

Problem Analysis and Optimization Strategies of Peer Feedback Behavior in Primary School Mathematics

Jiakang Xu

Yangtze University, Jingzhou, China

Abstract: As a key interactive form of cooperative learning in primary school mathematics, the quality of peer feedback directly affects students' mastery of knowledge and development of thinking. Based on classroom observations and reflections on teaching practice, this paper focuses on three core problems in peer feedback behavior in primary school mathematics: supercivilization of content, one-way orientation of interaction, and fragmentation of implementation. By analyzing the causes of these problems in combination with the cognitive characteristics of primary school students and the disciplinary attributes of mathematics, targeted optimization strategies are proposed from three dimensions: "teacher guidance", "student ability cultivation", and "classroom environment optimization". The aim is to help teachers break through the practical dilemmas of peer feedback and achieve the teaching goal of "promoting thinking through feedback and enhancing effectiveness through interaction".

Keywords: Primary school mathematics, Peer feedback, Problem analysis, Optimization strategies.

1. Introduction

Mathematics provides people with a way to describe and communicate with the real world. Specifically, it uses mathematical language to accurately describe quantitative relationships and spatial forms in daily life, express and solve problems, thereby developing the ability to express and communicate mathematically—and this is exactly the ability required for peer feedback³. Peer feedback encourages students to apply mathematical knowledge in real scenarios, strengthen expression and communication, and analyze and solve problems from a mathematical perspective, with mathematical thinking and language through interaction.

Feedback literacy is an important component of core literacy assessment [1]. It highlights students' initiative and agency in feedback, connects to self-regulated learning, and enables students to receive teacher feedback and actively use feedback to improve their learning. In this context, peer feedback, as an effective evaluation method, helps students obtain timely feedback [7], identify their strengths and weaknesses, enhance self-monitoring, deepen their understanding of mathematical knowledge, and improve problem-solving efficiency—so as to conform to the trends of educational evaluation reform and promote the improvement of mathematics learning effects.

However, in practical teaching, peer feedback often falls into formalistic dilemmas: in some classrooms, only mutual checking between desk mates is arranged after exercises, and feedback is limited to simple judgments of "correct" or "incorrect"; in other classrooms, students passively accept error correction from peers, lacking active discussion; still, some teachers regard peer feedback as a means to save time, without systematic design and guidance, resulting in a significant reduction in feedback effectiveness. Against this background, in-depth analysis of the core problems of peer feedback in primary school mathematics and exploration of practical optimization strategies have become important issues to improve the quality of mathematics classroom teaching.

2. Core Problems and Cause Analysis of Peer Feedback Behavior in Primary School Mathematics

2.1. Supercivilization of Feedback Content: Focusing on Error Correction Rather Than Thinking

From the current practical situation of peer feedback in primary school mathematics, the most core problem is that the content of feedback has long remained at the superficial level of knowledge error correction [6], failing to reach the in-depth level of optimizing problem-solving methods and sorting out thinking processes.

Specifically, in computational teaching scenarios, students' feedback is mostly limited to simple judgments on the correctness of problem-solving results, such as pointing out that "the problem-solving result is wrong" or "the answer does not meet expectations". However, they rarely clearly identify the specific causes of errors—such as omission of carry operations, misalignment of decimal point placement, or errors in applying multiplication tables—and it is even more difficult for them to put forward operable suggestions for correction methods. In geometry teaching, peer feedback usually only focuses on intuitive problems in the presentation of geometric figures, such as "the sides of the drawn rectangle are not neat", but cannot provide constructive guidance from the perspective of operation methods (e.g., "aligning with grid lines using a ruler to improve the standardization of the figure"). In the teaching of word problems, the focus of feedback is mostly on the consistency between the final answer and the standard answer, and there is rarely discussion on core issues related to thinking quality, such as the logic of problem-solving thinking, the conciseness of problem-solving steps, and the existence of better problem-solving paths.

