Student’s thinking processes on bloom’s taxonomy: exploring direct instruction learning model

A Widayanto*, H Pratiwi, and M Mardiyana
Post Graduate of Mathematics Education, Universitas Sebelas Maret, Jl. Ir. Sutami No.36 A, Kentingan, 57126, Jebres, Surakarta, Indonesia

*arifwidayanto23@gmail.com

Abstract. This research aimed to describe the levels of thinking students in mathematical problem-solving based on Bloom's taxonomy as seen from Direct Instruction learning model. The cognitive domain contains intellectual-centered behavior, such as knowledge, and thinking skills. Direct Instruction is an instructional model that focuses on the interaction between teachers and students. The type of this research is descriptive research with a qualitative approach. The research subjects were taken by one student in Direct Instruction learning model which then given the mathematical problem-solving test and the result was triangulated by interview. From this research, it is found that Direct Instruction student can achieve analyzing thinking level.

1. Introduction
In the 21st century, students face severe difficulties at the social, economic, and personal levels. Socially, students struggle to interact with others. Economically, globalization and innovation are rapidly changing the fulfillment paradigm. Personally, students try to achieve happiness, one of them by reaching the ideals. The increasing call for a culture of innovation, driven by technological shifts in industry, necessitates the development of 21st century skills which promote creative thinking and teamwork in educational and business settings, and facilitate the creation of new knowledge [1]. One of the efforts to improve 21st-century skills is to develop 4C’s learning and innovation skills.

Learning and innovation skills are what separate students who are prepared for increasingly complex life and work environments in today’s world and those who are not. Most states are implementing integrate the 4Cs as well and foster the deeper learning that prepares students to apply the content they learn. One of the countries that have implemented 4C is the United States. Through the US-based Partnership for 21st Century Skills (furthermore P21), a coalition of business leaders and educators proposed a Framework for 21st Century Learning, which identified essential competencies and skills vital for success in twenty-first-century work and life [2]. These included ‘The 4Cs’ – communication, collaboration, critical thinking and creativity, which are to be taught within the context of core subject areas and twenty-first century themes.

1.1. Learning and Innovation Skills – 4Cs
The 4Cs are critical thinking and problem solving, communication, collaboration, and creativity and innovation. Critical thinking involves accessing, analyzing, and synthesizing information that refers to communication skills, information literacy, and the ability to examine, interpret, and evaluate evidence. In addition, critical thinking is one of the most important skills outside of formal education. Lack of critical thinking skills results in students lacking the necessary competence to select relevant
sources of information. Another basic competency of 21st century learning is problem-solving [3]. Research and problem-solving skills are an identification of the ability to search, select, evaluate, organize and weigh alternatives and interpret information. Finding solutions to today's complex problems demands a variety of skills related to critical thinking, innovation, and creativity [2]. Certainly, critical thinking skills become an essential part of problem-solving. To resolve a problem, it is important to first define it and understand its constituent elements. In addition, it is necessary to identify the resources and strategies needed to solve the problem.

Strong communication abilities in articulating thoughts and ideas effectively using oral and written communication skills in various forms and contexts. One way to improve communication skills is by cooperative learning and educators in many parts of the world have applied it with a high level of success [4,5]. Communication and collaboration are highly appreciated, while empathetic and social skills will bring significant values. In this context, effective communication and collaboration skills can help in helping to avoid misunderstandings. Collaboration and teamwork can be improved anywhere, not centered on school. Students will learn together because they work collaboratively on authentic project-based tasks and develop skills by teaching their peers [2,6]. Communication and collaboration is an act of articulating perceptions and ideas effectively using oral or written communication skills in various forms and contexts and is able to demonstrate the ability to work effectively and respectfully with diverse teams.

Just as business and industry must always adapt to rapid change in the 21st century, as well as education. Creativity and innovation use various idea-making techniques to create new and valuable ideas. They are quickly become a requirement for success, either individually or in groups. Humanity depends on the ability to re-invent the understanding and place creativity and innovation at the forefront of the education system [7]. Creativity can be formed for by teachers and a learning environment that encourages openness to new ideas and learns from mistakes and failures. Creativity and innovation skills can be improved like any other skill, with practice over time [6].

