

Research on Homework Design for the Integration of “Teaching, Learning, and Assessment” in Junior Secondary Mathematics Based on Backward Design

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Abstract: *Against the backdrop of the full implementation of the Compulsory Education Mathematics Curriculum Standards (2022 Edition) and the continued deepening of the “double reduction” policy, the competency-oriented education reform calls for a transformative shift in junior secondary mathematics homework design—from mechanical training toward quality-oriented education. The concept of “integration of teaching, learning, and assessment” emphasizes the alignment of goals and the seamless integration of teaching, learning, and evaluation throughout the process, providing a key leverage point to address the persistent challenges in current junior secondary homework design. Focusing on issues such as vague objectives and disconnection between assessment and instruction in existing mathematics homework design, this paper proposes a strategic framework based on backward design, centered on four core elements: “precise goal specification, explicit rubrics, structured tasks, and feedback-driven learning”. The aim is to offer concrete, practice-based references for in-service junior secondary mathematics teachers to optimize their homework design strategies.*

Keywords: Integration of teaching, learning, and assessment; Backward design; Junior secondary mathematics; Homework design.

1. Introduction

The *Compulsory Education Mathematics Curriculum Standards (2022 Edition)* issued by the Ministry of Education puts forward further requirements regarding teaching, learning, and assessment, stating that it “emphasizes promoting the organic integration of teaching, learning, and assessment under the guidance of core competencies” [7]. This requires that the integration of teaching, learning, and assessment not remain merely at the theoretical stage but be implemented in practice. Homework, as an integral part of teaching practice, has long been assigned by most teachers based on fixed textbook content and their own experience, making it difficult for the integration of teaching, learning, and assessment to be effectively embedded and carried out in homework design. Therefore, further in-depth research on this issue is necessary.

2. Current State of Junior Secondary Mathematics Homework

As an extension of classroom instruction and a key vehicle for student learning, the quality of homework reflects the extent to which the integration of teaching, learning, and assessment has been realized. However, at the junior secondary level, numerous common problems persist in mathematics homework—and in homework for other subjects as well.

First, there is a disconnect from instructional objectives. Instructional objectives are the concretization of curriculum goals and play a soul-like role in the teaching process. They serve as both the starting point and the destination of instruction, governing the entire teaching process and determining the fundamental direction of teaching and learning [1]. However, looking at traditional junior secondary mathematics homework design, teachers are often constrained by examination-oriented thinking. Most homework design serves the single goal of test preparation, frequently adopting a “drill-based approach”. This approach tends to have

students solve large numbers of similar problems to summarize problem-solving techniques and procedural frameworks for specific question types, which they then apply as a set of “formulas” in examinations. As a result, homework is reduced to a tool for mechanical training, straying from the competency-based, student-centered educational orientation of the new curriculum standards and creating a disconnect between homework and the cultivation of students’ core competencies.

Secondly, there is a disconnect in homework assessment. As a key intermediate link that connects classroom instruction and provides feedback on student learning quality, homework assessment serves not only as a standard for diagnosing learning progress but also as an important basis for guiding students in optimizing their learning methods. Moreover, it is an indispensable component in implementing the concept of the integration of teaching, learning, and assessment. However, in the current routine grading of junior secondary mathematics homework, teachers tend to emphasize outcome-based evaluation, reducing assessment to a mere ancillary step in classroom instruction and thereby losing the function of promoting teaching and learning through assessment. At the same time, when grading homework, teachers often focus solely on whether answers are correct or incorrect, overlooking the thought processes students engage in while solving problems. As a result, they fail to capture students’ actual learning conditions and cognitive errors.

Furthermore, in the current process of assigning junior secondary mathematics homework, there is also a lack of targeted design. For a long time, educators have overlooked the importance of homework in student learning, and research on homework assignment methods has been relatively scarce. Homework is often assigned using a “one-size-fits-all” approach, which represents a major drawback of traditional homework practices. Teachers should fully take into account students’ varying academic foundations and learning abilities, designing tiered homework to accommodate different learning situations and thereby promote the holistic

development of all students. However, at this stage, most teachers have not genuinely implemented tiered homework in practice [2].