From the root cause, the supercivilization of feedback content is mainly caused by two factors. On the one hand, it stems from the deviation of teachers' teaching goal

orientation. Affected by the exam-oriented teaching mindset, some teachers simplify students' mastery of mathematical knowledge to the accuracy of problem-solving. When designing and implementing peer feedback links, they overemphasize the basic goal of "error identification and answer correction", and fail to guide students to shift the focus of feedback to the review and optimization of problem-solving thinking processes through teaching guidance—resulting in the narrowing of the educational value of feedback activities [4].

On the other hand, it is limited by the cognitive development level and ability characteristics of primary school students [8]. From the perspective of grade differences: lower-grade students mainly rely on concrete and figurative thinking, and it is difficult for them to abstract the concrete problem-solving process into systematic problem-solving methods, so they can only judge the correctness of problem-solving results through intuitive perception; middle-grade students have initially developed logical thinking ability, but their language expression and logic organization abilities are still insufficient, making it impossible for them to clearly explain the causes of errors and corresponding correction ideas; upper-grade students can understand the differences between different problem-solving methods and have the cognitive basis for in-depth feedback, but due to the lack of systematic guidance on feedback methods, they cannot transform their thinking on the problem-solving process into organized and guiding feedback content—eventually leading to feedback remaining at a superficial level.

2.2. One-way Orientation of Interaction Form: Lack of Discussion and Collision

From practical observations, peer feedback in most primary school mathematics classrooms presents the characteristic of one-way notification: one party initiates feedback, while the other party either accepts it in silence or only makes simple rebuttals [3]. Rarely does two-way in-depth discussion and thinking collision occur.

Specifically, in the teaching scenario of "area of parallelograms" in the fourth grade, Student A pointed out to Student B that using the method of multiplying adjacent sides to calculate the area was wrong. When Student B further asked about the reason for the error, Student A could not give a reasonable explanation, leading to the interruption of the feedback process. In the practice session of fraction division word problems in the fifth grade, Student C suggested that Student D use the equation-solving method to solve the problem, while Student D believed that the arithmetic method was more convenient. The two parties did not further discuss the applicable scenarios of the two problem-solving methods, and the feedback only stayed at the one-way interaction level of "suggestion and refusal".

The reasons for the one-way orientation of peer feedback can be summarized into three points: First, teachers lack the awareness of guiding interaction. When organizing peer feedback activities, most teachers only assign the basic task of mutual checking between peers, without clearly requiring students to discuss the feedback content. As a result, students gradually form the habit of informative feedback in long-term practice, lacking the awareness of active interaction. Second, the limitation of classroom time allocation. Each mathematics class in primary school has a limited duration, and teachers need to complete teaching links such as the teaching of new knowledge, classroom exercises, and summary review within

a fixed time. To ensure the teaching progress, they often shorten the time for peer feedback, leaving students with no sufficient opportunity for discussion—they can only quickly inform the feedback results, making it difficult to carry out in-depth interaction [9]. Third, students have feedback anxiety. Some students worry that expressing mistakes in discussions will be laughed at by peers, or that refuting peers' views will affect interpersonal relationships. Due to such psychological concerns, they take the initiative to give up participating in interaction and choose to respond to peer feedback in a passive acceptance manner—further exacerbating the one-way tendency of feedback.

2.3. Fragmentation of Implementation Process: Failure to Integrate into Teaching Design

From the current implementation status of peer feedback in primary school mathematics, related activities are mostly ad-hoc arrangements, lacking systematic design and planned support, and showing the characteristic of fragmented implementation.

The specific manifestations are as follows: Some teachers only temporarily ask students to conduct mutual checking between desk mates during the exercise link (e.g., simply reminding desk mates to check each other's homework completion), without designing structured tasks in advance around feedback goals, feedback content, and feedback methods—resulting in a loose and disorderly feedback process. Some teachers only arrange peer feedback activities in computational courses but completely exclude feedback links in other lesson types such as geometry teaching and word problem teaching, failing to adapt feedback activities to the learning needs of different mathematical knowledge modules. In addition, some teachers lack follow-up tracking of feedback effects. Key issues such as whether students truly understand the causes of errors and master correct problem-solving methods after receiving peer feedback are not further observed and evaluated by teachers—making feedback activities become one-time interactions.

