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TEACHING PROCESS OF A RIGHT PRISM IN GRADE 7 TO DEVELOP MATHEMATICAL COMMUNICATION COMPETENCE FOR STUDENTS

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Abstract. In the 2018 Mathematics General Curriculum, the content of mathematics is integrated into three branches of knowledge: numbers, algebra, and elements of analysis; geometry and measurement; and statistics and probability. In grade 7, geometry and measurement focus on shapes in practical contexts. Moreover, mathematical communication competence is one of the core competencies outlined in the 2018 Mathematics General Curriculum. This article introduces a method for developing students' mathematical communication competence through lessons on triangular and quadrilateral right prisms in grade 7. The study involves designing a math teaching process comprising four phases: Phase 1: Students work individually to answer Worksheet 1; Phase 2: Students work in pairs to answer Worksheet 2 (identical in content to Worksheet 1); Phase 3: Students work in groups of four to answer Worksheet 3 (identical in content to Worksheets 1 and 2); Phase 4: Students apply the knowledge from the previous phases to create a vertical prism with a known base and height by individually answering Worksheet 4 (similar in content to Worksheet 1). Data, including recordings and answer sheets, were collected from 11 grade 7 students. The data was analyzed quantitatively and qualitatively to assess the development of students' communication skills. The research findings demonstrate that this method is an effective teaching process. It not only helps students solve problems but also enhances their communication competence. Students learn to observe and draw a plane shape of a prism on A4 paper, cut out the shape, and fold it to create a vertical prism.

***Keywords**:* right prism, competence, mathematical communication competence, students.

1. Introduction

In the 2018 Mathematical General Education Program, the content of grade 7 mathematics underwent significant changes in the Geometry and Measurement section. Previously, 7th-grade math focused on plane geometry. Math 7, Episode 1, introduced perpendicular lines, parallel lines, and triangles, while Episode 2 covered the relationships among elements in a triangle and the concurrent lines of a triangle. In contrast, the current Math 7 curriculum dedicates Chapter 3 in Episode 1 to practical shapes such as rectangular prisms, cube prisms, triangular prisms, and quadrilateral right prisms. It also addresses triangles and the relationships among their elements. Thus, the 2018 curriculum emphasizes spatial geometry and the creation of 3D figures from flat shapes.

In Vietnam, several research studies have focused on teaching mathematics to develop students' mathematical communication competence (Hoa Anh Tuong, 2014; Vu Thi Binh, 2016) [1], [2].

These studies employed open-ended problems, lesson studies, and mathematical representations to enhance students' written mathematical communication skills. Another study by Uyen et al. (2021) focused on developing the mathematical communication abilities of 8th graders learning congruent triangles. This study emphasized three factors: mathematical vocabulary, mathematical representation, and explanatory reasoning [3]. The most recent research by Nguyen Ai Quoc (2022) explored the use of scientific debate as a teaching method to develop components of students' mathematical communication competence [4].

Internationally, Ping (2001) [5] and Chisu (2016) [6] utilized lesson study to examine the role of verbal communication in assessing students' mathematical understanding. Kilpatrick et al. (2005) [7] investigated communication and the construction of mathematical meaning through mathematical software. Haji and Ilham (2016) [8] explored students' communication abilities in solving practical problems.

Although there are numerous studies on developing students' mathematical communication skills, research addressing the development of these skills during the transition from plane geometry to spatial geometry in the new 7th-grade mathematics program remains unexplored.

In this study, we present a theoretical synthesis of communication, mathematical communication, and mathematical communication competence. Subsequently, we propose a process for teaching mathematics that aims to develop students' mathematical communication abilities, applying this process to a right prism lesson in grade 7. The experimental results validate the effectiveness of the proposed teaching process, aligning with the goal of enhancing students' quality and competence.

2. Content

2.1. Mathematical communication and mathematical communication competence

2.1.1. Communication concept

The term "communication" originates from the Latin word communicare, meaning "to share" or "to make known" (Cherry, 1978) [9]. According to the Oxford Dictionary, communication is defined as the activity or process of expressing ideas, feelings, or providing information to others (Wehmeier et al., 1997) [10, p. 291]. From a psychological perspective, communication is an interactive process between individuals that establishes psychological contact, enabling the exchange of information and emotions, mutual perception, and influence (Nguyen Xuan Thuc et al., 2017) [11, p. 56-57].

2.1.2. Mathematical communication

In their work, NCTM (2000) introduces the topic of communication as follows: "Communication is an essential part of mathematics and mathematics education. It is a way of sharing ideas and clarifying understanding. Through communication, ideas become objects for reflection, refinement, discussion, and amendment. The communication process also helps build meaning and permanence for ideas and makes them public" [12, p. 60].