1.2. Bloom's Taxonomy

Bloom's Taxonomy, a taxonomic goal of education and learning, was explained by Benjamin Bloom. Bloom's taxonomy raises ways to align school goals, curricula, and educational assessments, and develops in-depth and in-depth instructional activities and curricula that teachers provide for students. The learning domains as described by Bloom's Taxonomy are cognitive, affective and psychomotor [8]. Bloom's taxonomy on the cognitive domain consists of six levels of knowledge, understanding, application, analysis, synthesis, and evaluation [9]. As time moves and the dynamic times, Bloom's taxonomy is growing. The cognitive domain dimension of Bloom's taxonomy is remembering, understanding, applying, analyzing, evaluating, and creating. Remember is an action shown by the student to extract the required knowledge from long-term memory. Understand is an act of building the meaning of instructional messages, whether oral, written, or graphics, delivered through teaching, books, or computer screens. Apply is an action that students do to apply or use a procedure in problem-solving. Analyze is an action done by students in separating the material into small parts and discovering how the relationship between parts and between each part of the overall structure. Evaluate is an action given by a student in using a decision based on a criterion or standard. Create is an action executed by students in mixing or organizing elements into a coherent or functional whole [10].

1.3. Direct Instruction

In this section, we describe the three main components of Direct Instruction: the program design, organization of instruction, and student–teacher interactions that make Direct Instruction effective. The first is program design. Program design includes five main elements. First, program design begins by carefully analyzing the content matter and identifying central organizing ideas and generalizable
strategies that enable students to learn more in less time. Second, clear communication is designed to minimize ambiguity for students. Third, instructional formats are designed to structure the dialogue between teachers and students. Fourth, skills are sequenced to maximize student success and minimize points of confusion. Fifth, instructional topics and objectives are organized into tracks that allow for systematic skill development across the length of a program and support cumulative review and application. Together, these elements result in instructional programs that are highly effective for a wide range of learners [11,12,13].

The second is organization of instruction. In addition to program design whereby the characteristics are embodied in the written program, we turn to the second major component of Direct Instruction: how the teacher organizes instruction. There are four key elements to organizing instruction. First, Direct Instruction teachers organize students into groups to best meet the needs of each individual. Second, Direct Instruction teachers allocate sufficient time for teaching and assure that the time is used well. Third, Direct Instruction teachers implement precise and careful plans for instruction through the use of a scripted presentation. Fourth, Direct Instruction teachers engage in continuous assessment of student performance [14,15,16].

The last is student–teacher interactions. Direct Instruction defines the teacher’s role more clearly and explicitly than most other forms of instruction. Scripted programs relieve teachers of the role of instructional designer. Instead, their role is to deliver instruction in a way that is effective and motivating to the particular group of students and to make the critical decisions about how the program should be adapted to the needs of the particular group. This role emphasizes (a) knowing the students as individuals and creatively motivating them through presentation of the script and by adding motivational systems that are appropriate to the particular group, and (b) knowing the students’ ever-changing skills and adjusting the pacing of lessons, amount of practice, and other factors according to their needs. These roles emphasize problem solving and creativity. However, this creativity is not unstructured and undirected. It is creativity within the context of well-conceived lessons and with the clear goal of enhancing learning and motivation. There are seven components for promoting effective teacher–student interactions: active student participation, group unison responding, signals, pacing, teaching to mastery, correction procedures, and motivation [17,18,19].

2. Experimental Method
This study used grounded theory, which is a fit to analyze large quantities of unstructured or semi-structured data is qualitative. In order to understand the progress of students' abilities, this study deals with Bloom's taxonomy in terms of direct learning models. Research subjects were taken randomly as many as two students. Each student is given 2 questions about mathematical problem-solving. The results will be analyzed based on Bloom's Taxonomy. Triangulation of data is done to test the validation of data analysis by an interview on each subject research.

3. Result and Discussion
Sampling was done randomly by choosing one student who was subjected to direct instruction, then analyzing problem-solving based on Bloom's taxonomy.

