Management of authentic assessment in mathematics lessons to develop 4C skills

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Abstract. Essential skills for 21st-century called 4c, namely critical thinking, creativity, collaboration, and communication. This ability is following the demands of the curriculum and can be developed in mathematics learning. Concerning assessment, all student views in a series of learning activities can be assessed objectively, as is, and not only based on the final results using an authentic assessment. Thus, this study aims to describe the management of authentic assessment in mathematics lessons to develop 4c skills. This study uses qualitative research with a case study method. The research subjects were mathematics teachers and grade X students at one of the state vocational high schools in West Java province. The data in this study came from observations, interviews, and documentation. Data analysis of aspects of the teacher’s role, support systems, social systems, instructional impacts, and assessment management. The results of this study indicate that: (1) The formulation of assessment instruments is carried out by formulating assessment objectives, making assessment grids, making instruments assessment following assessment guidelines, and analyzing the quality of the instruments; (2) Assessment of attitude aspects using observation and journals techniques. Knowledge assessment uses oral tests, written tests, and assignments according to the competencies being assessed. Skill assessments are conducted through practices or other techniques by competencies assessed using an assessment scale accompanied by a rubric; (3) Utilizing the results of the assessment to monitor and evaluate the process, learning progress, and improvement of students’ learning outcomes.

1. Introduction

Education supports human development in mental, physical, emotional, social, to grow independently and live harmoniously in society [1]. Education has functions to develop human potential to compete in various fields, including science and technology. Therefore, teachers, schools and governments have the role of preparing students for future and career, providing students with the necessary competencies in the 21st century.

Twenty-first-century skills consist of three main knowledge: (a) critical learning and innovation skills; (b) information, media, and technology skills; and (c) life and career skills [2]. Accelerating advances in technology have made digital skills important to people in the information era [3]. The important skills of the students include the ability of 4c: critical thinking, creativity, collaboration, and communication [4]. The development of such capabilities must be continuous, so the need for efforts to monitor the quality of education so that educational objectives can be achieved.
Quality control of education can be done by evaluating the process, learning progress, and improvement of student learning outcomes. This can be done through assessment activities. Assessment is the process of collecting and processing information used to measure the achievement of student learning outcomes [5]. The same thing is expressed that judgment is a process to gather information as an ingredient to evaluate [6]. Assessments have an important role in education, as they aim to measure the increase in educational achievement. Besides, assessments are used to evaluate the learning outcomes performed by students [7], [8].

To be able to measure the achievement of students’ learning outcomes can be realized through the planning of Learning Plan: a selection of assessment techniques. Teachers need to have the ability to use various assessment techniques by observing the subject matter characteristics, the availability of learning media, the mental and physical development of students [9]. Choosing and using various scoring techniques can be a challenge for teachers. Teachers can integrate performance-based assessments into learning to provide learning experiences for students [10].

A series of learning activities can be assessed objectively and thoroughly, not solely based on the result (product only). The assessment can be done using an authentic assessment. An authentic assessment emphasizes process assessment and results at once. The need for an authentic assessment to be applied is emphasized through teaching, learning, and assessment [11]. To achieve educational objectives, the assessment is not only focused on cognitive aspects but also attitude assessment [12]. There is a positive relationship between attitudes and mathematical achievements [13], [14]. A positive attitude affects behavior in a positive direction, while negative attitudes will lead to negative behaviors. Students’ positive or negative attitudes toward science affect their educational background [15]. This suggests that one of the orientations of learning is to develop attitudes.

The skills assessment of the 21st century can be done with a comprehensive approach, using criteria such as [16], [17]: (a) a scoring system adapted to students’ abilities spanning 21st century skills; (b) the assessment of 21st century skills as an integral part of academic assessment; (c) reporting must be expanded to include 21st century students’ skill achievement information. The results of attitude assessment, skills and knowledge are used to provide feedback to students, teachers, schools, and parents to find out how well students are achieving the standards set.