In mathematics education, "Teachers must help students clarify their statements, focus carefully on problem conditions and mathematical explanations, and refine their ideas" (NCTM, 2000, p. 351). Teachers should provide opportunities for students to discuss mathematical ideas and listen to their peers, as this enhances their understanding of mathematical problems. Consequently, the goals of learning mathematics include developing the ability to: (1) solve mathematical problems, (2) communicate mathematical ideas, (3) reason and prove mathematically, (4) make mathematical connections, and (5) create mathematical representations (NCTM, 2003) [13].

Emori (2008) [14] suggests that mathematical communication, in its narrow sense, encompasses listening, speaking, reading, and writing about mathematics. In its broader sense, mathematical communication includes listening, speaking, reading, writing, problem-solving, argumentation, and making connections in teaching mathematics [14, p. 74]. In this study, we adopt Emori's broader perspective, where reasoning and problem-solving are regarded as essential components of mathematical communication. Writing and discussion are two critical elements of mathematical communication. Writing is viewed as a means for individuals to think, explain mathematical ideas in detail, and develop problem-solving strategies. Similarly, discussion among students facilitates the process of thinking and verbalizing their mathematical understanding.

2.1.3. Mathematical communication competence

One of the standards for designing programs and organizing math learning activities, as outlined by NCTM (2000), is the promotion of mathematical communication. The math curriculum should be structured to ensure that every student has the opportunity in order to

- Organize and consolidate their mathematical thinking through communication;
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
- Analyze and evaluate the mathematical thinking and strategies of others;
- Use the language of mathematics to express mathematical ideas precisely.

According to NCTM (2000), mathematical communication competence refers to students' ability to present, express, explain, and share mathematical content, as well as their ability to receive the presentation, expression, explanation, and sharing of mathematical content.

The general education program in mathematics defines four components of students' ability to communicate mathematically: (1) The ability to listen, understand, read, and record mathematical information; (2) The ability to present and express ideas; (3) The ability to use mathematical and natural language effectively; and (4) Confidence in communication.

The 2018 general education program in mathematics further describes mathematical competence using terms such as listening comprehension, reading comprehension, recording information, presenting and expressing ideas (both orally and in writing), and effectively using language to present, explain, and evaluate mathematical concepts (Do Duc Thai, et al., 2020) [15, p. 16].

2.2. Mathematics teaching process to develop students' mathematical communication competence

Drawing from various effective math teaching processes aimed at deepening students' understanding of mathematical concepts, such as the teaching process of Arsac et al. (1992) [16], the ACODESA teaching process by Hitt and González-Martín (2015) [17], and the teaching process incorporating a scientific debate phase to enhance students' mathematical competence by Vuong Vinh Phat (2021) [18], we propose a teaching process focused on developing students' mathematical communication capacity as follows:

Stage 1: Individual work.

Each student is given Worksheet 1 and answers the questions independently.

Stage 2: Working in pairs.

Students are randomly grouped into pairs (or occasionally groups of three) to answer questions collaboratively. Each pair is given Worksheet 2, which contains the same content as Worksheet 1.

Stage 3: Working in groups of four.

Students are randomly grouped into teams of four (or occasionally three or five) to answer the questions collaboratively. Each group is given Worksheet 3, which contains the same content as Worksheet 1. The results from Stages 2 and 3 provide opportunities for teachers to evaluate students' verbal communication competence.

Stage 4: Apply knowledge.

At this stage, the teacher assigns students an individual problem in class. This problem is similar to those in Stages 1, 2, and 3. The purpose is to allow students to reapply their knowledge, consolidate their understanding, and deepen their grasp of mathematical concepts. This activity also enables teachers to analyze and evaluate students' written mathematical communication competence.

This process is similar to previous teaching processes in Stages 1, 2, and 4 but differs in Stage 3, where the focus shifts from scientific debate to student discussion.

2.3. Teaching the illustration of "Triangle right prism and quadrilateral right prism" (Math 7, episode 1) to develop mathematical communication ability for students

2.3.1. Triangle right prism and quadrilateral right prism

In the 2018 Mathematical General Education Program, the Geometry and Measurement section for grade 7 is presented in Chapter 3: Real-life Shapes, and Chapter 4: Parallel Angles and Lines. The content of Chapter 3 includes concepts related to rectangular solids, cubes, triangular right prisms, and quadrilateral right prisms, focusing on calculating their surface area and volume.

