

PRESERVICE TEACHERS' PERCEPTIONS OF LARGE-SCALE INSTRUCTIONAL UNITS IN MATHEMATICS EDUCATION

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Abstract

While Large-Scale Instructional Units in Mathematics Education benefit students' core competencies, in-service teachers' professional capabilities, and preservice teachers' higher-order thinking, research on this construct remains scarce. Most preservice and in-service teachers lack in-depth understanding of these units, with some unaware underscoring the urgency of investigating Preservice Teachers' Perceptions of Large-Scale Instructional Units in Mathematics Education, as such perceptions shape the units' classroom implementation. This study explores preservice mathematics teachers' perceptions of these units via a questionnaire survey, with participants from over ten universities (e.g., Guangxi Normal University, Chongqing Normal University). Using data from more than 400 valid questionnaires, it identifies their knowledge levels and internal recognition of the units, analyzes their views on the units' learning and practical value, and synthesizes strategies for learning and disseminating the units. Key findings reveal 69% of the preservice teachers have limited knowledge of the units, while over 95% recognize their learning value. Ultimately, this study fills the research gap, strengthens their awareness of the units, and provides empirical references for subsequent mathematics teaching practices.

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INTRODUCTION

With the advancement of the new curriculum reform, the concepts of unit teaching and holistic teaching have attracted widespread attention from teachers (Ministry of Education of the People's Republic of China, 2017, General Senior High School Mathematics Curriculum Standards). Additionally, the Mathematics Curriculum Standards for Compulsory Education (2022 Edition) explicitly mentions that teachers should enrich teaching methods and explore large-scale instructional units (Ministry of Education of the People's Republic of China, 2022, Compulsory Education Mathematics Curriculum Standards).

Specifically, large-scale instructional units refer to the approach where teachers, from a macro perspective, consider a learning stage as a whole, take major themes or tasks as the core, realize effective knowledge transfer across grades, and reconstruct new knowledge systems that align with actual teaching needs. As both a teaching ideology and a teaching method, its essence lies in integration, systematization, and correlation. When teachers conduct holistic processing of teaching content and processes, and design large-scale instructional units to improve students' core mathematical competencies, they fully focus on knowledge generation in mathematics learning and the entire process of students' thinking—this is exactly the process of instructional design and classroom implementation based on the concept of large-scale instructional units (Pu, 2022).

Existing studies have shown that the application of the concept of large-scale instructional units in mathematics can not only better cultivate students' core mathematical competencies and improve teachers' teaching skills, but also serve as an effective way to develop higher-order thinking among preservice and prospective teachers (Jing, 2022). However, current research on large-scale instructional units in mathematics remains limited: most preservice teachers and in-service teachers have not yet carried out in-depth exploration and practice of this concept, and some even lack understanding of it. As a teaching ideology and method still in the exploratory stage, its application poses certain difficulties for both preservice and in-service teachers.

Integrating the concept of large-scale instructional units into mathematics teaching is not easy for in-service mathematics teachers. As prospective teachers, preservice mathematics teachers need to learn and implement this concept. Therefore, this study focuses on preservice teachers' perceptions and sense of identity regarding the concept of large-scale instructional units in mathematics education, aiming to understand their current level of understanding, help them recognize the concept and further perceive its learning value, and enable them to practice the concept through future exploratory learning.

The main research contents include preservice teachers' perceptions of the concept of large-scale instructional units in mathematics education and the advantages of this concept in promoting their professional development. Based on the research conclusions, relevant suggestions will be put forward on ways for preservice mathematics teachers to enhance their perceptions of the concept.

Specifically, this study contributes to the existing research by filling the gap in empirical studies on preservice mathematics teachers' cognitive status of large-scale instructional

units—most prior works have focused more on in-service teachers rather than preservice groups. It also provides practical implications: the targeted suggestions for perception enhancement can directly guide teacher education programs, helping preservice teachers build a solid cognitive foundation before entering the workforce. More generally, in the field of education, this study enriches the theoretical and practical exploration of large-scale instructional units, offering a reference for promoting the integration of this concept into pre-service teacher training systems and further advancing the implementation of the new curriculum reform in mathematics education.

