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The Effect of a Blended Learning Course on Chinese Seventh Graders' Mathematical Key Competences

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Abstract

This paper explores whether a blended learning course can foster students' mathematical key competences (MKC). MKC are the competences that students acquire to prepare for the future and the necessary mathematical literacy involved. Therefore, fostering students' MKC has become an important goal of mathematics education in China. With the advent of the digital era, traditional face-to-face teaching formats have been modified and gradually have been replaced by online and blended learning arrangements. How to benefit from the advantages of information technology to foster students' mathematical literacy has become an urgent problem to be solved. We applied MKC theory in blended learning to explore a new form of fostering students' mathematical literacy. This paper evaluates a blended learning course based on the theory of MKC, including online learning design and classroom learning. In a quasi experimental design, the study targeted 520 seventh-graders in nineteen classes in China. Data consisted of pre-test and post-test of students' MKC. The results show that students' MKC post-test scores improved significantly for the experimental group compared to the control group, with small but significant positive effects in the different dimensions of the MKC model.The learning effects proved to be different for the different dimensions of the MKC model. As a conclusion, blended learning arrangements seem to have a potential for fostering students' MKC.

Keywords: Blended learning; Mathematical key competences; Mathematical learning

Introduction

Mathematics is closely related to human development and social progress. Mathematical literacy helps people to understand the role of mathematics in the world and to make the reasonable judgments and decisions needed for a productive, committed and thoughtful citizen. The core literacy of mathematics is a comprehensive manifestation of thinking qualities, key competences, emotions, attitudes and values with basic characteristics of mathematics. The mathematical key competences (MKC) are the necessary competences that students acquire through mathematics learning, facing the future and supporting the development of mathematical literacy. Therefore, fostering students' MKC has become an important goal of mathematics education in China [1-3].

Information technology nowadays plays an important role in teaching and learning. In China, many research studies have been devoted to exploring the integration of information technology in mathematics education, and transforming the learning, teaching models, teaching environments and classroom teaching structures of traditional subject teaching. However, in the process of transforming teaching, we do not really know if and how we can foster MKC in mathematics education [4-7].

One way in which information technology may complement regular teaching is through blended learning. Blended learning refers to the combination of online learning and face-to-face learning, which integrates the best practices of traditional learning methods and those of online learning. In literature, the potential of blended learning is described as follows: (1) provide flexibility and convenience in the learning environment, (2) increase the learning level and success, (3) increase the retention level of knowledge, (4) increase the interest in learning, (5) increase the motivation for learning, (6) interaction, and (7) cost efficiency.However, much remains unknown on how to exploit the advantages of blended learning for the case of enhancing students' MKC [8-13].

The purpose of this study is to investigate if students' MKC can be fostered through blended learning. Therefore, the research questions of this study are:

1. What is the learning effect of a blended mathematics course on seventh grade Chinese students' MKC?
2. Are these learning effects different for the different dimensions of the MKC model?

Theoretical Background

Mathematical Key Competences

Mathematical key competences are the competences that are key in the knowledge and skills students should acquire through mathematical activity. Mathematical competence has become a focus in the field of mathematics education. Large-scale academic achievement tests such as TIMSS and PISA, as well as curriculum documents from various countries have put forward systematic standards and requirements for mathematical competence performance. TIMSS's mathematical competence test framework includes a content dimension and a cognitive dimension. The content dimension defines the specific content covered by the assessment; the cognitive dimension explains the competences that students need to solve the corresponding problem. The PISA 2012 expresses competences in terms of mathematical literacy including four dimensions: situation, content, process, and cognitive ability. In 2010, the United States Unified State Core Curriculum Standards proposed understanding, reasoning, questioning, modeling and eight other competence goals, and encouraged the development of a unified all-round student performance evaluation system. The Australian mathematics curriculum standard clearly stated the level of competence that should be achieved before the specific content standard description, including understanding, proficiency, and problem solving, and reasoning [14-17].

The above-mentioned research on mathematical competence distinguishes content attributes and process attributes (core knowledge, competence activities, cognitive level, etc.), and pays more attention to the former. It is common that mathematical competence is separated from knowledge and experience. Research of the integration, however, of knowledge and experience, connotative nature, thinking mechanisms and competence performance of mathematical competence, is still lacking. The mathematics teaching practice of performance evaluation and competence training has been disconnected.