These issues result in homework, as a learning vehicle, being unable to fulfill its core function of “using assessment to promote learning and instruction”. This also stands in direct opposition to the concept of “assessment as learning” advocated by the new curriculum standards. Therefore, it is particularly important to construct a strategic framework for mathematics homework design based on the concept of integrating teaching, learning, and assessment.

3. Intrinsic Consistency Between the Integration of Teaching, Learning, and Assessment and Backward Design

The integration of “teaching, learning, and assessment” refers to a pedagogical concept that, guided by the cultivation of core competencies and instructional objectives, embeds student learning assessment comprehensively into the processes of both teacher instruction and student learning. It aims to promote teaching and learning through assessment, ultimately enhancing teachers’ instructional effectiveness and students’ academic achievement [4].

Backward design was proposed by American professors Grant Wiggins and Jay McTighe [5] in their work *Understanding by Design*. Its core feature lies in adopting an “end-to-beginning” reverse thinking approach, emphasizing that assessment design should precede the arrangement of instructional activities. Specifically, backward design refers to a model of instructional design in which teachers start from the expected student learning outcomes, identify the evidence for achieving those outcomes—that is, “how to assess whether students have met the goals”—and then design instructional activities. The model is divided into three clear implementation stages. This theory emphasizes that assessment design precedes activity design, establishing the leading role of assessment in instructional design. It not only provides clear guidance for teaching practice but also offers a design framework for integrated mathematics homework design [3].

A comparison of the two reveals that the integration of teaching, learning, and assessment and backward design share a high degree of intrinsic consistency.

3.1 Both are Guided by Clear Instructional Objectives

The integration of teaching, learning, and assessment focuses on the synergy among instruction, learning, and evaluation, requiring that instructional objectives run through the entire process of both teaching and assessment. Backward design emphasizes anchoring on expected student learning outcomes—that is, learning objectives—and deriving the design pathway in reverse. Both approaches revolve around instructional objectives, thereby transforming the traditional model of instructional design, which merely followed the logical sequence of textbook content.

3.2 Both Emphasize the Importance of Assessment

Both the integration of teaching, learning, and assessment and

backward design redefine the value of assessment. Backward design states that assessment should precede the arrangement of instructional activities—that is, after clarifying the instructional objectives, teachers should first consider “how to assess whether students have achieved the objectives”, and then design instructional activities accordingly. This approach largely prevents a disconnect between instructional processes and assessment. In contrast, the integration of teaching, learning, and assessment emphasizes that assessment should run through the entire process of instructional activities, advancing simultaneously with instruction. Both approaches reject the view of assessment as merely a summative test at the end of a lesson; instead, they highlight the leading role of assessment.

3.3 Backward Design and the Integration of Teaching, Learning, and Assessment Complement Each Other

As an educational concept, the integration of teaching, learning, and assessment does not provide a specific, actionable framework for instructional design. In contrast, backward design, through its structured three-stage process, offers a concrete and operable practical framework for implementing the integration of teaching, learning, and assessment. This framework can be directly transferred and applied to homework design. At the same time, the integration of teaching, learning, and assessment provides conceptual guidance for backward design.

4. Homework Design Strategies for Integrating “Teaching, Learning, and Assessment” in Junior Secondary Mathematics Based on Backward Design

In response to the prevalent practical problems in current junior secondary mathematics homework—such as the disconnect between objectives and assessment and the lack of targeted design—teachers can systematically construct practical strategies for mathematics homework design based on the three-stage principle of backward design. This will enable the true integration of “teaching, learning, and assessment” in daily instruction and effectively realize the educational value of homework.

4.1 Precise Goal Specification

The primary prerequisite for homework design under the integration of teaching, learning, and assessment is to clarify student learning objectives. As a national-level instructional guideline, the mathematics curriculum standards specify the core requirements and developmental expectations for student learning outcomes [6]. Based on backward design, before designing homework, teachers need to follow a logic that moves from curriculum standards to classroom instruction and from teachers to students, completing the transformation and refinement of learning objectives across three levels.

First, teachers should thoroughly study the unit teaching objectives for the corresponding chapter as outlined in the curriculum standards, grasping the core direction and ultimate requirements of unit learning. Second, by combining the curriculum standards, the logical organization of the textbook,

and the actual learning conditions of students in the class, teachers should break down the unit objectives into attainable lesson-specific teaching objectives. Finally, teachers should transform their own instructional objectives into student learning objectives.