METHOD

Data will be collected through literature review, questionnaire survey, and interview survey, and analyzed using SPSS statistical software. The study intends to clarify preservice teachers' current understanding, degree of identity, and their perceptions of the concept's learning value and educational teaching value. The research subjects were in-service preservice mathematics teachers. A total of 404 valid questionnaires were collected, including data from 354 undergraduate preservice mathematics teachers and 50 postgraduate students majoring in mathematics education. These preservice mathematics teachers who provided questionnaire data were mainly from normal universities and colleges such as Guangxi Normal University, Chongqing Normal University, Nanjing Normal University, Central China Normal University, Jiangxi Normal University, Tianjin Normal University, Nanning Normal University, and Guilin University.

To address the aforementioned research questions and align with the specific needs of the study, this research referred to the questionnaire "Teachers' Perceptions and Implementation of Unit Instructional Design in Mathematics from the Perspective of Big Ideas" developed by scholars such as Zhang Dingqiang (Zhang, Ma, & Feng, 2022), and compiled a study-specific questionnaire based on it for data collection. The questionnaire consisted of 25 items, covering 4 dimensions and 12 indicators. The 4 dimensions were: understanding of large-scale instructional units, sense of identity with large-scale instructional units, attitude towards learning the concept of large-scale instructional units, and perceptions of the concept's role in promoting preservice teachers' development. The 12 specific indicators included: institution attended, educational background, academic year, educational internship experience, instructional design ability, level of perception of the concept of large-scale instructional units, degree of identity with the concept, channels for understanding the concept, comprehension of the connotation of large-scale instructional units (Cui, 2019), learning attitude, perceptions of the advantages of large-scale instructional units, and preferred learning methods.

Reliability and validity analysis of the questionnaire: Reliability was assessed using Cronbach's Alpha coefficient. The coefficient of the questionnaire was 0.88, which is greater than 0.7, indicating good reliability and certain credibility. Validity was tested from two aspects: content validity and construct validity. First, after expert review, the questionnaire items were confirmed to comprehensively and accurately reflect the research content, demonstrating good content validity. Second, factor analysis was used to test construct validity. The results showed that the KMO value was 0.760 (greater than 0.7), indicating that the sample data was suitable for factor analysis; the Bartlett's test of sphericity reached a significant level ($p=0.000 < 0.05$), indicating significant

correlations among variables. In summary, the questionnaire had good overall validity (Zhou, Gan, Chen, Wijaya, & Li, 2023).

Table 1. Validity Test of the Questionnaire

Test Indicator	Value	Criterion	Conclusion
KMO Value	0.76	> 0.7	The data is suitable for factor analysis
Significance of Bartlett's Test of Sphericity (p)	0.000	< 0.05	There is a significant correlation between variables

Data for this study were collected via online questionnaire completion. To enhance the validity and reliability of the research findings, data triangulation was incorporated into the study design. Specifically, the study was conducted in two phases: a pre-survey and a formal survey. The pre-survey was used to refine the questionnaire design and conduct an initial test of the reliability and validity of the indicators, while the formal survey further verified the discriminant validity among the indicators. After data collection, Excel was used for the preliminary processing of the questionnaire data, and SPSS 27.0 was applied to conduct analytical procedures such as descriptive statistics, correlation analysis, and non-parametric tests.