To better connect the mathematical content and mathematical competences based on the specific cognition and specific activities of mathematics, the MKC model was developed in China. The MKC model is based on the research on the structure of mathematical competences, the systematic psychological analysis of the core knowledge activities and problem-solving activities of mathematics, and the comprehensive extraction and generalization of mathematical competence elements such as domestic and foreign curriculum standards, examination syllabus, and international large-scale academic achievement tests [18].

The MKC model includes three dimensions: mathematics learning and understanding, practical application, and innovation and transfer. First, mathematics learning and understanding refers to the process of students' memorization, generalization and connection involved in mathematics learning. Learning and understanding is the process of internalization of mathematical knowledge. Second, practical application refers to students using methods to complete simple tasks in a given mathematical situation, or extracting relevant knowledge analysis and interpretation problems in slightly more complex problem situations, extracting useful information and analyzing in redundant conditional situations and answer questions. In practical application, students show their knowledge. Third, innovation and transfer is a high-level cognitive process based on mathematics learning and understanding and practical application, and is also a high-level knowledge output process. Cognitive processes involving innovation usually require the cooperation of students' previous learning experiences. Furthermore, the MKC model divides each of the three main components into three sub-dimensions, shown in (Table 1).

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Code	MKC dimension	Code	Sub-dimension
A	Learning and understanding	A1	Recognition and recall
		A2	Calculation and operation
		A3	Explanation and communication
B	Practical and application	B1	Analysis and generalization
		B2	Reasoning and argumentation
		B3	Simple problem solving
C	Innovation and transfer	C1	Comprehensive application
		C2	Conjecture and discovery
		C3	Inquiry and modeling

Table 1: The MKC competences model

In the recent past, fostering of MKC was only done through classroom teaching. With the development of information technology, information technology has penetrated into learning and life of secondary school students. How to make full use of the advantages of technology for enhancing secondary school students' MKC has become an important question.

Blended Learning

Blended learning plays a leading role in teacher guidance, inspiration, and monitoring of the teaching process, and also fully reflects the initiative, enthusiasm and creativity of students as the main body of the learning process. Compared to pure face-to-face teaching and pure online learning, blended learning is an effective educational model. Blended learning can enhance effective communication between trainers and learners; strengthen effective cooperation between students; enhance the generation of new student-centered knowledge and interaction; strengthen flexible learning and teaching; combines appropriate technology and learning processes. Blended learning supports flexible learning at a self-set pace at any time and any place, and emphasizes constructive learning through social interaction. It can fully meet learner interactions in different time and space environments, thereby promoting the construction of knowledge and the construction of learner identity [19-23].

With the use of blended learning, students' academic achievement levels are expected to increase. When related literature is reviewed, studies are found that students trained in the blended learning environment are more successful than those trained in the traditional face-to-face teaching environment. However, empirical research on blended learning is currently focused on higher education. Empirical research on K–12 learners is in its infancy, and lacks high-quality research. Therefore, how to use the advantages of blended learning to cultivate students' MKC is worth further exploration [24].

Blended learning design based on MKC

Based on the theory of MKC and mathematical knowledge as a carrier, an index system of MKC is established, on the basis of which the blended learning course was designed.

The MKC index system

The index system consists of two parts, the mathematics part and the real MKC part. The mathematics part concerns mathematical knowledge. Mathematics knowledge is the foundation of MKC, and MKC cannot exist without mathematics knowledge and mathematics activity. Cognitive psychology research shows that the main reason why a person cannot think and solve problems mathematically is the lack of necessary mathematical knowledge.

According to the essential characteristics of the mathematics discipline, the test content of the international evaluation project and the specific requirements in "Compulsory Education Mathematics Curriculum Standards (2011 Edition)", the mathematics knowledge which secondary school students (aged 12-14) learn is carried out within differentdomains (as shown in Table 2): On the first level, there are three major knowledge topics: number and algebra, graphics and geometry, statistics and probability. On the secondlevel, there are seven knowledge topics: numbers and expressions, equations and inequalities, functions, characteristics of graphs, changes in graphs, sampling and data analysis, probability of events. On the third level, there are 38 knowledge topics (core concepts). For example, 'number and algebra' includes: numbers and expressions, equations and inequalities, functions. Numbers and expressionsincludes seven core concepts as follows: rational number, real number, integer and its addition and subtraction, multiplication of integer, factorization, fraction, quadratic root [25].

