning, Discovery Learning, Inquiry Learning, and Problem Based Learning with science approach or known as Scientific approach. At least the learning in the science study program on the concentration of Integrated Science and Biological concentration has been carried out by experiment / practicum. Thus the students are trained to find their own concepts or materials that will be studied, so that learning outcomes will be more memorable and not easy to forget.

If the test results listed in Table 1. and Table 2, converted to an assessment with a scale of 0 - 100, obtained the average value of basic mastery of science, physics, biology and chemistry skills 43.23, 35.4, 43.7 and 49.7 respectively. While the mastery of Biology material ability at the concentration of Biology education is 45. The result shows that the initial test value of mastering the basic skill of science materials from each basic component both Integrated Science concentration, and Biology concentration is low, that is under 50. This condition is easy to understand as revealed in interviews that respondents feel uncomfortable because they feel not mastering the whole basic materials in accordance with the field of science. If it is not followed up will have an impact on the quality of learning that becomes the responsibility later.

Based on the basic capability profile of the subject matter of science students, the concentration of science and biology is a challenge for the UNNES Postgraduate study program to prepare a curriculum and require the use of learning strategies that can meet the challenges of the field work. It should also be considered to be able to carry out experimental or practicum activities to improve students' understanding and reasoning.

Conclusion

Initial mastery of the basic skills of science subjects for Magister science education students is low. Mastery of basic science skills of the magister science education student is not related to various backgrounds of the students. Not all the basic capabilities of the subject matter of science are well controlled, especially the abstract, complex and many scientific terms.

The material that deals with many interrelationships with other concepts or material discusses mechanisms and processes, complex and abstract, many foreign terms or scientific terms, demands reasoning and a high level of comprehension and not easily memorized is an unwelcome material. While the preferred material is the basic material that is simple or not complex and not much is discussed, concrete and related to everyday life, not many scientific terms and easy to memorize. It is necessary to develop a lesson that fits the needs of the students in facing field challenges and learning models that enable students to find concepts and reasoning through practical / experimental, problem-solving, assignment or project activities, findings and simulations.



Disclosure statement

No potential conflict of interest was reported by the authors.

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