RESULTS AND DISCUSSION

Among all the research subjects, 214 had participated in educational internships at primary and secondary schools, while 190 had no internship experience. The latter included undergraduate students from the first to third years (who had not yet undergone centralized educational internships) and some postgraduate students (who were non-preservice teachers during their undergraduate studies, thus lacking internship experience). Regarding the instructional design ability of the subjects (Level 1 to 5 respectively represent: no learning experience in instructional design, basic ability to conduct instructional design, average, good, and excellent), the results showed that 23.51% of the students had no learning experience in instructional design—among whom were first and second-year undergraduates who had not yet taken courses related to instructional design. Approximately 65% of all subjects were at the levels of "basic ability to conduct instructional design" and "average instructional design ability". Details of the subjects' basic information are shown in Table 2

Table 2. Basic Information of Participants

Education Level	Grade	Number of Participants	Number of Those Who Have Undergone Educational Practice	Number of Participants at Each Instructional Design Level				
				Level 1	Level 2	Level 3	Level 4	Level 5
Master's Degree	1	22	15	1	8	10	3	0
	2	20	19	0	6	9	5	0
	3	8	8	0	4	0	4	0

Total for Master's Degree		50	42	1	18	19	12	0
Undergraduate	1	41	3	31	6	4	0	0
	2	99	7	63	16	19	1	0
	3	72	21	0	37	31	4	0
	4	142	141	0	52	60	28	2
Total for Undergraduate		354	172	94	111	114	33	2

The survey showed that 44.31% of the preservice teachers reported having never heard of the concept of large-scale instructional units in mathematics education; 25.00% had heard of it but did not understand it; 22.77% had a brief understanding of the concept; 5.94% had a relatively good understanding of it; and only 1.98% had systematically learned the concept.

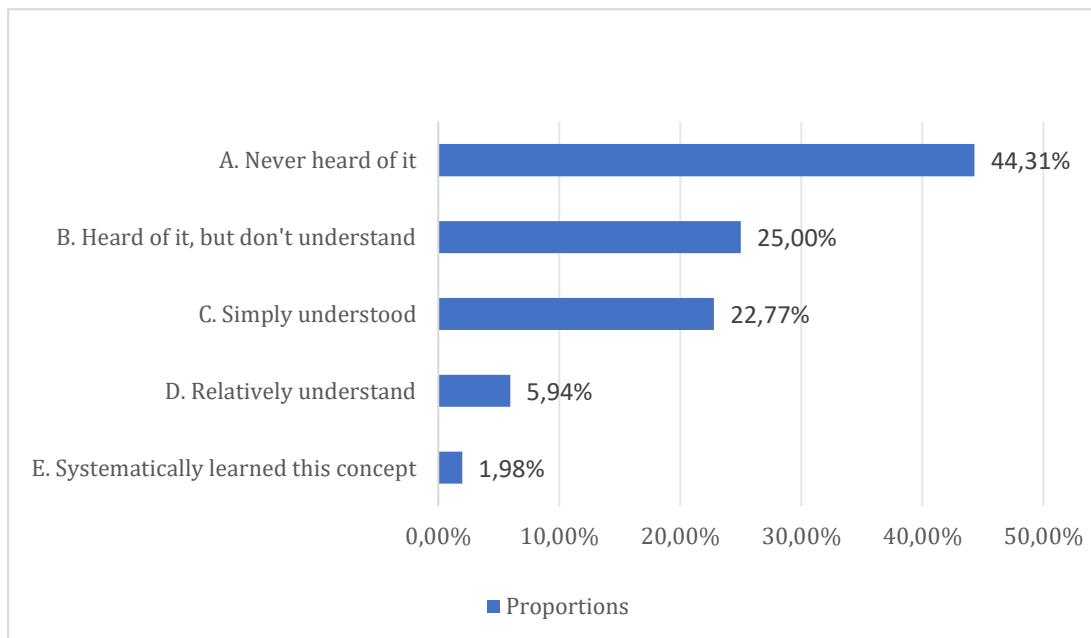


Figure 1. Preservice Teachers' Perceptions of Large - Scale Instructional Units in Mathematics Education

In the study, first and second-year undergraduates were coded as "Group 1" (lower-grade undergraduate group), third and fourth-year undergraduates as "Group 2" (upper-grade undergraduate group), and all postgraduate students as "Group 3". The preservice teachers' perceptions of the concept of large-scale instructional units in mathematics education were defined with corresponding values: "never heard of it" = 1, "heard of it but not understood it" = 2, "had a brief understanding of it" = 3, "had a relatively good understanding of it" = 4, and "had systematically learned it" = 5. The study explored whether there were significant differences in the level of perception of the concept among different grade groups.