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Firstlevel (Domain)	Secondlevel (Sub-domain)	Third level (Core concepts)
Number and Algebra	Numbers and expressions	Rational number
		Real number
		Integer and its addition and subtraction
		Multiplication of integer
		Factorization
		Fraction
		Quadratic root
	Equations and inequalities	One-dimensional linear equations
		Two-dimensional linear equations
		One-dimensional linear inequalities
		One-dimensional quadratic equation applications
	Functions	The relationship between variables
		Linear function
		Quadratic function
		Inverse function

Table 2: Mathematics knowledge domains for 12-14-year-old students in China

Mathematics knowledge is considered the carrier of MKC, and the index system of MKC provides refined reference standards for students to learn mathematics knowledge. The index system of MKC is shown in Table 3, with the core concept of factorization as an example.

MKC Sub-dimension	Code	Learning performance indicator
A1	A1-1	Able to recognize'a^2- b^2'type factor.
	A1-2	Able to recognize the'a^2+2ab+b^2'type factor.
A2	A2-1	Will use the factorization method for factoring.
	A2-2	Will use the formula method for factorization.
A3	A3-1	Can explain the rationality of extracting common factors…
	A3-2	Can explain the rationality of the factorization of …
	A3-3	Can give an example to illustrate the relationship between …
B1	B1-1	Can summarize the conditions or steps of extracting common …
	B1-2	Can summarize the conditions or steps of factoring using…
B2	B2-1	Can summarize the law of deformation of multiple …
B3	B3-1	Can directly use the common factor extraction method for factorization in specific problems.
	B3-2	Able to use the formula method for factorization directly in …
C1	C1-1	Can comprehensively use the extraction common factor …
	C1-2	Able to solve problems such as fractions and quadratic …
C2	C2-1	Can use the knowledge of factorization to guess the law …
C3	C3-1	Able to explore other methods of factorization and explain…

Table 3: The MKC index system for the topic of factorization

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In the index system of 'Factorization' there are nine sub-dimensions of MKC. On different levels, there are special learning performance indexes. At the A1 level, there are two learning performance indicators A1-1 (Able to recognize an 'a^2- b^2'type factor) and A1-2 (Able to recognize the'a^2+2ab+b^2' type factor).

The MKC index system informs the design of an assessment tool (pre-test and post-test) and online resources (micro-video and micro-test).Compared with normal video, the duration of micro-video is between 5-15 minutes. The micro-test includes several questions which were developed by researchers, based on the sub-dimensions of MKC.

Design principles for a MKC-based blended course

The design of a blended course can be based on the MKC in different ways. First, develop assessment tools based on the MKC index system, including pre-test, post-test and online micro-test, to diagnose students' performance of MKC. The pre-test and post-test focus on students' overall performance, the micro-test focuses on students'performanceon special core concept learning. Second, develop micro-videos based on the MKC index system. Micro-videos are developed according to learning performance indicators. One learning performance indicator has one micro-video.Taking the core concept of factorization as an example, it has sixteen learning performance indicators (see Table3), so there are at least sixteen videos about factorization. Third, the index system provides a reference for teachers to design classroom teaching goals. Following thesystem, teachers can effectively grasp the teaching objectives, and use them to design and carry out classroom teaching. The index system makes teachers' teaching more directional.

The design of blended learning that is based on MKC includes online learning and classroom teaching. First, the design of online learning based on MKC made use of the Smart Learning Partner platform (SLP, http://slp.bnu.edu.cn/). SLP is a platform on which students learn micro-videos and do micro-test based on MKC. When students study, their learning records are immediately saved on the platform. Students first watch micro-videos, then do a micro-test to diagnose MKC, and finally watch the corresponding micro-videos based on weak learning performance indicators. Second, the design of classroom teaching based on MKC. The teacher first determines the classroom teaching goals based on MKC; then designs classroom teaching activities based on students' performance of the MKC and online learning performance; finally, implements classroom teaching.

Methods

In the study, we first designed a blended learning course for seventh grade based on MKC, then implemented the course, and finally analyzed the effect of this teaching design and the learning effects of different dimensions of the MKC model after the course. This study employed an untreated control group design with pre- and post-tests.

To evaluate the learning effect, our design was based on the students' pre-test and post-testperformance. The tests were developed based on the MKC indicator system. The pre-test involved elementary school mathematics and the post-test included all core concepts in seventh grade.Quantitative research was used in this study.

