Testing the research abilities of student teachers at pre-service training and education

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Abstract. Some academic supervisors claimed the low abilities of pre-service students on conducting a research. This research aims to measure the Research Abilities (RA) of students by developing the instruments to test the knowledge of students on essential components of research, i.e., understandings on the type of research, research design, research problem, hypothesis, variable, type of data, research method, sampling, and data analysis. The instrument is an essay, and multiple-choice test consists of 30 questions divided into four categories, i.e., Research Problems, Hypothesis, and Variables (Q1); Research Method (Q2); Data Analysis (Q3); and Action Research (Q4). About 36 science and non-science students participated voluntarily on the online test, 89% are females, and 14% are science education students. Only 35 data are valid to be analyzed. The result shows that the highest score belongs to a non-science student (24), and the average rating of science students (12.14) is almost equal with non-science ones (12.62). The average score of Q1 is 5.1 of 12, Q2 4.4 of 8, Q3 is 1.1 of 3, and Q4 is 0.9 of 3. The conclusion is students show low performances on RA's components.

1. Introduction

One of the abilities have to be nurtured to teacher trainee students in the pre-service training is the ability to do research or called Research Abilities (RA) or Research Competencies (RC). This ability is essential for students to accomplish their final thesis. Performing a research is also a prominent skill to solve the real-world problem scientifically, either as a regular task of lectures or as to fulfill the curiosity of the researcher.

The issue of research as a culture of university or school is not new, though some students even lecturers consider it as a coercion, especially for adult learners who not also been cultivated and internalized adequately among undergraduate students. The idea of integrating research into the curriculum of undergraduate becomes debatable. Some undergraduate programs offer two kinds of final task for graduation, such as students are possible to choose internship instead of conducting a research as a final task to take master program [1]. Doing research for some students is a heavy burden, due to some reasons, such as it costs a lot, time-consuming, and strong initiative and efforts are needed. For some students, assigning the research within the undergraduate curriculum means that the students wishing to obtain a research experience as a preparation to pursuing a high level of study [2]. In order to nurture the research as routine activity in the undergraduate students, the research method and thinking scientifically have to be inserted in the higher education curriculum [3]. The ways of integrating research skills training in the curriculum might differ depends on school culture [4].
A research is an action to obtain knowledge through the scientific process. The sources of knowledge are five, i.e. experience, authority, deductive reasoning, inductive reasoning and scientific approach or method. Experience is the source of knowledge, which are subjectively got, while authority is a source of knowledge found from dictionaries, books, internet sources, expert, or government. Deductive reasoning is a systematic approach, i.e. the thinking process which uses logical argumentation to conclude a phenomenon or an interpreting from general law to various specific facts. In the contrary, inductive reasoning introduced by Francis Bacon (1561-1626) is a thinking process to generate the theory based on similar facts. Through some observations and measuring activities, scientist concludes the interrelation among facts. The last source of knowledge is scientific method or doing research. It is an approach, which gathers the data by integrating the deductive and inductive reasoning. However, it totally differs from inductive reasoning, since research should be supported by resumed the problems, generated hypothesis or tentative assumption about the true relation between variables, experiments to test the hypothesis or to collect data, data analysis, and conclusion. The approach that need to be acquired by the university students is scientific approach [5].

According to Wilson and O’ Regan (2007), there are six skills of research that students must have, i.e. (a) identifying questions to pursue, (b) applying appropriate methods to collect data, (c) evaluating data, (d) organizing data, (e) synthesizing and analyzing collected data, and (f) communicating the results with an awareness of the associated ethical and social issues [6].

In the preliminary study, we roughly analyzed the thesis made by student-teacher of Biology Education Department at Universitas Sebelas Maret, who supposed to be high school biology teacher after graduated. We sampled the documents randomly from 2014 to 2017. There are two main types of research done by student teachers or teacher candidates. First, it is a comparison group quasi-experiment, which are some thesis wrongly mentioned this as a true experiment. The second type is an action research mostly done in two or three cycles. The most common intervention in those action research is teaching-learning method or sometimes called learning model. Furthermore, we also found that some students are not correct in designing their research, resuming the research problem, generating the hypothesis, and analyzing the data. Based on the result of the preliminary study, we then proceeded this research by empirically surveyed the research ability of student teachers. The research problems are how is the profile of student teachers’ research abilities? What is the highest component gained by students, and what the lowest one?

2. Method
This research is a survey aims to identify the research abilities of student teachers who admitted the course of science education and non-science education at Faculty of Teacher Training and Education Universitas Sebelas Maret. Online questionnaire delivered to students in limited courses, i.e. accountant education, economy education, Indonesian Language education, biology education, geography education, physics education, and chemistry education. Participants voluntarily filled in the online survey. There was 36 students age ranged between 20 to 21 years old joined the survey, which was shared for four weeks, but only 35 data are valid. The participants were 89% females, and 14% were science education students.