Normality test (Kolmogorov-Smirnov test) was conducted on the perception level data using SPSS 27.0, and the results showed that the data significantly deviated from the normal distribution ($p < 0.01$).

Table 3. Results of Normality Test

Variable	Statistic	Degrees of Freedom	Significance	Skewness	Kurtosis
Cognitive Level	0.265	404	<0.01	0.813	-0.141

Therefore, non-parametric tests were adopted for analysis. The Kruskal-Wallis H test (for multiple group comparison) showed that there were significant differences in the level of perception of the concept of large-scale instructional units in mathematics education among different grade groups ($H=121.824$, $p < 0.01$).

Table 4. Kruskal-Wallis Test Results for Cognitive Levels Across Grade Groups

Variable	H Value	Degrees of Freedom	p Value
Cognitive Level	121.824	2	<0.01

Further pairwise comparisons were conducted using the Mann-Whitney U test (with Bonferroni correction, the significance threshold was adjusted to $\alpha=0.0167$). The results showed that: the level of perception of the concept of large-scale instructional units in mathematics education in the upper-grade undergraduate group was significantly higher than that in the lower-grade undergraduate group ($U=8620.000$, $p < 0.001$); the postgraduate group had a significantly higher perception level than the lower-grade undergraduate group ($U=387.000$, $p < 0.001$); and the postgraduate group also showed a significantly higher perception level than the upper-grade undergraduate group ($U=2213.500$, $p < 0.001$).

Table 5. Mann-Whitney U Test Results for Cognitive Levels Across Grade Groups

Comparison Groups	U Value	Asymptotic Significance (Two-tailed)	Corrected p Value
1 vs. 2	8620.000	<0.01	<0.0167
1 vs. 3	387.000	<0.01	<0.0167
2 vs. 3	2213.500	<0.01	<0.0167

Among the research subjects who had basic knowledge of the concept of large-scale instructional units in mathematics education, it was found that most had gained initial perceptions of the concept through teachers' lectures in university classrooms, or educational and teaching-related articles or videos. Research data showed that nearly 50% of the students further understood the concept through channels such as "searching for relevant information online by themselves" and "teachers' lectures in class". This indicates the importance of autonomous learning and teachers' in-class guidance for learning the concept of large-scale instructional units in mathematics education.