Participants

The participants in this study were 520 seventh grade students (12–13 years old, in nineteen different classes) from fivesecondary schools in Beijing, China. Nine classes of 249 students acted as the experimental group, andanother ten classes of 271 students acted as the control group. A pre-test was administered before the experimental instruction, followed by a post-test. The design of blended learning based on MKC was implemented in the experimental group. The traditional teaching method was used in the control group.

Implementation of blended learning based on MKC

We take the notion of parallelogram as an example to explain the implementation of blended learning based on MKC. First, pre-test data were collected to understand the starting level of the students. Through the analysis of the pre-test data, the teacher became aware that the students' competences A and B were weaker than the school average, and they needed to pay special attention to these in the teaching. Further, according to the teaching content, through communication with the teacher, it is determined that the key points for the parallelogram before the class to conduct micro-test.

Second, teaching goals were determined, based on micro-test data. Through a micro-test, we foundthat the students' average A1 score rate was 0.89, 0.81 for A2, and 0.56 for B3. The teaching goals include: understand and master the decision theorem of parallelogram; develop students' intuitive literacy and reasoning ability; cultivate students' awareness of cooperative learning and innovation.

Third, the teacher designed key teaching activities based on the above analyse. At first, the teacher reviewed what kind of quadrilateral a parallelogram is, and consolidated the old knowledge. Then the teacher supported method exploration. Students used hands to draw pictures, and explored judgment methods. Finally, the teacher set open-ended questions to divert students'thinking.

Lastly, learning was consolidated based on micro-videos after class. After the lesson, based on the pre-test index parallelogram A1-3, ruler drawing A2-1, A2-4, B3-7, the teacher recommended the micro-videos under the corresponding index for students to further consolidate.

Data collection and data analysis

The MKC test design

The MKC test was developed by researchers as an instrument to measure students' MKC. The test covers different dimensions of MKC.

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In total, twenty-five items were pre-tested, including multiple choice questions, fill-in-the-blank questions and answer questions.Fourteen questions at A1-A3 level, seven questions at B1-B3 level, and four questions at C1-C3 level were presented. Similarly, thirty items were post-tested.Fifteen questions at A1-A3 level, nine questions at B1-B3 level, and six questions at C1-C3 level were presented. Appendices 1 and 2 show the item-domain matrix for pre- and post-test, and Appendix 3 shows some exemplary test items.

A panel of researchers and schoolteachers who had experience teaching mathematics constructed and reviewed the items to ensure the content validity, clarity, and grade-level appropriateness of the assessment instrument in the local context. Both the pre-test and post-test were examined for reliability using Cronbach's Alpha (α = 0.86 and 0.93, respectively). The examination time was 90 minutes. The exam scores were collected and used to evaluate students' MKC in the learning process.

Data analysis

All quantitative statistical analyses were conducted using SPSS. Descriptive statistics were obtained, and independent sample *t*-test was conducted on the scores from the MKC tests. Before the *t*-test analyses, assumptions of parametric statistics were tested visually, numerically, and statistically. In the *t*-test analysis, post-test scores of the tests were used as the dependent variables. After analyzing and comparing the differences of each group using Cohen's *d* test, the validity of the experimental results was verified.

Results

Students' learning effect

Select mathematics score as the index to examine MKC. Because the students are divided into two groups: an experimental group and a control group to compare, the independent sample *t*-test method is used. The results are shown in Table 4.

	Condition	Number (N)	Mean (M)	Standard deviation (S)	*t*-value	*p*-value (sig.)
Pretest	Experimental	249	66.09	20.37	0.043	0.966
	Control	271	66.01	19.42		
Posttest	Experimental	249	70.38	22.49	2.467	0.014
	Control	271	65.54	22.22		

Table 4: Results of *t*-test for the difference in MKC between the experimental group and control group

The results of a *t*-test showed that there were no statistically significant differences on pre-test scores of MKC between the experimental group (M = 66.09, SD = 20.37) and the control group (M = 66.01, SD = 19.42) , $t(519) = 0.043$, $p > .05$.Therefore, these results indicate that students in both the experimental and control group had similar pre-test scores in MKC.

As displayed in Table 4, the students in the experimental group, who were taught with blended learning, had a higher MKC post-test score (M=70.38, S=22.49) than students in the control group, who were taught by conventional learning (M=65.54, S=22.22). To answer the first research question "What is the learning effect of a blended mathematics course on seventh grade Chinese students' MKC?" we calculated the post-test score of both groups by using a *t*-test as displayed in Table 4. As shown there, the test is significant at 0.05 level. This means that there is a significant difference in MKC between the two groups. This result indicates that there is an effect of a blended mathematics course on seventh grade Chinese students' MKC. Although the average scores for the pre-test were similar between the experimental group and the control group, the post-test scores showed that the experimental group improved significantly compared to the control group.

