The profile of problem-solving ability of students of distance education in science learning

Widiasih¹*, A Permanasari², Riandi³ and T Damayanti⁴

¹Department of Physics Education, Universitas Terbuka, Tanggerang Selatan, Indonesia
²Department of Chemistry Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
³Department of Biology Education, Universitas Pendidikan Indonesia, Bandung, Indonesia
⁴Department of Political and Social Science, Universitas Terbuka, Tanggerang Selatan, Indonesia

*Corresponding author’s e-mail: widiasihbela@gmail.com

Abstract. This study aims to analyze the students’ problem-solving ability in science learning and lesson-planning ability. The method used is descriptive-quantitative. The subjects of the study were undergraduate students of Distance Higher Education located in Serang, majoring in Primary Teacher Education in-service training. Samples were taken thoroughly from 2 groups taking the course of Science Learning in Primary School in the first term of 2017, amounted to 39 students. The technique of data collection used is essay test of problem solving from case study done at the beginning of lecture in February 2017. The results of this research can be concluded that In-service Training of Primary School Teacher Education Program are categorized as quite capable (score 66) in solving science learning problem and planning science lesson. Therefore, efforts need to be done to improve the ability of students in problem solving, for instance through online tutorials with the basis of interactive discussions.

1. Introduction
Science teaching in the 21st century should offer a variety of contexts that can be developed such as critical thinking, problem solving, and the concept of Science itself. Problem solving is amongst the key 21st century talents instructor poverty students to advance including in science learning [1]. It also goes well together with the goal of 21st Century National Education that is to realize the ideals of the nation; prosperous and happiness for the people of Indonesia, and equally honoured with other nations in the global world, through the foundation of a society consisting of competent human resources, that is independent, determined and capable in achieving the ideals of the nation. To achieve the goals, hence it is needed that the human resources must have several competences/skills based on the “21st Century Partnership Learning Framework” those are: Critical-Thinking and Problem-Solving Skills; Communication and Collaboration Skills; Creativity and Innovation Skills; Information and Communications Technology Literacy; Contextual Learning Skills; Information and Media Literacy Skills [2].
To achieve the 21st century HR as expected as mentioned before, an educational model that takes consideration in utilizing of educational technology is needed; the role of teachers/lecturers and learners, 3) creative teaching and learning methods, 4) contextual teaching materials, 4) independent individual-based curriculum structure [2]. However, in reality, the competence of human resources, especially educators who are expected to meet the objectives, is still far from expectations. Research conducted on In-service Training program studies college students of Distance Education, shows that students find difficulties in learning Science especially when it is related to planning and implementing learning [3]. The heads are not answering the glitches of teachers and students in substances teaching and learning. So it is rational to accomplish that the decision-making skill is unnoticed [4]. We argue the manager in teaching learning process in class room is teacher. For that reason, this research measures the ability of teachers in solving problems of learning Science.

Problems occur when there is a gap between a person's current states with his/her own desire, where he/she does not know how to find a way out [5]. Furthermore, the problems have original state, desired goal, and pathway to achieve that goal [6]. Supporting the idea, problem solving is a quick way to achieve goals [7]. In general, problems contain questions. The problem solving involves high-level thinking skills such as visualization, association, abstraction, manipulation, reasoning, analysis, synthesis, and generalization [8]. Based on that, it can be inferred that problem solving is a thought process to find the right way to obtain a solution. The thinking is assumed as a cognitive process, a mental process for acquiring knowledge. Furthermore, it is said that the thinking skills are grouped into two, basic thinking skills and complex thinking skill or higher order thinking. Higher order thinking is grouped into four: problem solving, decision making, critical thinking, and creative thinking [9]. Thus solving problems requires complex thinking skill or higher order thinking.

The problem solving is a process involving the use of certain steps (heuristics), which are often referred to as model or problem-solving steps to find a solution [10]. Heuristics are common guidelines or steps used to guide problem solving. However, these measures do not guarantee individual’s success in solving the problem. We also reflect insinuations of these influences for the instruction of problem solving, arguing that the advance of problem solving skills is an significant metacognitive skill [2].