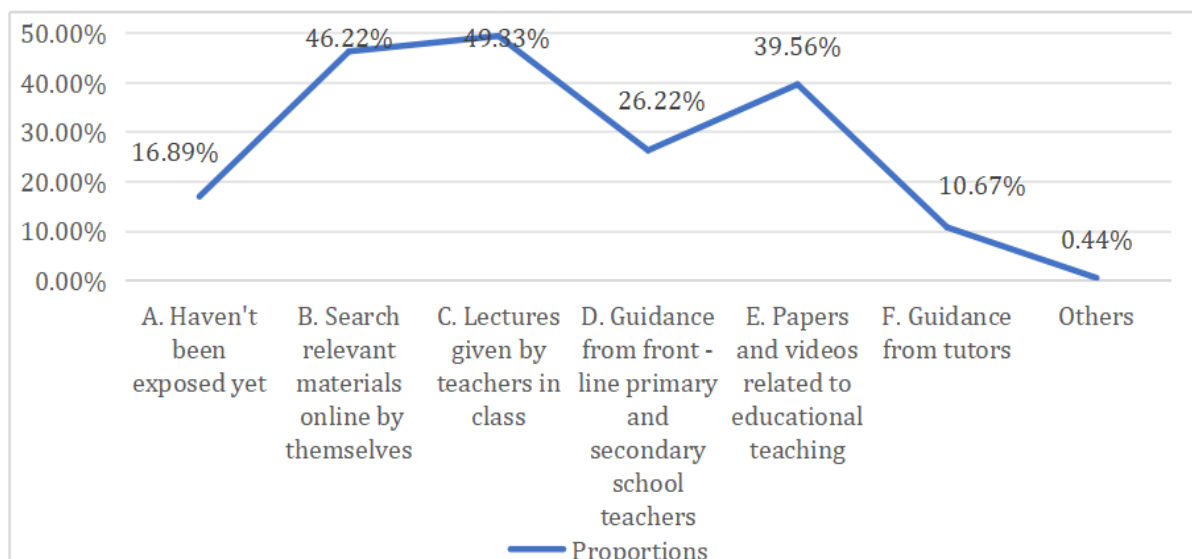


Figure 2. Statistics on the Ways Preservice Teachers Learn about the Concept of Large - Scale Instructional Units in Mathematics Education

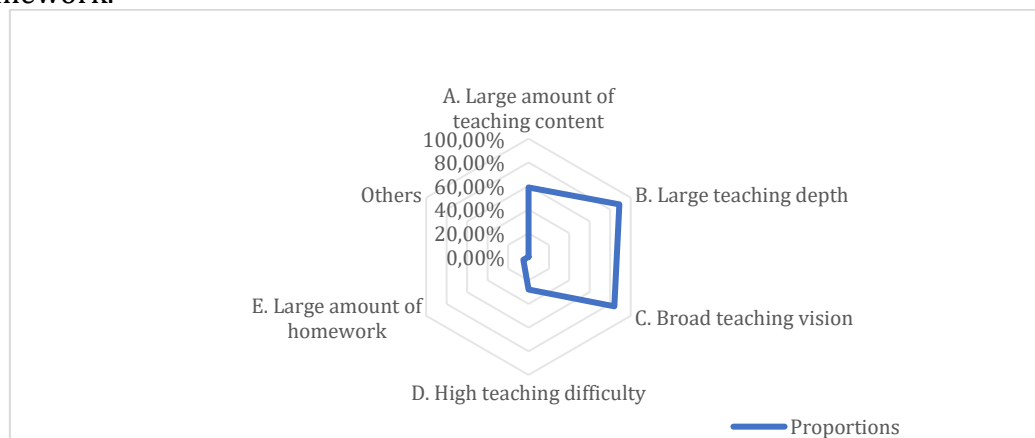
Among the surveyed preservice mathematics teachers, as high as 69% had little understanding of the concept of large-scale instructional units in mathematics education, or even had never heard of it. Regarding the current situation where some preservice mathematics teachers still do not understand or even know about the concept, the author explored the possible causes based on interview and questionnaire survey results: university teachers did not cover the learning and teaching of this theory in mathematics education and other related courses; preservice teachers had insufficient awareness of learning advanced teaching concepts; the concept was not widely applied in mathematics teaching; the practical application of the concept was difficult, required heavy workload, and was not suitable for most in-service teachers; there were too few existing studies on the concept in the field of primary and secondary school mathematics teaching, with insufficient high-quality references (Qi, 2021); and the concept was difficult for preservice teachers to master, apply and implement.

Among the students who had a certain understanding of the concept of large-scale instructional units in mathematics education, they were asked: "What is the 'concept of large-scale instructional units' in your perception?" From the written responses in the questionnaire, it can be seen that most students who had learned about the concept could recognize its characteristics of systematization, integrity and correlation (Ma Guizhi et al.,2024), and knew that it centered on major themes and tasks, requiring the integration of knowledge points in a learning stage, as well as consideration of the connections between the disciplinary knowledge of the unit, between the disciplinary knowledge structure of the unit and other disciplines or fields, and between the unit content and students' current social practices and life experiences. However, in general, students could not fully express the specific definition of the concept of large-scale instructional units in mathematics education. Some students also had incorrect understanding of the concept: they could not state its definition and even easily confused "unit teaching" with "large-scale instructional units" (Sang, 2022).