Essentially, the root cause of this fragmented implementation lies in teachers' positioning of peer feedback as an auxiliary teaching link rather than integrating it into the core process of mathematics teaching. On the one hand, some teachers have a biased understanding of the educational value of peer feedback. They believe that the core of primary school mathematics teaching is to explain knowledge points clearly, and peer feedback only plays a role in filling knowledge gaps. They fail to recognize the value of peer feedback in cultivating students' logic of mathematical thinking, accuracy of expression, and ability of cooperative interaction—thus ignoring the systematic design of feedback links. On the other hand, teachers generally lack specific methods to systematically integrate peer feedback into teaching design. Facing the differences in teaching goals among different lesson types (e.g., computation, geometry, word problems) and the differences in cognitive development levels of students in lower, middle, and upper grades, they cannot design feedback links with strong pertinence and adaptability. They can neither design detailed feedback tasks in combination with the "accuracy requirements" of computational teaching nor design operational feedback activities for the "cultivation of spatial concepts" in geometry teaching. Eventually, peer feedback activities are arranged randomly according to the teaching progress, and the implementation effect cannot be effectively guaranteed.

3. Optimization Strategies of Peer Feedback Behavior in Primary School Mathematics

To address the above problems, combined with the disciplinary attributes of primary school mathematics and the cognitive laws of primary school students, optimization strategies can be constructed from three dimensions—teacher guidance, student ability cultivation, and classroom environment optimization—to promote peer feedback from formalization to in-depth development.

3.1. Teacher Guidance: Constructing a Three-stage Design

As the core decision-maker of the quality of peer feedback, teachers need to promote feedback from fragmentation to systematization through pre-class, in-class, and post-class three-stage strategies.

In the pre-class stage, it is necessary to embed feedback tasks adapted to lesson types: In computational teaching, focus on error cause identification and correction method provision, and design feedback task sheets. For example, in the teaching of "two-digit by one-digit multiplication" in the third grade, clearly requires students to check the correctness of their peers' calculation results, identify error types, and put forward correction suggestions in fixed sentence patterns. In geometry teaching, design visual feedback tools around the standardization of operation methods and the cultivation of spatial concepts. In the teaching of word problems, take the sorting out of problem-solving thinking and the optimization of methods as the core, and design thinking sharing cards to guide students to discuss the differences and applicable scenarios of different problem-solving methods. At the same time, the difficulty of tasks should be adjusted according to students' grades: lower-grade students use task sheets with pictures and simple sentence patterns; middle-grade students use guiding tools with semi-open sentence patterns; upper-grade students design open-question feedback tasks to meet the needs of students with different cognitive levels.

In the in-class stage, it is necessary to implement three-step guidance of "demonstration, questioning, and summarization" to activate two-way interaction: First, teachers present high-quality feedback cases that include three elements—affirming strengths, pointing out problems, and providing method suggestions—to let students clarify the standards of high-quality feedback. Second, in response to the supercivilization or one-way orientation of students' feedback, deepen discussions through targeted questioning (e.g., "Why do you think this method is wrong?" "Is there a more convenient problem-solving method?"), promoting the transformation from one-way informative feedback to two-way thinking collision. Finally, after each round of feedback, spend 3-5 minutes summarizing: extract excellent feedback cases, sort out common problems in students' feedback, and clarify the goals of the next feedback—helping students accumulate feedback experience.

In the post-class stage, it is necessary to establish a feedback effect tracking mechanism: On the one hand, guide students to establish feedback error notebooks, where they record errors pointed out by peers, corresponding correction methods, and their own understanding of errors. Teachers check the error notebooks regularly and provide individualized tutoring to students who have incomplete records or insufficient understanding—ensuring that students

truly master correction methods. On the other hand, design 1-2 similar problems for mini-quizzes targeting the problems that appear intensively in feedback, to test whether students have mastered the relevant knowledge and methods after feedback.