The research abilities addressed specifically in this study were understandings on the research approach, research design, research problem, hypothesis, variable, type of data, research method, sampling, and data analysis. The instrument is an essay, and multiple-choice test consists of 30 questions divided into four categories, i.e., Research Problems, Hypothesis, and Variables (Q1); Research Method (Q2); Data Analysis (Q3); and Action Research (Q4).

There are three abstracts of research selected purposively from online journal of education to be identified for the research problems, hypothesis, and the variables. Each case is followed by four short-answer questions of (1) research problems, (2) hypothesis, (3) dependent variable, and (4) independent variable.

The Q2 group consists of two cases, i.e. research on language ability of early childhood; and research on the thematic instructional model and the conventional model of learning. Participants were asked to identify (1) the sampling technique, (2) the participants or subjects of research, (3) research approach
(qualitative, quantitative or mixed), and (4) research design (true experiment, quasi-experiment, survey, ex-post facto, correlational, or others). The questions are mixed with multiple choices and short answer.

While in the Q3 group of questionnaires, participants were asked to search the component of data collecting and analysis. One abstract of research was figured out, and it was followed by mixed of multiple choices and short answer questions on (1) data collected, (2) type of data (ordinal, nominal, interval, or ratio), and (3) data analysis (normality test, homogeneity test, analysis of variance test, analysis of covariance test, regression and correlational test, others). The last group, Q4 consists of one case of a classroom action research. Participants were asked to respond seven short-answer questions on (1) resume of research problems, (2) the subject of the research, (3) data collecting technique, (4) the number of cycles of action, (5) the purposes of the action, (6) the intervention in the cycle, and (7) the result of the research.

3. Result and Discussion
Science education and non-science education students performed almost equal for all components, with the average score of 12.14 and 12.62 respectively. However, the highest score (24 of 30) achieved by a non-science education student. The highest score among science education students was 21 of 30. For all components measured, students performed relatively low, in which the average score for Q1 is 5.1 of 12, Q2 is 4.4 of 8, Q3 is 1.1 of 3, and Q4 is 0.9 of 3.

3.1. Understanding the Research Problems, Hypothesis and Variables
Figure 1 shows that the understanding of students on research problems varied on each case (Fig 1A). On case 1 (a quantitative research), the number of students who answered correctly were 29 or 82.57%, in case 2 (a qualitative research), 45.71%, and in case 3 (quantitative research), only 7 students answered as expected (20.0%). Case number 3 is the most difficult one for students.

![Figure 1](image_url)

**Figure 1.** Research Abilities of students on (A) Research Problems, (B) Hypothesis, (C) Independent Variables, and (D) Dependent Variables.

Research problems have to be stated in the question forms, and some students did not follow this rule. To perform the research problems, students must understand the dependent and independent variables if the research is quantitative. Since some students could not detect the independent and dependent
variables in each abstract, they made mistakes on constructing the research problems and hypothesis as well.

Figure 1B indicates that students were mostly incorrect in constructing the hypothesis of the research. On average, only 14 students could construct hypothesis correctly. The hypothesis should be developed based on the research problems. In this study, we found that even the students were able to make a research problem, they were not automatically able to generate the hypothesis. In case number 1, 29 students were able to develop the research problem correctly, but only 19 succeeded in performing the hypothesis. Figure 1C and 1D shows that the number of students answered correctly about dependent and independent variables is few. In case number 1, there are 13 students correctly determined the independent variable, but 21 performed correctly too in identifying the dependent variable. While in case number 2 and 3, students could not correctly answer for both variables.

As described above, the knowledge of students on research problems, hypothesis, and variables are intertwined. Once students can define the problems of the quantitative research, they should be able to create the variables that will be measured (dependent variable), and also the treatment (independent variable). If both variables are understandable adequately, then students should be able to generate the hypothesis. However, the data also note that students have difficulties in performing the skills in a qualitative research (Case 2). Qualitative papers in the educational journal are not common compared to the quantitative [7]. The similar fact also found in some educational research in the faculty of teacher training. Therefore, it is understandable if students more familiar with the quantitative. In this study students shows consistency in connecting between three essential components of research, or they show low performance on constructing the research problems as well as hypothesis and variables.

3.2. Understanding the Research Methodology

Table 1 shows that among the components of research methodology, students have already known well the respondents or the subjects of the research. However, 41.43% of students still confuse on identifying the sampling technique, and only 41.43% students answered correctly on the research approach. In the other word, they have difficulties in distinguishing between the quantitative, qualitative, and mixed method research. Students showed very low performance in deciding the research design. They are failed to recognize true experiment and quasi-experiment research, as well as differentiate between survey and ex-post facto research.