The effect size d in our study is 0.22.As a randomized quasi-experiment, the effect size in our study is lower than the average (0.24). As a large study with sample size greater than 250, the effect size in our study is higher than the average (0.12). As a secondary study, the effect size in our study is higher than the average (0.13). As supplemental CAI technology, the effect size in our study is higher than the average (0.18) [26].

Students' learning effects of different dimensions of the MKC

Through blended learning, the MKC score of the experimental group students has improved significantly. To determine whether all parts of the MKC for students have improved, or whether only some parts have improved, we have made a further analysis.

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	Condition	Number (N)	Mean (M)	Standard deviation (S)	*t*-value	*p*-value (sig.)
Pretest	Experimental	249	35.85	11.35	0.061	0.951
	Control	271	35.79	10.92		
Posttest	Experimental	249	40.02	11.08	2.359	0.019
	Control	271	37.74	10.97		

Table 5: Results of *t*-test for the difference in dimension A between the experimental group and control group

The results of a *t*-test showed that there were no statistically significant differences on pre-test scores of dimension A between the experimental group (M=35.85, S=11.35) and the control group (M=35.79, S=10.92), $t(519) = 0.061$, $p>.05$. Therefore, these results indicate that students in both the experimental and control group had similar pre-test scores in dimension A. As shown in Table 5, the students in the experimental group had a higher post-test score in dimension A (M=40.02, S=11.08) than students in the control group (M=37.74, S=10.97). The obtained p (.019) is smaller than 0.05, which means the test is significant. This result indicates that the experimental group improved significantly compared to the control group in dimension A.

Similarly, we found that there were no statistically significant differences on pre-test scores of dimension B between the experimental group (M=18.31, S=5.11) and the control group (M=18.34, S=4.87), $t(519) = -0.051$, $p>.05$. There were no statistically significant differences on pre-test scores of dimension C between the experimental group (M=11.92, S=6.14) and the control group (M=11.89, S=6.09), $t\ (519) = 0.071$, $p>.05$. In the post-test, we found that there were statistically significant differences on dimension B between the experimental group (M=19.98, S=7.87) and the control group (M=18.55, S=7.87), $t(519) = 2.065$, $p<.05$. There were statistically significant differences on dimension C between the experimental group (M=10.38, S=4.80) and the control group (M=9.25, S=4.80), $t\ (519) = 2.683$, $p<.05$.

Students' learning effects of sub-dimensions of the MKC

As shown in Table 1, the sub-dimension of MKC includes nine parts. We have made further analysis on whether all parts of the MKC sub-dimensions for students have changed.

The results of a *t*-test showed that there were no statistically significant differences on pre-test scores of all parts between the experimental group and the control group. In the post-test, we found that there were statistically significant differences on sub-dimension A1, $t(519) = 3.416$, $p<.05$, A2, $t(519) = 2.030$, $p<.05$,B3, $t(519) = 2.574$, $p<.05$, and C1, $t(519) = 3.052$, $p<.05$. This result indicates that the experimental group improved significantly compared to the control group in sub-dimension A1, A2, B3 and C1.Similarly, in the post-test, we found that there were no statistically significant differences on other sub-dimensions.

Conclusion and Discussion

In this study, we explored fostering students' MKC through a blended learning course. We addressed the questions on (1) the learning effect of a blended mathematics course on seventh grade Chinese students' MKC, and (2) the learning effects of different dimensions of the MKC model. To answer these questions, we designed and implemented a blended learning course based on MKC, and then analyzed the effect of this teaching design in an experimental study with 520 seventh grade students, and finally analyzed students' learning effects in different dimensions and sub-dimensions of MKC.

In answering the first research question, we designed the experimental group and the control group. First, the two groups were pre-tested. The pre-test can clarify the MKC performance of the two groups of students, and lay the foundation for future data analysis. Then, in the nine classes in the experimental group, we implemented a blended learning design based on MKC, and the control group (ten classes) received traditional classroom teaching. After the experiment, we conducted a post-test on the two groups and observed the MKC performance of the two groups of students. We took the student's MKC performance as the dependent variable and the group as the independent variable, and conducted an independent sample *t*-test to observe whether the two groups of students had different MKC after the course; further, we calculated the effect of the experiment. Finally, we came to the following conclusion：The MKC scores for the pre-test were similar between the experimental group and the control group, but the post-test scores showed that the experimental group improved significantly compared to the control group, with a positive, but small effect.