In Textbook of Mathematics 7, Volume 1 (Tran Nam Dung et al., 2022) [19, p. 56-57], there is a mathematical activity titled "Creating a triangular right prism and a quadrilateral right prism". The activity consists of the following steps: Step 1. On a piece of cardboard (or A4 paper), draw a flat layout of the right prism; Step 2. Cut out the cardboard layout and fold it to form a vertical prism.

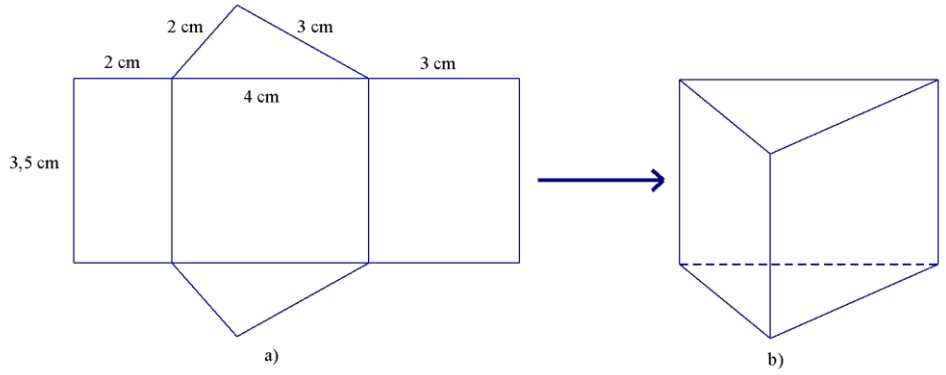


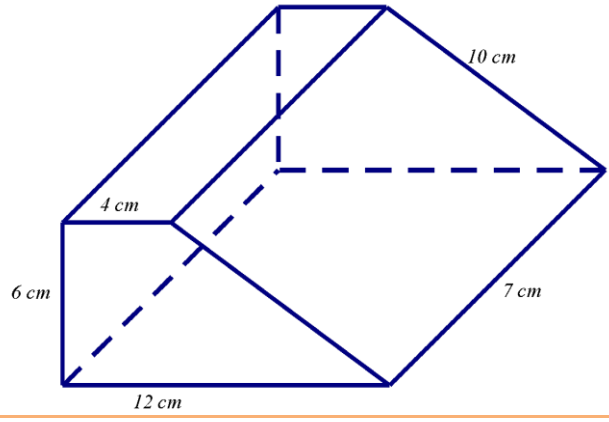
Figure 1. Triangular right prism

Experimental content

Stage 1: Students work individually to answer the questions in worksheet No. 1. Time: 15 minutes.

WORKSHEET NUMBER 1

Problem: Create a quadrilateral right prism with measurements as shown in Figure. Calculate the height and area of the base of the prism.



Stage 2: Students work in pairs. Each group of two students is randomly selected to answer the question in worksheet No. 2. The content of the question in sheet 2 is the same as in sheet 1. Time: 15 minutes. When students discuss and answer questions, the teacher records the discussion process for each group.

Stage 3: Students work in groups of four. Each group has four students randomly selected to answer the question in worksheet 3. The content of the question in sheet 3 is the same as in sheet 1. The time: 15 minutes. When students discuss and answer questions, the teacher records the discussion process for each group.

Stage 4: Students work individually to answer the questions in worksheet No. 4. Time: 20 minutes.

WORKSHEET NUMBER 4

Problem: Create a triangular prism whose base is an isosceles triangle with three sides of 5 cm, 4 cm, and 4 cm and a height of 6 cm, respectively.

2.3.2. Respondents and research tools

** Respondents*

The experiment was conducted during the first semester of the 2022–2023 academic year. The experimental group consisted of 11 grade 7 students who were randomly selected from a secondary school. These students are labeled HS1, HS2,..., and HS11. In Stage 2, the pairs were designated as N1, N2, N3, N4, and N5. In Stage 3, the groups of four were labeled G1, G2, and G3.

** Research tools*

The research tools included students' worksheets and audio recordings of their discussions.

2.3.4. Methods of data collection, data analysis, and results evaluation

The collected data included audio recordings and individual answer sheets from students in Stages 1, 2, 3, and 4. Based on this data, we assessed students' mathematical communication abilities as follows:

- Scoring students' individual work in Stages 1 and 4 and comparing these results.

- Comparing the results of individual work (Stage 1) with group work (Stages 2 and 3).

This quantitative assessment focused on students' written communication abilities, with initial results indicating the development of their mathematical communication skills.

- Analyzing the development of students' verbal communication skills in Stage 2 (pair work) and Stage 3 (group work).