Table 6. Partial Responses to the Semi-structured Questionnaire

Response No.	"What is the 'concept of large-scale instructional units in mathematics education' that you perceive?"
1	Integrate scattered knowledge points into a systematic knowledge structure of large-scale instructional units for teaching.
2	Teach related contents in one unit. For example, the arrangement of mathematics textbooks, or combine relevant contents into a large thematic unit based on one's own experience.
3	Reorganize the teaching process with a big knowledge point as the core, break the traditional teaching order, and not be limited to the division of units in the textbook catalogue. Classify according to the types of knowledge points, such as large-scale instructional units on functions, large-scale instructional units on inequalities. It can also be said to integrate knowledge of the same origin into a large-scale instructional unit. Large-scale instructional unit design in mathematics enables teachers to rise from the "teaching" level to the "curriculum" level. They used to be accustomed to standing from the perspective of teaching, but now they need to stand from the perspective of curriculum, which is more systematic and scientific.
4	It develops from single teaching to unit teaching, and then to thematic unit teaching. The large-scale instructional unit teaching in mathematics needs to go through a long period.

When the study investigated whether preservice mathematics teachers understood the essence of the concept of large-scale instructional units in mathematics education, they were asked the question: "What does 'large' in 'large-scale instructional units' refer to?" The relatively accurate answers should be large teaching content, large teaching structure, and large teaching perspective. Survey data showed that basically all subjects could recognize that "large" in large-scale instructional units refers to large teaching structure and large teaching perspective. However, some subjects did not understand that "large" also refers to large teaching content. Additionally, about a quarter of them thought it meant high teaching difficulty, and a small number believed it referred to a large amount of homework.

**Figure 3.** Data Distribution Map of "What Students Think the 'Large' in Large - Scale Instructional Units Refers to"

As can be seen from the data analysis in the figure below, almost all preservice teachers recognized that instructional design based on the concept of large-scale instructional units in mathematics education embodies the characteristics of "implementing the new curriculum concept", "integrity", "systematization", "correlation", "realizing effective knowledge transfer in the same learning stage", and "helping improve students' subject core competencies" (Zhao, 2020). However, 16.09% of the students mistakenly believed that large-scale instructional unit design only follows the original unit division in textbooks. Additionally, more than half of the students had little understanding of two features of large-scale instructional unit design: its application of the "backward design" principle and its common use in review lesson instructional design.