Development of collaborative problem solving abilities is an important metacognitive skill. Steps in problem solving are different for each expertise; the steps in problem solving: 1) find and understand the problem; 2) develop a good problem-solving strategy; 3) explore solutions; 4) rethink and redefine problems and solutions over time [7]. The problem-solving processes form a cycle with the following stages: 1) identifying problems; 2) define the problem mentally; 3) solutions; 4) organized the information of the problem; 5) allocate mental and physical resources for solving the problems; 6) observe the progress; 7) evaluate the solution for accuracy [11]. Though this cycle tends is flexible.

2. Methods
In this research, problem solving is done on Science learning situation. The problems solved by students are situated cases that occur in the real class in Science learning. Thus, the method used in solving the problem is more specific, although it is not much different from the method suggested by experts. The Distance Education team addresses the following steps: 1) identifying key or significant information in the case of learning; 2) connecting the information so that a problem or question arises; 3) analyzing the cause of the problem; 4) developing alternative solution for the problem; 5) analyzing the strengths and weaknesses of each proposed alternative; 6) choose one or several alternatives that are considered the most effective, 7) presents some effective problem-solving alternatives for developing lesson plans [12].

The sample used in this research comes from 39 bachelor degree students of In-service Training of Primary School Teacher Education Program with different expertise (non-teacher-educational subject). The instruments used are Essay Test, Multiple Choice, multiple choices with argument. The reason to which the instruments are used is to measure students’ ability in solving learning problem related to
learning theory; approaches, methods, media, integrated science learning, evaluation, and general learning procedures. Instruments are presented in the form of learning cases. It was followed by multiple choice questions and argumentative multiple-choice. The detail of blue print of instrument is as follows Table 1.

**Table 1. The blue print of research instrument**

| No | Indicator of Problem Solving Skill                                                                 | Type of test          |
|----|---------------------------------------------------------------------------------------------------|-----------------------|
| 1  | Identify key or important information contained in the case                                       | multiple choice       |
| 2  | Linking the information so that the problem or question arises from the case                     | argumentative multiple-choice |
| 3  | Analyse the cause of the problem                                                                  | argumentative multiple-choice |
| 4  | Develop alternative problem solving                                                               | argumentative multiple-choice |
| 5  | Analyse the advantages and disadvantages of each alternative                                       | argumentative multiple-choice |
| 6  | Choose one or several alternatives that are considered most effective                              | multiple choice       |
| 7  | Presents some effective problem-solving alternatives for developing lesson plans                  | essay                 |

The reason for using objective test is because it can measure the ability of different thinking level that is memory, understanding, application, evaluation, synthesis, analysis, and evaluation. In addition, multiple choice tests facilitate scoring. It does not take long in the examination, and can test a broader topic. Argument in the multiple choice question aims to confirm the problem solving skill. The instrument used has been validated by 5 experts with scope of science learning and evaluation. Data is collected through tests and interviews conducted in April 2017. The data in this research was analyzed descriptive quantitative because to explain the characteristic of teacher ability in solving learning problem in the form of numbers [13].

**3. Results and Discussion**

The results shows that students' ability in solving learning Science problem is tagged into 6 indicators: 1) identifying key or significant information in the case of learning: 55%; 2) connecting the information so that a problem or question arises: 74%; analyzing the cause of the problem: 62%; developing alternative solution for the problem: 77%; analyzing the strengths and weaknesses of each proposed alternative: 56%; choose one or several alternatives that are considered the most effective: 66%; Presents some effective problem-solving alternatives for developing lesson plans: 63%. The profile of student’s problem solving skill can be seen in Figure 1.

![Diagram of Students' problem solving skill Profile](image-url)
The result shows that students' lowest ability is in the "identifying key or significant information" indicator that is only 55%. The answers are varied from answering all the questions wrong to answering all the questions correctly. Some students choose only one option (media used is only image) and some students choose all the options. Hence, the competence to identify key or significant information related to the case of learning has not been grasped so well by the students. It is recommended that students be given a reference question related to the integration of learning, general procedures of learning, learning media, student’s learning outcomes. By giving a reference, students are helped in focusing their thoughts to the subject being learned [14].

