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A Practical Study on Stratified Teaching of Mathematics in Vocational Undergraduate Education from the Perspective of Adaptive Learning

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Abstract: In the context of vocational undergraduate education, students exhibit significant variations in their mathematical competence, rendering the traditional one-size-fits-all teaching model ineffective in meeting the developmental needs of learners at different levels. Based on the concept of adaptive learning, this study explores ways to implement stratified teaching in mathematics courses at the vocational undergraduate level. After analyzing the main problems in the current implementation of stratified teaching, a teaching model centering on learning condition diagnosis, hierarchical objective design, adjustment of instructional processes and evaluation-feedback mechanisms is constructed. A comparative teaching experiment is conducted to examine the effectiveness of the proposed approach. The results suggest that this model can enhance the relevance and adaptability of instruction to a certain extent, improving students' learning outcomes and being particularly effective in promoting the learning progress of those with weaker foundations.

1. Introduction

Vocational undergraduate education is an important part of China's modern vocational education system. In the talent development process, emphasis is placed on developing practical abilities and laying a solid theoretical foundation. As a core subject, mathematics is crucial in developing students' logical thinking, supporting learning in other subjects, and improving their ability to analyse and solve problems. Consequently, the quality of mathematics instruction directly affects the effectiveness of talent cultivation [1].

In practice, learners show significant variation in mathematical foundations, learning abilities, and learning attitudes due to differences in student backgrounds. Some students have relatively weak foundations and struggle to understand concepts and master basic methods, while others have stronger foundations and require further academic development. A uniform teaching model finds it difficult to accommodate students with different needs in terms of content and pace. This often leads to some students grappling with persistent learning difficulties, while others are not sufficiently challenged, thereby affecting overall teaching effectiveness [2].

Stratified teaching has been widely adopted as an effective approach to addressing student differences, particularly in vocational undergraduate education. Nevertheless, several issues remain in its implementation, including overly simplistic grouping criteria, a lack of dynamic adjustment mechanisms and insufficient evaluation and feedback processes. These limitations restrict the effectiveness of stratified teaching. Therefore, improving its flexibility and relevance while maintaining the integrity of classroom teaching has become an important issue requiring further exploration [3-8].

Adaptive learning emphasizes the dynamic adjustment of teaching based on the continuous monitoring of learning processes, providing a new perspective for optimizing stratified teaching. This study therefore analyses the existing problems in stratified teaching in vocational undergraduate mathematics course, exploring corresponding implementation pathways from the perspective of adaptive learning. Furthermore, a teaching experiment is conducted to preliminary examine the effectiveness of the proposed approach, with the aim of providing a reference for related teaching reforms.

2. Pedagogical Implications of Adaptive Learning

2.1. Connotation of Adaptive Learning in Teaching

From a pedagogical perspective, adaptive learning emphasizes a learner-centred approach involving the continuous observation and analysis of the learning process and the targeted adjustment of instructional activities based on this analysis. The core concept is to incorporate the variability and dynamics observed during learning into instructional decision-making so that teaching is not solely reliant on predetermined plans, but is instead dynamically optimized within the framework of established learning objectives [9, 10].

Specifically, this adjustment is reflected in three main areas. Firstly, the learning pace is regulated by adjusting the teaching tempo according to students' levels of understanding and mastery. While ensuring overall progress, more time is allocated to challenging content and the pace is accelerated for topics that have been well mastered, thus improving instructional efficiency. Secondly, instructional content is adjusted to provide differentiated learning materials for students at different levels, while maintaining the integrity of the core knowledge system. Weaker students are supported in strengthening their conceptual understanding and basic skills, while stronger students are provided with more comprehensive and extended content. The third aspect involves adjusting learning tasks by varying their difficulty, quantity and format. This enables students to engage in learning within their 'zone of proximal development', thereby enhancing both effectiveness and sustainability.

It is important to emphasize that adaptive learning does not equate to fully personalized instruction. In real classroom settings, complete individualization is difficult to achieve due to constraints in time and resources. Instead, adaptive learning emphasizes providing differentiated support within a collective teaching framework. This approach preserves the integrity of classroom instruction while enhancing its relevance and flexibility.

2.2. Further Understanding of Stratified Teaching

Although stratified teaching has accumulated a certain degree of practical experience in vocational undergraduate education, its effectiveness largely depends on the instructional organization and operational mechanisms implemented after grouping. From an implementation perspective, stratified teaching should consist of three interrelated components: reasonable grouping, differentiated implementation and dynamic adjustment.

