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A Study on the Application of Performance Assessment in Mathematics Comprehensive Practical Activities

Enchi Liu*

College of Education, Zhejiang Normal University, Jinhua, China
**Corresponding author*

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Abstract: In the era of core literacy, comprehensive practical activities are conducive to the cultivation of new types of talents. The Mathematics Curriculum Standards for Compulsory Education, issued in 2022, also set out higher requirements for comprehensive practical activities. Correspondingly, performance assessment is an authentic assessment method that can effectively evaluate the level of students' core literacy, which coincides with the core of comprehensive practical activities. This study summarizes 4 steps for implementing performance assessment in mathematics comprehensive practical activities: (1) Set assessment objectives according to the mathematics curriculum standards, the characteristics of mathematics comprehensive practical activities and students' actual learning conditions; (2) Design performance tasks; (3) Set up scoring rules; (4) Conduct evaluation and feedback. In summary, performance assessment and comprehensive practical activities have a good theoretical fit, but there is not enough practical experience in actual teaching and learning process, which needs to be justified by researchers at practical level.

1. Introduction

The Chinese Ministry of Education has stated the great importance of mathematics comprehensive practical activities in the "Curriculum Standards for Compulsory Education" published in 2022. It is believed that this kind of activity is undoubtedly an important way to develop students' innovative talents and mathematical literacy. However, in practical teaching, mathematical knowledge and skills are mainly assessed by tests and exams, while the comprehensive practical activities focus more on students' innovation, investigation, and manipulative skills, and therefore cannot only be assessed by traditional means [1].

As a form of authentic assessment, performance assessment refers to higher-order thinking and core concepts' evaluation [2], which can effectively evaluate students' core literacy levels and promote literacy development, coinciding with the core of "mathematics comprehensive practical activities." Performance assessment evaluates complex learning processes and outcomes. As a result, it is considered to be an appropriate assessment method for the comprehensive practical activities. Therefore, the crucial point of this study is the design and application of performance assessment in mathematics comprehensive practical activities, especially the design of scoring rules

as well as the application of performance tasks, and summarizes the specific steps for implementing the assessment in the hope that it can provide a reference for the research in this direction.

2. Core Concept Definition

2.1. Performance Assessment

Performance assessment (Hereinafter referred to as PA) is a product of the rise of constructivist learning theory [3]. Domestic and international definitions of PA, regardless of the perspective from which the definitions are set, are characterized by four main features: complex tasks that require students to construct knowledge and can test both processes and outcomes; direct testing of performance; proximity to real-life situations; and the need for professional judgment [4]. In summary, PA means that teachers design contextualized and observable expressive tasks through the analysis of assessment objectives. The design process involves varying degrees of student participation as students complete the task and demonstrate their overall literacy as required [5]. After that, teachers should evaluate the students' performance in all areas according to certain criteria, as needed.

2.2. Mathematics Comprehensive Practical Activities

Mathematics Comprehensive Practical Activities mainly include theme activities and project-based learning [6]. On the one hand, in the theme activities, students will be in a realistic context, identifying and posing problems from a mathematical perspective, and integrating knowledge from mathematics and other disciplines to solve problems. On the other hand, project-based learning requires students to integrate their knowledge of mathematics and other disciplines to solve realistic problems. Apart from that, students can learn to appreciate the value of mathematical knowledge and the connection between mathematics and other subjects [6].

This study uses theme activities and project-based learning as a carrier to assess observable behavioural performance to help students develop a rich conception of activity and comprehensive literacy in mathematical activities.

3. Suitability of Using PA in Mathematics Comprehensive Practical Activities

Mathematics comprehensive practical activities cross the boundaries of the modules "Mathematics and Algebra", "Graphics and Geometry" and "Statistics and Probability". It is a more systematic and integrated way of linking all parts of knowledge together [7], and it focuses on developing students' ability to integrate their knowledge flexibly when facing new problems. At the same time, mathematics comprehensive practical activities also has a strong practical nature, and the materials in the last part of the textbook include a series of activities such as hands-on operations, practical investigations, subject investigations, etc. To complete these activities, students need to do a lot of practical operations to gain direct experience. In this activity-driven "brain, hands, mouth" activity process, students can effectively improve their comprehensive practical skills.