Table 1. Percentage of student answered correctly about research methodology.

| Component               | Case 1  | Case 2  | Average |
|-------------------------|---------|---------|---------|
| Sampling technique      | 37.14   | 80.00   | 58.57   |
| Respondents             | 82.86   | 100.00  | 91.43   |
| Research Approach       | 37.14   | 45.71   | 41.43   |
| Research design         | 22.22   | 28.57   | 25.40   |

According to our preliminary study on the research design conducted by student teachers in 2010 to 2017, students mostly did a quasi-experiment and an action research. This fact may influence participated students to have a narrow concept and understanding of research design when they independently learned by reading the thesis of seniors. Moreover, in the course of Biology Educational Research, it seems that students are pursued to do the two types of above-mentioned research. In addition, some research designs of quantitative, such as true experiment, survey, ex-post facto, and correlational study, as well as some research design of qualitative research such as case study, narrative, document analysis are not proportionally taught to the students.

Prior to the research design, students must confirm what research is, what are the essential component of research, and vital skills needed to conduct a research. In some facts, students do not aware of the basic principles of research and feel uncertain whether they have done a research or just a project [2].
3.3. Understanding the Data Collecting and Analysis

The basic knowledge that students have to acquire is understanding what kind of data have to be collected, how to gather the data, and how to analyze the collected data. Data in educational research that commonly measured are the students' learning outcomes or cognitive domain, thinking skills, psychomotor skills, and attitudes.

![Understanding Data Collecting and Analysis](image)

*Figure 2. Students abilities about data collecting and analysis.*

Figure 2 shows the responses of students about data collecting and data analysis. For all categories, the number of students answered incorrectly bigger than whom in the opposites. There are only 5 of 35 students or 14.29% who were able to key out the type of data (ordinal, nominal, interval, ratio) which actually taught in the Course of Research Methodology or The Fundamental of Statistics.

Regarding the data collected, students are asked to identify what kind of data collected by the researcher in the given abstract. In responding this question, only 48.57% of students were able to correctly answer. The similar fact is also detected when students have been asked about what kind of statistic tests that possibly used by the researcher. The answer should be the Analysis of Variance Test or the Hypothesis test. However, half of the students opted Regression or Correlational Test.

The unexpected responses of students might be caused by the lack of knowledge, which probably is stimulated by their learning experiences. The participants of this survey are students aged 20 to 21 years old, or they are in the 2nd year or 3rd year. The Fundamental of Statistics is the course for the 1st semester, and for the Department of Biology, there is a course, namely Biostatistics delivered in the 2nd semester. It means that most of the students have attended or currently attending those courses. The findings of this study may alarm about the misconceptions or lack of understandings of participating students who attended the above-mentioned courses. Besides improving the lecture, it also needs to redesign the curriculum to accommodate the training of research skills for students. For medical students, it is argued that promoting evidence-based practice, and inviting students to participate in the research guide by a professor or senior lecturer may influence much students' research abilities [8, 9, 10].

3.4. Ability to do Action Research

The last question asked in the survey is about the concepts of action research. One abstract of the article of action research was put as a case to be analyzed. The vital point is the ability of students to identify the component of action research, and able to distinguish it with the quasi-experiment. In our preliminary study, we found that some action research carried on by the undergraduate students of Faculty of Teacher Training and Education are not clear in defining the intervention. Some misconduct such as deciding the intervention of action research before deeply analyze the problem in the classroom. In this situation, students are not working in anticipating the classroom's problems, but they tend to test the effectiveness of a model, method or strategy of learning as the treatment.
Table 2. The understanding of students on action research.

| Answer | Percentage of students with the correct and incorrect answer (%) |
|------------------|---------------------------------------------------------------|
|                  | Research problems | Participant Data collecting | Cycles | Purposes | Result |
| Correct          | 28.57             | 25.71                        | 34.29  | 2.86     | 34.29  | 28.57  |
| Incorrect        | 71.43             | 74.29                        | 65.71  | 97.14    | 65.71  | 71.43  |

Table 2 shows that in all aspects of action research, students scored low. Students failed to construct the research problems, in which most of them wrote a typical quasi-experiment research problem. In the given abstract, the number of cycles is not clearly stated, but students mostly failed to interpret. There are some reasons for students' incorrectness, such as they might not understand well the principles of action research, they were confused to distinguish between an action research and a quasi-experiment, and they were not able to grasp the content of given abstract or problem in reading literacy.

4. Conclusion
In all components of research abilities, all participants show low performance. They only scored on average about 12 of 30, and also the achievement between non-science education students and science education students slightly differed. The participated students show the inability to construct correct research problem, hypothesis and variables of research. They also performed insufficient on research methodology, confusing on research design and approach, and even on data collecting and its analysis. These findings should be as a warning to improve the curriculum of research and statistics related courses in the teacher training and education. Detail research with more participants is also suggested to be conducted in the future research.

Acknowledgments
Research was sponsored by the grant from the Research and Community Services Institute of Universitas Sebelas Maret in 2017. Research leader was Murni Ramli

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