In terms of grouping criteria, multiple factors such as students' knowledge base, learning performance and attitudes to learning should be considered rather than relying solely on one-time test scores. These multidimensional criteria provide a more comprehensive understanding of students' learning status, thereby improving the rationality and stability of grouping. Secondly, during the instructional implementation phase, teaching content and learning tasks should be designed according to students' characteristics and needs at different levels: instruction for those with weaker foundations should focus on conceptual understanding and basic skill training, while those with stronger foundations should be provided with more integrative, context-based tasks to promote higher-order thinking. Thirdly, an ongoing learning performance-based dynamic adjustment mechanism should be established to allow for the timely modification of grouping, enabling students to move across levels as their learning progresses.

In the absence of such a mechanism, stratified teaching will become a rigid structure that fails to mirror students' evolving learning levels and may undermine their confidence and motivation. Therefore, it is essential to introduce continuous regulation through formative assessment and process-oriented feedback to optimize stratified teaching and enhance its effectiveness.

2.3. Implications for Mathematics Teaching

Mathematics is characterized by a strong logical structure and systematic organization, with clear dependencies between different areas of knowledge. Students' mastery of the fundamental concepts and methods learnt in earlier stages directly affects their understanding and application of subsequent content. Neglecting individual differences in teaching can lead to the accumulation of learning difficulties and affect overall learning outcomes.

In practice, students exhibit significant differences in how they learn mathematics. Some students struggle to understand basic concepts and master fundamental methods, requiring repeated practice and targeted guidance. Conversely, students with stronger foundations may lose interest if confined to repetitive exercises over an extended period. Therefore, instructional design should accommodate these differences by providing appropriate learning tasks and content for students at different levels, enabling all students to progress based on their starting point.

Integrating adaptive learning principles into stratified mathematics teaching maintains the stability of the curriculum structure while enabling adjustments to be made to the teaching pace, content and tasks as appropriate. This approach alleviates the learning pressure experienced by lower-performing students due to accumulated difficulties, while providing higher-performing students with opportunities for further development. In summary, this approach improves the effectiveness and adaptability of classroom teaching.

3. Major Problems in Current Stratified Teaching

3.1. Student Differences Increase the Difficulty of Instructional Organization

Students on vocational undergraduate demonstrate significant differences in their approach to learning mathematics. These differences are reflected not only in their knowledge base, but also in their learning habits, strategies and attitudes. Some students have an insufficient grasp of fundamental concepts, lack systematic learning methods and struggle with anxiety when learning mathematics. In contrast, others have a strong foundation of knowledge and are more self-directed learners, enabling them to understand new concepts more efficiently and complete learning tasks effectively.

In the classroom, these differences manifest as inconsistent learning paces, varying levels of participation and uneven feedback cycles. Teachers must strike a balance between consolidating foundational knowledge and promoting advanced learning. If the teaching pace is set according to overall progress, students with weaker foundations may gradually lose confidence as they encounter increasing difficulties. Conversely, if too much emphasis is placed on basic content, students with stronger foundations may be given insufficiently challenging tasks, which can lead to reduced engagement. Therefore, the existence of these differences among students increases the complexity of classroom organization and places higher demands on instructional design and implementation.

3.2. Single and Static Grouping Criteria

Current stratified teaching practices often base grouping primarily on entrance examination scores or one-time assessment results. While these quantitative indicators can reflect students' basic knowledge to some extent, they fail to capture their learning ability, attitudes and developmental potential comprehensively, thus presenting certain limitations. This is particularly true in vocational undergraduate education, where students' learning conditions are highly dynamic and their performance can fluctuate significantly in response to changes in learning environments and methods.

Furthermore, existing practices generally lack effective dynamic adjustment mechanisms. Once a group has been formed, its composition often remains unchanged for a long time. This relatively rigid structure makes it difficult to reflect changes in students' learning status in a timely manner. Consequently, students who demonstrate significant progress may be denied access to higher-level learning opportunities, while those who are struggling may remain at an inappropriate level for a prolonged period. Consequently, stratified teaching may fail to promote effective learning and may even hinder students' development and motivation.

3.3. Insufficient Alignment between Instructional Implementation and Stratification Goals

In some teaching practices, stratified instruction remains largely moralistic, with limited alignment between the outcomes of grouping and the implementation of teaching. Specifically, although students are divided into different ability groups, the teaching content and methods used in the classroom remain largely uniform. Students at different levels receive the same instruction, with differentiation reflected only in the difficulty of homework assignments. This approach, characterized by formal stratification with homogeneous instruction, fails to realize the full potential of stratified teaching in promoting differentiated learning.

At the same time, the teaching pace is often determined by the overall progress of the course, offering insufficient flexibility to accommodate students at different levels. Students with weaker foundations may lack the repeated explanations and step-by-step guidance they need, while those with stronger foundations may not be given opportunities for deeper exploration and comprehensive application. Under these conditions, the potential benefits of stratified teaching for improving learning outcomes are limited as it is not effectively translated into concrete instructional practices.