In terms of PA, it bridges the limitations of traditional paper-and-pencil tests and not only detects literacy but also facilitates the development of literacy [8]. A large body of evidence suggests that PA is better suited for detecting high-level, complex thinking skills and is more likely to facilitate the acquisition of these skills; it can also support more diagnostic teaching practices and facilitate curriculum and instruction.

According to the theoretical analysis of the nature of mathematics comprehensive practical activities and the characteristics of PA revealed a strong match, as shown in Table 1.

Table 1: Suitability of PA and comprehensive practical activities at the theoretical level.

Nature of comprehensive practical activities	Characteristics of PA
·Comprehensiveness: Integrate various parts of knowledge and cultivate students' ability to comprehensively apply knowledge. ·Practicality: Focusing on students' direct experience and using activities as the main form, allowing students to participate in activities firsthand.	·Realistic problem scenarios with relatively complex tasks that require students to integrate all aspects of knowledge. ·Emphasis on learning by doing, focusing not just on how much students know, but how much they do.

It is clear from Table 1 that PA is well suited for evaluating the process of mathematics comprehensive and practical activities. This is an indication of the appropriateness of the application at the theoretical level.

In addition, this study also conducted a questionnaire survey and interviews with 20 mathematics teachers in an elementary school in Hangzhou as the research subjects in order to understand the current situation of carrying out comprehensive practical activities and the implementation of evaluation. After analysing the survey results, the problems in the current implementation of these activities and the methods of PA are summarized in Table 2.

Table 2: Suitability of PA and comprehensive practical activities at the practical level.

Shortcomings of the activities	Methods of PA
·Unclear evaluation standards ·Neglecting non-cognitive goals ·Poor implementation level ·Too many verbal evaluations ·Single evaluation target ·Lack of evaluation feedback function	·Evaluation criteria setting based on curriculum standards ·Focus on the integrated performance of the activity process ·Using evaluation to help the implementation of activities ·Combination of qualitative and quantitative evaluation ·Self-assessment and group mutual assessment ·Checklists, rating scales and scoring rules

As is shown in Table 2, PA can remedy the shortcomings of the current problems existing in mathematics comprehensive practical activities. To sum up, both at the theoretical and practical levels, PA is well adapted to mathematics comprehensive practical activities. It can be tentatively concluded that the use of PA in the activities is appropriate.

4. Steps for Using PA in Mathematics Comprehensive Practical Activities

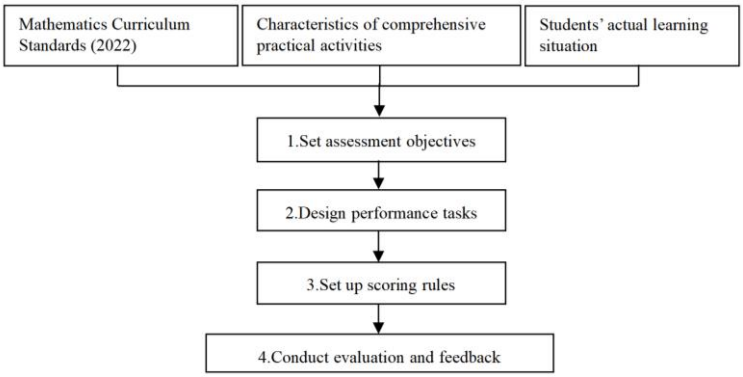

Figure 1: Steps for using PA in mathematics comprehensive practical activities.

This study applies PA to comprehensive practical activities in elementary school mathematics, and the specific steps are as Figure 1.

The block diagram shows the steps of applying PA in elementary school mathematics comprehensive practical activities, as shown in Figure 1. The whole process of implementation is divided into four steps: (1) Set assessment objectives according to the mathematics curriculum standards, the characteristics of mathematics comprehensive practical activities and students' actual learning conditions; (2) Design performance tasks; (3) Set up scoring rules; (4) Conduct evaluation and feedback.