2. Experimental Method

The research aims to obtain a clear picture of the management of authentic assessments in mathematics lessons to develop the skills of 4c (critical thinking, creativity, collaboration, and communication). The importance of this research is based on the basic assumption that: (a) important assessment activities are conducted to determine the achievement of the study outcomes and as an evaluation material [5], [6]; (b) the learning assessment is conducted objectively and comprehensively, covering the affective, cognitive and psychomotor aspects [5]; and (c) the ability of 4c is important to be owned by students in the twenty-first century [4], so that learning orientation should equip students with that ability.

This study used qualitative research with case study types. Qualitative research is done to understand the phenomenon experienced by the subject of research such as behavior, perception, motivation or action [18]. In this study, researchers investigated carefully an activity or process of escaping the authentic assessment in mathematics lessons to develop the skills of 4c at one of the state vocational high schools in West Java province, Indonesian. The subject of this study were mathematics teachers and grade X students. Researchers gather information complete with data collection procedures used documentation techniques, observations, and interviews.

The search for assessment documents is based on educational and cultural regulations and mathematics teacher assessment documents covering aspects of attitude, knowledge, and skills. It is done to see the suitability of the assessment in the field by participants. Interpretation of the data obtained from participants is done by researchers to see the authentic assessment in mathematics lessons.

3. Result and Discussion

The authentic assessment management in mathematics lessons to develop the skills of 4c (critical thinking, creativity, collaboration, and communication) in this study was analyzed through three phases,
namely (a) the preparation of assessment instrument (b) the implementation of assessment; and (c) utilization of assessment results.

Based on the observation results obtained information about the preparation of authentic assessment instruments. Researchers found that teachers devised assessment strategies during the preparation of the Learning Plan based on the syllabus. Some of the steps that have been done in arranging the instruments are presented in the Table 1.

**Table 1. Preparation of an authentic assessment of mathematics lessons to develop the ability of 4c**

| No | Instrument preparation steps | Description of activities |
|----|-------------------------------|---------------------------|
| 1  | Setting assessment objectives | Formulating the objectives of assessment of the 4c capabilities integrated into the aspects of attitudes, knowledge, and skills. |
| 2  | Create the scoring grid       | The teacher determines and selects the assessment technique to be used to measure each aspect. Subsequently compiled a grid of assessments as a guideline for drafting assessment instruments. |
| 3  | Creating assessment instruments and scoring guidelines | Creating assessment instruments used to measure each aspect of attitudes, knowledge, and skills. The assessment of mathematics learning on the aspect of attitude consists of spiritual and social attitudes, and assessment conducted through observation and journal. In the knowledge aspect, the assessment is done by written tests, oral tests, and assignments. Assessment of the skill aspect is done through practical. |
| 4  | Creating minimal submission criteria | In determining the criteria of minimal submission, teachers are guided on the competency standards of graduates. The steps taken to make the minimum submission criteria are: (a) calculating the number of basic competencies in one year of the lesson; and (b) determining the value of the student’s characteristic aspect (intake), the characteristics of the subjects (material complexity), and the condition of the education unit (carrying capacity). For students who have not achieved the minimum submission criteria, they must follow the study of the remedies. |

According to Table 1 shows that in the feeding of authentic assessment instruments, teachers know the objectives of judgment in accordance with the demands of the curriculum and needs of the 21st century, namely developing the capability of 4c. Teachers have taken steps to develop assessment instruments by setting assessment objectives, drafting the assessment grid, creating assessment instruments and scoring guidelines, and creating minimal submission criteria. Based on the interviews, the difficulties experienced by the teacher are in determining the indicator of each of the 4c capabilities. Teachers need to conduct in-depth analysis tailored to the competencies assessed. Besides, teachers have not tried to make modifications to create assessment instruments.

Suppose in an attitude assessment, the teacher has not tried to create self-assessment instruments, peer assessment or other techniques according to the competencies assessed. As for the skills assessment, the teacher has not tried to make a project assessment instrument, portfolio or other techniques according to the competencies assessed. For 21st century teaching skills, teachers need to be given professional development. An effective teacher in teaching, characterized by being able to explore technology and encourage 21st century learning. This can be done when they have the interest, motivation and support to do so [19], [20].

In the stage of the authentic assessment, the teacher first informs students about the aspects to be assessed, assessment techniques, assessment instruments to be used, and the criteria of their submission. Such information will help students prepare for learning activities and can motivate students to participate actively in learning.