Indicator “connecting the information so that a problem or question arises” is the second highest score the students achieved, that is 74%. The question is "Is the learning method by the teacher as a whole correct? Has the material correct? Are the general learning procedures correct? Has learning media been used correctly? Give explanation!" Most students answer correctly, “Not correct”. Students get average score of 62% in "analyzing the cause of the problem" indicator. This can be seen by how students answer when asked to give reason on why teacher’s learning is incorrect.

Example in figure 2 shows: "from general procedure, learning is incorrect, the cause is that teachers only instruct the students to observe images and ask them to write down their observations." Whereas the student's answer should be "based from general procedure learning is not correct, the cause is that there is no pre-learning activity". Not all students are able to answer questions which require higher level of thinking in analyzing and evaluating [15]. Whereas in solving the problem should involve high-level thinking skills [8], [9]. Example in figure 3 shows: "from general procedure, learning is correct, because teachers instruct the students to observe environment around the school and ask them to write down their observations".

The students' ability in “developing alternative solution for the problem” achieved the highest score among other indicators, students are able to achieve 77%. The correct alternative solution is to combine learning materials, apply the general procedures, use real media, and get students to be more active. In this indicator, some students are inconsistent with the previous answer. For example, the answer to the question about the inaccuracy of learning is correct when viewed from the integration of materials, general procedures, and media learning. However, the alternative proposed by the students is only "there is apperception in the beginning and at the end of the activities".

Students achieve an average score of 56% in “analyzing the strengths and weaknesses of each proposed alternative” indicator. Mostly, students' answers are weak, especially in analyzing the weaknesses of proposed alternative solution. Not all students are able to answer questions which require higher level of thinking in analysing and evaluating [15].

The ability to “choose one or several alternatives that are considered the most effective” has a mean score of 72%. There are students who answer beside the give choices and answered it incorrectly, but most of the students answered completely and correctly. Thus, the students' ability in solving interrelated learning problems forms cycles from identifying key or significant information to suggesting one or several alternatives that are considered the most effective with the average score of each indicator being relatively close from 55% to 77% [11].

The next step is that the "the most effective alternative solution" is transferred into preparing the learning Implementation plan, students obtained the average score 63%. The students' difficulties in
preparing the learning implementation plan consecutively are planning assessment is in low category, planning learning scenarios is in moderate category, developing and organizing the material is in moderate category and determining materials that is related to the applicable curriculum is in moderate category [16]. For additional information, when doing the research, the in-service training students were only 2 weeks old of becoming distance learning students, so it was expected that the students had not yet given enough materials from the class. However, 92% of them had already bachelor in educational program while the rest were bachelor in non-educational program can be seen in Table 2.

### Table 2. Students’ educational background

| Bachelor in                                      | students | %   |
|-------------------------------------------------|----------|-----|
| Indonesian Language and Literature Education    | 1        |     |
| English Language and Literature Education       | 10       | 92% |
| Mathematics Education                           | 4        |     |
| Islamic Education                               | 11       |     |
| PGSD (SPDI)                                     | 3        |     |
| Pancasila and Citizenship Education             | 3        |     |
| Arts Education                                  | 1        |     |
| Public Health                                   | 1        | 8%  |
| Agricultural Technology                         | 1        |     |
| Biology                                         | 1        |     |
| Economic Managements                            | 2        |     |
| Communication                                   | 1        |     |
| **Total**                                       | **39**   | **100%** |

The data in Table 2, shows that 92% of students have finished their undergraduate education, so they should be experts in preparing learning implementation plan. Moreover, 95% of students have experience in teaching for over 5 years. It is assumed they are experts in preparing the learning Implementation plan. However, in reality, it is still far from expectation.

The student who has bachelor degree in Pancasila and Citizenship Education and a 12 years of teaching experience organizes learning materials poorly, while a relatively good organized material is achieved by the student who have bachelor degree in Mathematics Education and a 5 years of teaching experience. This means teaching duration does not guarantee teacher to be able to make a better learning implementation plan.