Using the second lesson of Chapter 11, Inequalities and Inequality Groups, in the Grade 7 second semester textbook of the People’s Education Press—specifically, Linear Inequalities in One Unknown—as an example, the practical process of objective decomposition is fully demonstrated as follows.

Step 1: Study the Curriculum Standards and Formulate Unit Teaching Objectives

Based on the curriculum standards, clarify the overall unit’s educational objectives, which will guide the direction of both instructional and homework design throughout the unit.

Table 1: Unit Teaching Objectives for the Unit “Inequalities and Inequality Groups”

Category	Unit Teaching Objectives
Unit Teaching Objective 1	Understand the meaning of inequalities in the context of specific problems, explore and master the basic properties of inequalities.
Unit Teaching Objective 2	Solve linear inequalities in one unknown with numerical coefficients, represent the solution set on a number line; use a number line to determine the solution set of a system consisting of two linear inequalities in one unknown.
Unit Teaching Objective 3	Based on the quantitative relationships in specific problems, formulate a linear inequality in one unknown to solve simple real-world problems.

Step 2: Formulate Lesson-Specific Teaching Objectives by Integrating Curriculum Standards, Textbook, and Student Learning Conditions

Break down the unit objectives into instructional requirements for individual lessons, aligning with students’ cognitive pacing and the logical progression of classroom learning.

Table 2: Lesson-Specific Teaching Objectives for “Linear Inequalities in One Unknown”

Category	Lesson-Specific Teaching Objectives
Lesson Objective 1	Understand the concept of linear inequalities in one unknown and identify such inequalities based on the concept.
Lesson Objective 2	Solve linear inequalities in one unknown and represent the solution set on a number line.
Lesson Objective 3	Based on the quantitative relationships in specific problems, formulate a linear inequality in one unknown to solve real-world problems.

Step 3: Transform Lesson-Specific Objectives into Student Learning Objectives

Convert the teacher’s instructional objectives into student learning tasks, enabling students to clearly understand the learning requirements and providing a direct basis for homework assessment.

Table 3: Student Learning Objectives for “Linear Inequalities in One Unknown”

Category	Student Learning Objectives	Corresponding Lesson Objective
Learning Objective	Identify linear inequalities in one unknown from given expressions and explain the basis	Lesson Objective 1

1	for judgment.	
Learning Objective 2	Independently solve linear inequalities in one unknown with numerical coefficients based on the basic properties of inequalities, and represent the solution set on a number line in a standardized manner.	Lesson Objective 2
Learning Objective 3	Analyze the inequality relationships in simple real-world problems, formulate a linear inequality in one unknown, solve it, and explain the real-world meaning of the result.	Lesson Objective 3
Learning Objective 4	Reflect on the reasonableness of the solution results for real-world inequality problems and attempt to propose optimization suggestions.	Lesson Objective 3

4.2 Explicit Rubrics

The integration of “teaching, learning, and assessment” requires that homework assessment move beyond the traditional single criterion of “right or wrong” and instead construct an assessment rubric oriented toward cognitive development, thereby making students’ levels of thinking visible. This is precisely the core requirement of the second stage of backward design: “determining evaluation criteria”. The key to this step lies in establishing a unified assessment standard shared by both teachers and students. When grading homework, teachers annotate the corresponding competency level for each student. In this way, the feedback students receive is no longer a vague “correct” or “incorrect”, but rather a clear indication of their current ability level and direction for further development. Consequently, students shift from passive error correction to active progression. At the same time, teachers can accurately grasp the cognitive distribution and ability differences among students in the class, avoiding a “one-size-fits-all” approach to instruction and enabling teaching tailored to individual students’ needs.

Using the lesson on “Linear Inequalities in One Unknown” as an example, student competencies can be categorized into four levels in conjunction with the student learning objectives, forming a clear assessment rubric:

Basic Level: Students at this level can accurately identify linear inequalities in one unknown and articulate the basis for their judgment. This corresponds to Learning Objective 1.

Proficient Level: Students at this level can correctly solve linear inequalities in one unknown and represent the solution set on a number line in a standardized manner. This corresponds to Learning Objective 2.

Integrated Level: Students at this level can analyze inequality relationships in real-world problems, formulate a linear inequality in one unknown, solve it, and explain the real-world meaning of the results. This corresponds to Learning Objective 3.