Based on the results of documentation and observation studies conducted by researchers obtained findings that authentic assessment results are presented in the following table.
Table 2. Implementation authentic assessment of mathematics lessons to develop the ability of 4C

| No | Assessment techniques | Description of activities |
|----|-----------------------|--------------------------|
| 1  | Observation           | The teacher makes the observation sheet according to the material to be taught that has been designed to develop the skills of 4c. The level of assessment of teacher attitudes is to record student behavior, follow up on observations and describe student behavior. |
| 2  | Journal               | Implementation of attitude assessment using the journal is done by the teacher by observing the behavior of students both in class and outside the class. |
| 3  | Written tests         | The written tests used are daily replay and semester recurrence. The daily replay is performed after certain basic competencies have been taught. Questions that are used with multiple-choice questions and description questions. |
| 4  | Oral tests            | Oral tests are used by teachers to check students’ understanding of the assignments they have given. Besides, oral tests are given to develop students’ communication skills. |
| 5  | Assignment            | The assignment techniques are conducted in groups to develop student collaboration skills. Teachers give assignments to work at school and at home. |
| 6  | Performance assessment | Performance assessment performed when students interactions in groups. Students are required to be able to collaborate, communicate, and become good problem solvers. Teachers divide students into groups so that each individual must demonstrate their performance. |

Based on the results of observations and interviews conducted by researchers in observing the implementation of authentic assessments, the teacher was still in trouble in carrying out authentic judgment, developing assessment instruments, formulating Indicators, and designed a customized assessment section with the capability of 4c.

To develop students’ critical thinking skills, which are characterized by students being able to: (a) analyze; (b) evaluate; (c) and have ideas for problem-solving. Teachers need to equip students with skills, including (a) categorize; (b) make great ideas; (c) identifying relationships; and (d) ask more students to ask questions. To enhance the creativity of students, teachers need to create an environment that can make student creativity flourish. To develop collaboration, students need to learn to respect one another, listen to, and contribute. Students need to have communication skills including the ability to read and share thoughts, questions, ideas, and solutions in a variety of ways [16], [20].

The final stage of authentic assessment management is the use of authentic assessment results in mathematics lessons. Authentic assessment results are used by teachers as: (a) measuring and knowledge of students’ competency achievement; (b) learning process improvement tools; and (c) progress report preparation materials daily study results, middle of the semester, end of the semester, year-end, and increase in class.

Based on observations and interviews conducted by researchers in reviewing the use of authentic assessment results, the teacher was difficult to describe the ability of 4c students. To create learning that supports the development of the 4c capability, a learning environment is required to accommodate each student's learning needs. Learning environments of 21st century include: (a) making learning practices and physical environments that will support teaching and learning; (b) support the learning community to collaborate with each other to integrate 21st century skills into practice; (c) students learn by interacting with the real world; (d) has tools, technology, and resources [16], [17].

In addition, in order to make authentic assessment management run well, it is necessary to: (a) develop teacher profession development programmes and special focus training of skills of 21st century; (b) the integration of 21st century skills; (c) the development of a professional community learns to support each other; (d) development of ICT capability; (e) the development of 21st century skills in
higher education; (f) integrating 21st century skills into standard teaching, and (g) utilization of Web outreach to distribute resources [16], [22].

4. Conclusion
Assessments are conducted to measure the success of educational objectives. Students are expected to have the ability to suit the demands of the 21st century, including critical thinking, creativity, collaboration, and communication. Therefore, important teachers possess teaching skills and assessing skills according to the demands of the 21st century. The teacher’s assessment of learning results is conducted through the planning, implementation, and utilization of research. Assessment planning is conducted by formulating assessment objectives, making assessment instruments, assessment guidelines, and minimal submission criteria. Techniques used in the assessment of the attitude aspect using observation techniques and journals or other techniques by the competencies assessed. Techniques used in the assessment of knowledge aspects using oral tests, written tests, and assignments. Techniques used in the assessment of skill aspects are carried out through practices or other techniques by competencies assessed using the assessment scale accompanied by rubric. Assessment results are helpful for monitoring and evaluating processes, shaping students’ positive attitudes, increasing interest and learning motivation, and providing student learning progress information to parents.

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