Similarly, in preparing steps of learning, it is very varied from less good to a relatively good, as has been mentioned above. Examples of less good learning steps, are as follows: Pre-core activity: applying thematic “my home environment”; Core activities: showing pictures of the home environment; End activities: students work on groups. The situation was very sad, because this student had a bachelor degree in Citizenship Education and had been teaching in elementary school for 12 years. Can you imagine how the quality of learners it produces? Has it been able to meet the expectations of forming competence human resources that can compete in the 21st Century. The students are mostly weak in evaluating. Most of them make questions with less measurement of learning indicator. For example, the learning indicator that is "Students can explain the importance of living healthy", while the question is "Mention the properties of light".

Based on the data of students’ ability in preparing lesson planning, the students are still far from expectations. The purpose of developing a learning plan is to provide assurance that learners will learn well. Learning planning is related to the decisions teachers make in organizing, implementing, and evaluating learning outcomes [17]. Planning is a very important task to do by the teacher. When teachers make decisions about planning, it is necessary to consider "what one does, when and what
sequences of learning events will occur, where the learning event lasts, the amount of time spent, and the resources and materials used”. The role of a science teacher to drive problem solving creates creative solutions [18]. Based on the data of learning problem solving abilities and learning planning, it is proposed online learning tutorial model based on problem solving discussion. In the learning problem solving discussion through the online tutorial, participants can brainstorm the learning problems in the classroom. Brainstorming strategy can increase effectiveness in developing creative thinking ability [19]. The problem solving strategies in physics education are very effective and improve students’ performance [20].

4. Conclusion
The results of this research can be concluded that in-service training students of In-service Training of Primary School Teacher Education Program are categorized as quite capable in solving science learning problem and planning science lesson.

5. References
[1] Wismath S L and Orr D 2015 Collaborative learning in problem solving: A case study in metacognitive learning The Canadian Journal for the Scholarship of Teaching and Learning 6 3 10
[2] BNNSP 2010 (Jakarta: Badan Standar Pendidikan Nasional)
[3] Widiash 2016 Prosiding Seminar Pendidikan Dasar dan MIPA Tahun 2016
[4] Rafiq M, Javed M, Khan M, and Ahmed M 2012 Effect of rewards on job satisfaction evidence from Pakistan International journal of contemporary research in business 4 1 337-347
[5] Lorenzo M 2005 The development, implementation, and evaluation of a problem solving heuristic International Journal of Science and Mathematics Education 3 1 33-58
[6] Woolfolk A 2009 Educational Psychology (Active Learning Edition) (Yogyakarta: Pustaka Pelajar)
[7] Santrock J W 2007 Psikologi Pendidikan (Jakarta: Kencana Prenada Media Group)
[8] Kirkley J 2003 Plato Learning Center http://www.plato.com
[9] Presseisen BZ 1986 Critical Thinking and Thinking Skills: State of the Art Definitions and Practice in Public Schools (Alexandria: Association for Supervision Curriculum Development)
[10] Nakin J B N 2003 Disertasi University of South Africa http://uir.unisa.ac.za
[11] Pretz J E, Naples A J and Sternberg R J 2003 Recognizing, defining, and representing problems The psychology of problem solving 9 30 3
[12] Distance Learning 2013 (Jakarta: Distance Learning)
[13] Syamsuddin M A 2007 Psikologi Kependidikan (Bandung: PT Remaja Rosdakarya)
[14] Anitha S 2008 (Jakarta: Distance Education)
[15] Adji S S 2014 Analisis jawaban tugas mahasiswa pada tutorial online berdasarkan blooms taxonomy Jurnal Pendidikan Terbuka Dan Jarak Jauh 14 15 1 21-31
[16] Widiash et al 2017 International Conference of Educational Science at Bandung Indonesia
[17] Burdon P R and Byrd D M 1999 (Boston: Allyn & Bacon)
[18] Mukhopadhyay R 2013 Problem Solving In Science Learning-Some Important Considerations of a Teacher IOSR Journal of Humanities and Social Science 8 6 21-5
[19] Alkitab BA 2012 American International Journal of Contemporary Research 2 10
[20] Gok T 2010 The general assessment of problem solving processes in physics education Eurasian Journal of Physics and Chemistry Education 2 2 110-22

Acknowledgments
The authors acknowledge Henny Johan for the contribution in proofreading and paper writing