In answering the second research question, we analyzed the learning effects of different dimensions of the MKC model. Through an independent sample *t*-test, we found that there were no statistically significant differences on pre-test scores for dimension A, B, and C between the experimental group and the control group. In the post-test, we found that there were statistically significant differences for each dimension. Then, we analyzed students' learning effects in sub-dimensions of MKC. Through an independent sample *t*-test, we found that there were no statistically significant differences on pre-test scores of nine parts between the experimental group and the control group. In the post-test, we found that there were statistically significant differences on sub-dimension A1, A2, B3 and C1, but there were no statistically significant differences on other sub-dimensions. Finally, we conclude that the experimental group improved significantly compared to the control group in dimension A, B and C, and in sub-dimensions A1, A2, B3 and C1.

The study has its own limitations. First, our study is a quasi-experimental research, the sample could not be drawn randomly. Second, it was conducted in one city in China. Third, the instruments which evaluated students' MKC were developed by the researcher. In actual teaching, although the classes of the control group used traditional classroom teaching, now that information technology is so widespread, students will already make some use of certain information technology.

If we reflect on these findings, the positive results of the blended approach to seventh grade Chinese students' MKC are in line with findings from literature. For instance, researchers have found that the blended learning method is more effective in terms of academic achievement than traditional methods. The reason may be that in traditional classroom teaching, especially in large-scale teaching with class sizes of 40 as is the case in China, students learn under the guidance of teachers, and the learning rhythm of all students is equal. However, traditional classroom teaching is less able to do justice to individual learning differences among students. In MKC-based blended learning, students learn targeted network resources based on micro-test diagnosis; teachers design and conduct teaching according to students' online performance data and students' MKC development rules, to a great extent, promote students' personalized learning. In addition, students can study independently without the constraints of time and space [27,28].

We found that the students' MKC scores significantly improved after blended learning, and this improvement occurred in dimensions A, B and C. As a possible explanation, blended learning provides students with more learning options and can help students solve problems better in real life. Blended learning may be an effective way to promote students' MKC. This topic deserves more attention in future design and research on blended learning.

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Appendices

Appendix 1: Item-MKC distribution in Pre-test

Item	Dimensions of MKC		
	A1-A3	B1-B3	C1-C3
1	×		
2	×		
3	×		
4	×		
5		×	
6	×		
7		×	
8		×	
9	×		
10		×	
11	×		
12		×	
13	×		
14		×	
15	×		
16	×		
17	×		
18			×
19	×		
20	×		
21		×	
22			×
23			×
24	×		
25			×

Appendix 2: Item-MKC distribution in Post-test

Item	Dimensions of MKC		
	A1-A3	B1-B3	C1-C3
1	×		
2	×		
3	×		
4	×		
5	×		
6	×		
7	×		
8			×

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9	×		
10		×	
11	×		
12	×		
13	×		
14	×		
15	×		
16			×
17		×	
18		×	
19		×	
20			×
21	×		
22	×		
23		×	
24			×
25		×	
26		×	
27		×	
28		×	
29			×
30			×

Appendix 3: Exemplary Test Items

[Pre-test] Item 4: In an isosceles triangle, the ratio of the degrees of two internal angles is 2:5. Its three internal angles may be (   ).

A. 30°, 30°, 120°B. 50°, 50°, 80°C. 75°, 75°, 30°D. 80°, 80°, 20°

Dimensions: A2-1 the property theorem and judgment theorem of isosceles triangle can be used for simple calculation of angle and side length.

[Pre-test] Item 8: The height of a cylinder is 10 decimeters, and the bottom area is 6.28 square decimeters. After cutting it into two similar small cylinders, the surface area is increased by ____square decimeters.

Dimensions: B2-1 drawing conclusions through spatial imagination in the geometry.

[Pre-test] Item 22: Three road repair teams, A, B, and C, completed a road together. When completing the task, Captain A said: “We have completed half of all the tasks.” Captain B said: “We have repaired 120 meters.” Captain C said: “We have undertaken 30% of the total length.” Please calculate how long this road is.

Dimensions: C2-1 exploring the implicit equivalence relations or laws in the questions, formulating equations to solve specific problems.

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