3.2. Student Cultivation: Grade-based Ability Training

Students are the main body of peer feedback [5]. It is necessary to cultivate their abilities in stages according to the cognitive characteristics of different grades to solve the problem of "being unable to express effectively" [10].

For lower-grade students, focus on standardized expression and reduce difficulty through games: Design feedback sentence templates that are in line with mathematical content to provide expression scaffolds for students. Organize games such as "Feedback Little Detective"—let students take turns to act as "detectives" to find errors in peers' problem-solving processes and express them using the template—so that students can practice in a relaxed atmosphere and improve their willingness to express.

For middle-grade students, focus on thinking analysis and improve depth through cases and imitation: Provide comparative cases of excellent feedback and inadequate feedback (e.g., contrast "Your answer is wrong" with "Your answer is wrong because you forgot to convert units; you should first convert centimeters to meters and then calculate"), guiding students to realize the importance of analyzing error causes. Design imitation tasks combined with specific teaching content—for example, in the teaching of "area of rectangles", let students imitate the excellent feedback cases to analyze peers' problem-solving processes—helping them master the basic logic of in-depth feedback.

For upper-grade students, focus on interactive cooperation and stimulate collision through debates and sharing: Organize problem-solving method debates (e.g., "Which method is more efficient for solving engineering problems: the arithmetic method or the equation method?") to encourage students to express their views, question peers' opinions, and conduct in-depth discussions. Arrange weekly feedback sharing sessions, where students share the problems solved with the help of peer feedback—letting them feel the value of feedback and learn from others' experience, thereby improving their enthusiasm for interaction.

3.3. Classroom Environment: Creating a Relaxed Atmosphere

A safe classroom atmosphere is the guarantee for high-quality peer feedback. It is necessary to eliminate students' feedback anxiety through three-dimensional adjustments of "rules, incentives, and environment".

First, establish feedback conventions. Teachers and students jointly develop rules such as "listen carefully when others give feedback", "express views politely", and "respect different opinions", post them in a prominent position in the classroom, and remind students of the rules before each feedback—helping students internalize the rules into habits.

Second, implement positive incentives. Timely affirm excellent feedback behaviors through verbal praise (e.g., "You clearly explained the cause of the error, which is very helpful to your desk mate"). Establish an incentive mechanism for in-depth feedback and active interaction—for example, select "Excellent Feedback Stars" every week, display their feedback cases, and let students feel the value of

high-quality feedback—strengthening positive behaviors.

At the same time, adjust the physical environment to support interaction: Change the seating arrangement to four-student groups sitting in a circle, facilitating face-to-face feedback; set up a feedback corner in the classroom, placing mathematical toolkits containing rulers, triangular plates, and small sticks for demonstration during feedback; reserve 5-8 minutes for peer feedback in each class, avoiding hasty feedback due to time constraints—reducing the difficulty of interactive operations and allowing students to participate in feedback more smoothly.

4. Conclusion

The optimization of peer feedback behavior in primary school mathematics is not simply "increasing the frequency of feedback" but solving the core problems of "what to feedback", "how to feedback", and "how to ensure effectiveness". Teachers need to shift from "superficial error correction" to "in-depth thinking guidance" and make feedback a core link of mathematics teaching through "lesson-type-adapted task design", "progressive guided interaction strategies", and "sustained tracking of effect management". At the same time, they should cultivate students' feedback ability in accordance with the cognitive characteristics of primary school students and create a safe and supportive classroom atmosphere—guiding students to shift from "passive acceptance of feedback" to "active participation in feedback". Finally, the goal of "promoting understanding through feedback and fostering thinking through interaction" can be achieved, and the effective implementation of cooperative learning in primary school mathematics can be truly realized.

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