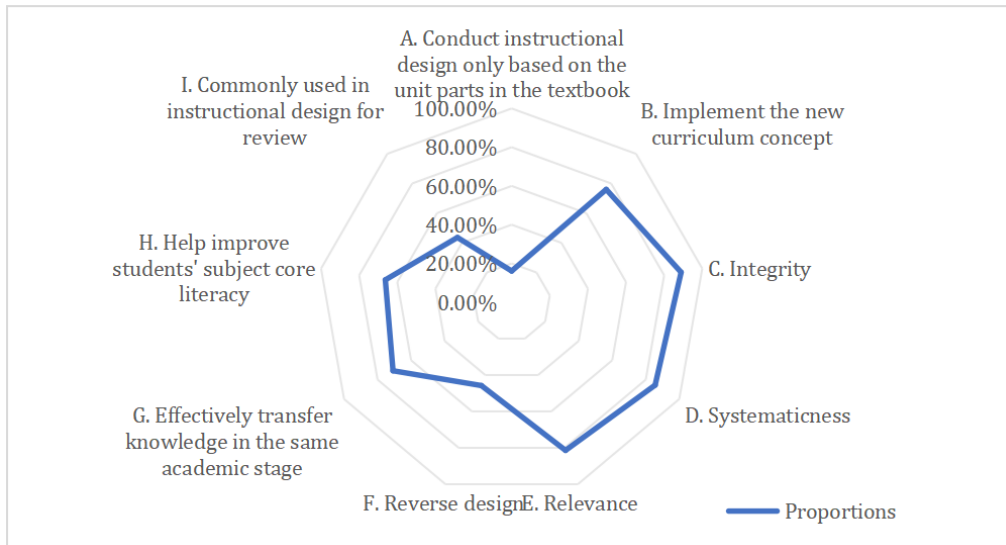


Figure 4. Distribution of Questionnaire Data on "What Characteristics Do Students Think Large - Scale Instructional Design Has?"

It can be seen from the above two sets of data analysis that preservice mathematics teachers' essential understanding of the concept of large-scale instructional units in mathematics education is not very accurate, and their perceptions remain superficial. The author conducted an exploration on "whether preservice mathematics teachers should learn the concept of large-scale instructional units in mathematics education" through questionnaire and interview methods. Survey data showed that 47.52% of the students believed that they should learn the concept to a certain extent; nearly 50% of the students stated that they should learn and master it in depth, and try to apply the concept of large-scale instructional units in mathematics education.

The study investigated whether preservice mathematics teachers thought "there should be dedicated class hours for learning the concept of large-scale instructional units in mathematics education in university mathematics education-related courses". Research data showed that 74.01% of the students believed that the concept should be taught in relevant university courses; 14.11% of the students stated that it was highly necessary to offer courses on the concept in universities. Overall, preservice mathematics teachers held a positive attitude towards learning the concept of large-scale instructional units in mathematics education, and affirmed the value and importance of the concept to a certain extent.

This section used Likert 5-point scale analysis. "Strongly disagree", "disagree", "not sure", "agree", "strongly agree" were scored 1-5 respectively. Reverse questions (Items 3 & 6) were set to handle invalid data.

- (1)Applying math large-scale instructional units in teaching improves students' core math competencies.
- (2)It enhances students' holistic thinking ability.
- (3)It causes students high academic pressure and lower grades.
- (4)Learning and applying it improves math teachers' teaching competence.
- (5)It promotes in-depth learning for teachers and students.
- (6)It increases in-service teachers' workload and hinders their professional development.
- (7)Learning it facilitates preservice math teachers' multi-aspect professional growth.
- (8)It improves teachers' "backward design" ability.
- (9)It enhances preservice teachers' holistic and systematic thinking.
- (10)It develops preservice teachers' higher-order thinking.

Table 7. Data Situation

Item	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mean	4.2	4.4	2.7	4.2	4.2	2.8	4.2	4.1	4.2	4.3
Standard Deviation (SD)	0.7	0.7	1.2	0.8	0.8	1.2	0.7	0.8	0.7	0.7

Data in the table show that except for the reverse questions, the mean values of the other eight items are all higher than 4 points, indicating that the respondents' answers are generally concentrated in the "agree" or "strongly agree" range. In addition, the degree of data dispersion (standard deviation) is small, which further shows that the respondents' answers have high consistency. These results demonstrate that preservice mathematics teachers hold a significantly positive attitude toward applying the concept of large-scale instructional units in mathematics education, reflecting their relatively sufficient understanding of the concept's learning value and educational implications.

This finding aligns with Zeng Xianyi's (2025) research, which emphasized that large-scale instructional units serve as an effective pathway to develop preservice teachers' professional literacy—specifically, their recognition of the concept's role in improving students' core competencies and promoting teacher development. It also resonates with the theoretical framework of constructivist learning, which posits that learners actively internalize knowledge when they perceive its practical value (Piaget, 1970). The high agreement among respondents thus confirms that preservice teachers have begun to construct a meaningful understanding of large-scale instructional units, recognizing their potential to bridge theoretical knowledge and teaching practice.