Innovative Level: Students at this level can deeply reflect on the reasonableness of the solution results for real-world inequality problems and propose optimization suggestions. This corresponds to Learning Objective 4.

4.3 Structured Tasks

The core component of homework design under the integration of “teaching, learning, and assessment” is the systematic design of homework tasks, which corresponds to

the third stage of backward design: producing instructional design. Integrated homework design should break away from the limitations of traditional drill-based approaches, abandoning the mechanical repetition of exercises, and instead shift toward task design driven by assessment. It should follow a tiered design principle from foundational to developmental levels, accommodating students' different zones of proximal development while aligning directly with the levels of the assessment rubric.

Through tiered and structured homework design, students' thought processes can be fully revealed, making their cognitive pathways explicit. This allows the homework completion process itself to serve as the core basis for assessment, truly achieving the goal of "using assessment to promote instruction and learning".

Based on the preceding decomposition of objectives for linear inequalities in one unknown, the operationalization of explicit rubrics, and the requirements for structuring learning tasks, a systematic design of homework for this lesson can now be carried out as follows.

Table 4: Lesson Homework Design for "Linear Inequalities in One Unknown"

Task Type	Homework Design
Diagnostic Task (Basic Level)	1. Determine whether the following expressions are linear inequalities in one unknown, and explain the basis for your judgment: (1) $3x - 2y > 5$ (2) $x^2 + 2 \leq 7$ (3) $4 - \frac{2x-1}{3} < x$
Consolidation Task (Proficient Level)	2. Solve the following inequalities and represent the solution sets on a number line: (1) $2(3x - 1) - 4x \leq 10$ $\frac{x-3}{2} - 1 > \frac{2x+1}{4}$
Transfer Task (Integrated Level)	3. Cinema membership: Pay 100 yuan for a membership card and enjoy 20% off on tickets. Non-member tickets cost 60 yuan each. (1) Let "x" be the number of visits. Make a table showing the total cost for members. (2) Find the condition under which "buying the membership card is cheaper than not buying it". (3) Xiao Ming plans to watch 4 movies. Does he need to buy the membership card?
Innovation Task (Innovative Level)	4. In question III (3), assume each visit is for one person. However, in reality, he may bring friends. (1) If he brings one friend (who is not a member), is the membership card still cost-effective? (2) The cinema introduces a promotion: "Bring two friends and one gets free admission". Design the optimal ticket-purchasing plan.

4.4 Feedback-Driven Learning

The final and most critical step in closing the loop of homework design under the integration of "teaching, learning, and assessment" is the precise implementation of homework feedback. Feedback serves as the core bridge connecting "assessment" and "instructional improvement". In traditional teaching, teacher feedback on student homework often consists of nothing more than simple right/wrong marks and vague comments such as "Good" or "Keep it up", lacking targeted suggestions for improvement. As a result, the learning-promoting function of homework is weakened, and its intended educational value cannot be fully realized.

Under the guidance of the integration of "teaching, learning,

and assessment", homework feedback needs to be grounded in the assessment rubric as the core reference. When grading homework, teachers should precisely identify students' strengths, weaknesses, and specific suggestions for improvement based on their competency levels, providing differentiated and personalized feedback for different students. At the same time, teachers should guide students to actively engage in error attribution or organize their mistakes. Based on the feedback from student homework, teachers can then accurately design targeted exercises, thereby enhancing students' learning efficiency and forming a virtuous cycle of "assessment-driven instructional improvement". This enables homework to truly serve as a bidirectional vehicle for both student growth and teacher instructional enhancement.

5. Conclusion and Prospects

This study reconsiders the function of mathematics homework at the junior secondary level based on the concept of the integration of teaching, learning, and assessment. Using backward design as a methodological guide, it constructs a strategic framework for junior secondary mathematics homework design, supplemented by illustrative examples. The framework facilitates the transformation of homework from a tool for mechanical training into a vehicle for student development, providing an operable pathway to address the persistent problems of objective misalignment and assessment disconnect in traditional homework practices.

Future research should focus on applying this strategic framework in actual classroom settings, exploring its adaptability and feasibility across different grade levels, and further promoting the implementation of the integration of teaching, learning, and assessment in junior secondary mathematics homework design.

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