3.4. Lagging Evaluation and Feedback Mechanisms

Current evaluation practices in mathematics courses are still dominated by summative assessments, which focus primarily on learning outcomes rather than processes. This results-oriented approach makes it difficult for teachers to obtain timely, detailed information about students' learning progress, thereby limiting the effectiveness and timeliness of instructional adjustments.

Furthermore, the feedback function of evaluation results is not fully realized in practice. In some cases, evaluation is mainly used for assessing students' performance at specific stages rather than for guiding subsequent teaching improvements and learning strategies. The absence of mechanisms for adjusting stratification, optimizing learning tasks and providing personalized support based on evaluation results undermines the role of assessment in instructional regulation. Therefore, an evaluation and feedback system that integrates formative and summative assessment is essential to improve the effectiveness of stratified teaching.

4. Implementation Pathways of Stratified Teaching

4.1. Continuous Understanding and Comprehensive Assessment of Learning Conditions

In the implementation of stratified teaching, a comprehensive and continuous understanding of students' learning conditions is essential for effective instructional adjustment. Teachers can obtain relevant information through various channels, such as classroom questioning and interaction, homework quality, in-class quizzes and periodic assessments. These data reflect students' understanding and application ability from different perspectives, providing a more holistic view of their learning status.

In practice, the integrated analysis of multi-source information should be emphasized over reliance on a single evaluation result. Combining classroom participation with homework performance provides a more accurate assessment of students' engagement in learning, while periodic test results help to identify gaps in knowledge. Based on such an analysis, teachers can make judgments about students' learning conditions at different stages and adjust the pace of teaching, the arrangement of content, and the difficulty of tasks accordingly. This process-oriented approach highlights the dynamic and continuous nature of instructional decision-making, helping to avoid simplistic classification based on static results and improving the precision and rationality of teaching adjustments.

4.2. Systematic Design of Stratified Objectives and Instructional Content

In stratified teaching, learning objectives should be clearly defined and systematically structured in line with the course's overarching goals. Based on differences in students' learning foundations and abilities, these objectives can be categorized into three levels: foundational, intermediate and advanced. Foundational level objectives focus on understanding basic concepts and mastering fundamental methods. Intermediate level objectives emphasize the comprehensive application of knowledge and problem-solving abilities. Advanced level objectives target the development of analytical and application skills in complex contexts.

In terms of instructional content design, a modular approach should be adopted to organize and integrate course materials. While maintaining a unified overall knowledge framework for all students, differentiation can be reflected in the depth and complexity of learning tasks. Within the same knowledge module, tasks of varying difficulty levels can be designed, such as foundational tasks for core knowledge training, intermediate tasks for integrated application and advanced tasks for open-ended or contextual problem exploration. Integrating stratified objectives and differentiated content enables instructional differentiation while preserving the integrity of the curriculum system. This allows students at different levels to engage in learning activities suited to their needs.

4.3. Dynamic Adjustment and Optimization of Instructional Processes

During classroom instruction, teaching processes should be adjusted dynamically based on student feedback to enhance adaptability of instruction. In terms of teaching pace, adjustments should be made according to students' levels of understanding. If many students are having difficulty with a particular topic, additional examples, step-by-step demonstrations or practice exercises can be provided. Conversely, when the class has achieved a satisfactory level of mastery, the teaching requirements can be increased by incorporating more integrative and application-oriented content.

To increase student participation, diverse teaching methods should be employed in terms of instructional organization. Strategies such as classroom questioning, group discussions and cooperative learning can encourage engagement from students at different levels. During implementation, different roles and tasks can be assigned according to students' levels, enabling those with weaker foundations to focus on fundamental learning activities and providing more challenging tasks for advanced students.

Furthermore, designing differentiated tasks is a key approach to achieving dynamic adjustment. Offering tasks with varying levels of difficulty within the same classroom allows students to engage in learning activities that are appropriate to their abilities, thereby improving participation and learning outcomes.

4.4. Coordinated Improvement of Evaluation and Feedback Mechanisms

In the context of stratified teaching,the evaluation system should gradually shift from an outcome-based approach to a comprehensive model integrating formative and summative assessment. Throughout the teaching process, a variety of methods can be employed to continuously collect information on students' learning. These methods may include homework, classroom performance, in-class quizzes and periodic assessments. This approach provides a more complete reflection of the learning process.

Regarding feedback mechanisms, greater emphasis should be placed on the practical application of evaluation results. Firstly, students should receive timely feedback to help them identify issues and adjust their learning strategies. On the other hand, evaluation outcomes should inform instructional improvements, including optimizing teaching content, adjusting teaching pace and refining stratification structures.

By establishing a cyclical mechanism of evaluation-feedback-adjustment, assessment can be transformed from a tool for reporting results into a key support for instructional decision-making. This mechanism enhances the relevance and effectiveness of teaching, providing data to support the dynamic adjustment of stratified instruction and promoting the continuous optimization of the teaching process.