Regarding preservice mathematics teachers' perceptions of the advantages of the concept of large-scale instructional units in mathematics education in facilitating their professional growth, specific data are shown in Figure 5.

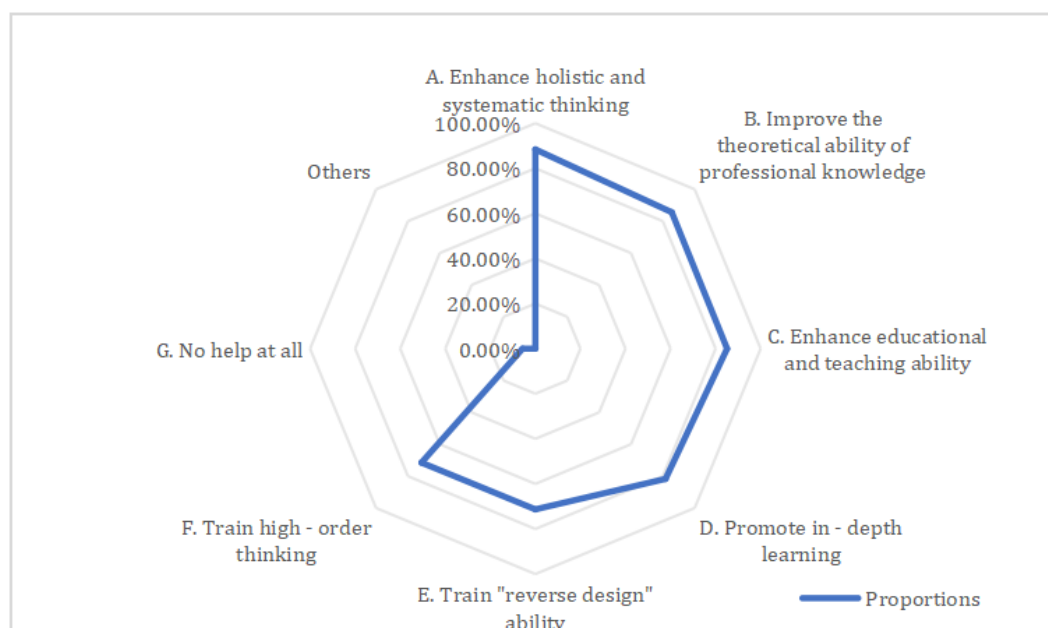


Figure 5. Preservice Mathematics Teachers' Perceptions of the Superiority of the Concept of Large - Scale Instructional Units in Aiding Professional Growth

CONCLUSION

To address the research contents in the problem statement, this study analyzed questionnaires and interviews, drawing key conclusions. Among surveyed teachers, nearly 70% had insufficient or no knowledge of mathematics large-scale instructional units, with perception levels rising by academic stage (postgraduates > upper-grade undergraduates > lower-grade undergraduates). Preservice teachers struggled to explain the concept accurately (often confusing it with “unit teaching”) but showed high identification and positive learning attitudes, confirming the concept’s potential. Notably, 90% deepened understanding and 98% planned further learning via the study.

This study fills the research gap by clarifying preservice teachers’ perceptions, identity, and attitudes but has limitations: questionnaire data focused on Guangxi Normal University undergraduates (few from other universities or postgraduates, affecting generalizability); no in-depth horizontal and vertical comparative analyses (e.g., cross-region or university comparisons or longitudinal tracking) were conducted.

Based on findings and limitations, recommendations follow. Preservice teachers should study the concept via resources, integrate it into instructional design, collaborate in courses, and apply it during internships. University teachers should optimize course hours, offer lectures, and assign tasks; in-service teachers should guide interns to practice the concept in teaching research.

Looking ahead, this study provides data and theoretical support for subsequent scholars. It is hoped more preservice teachers will master the concept, and continuous research will promote its application in primary and secondary mathematics education to exert full value.

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