2.4. Experimental results

2.4.1. Quantitative assessment

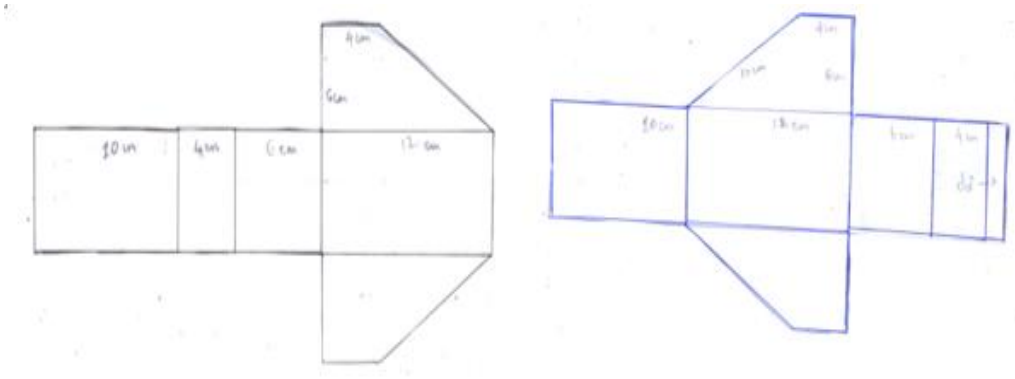
After conducting experiments with 11 grade 7 students, the teacher collected their submissions from Stages 1, 2, 3, and 4. The teacher graded the students' work from each stage using pre-prepared answer keys. Detailed measurements were required to determine whether the students were performing correctly. The results of the students' work on creating vertical prisms in Stages 1 and 4 are presented in Table 1.

Table 1. Distribution of scores of students' mathematical communication abilities in written language

Student	Stage 1	Stage 4
1	F	F
2	T	F
3	F	F
4	T	T
5	T	T
6	T	T
7	F	T
8	F	T
9	F	F
10	F	T
11	F	F
Sum	True 4/11 (36,4%)	True 6/11 (54,5%)

Since the problem in Stage 4 (Worksheet 4) is similar to the problem in Stage 1 (Worksheet 1), the results in Table 1 indicate that the number of students who successfully created a right prism increased from 36.4% to 54.5%. HS7, HS8, and HS10 initially answered the problem in Worksheet 1 incorrectly but, through discussions with their peers in Stages 2 and 3, they understood the problem and correctly answered the question in Worksheet 4. This demonstrates that, through mathematical communication, the students developed a deeper understanding of the concept and learned how to create the right prism.

The teacher measured the edges and labeled them with dimensions such as 10 cm, 4 cm, 6 cm, and 12 cm on the diagram. The teacher then folded the diagram to confirm whether the resulting prism matched the required specifications. In Figure 2, HS6 answered correctly, while HS11 drew a rectangle representing the side face.



HS6 HS11

Figure 2. Work of student 6 and student 11

For stages 1, 2, and 3, results of individual work (stage 1: 11 students), of 5 groups in pairs (stage 2: group 1-4 each group of 2 students, group 5 has 3 students), of 3 groups (stage 3: group 1, 2 each group has 4 students, group 5 has 3 students). The obtained results are described in Table 2.

Table 2. Students' individual and group work results

Stage	Correct answer result	Percentage of correct answers
Stage 1	True 4/11 students	36.4%
Stage 2	True 4/5 groups	80%
Stage 3	True 3/3 groups	100%

Through group discussion, students' results improved significantly, increasing from 36.4% correct answers to 80%. However, an additional stage of group discussion is necessary to ensure that students' results are entirely correct (100%). This outcome supports the conclusion that the proposed teaching process is initially effective for teaching mathematics in general and standing prisms in 7th grade in particular, with a focus on developing students' mathematical communication abilities.

Additionally, in Stage 1, 54.5% of students correctly identified the height (7 cm), and 27.3% correctly calculated the surface area of the right prism (48 cm^2). By Stage 3, 100% of students correctly identified the height, and 66.7% correctly calculated the area of the base surface. However, some students still misunderstood that the base of the prism is a square trapezoid (Figure 3).

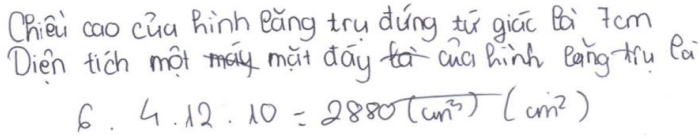


Figure 3. Group 3 work, stage 3

2.4.2. Qualitative assessment

We rely on stages 2 and 3 to assess students' verbal communication competence. Here, we choose HS5 to evaluate verbal communication competence. The reason we chose this student is that he has good arguments and explanations when discussing.