4.1. Set Assessment Objectives

The important basis for setting the assessment objectives of mathematics comprehensive practical activities is the "Curriculum Standards for Compulsory Education (2022 Edition)" which has authoritative subject specialization and basic concepts of teaching evaluation. Therefore, the most fundamental basis for determining the objectives of PA in the activity is the standards, which is refined and specified according to the teaching needs, as the key for teachers to set the objectives. For example, the standard points out in the Theme Activity.3 "Where is the time?" of the first academic period (i.e., grades 1 and 2), students are required to recognize the hours, minutes, and seconds in real-life situations, to experience and express the length of time in the context of life experience, to understand the meaning of time and to know how to observe time.

4.2. Design Performance Tasks

The work of designing performance tasks needs to take into account the quality requirements for the development of specific teaching activities, that is, the designed tasks must be consistent with the objectives [9]. What can students accomplish in the activities after the task? Which dimensions of the expected student performance in the evaluation objectives will be elicited through the task? For example, in the "Nutritious Lunch curriculum" for Grade 4, three thematic activities can be organized: "The Wisdom of Nutritious Lunches", "Weekly Lunch Arrangement" and "Healthy Eating Class". Among them, the main task of "The Wisdom of Nutritious Lunches" is to apply the knowledge of classification and statistics to learn how to prepare a nutritious lunch and to experience the importance of balanced nutrition and reasonable diet. In the "Weekly Lunch Arrangement", two group work tasks were arranged:(1) Record the lunch recipes of the school cafeteria in the recent week, calculate the nutritional composition of the school lunch in the week according to the table of scientific dietary matching and draw statistical charts, then analyse and communicate with each other to make suggestions to the school cafeteria; (2) Design a weekly nutritious lunch recipe and present it in the form of posters and other forms of communication.

4.3. Set up Scoring Rules

Setting up the scoring rules is a prominent step in the design of PA. After visualizing students' performance through performance tasks, assessment guidelines need to be used to evaluate and interpret the performance. The scoring rules for the activity refer to the vital student performances in the math activity as evaluation points, with each standard scale indicating different levels of student performance. Key performances here include math sub-competencies, affective-attitudinal elements, and so on. Prof. Cui Yunhuo pointed out that the curriculum standard is the most important and the main resource in the development. After grasping the curriculum standards, he broke down the scoring rules development process into the following steps: (1) accurately grasping the curriculum standard; (2) identifying scoring dimensions and elements; (3) identifying sub-elements of each element and the different characteristics of the performance; (4) selecting the type of scoring rules; (5) describing the grades; (6) formulating the scoring rules; (7) continuously

refining the scoring rules [10]. In practice, we are not only able to create brand new scoring rules, but also to utilize already developed scoring rules, but whichever way we use them, we will eventually go through the stage of modifying and refining them.

4.4. Conduct Evaluation and Feedback

In the case of matching the assessment objectives with the teaching objectives, students present comprehensive abilities by completing performance tasks, are these abilities the expected learning outcomes? This requires students to understand and participate in the development of scoring rules, and teachers to give timely evaluation and feedback in the process of the activity, which ultimately promotes students' learning. Under the continuous influence of the new curriculum reform, the original concept of evaluation has undergone radical changes. Teachers and students are both evaluators of evaluation activities. In order to help students utilize the grading rules to promote their own learning, teachers need to develop more evaluation tools, such as peer evaluation forms, self-evaluation forms etc., which is undoubtedly a great challenge for teachers.

5. Conclusion

Both PA and comprehensive practical activities focus on whether students' learning is actually happening. PA concerns more on students' thinking and behaviour in the learning process, while comprehensive practical activities concern on students' ability of design and comprehensive application. The two programs have a good theoretical fit, but there is not enough practical experience in actual teaching and learning process.

Overall, this study aims to stimulate students' interest and participation, meanwhile, enrich students' emotions so that students can understand and internalize the mathematical knowledge learnt in the class. Students can solve problems through small group work on the basis of understanding and internalization of the mathematical knowledge learnt in class. Students can show their co-operation, communication, problem analysis and creativity in such mathematical activities. In comprehensive practical activities, students can demonstrate their higher-order thinking skills such as cooperation, communication, problem analysis and creativity; and teachers can also reflect on their own thinking through students' performance in the activity.

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