5. Teaching Practice and Results Analysis

A one-semester teaching experiment was conducted in a vocational undergraduate institution to examine the effectiveness of the proposed stratified teaching approach. Two parallel classes were selected as the subjects of the study: the experimental class (48 students) adopted a teaching model based on adaptive learning and stratified teaching, while the control class (46 students) followed a conventional teaching approach. Both classes received the same course content from the same instructor on the same schedule to minimize the influence of extraneous variables.

Prior to the experiment, a baseline test was administered to both classes. The results indicated no significant differences in average scores or score distributions, suggesting comparability between the two groups. During the teaching process, the experimental class made dynamic adjustments to the teaching pace, instructional content and learning tasks based on the students' learning conditions. In contrast, the control class followed the predetermined teaching plan without making any adjustments.

The final examination results showed that the experimental class achieved an average score of

73.6, compared to 68.2 for the control class. The pass rate in the experimental class was 87.5%, which was higher than the 76.1% observed in the control class. Overall, the experimental class outperformed the control class in terms of both academic achievement and pass rate. This suggests that the improved stratified teaching approach contributed to enhanced teaching effectiveness.

Further analysis of students at different levels revealed that those with weaker foundations showed more significant improvement in their understanding of fundamental concepts and mastery of basic methods, as well as increased learning confidence. Students with stronger foundations maintained stable performance and demonstrated improvement in handling comprehensive problems without declining due to instructional adjustments. These findings suggest that the stratified teaching approach effectively caters for the developmental needs of students at different levels.

Additionally, classroom observations and process records revealed that students in the experimental class participated more actively in activities such as questioning, discussion, and task completion. Their overall learning engagement was also stronger, which further supports the positive impact of the adaptive stratified teaching model.

6. Conclusions

In vocational undergraduate mathematics teaching, the existence of differences between students poses higher demands on instructional organization. In a collective teaching context, addressing these differences while maintaining instructional coherence is key to improving teaching quality. Optimizing stratified teaching based on the concept of adaptive learning allows for adjustments to be made to the learning pace, instructional content and task design. This facilitates better alignment between teaching arrangements and students' learning conditions, enhancing the instruction's relevance and flexibility.

The results of the teaching practice indicate that the improved stratified teaching approach enhances students' learning outcomes to some extent. Notably, students with weaker foundations demonstrate significant improvement, while those with stronger foundations experience stable development without negative impact. These findings suggest that, when designed and implemented appropriately and effectively, stratified teaching can accommodate diverse learning needs and improve the overall effectiveness of classroom instruction.

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References

[1] Li, R. L., Zhang, Y., and Nan, H. (2025). Adaptive reform of classroom teaching in vocational undergraduate education: Logical framework, practical issues, and implementation strategies, Jiangsu Higher Vocational Education, 2, 71-79.

[2] Fan, Y. Q., Guo, S. F., and Huang, Y. F. (2026). Innovation in advanced mathematics teaching under the background of emerging engineering education, Western China Quality Education, 3, 164-167.

[3] Zhu, M. H. (2024). Exploration of stratified teaching model in higher vocational colleges: A case study of Suzhou Vocational University, Teaching and Educating (Higher Education Forum), 33, 110-112.

[4] Li, S. Y., and Yang, Y. F. (2024). Exploration and practice of stratified teaching in advanced mathematics for students with weak foundations, College Mathematics, 3, 11-17.

[5] Zhang, Q. Y., and Zhang, X. H. (2024). Current situation and implementation effect of stratified teaching in advanced mathematics courses in higher vocational colleges, Heilongjiang Science, 9, 134-136.

[6] Yang, Y. Y., and Liu, H. X. (2022). Reform and practice of classified cultivation and stratified teaching in higher

vocational colleges: A case study of Xiangyang Vocational and Technical College, Journal of Xiangyang Polytechnic, 6, 77-81, 115.
[7] Jiang, C. F., Fang, L. X., and Liu, G. (2022). Practical exploration of classified cultivation and stratified teaching talent training model under the concept of appropriate education, Journal of Jilin TV & Radio University, 5, 28-30.
[8] Yang, W. (2021). Exploration and practice of stratified and classified teaching methods in advanced mathematics in higher vocational colleges, Journal of Wuhan Institute of Shipbuilding, 2, 35-38.
[9] Li, W., and Ji, X. F. (2024). Exploration of the "three-all autonomous learning" model for middle school students based on adaptive learning theory, Journal of Lishui University, 6, 92-98.
[10] Chang, K., Wu, J. P., Ma, Y. J., and Wang, X. L. (2023). Practical research on personalized adaptive learning based on artificial intelligence technology, China Educational Technology & Equipment, 13, 44-46, 53.