The content of the group discussion is presented in Table 3.

Table 3. The results of HS5 and HS7 in stage 2

Row	Students	Discussion content
1	S5	To answer the question, we need to draw a plane shape, and then cut it.
2	S7	Which one is the base surface?
3	S5	Select the bottom face to be a trapezoid. I draw four rectangles first.
4	S7	Let me try drawing it.
5	S5	The data should be scaled smaller.
6	S7	What do you mean?
7	S5	I don't divide it into very large numbers. Now draw two more trapezoids at the bottom.
8	S7	Let me try drawing it; I don't know if I'm drawing it right.

In stage 1, HS5 has not yet created the required right prism. By stage 2 (Table 3), HS5 had the right ideas, but the pairs still did not answer the question correctly (Figure 4).

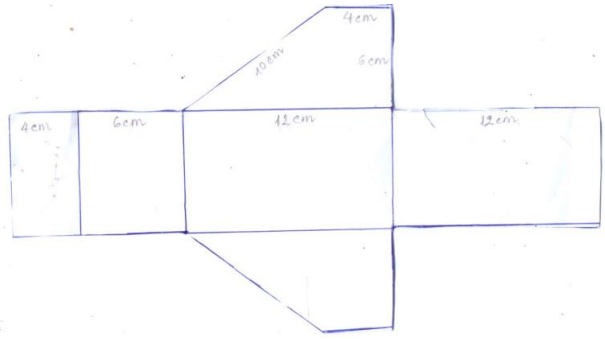


Figure 4. Group two's work: HS5 and HS7

The content of the discussion in group four is presented in Table 4.

Table 4. The results of group G1 in stage 3

Row	Students	Discussion content
1	S5	Who will draw the shape?
2	S1	Let me draw. I've seen this shape many times.
3	S5	Leave the paper right; draw right in the middle of the rectangles.
4	S9	How to draw?
5	S5	Draw four rectangles with lengths of 4 cm, 6 cm, 12 cm, and 10 cm, with the remaining side being 7 cm. Draw four rectangles with lengths of 4 cm, 6 cm, 12 cm, and 10 cm, and the remaining side is 7 cm.
6	S2	Measure again to see if it's correct.
7	S1	I drew it; you guys cut this shape.
8	S5	Stand up and fold.
9	S2	This shape is correct. So the height is 7 cm, and the area of one side is the area of a trapezoid of $48cm^2$.

In stage 3, HS5 belongs to group G1. Group G1 answered the question correctly (Figure 5).

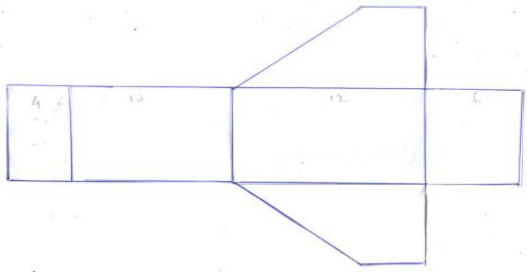


Figure 5. Work from group G1 – S1, S2, S5, and S9

During the discussion, HS5 accurately identified the lengths of the rectangles and trapezoids needed to draw, cut, and fold the shape. As a result, through Stages 1, 2, and 3, HS5 made significant progress and completed the task. The discussion activities in stages 2 and 3 helped students self-correct their knowledge and effectively solve problems.

3. Conclusions

Mathematical communication competence is one of the core mathematical competencies outlined in the 2018 Mathematics General Curriculum. The development of this competency is emphasized through interaction with others, guided by discussion and debate activities (Ministry of Education and Training, 2018) [20, p. 13-14].

In this study, we explored the role of mathematical communication in teaching mathematics, analyzed students' mathematical communication skills, and examined teaching processes aimed at developing students' communication competence. Based on this, we designed and implemented a teaching process for prisms in grade 7 to enhance students' communication skills. The research results indicate that this is an effective teaching process, as it not only helps students solve problems but also develops their communication competence. Students demonstrated the ability to observe and draw the plane shape of a prism on A4 paper, cut out the shape, and fold it to create a vertical prism.

However, this research has some limitations. First, we have not conducted experiments with a full class or multiple classes, as recording and processing data to evaluate students' verbal communication skills remain challenging. Second, we have not applied this teaching process to other mathematical topics. Moving forward, the next step is to apply this teaching process to teaching angles and distances in 11th-grade spatial geometry and to expand the research to include experiments in a full class or multiple classes.

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