![Figure 1. Subject 1 answer for number 1](image)
Figure 1 showed that the Subject 1 is able to understand the question and remember one way to solve linear equation system in two-variable. It is characterized by the subject's ability to find the set of settlements by a substitution-elimination method. Subject 1 recalled that the method of using the substitution-elimination method is by eliminating the variable $x$ for the first time, so that the value $y = 4$ is obtained. Next choose one equation, $2x - y = 2$ and substitute the value $y = 4$ to obtain the value $x = 3$. The steps are taken also did not experience any problems to obtain the set of settlements. In addition, subjects are also able to understand the real question that students are asked to look for a $2x - 3y$ value and the result is $-6$.

![Figure 2. Subject 1 answer for number 2](image2)

Figure 2. Subject 1 answer for number 2

Figure 2 shows that the Subject 1 has not been able to analyze the problems given so as not being able to understand and apply a problem-solving. Although in Figure 1 the subject is able to execute well the problem given when the problem is presented in the form of stories relating to everyday life, he has not been able to execute well the problem.

Based on interview results, the Subject 1 is still experiencing difficulties in understanding the problems presented in story form. The subject has not been able to turn the problem into a linear equation in two variables. This causes the subject to find other alternatives to solve the problem. Because the alternative in solving the problem is not appropriate then the results are also not in accordance with what is expected. Based on the results of the analysis and interviews it can be concluded that Subject 1 can achieve the third level of Bloom's education taxonomy that is apply, where it is carrying out or using a procedure for executing or implementing [20].

![Figure 3. Subject 2 answer for number 1](image3)

Figure 3. Subject 2 answer for number 1

Figure 3 showed that the Subject 2 is able to understand the question and recall one of the ways to obtain the set of solutions from the system of linear equations. It is seen in the use of the substitution-elimination method to find the solution set. Subject remembers how to use the method he uses that is by eliminating the variable $x$ first so that the variable $y = 4$. The next step chooses one equation $2x - y = 2$ and substituting $y = 4$ to obtain the variable $x = 3$. The steps are taken do not face difficulties and obtain the set of solutions. The subject understands the prescribed task that the student is assigned to find the value of $2x - 3y$ and the result is $-6$. 
Figure 4 showed that the Subject 2 is able to analyze the problem in story so that subject is able to understand and apply a problem-solving. A subject is able to change the problem into a mathematical form, in this case, a system of two linear equations. After obtained the system of linear equations in two variables $4a - 3b = 1$ and $a + b = 16$, where $a$ for age Syifa and $b$ for age Gita. It seems clear that subjects are able to analyze by breaking up problems and determining relationships with one another over the whole. Subjects use the method of substitution-elimination and obtained the value of variables $a = 7$ and $b = 9$. In addition, the subject is able to choose and use one of the procedures for problem-solving that is using elimination-substitution. Thus, the comparison of the three-year-old Syifa and Gita years is 10:12. The final answer given by the subject is correct so that he understands perfectly well that his task is to look for the age comparison of Syifa and Gita for the next three years.

Based on the interview the subject is able to analyze a problem given by the researcher and solve it in a good way even no errors. The subject is also able to explain the steps he took in solving the problem. Based on the results of the analysis and interviews it can be concluded that Subject 2 can reach the fourth level of Bloom's educational taxonomy that is analyzing, where it is able to break material into constituent parts that determine how parts are interconnected with each other and with the overall structure or purpose through differentiation, organization, and attribution [20].

4. Conclusion
Based on the aim of research and data analysis toward student’s thinking level in problem-solving used Bloom’s Taxonomy, it can be concluded that Subject 1 who has direct instruction could achieve the third level of Bloom’s Taxonomy which is applying level and Subject 2 can reach the fourth level of Bloom's education taxonomy that is analyzing. This difference can be assured because the researcher is not able to control the independent variable or other factors that can affect the results of research such as motivation, learning style, or multiple intelligences.

5. Acknowledgments
This paper is made possible through help and support from parents, family, and friends. I would like to express my great appreciation to Dr. Mardiyan, M. Si. and Dr. Hasih Pratiwi, M. Si., for their constructive suggestion and recommendation during the study. I also would like to express my great thank to the Government of Karanganyar and SMP N 2 Karanganyar for their support during this process of this study.

6. References


