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Design and practice of secondary mathematics teaching based on PAD class model

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Abstract

Amid the backdrop of the new curriculum reform, PAD (Presentation, Assimilation, Discussion)Class, an innovative local education model, has garnered significant momentum in teaching applications. In this paper, PAD Class is introduced to the realm of secondary mathematics instruction. Taking into account the distinctive characteristics of secondary mathematics classrooms, the inclusion of "Conclusion" is proposed as a complementary element to the fundamental PAD Class framework, aiming to promptly correct any deviations in students' thinking. The paper elaborates on the implementation of this teaching approach through a concrete teaching case, thereby offering a valuable example for the design and execution of secondary mathematics teaching strategies.

Keywords: PAD Class, secondary mathematics, Teaching model

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1. Introduction

Pursuant to the Mathematics Curriculum Standards for Compulsory Education (2022 edition) issued by the Ministry of Education of the People's Republic of China (2022), it is imperative to foster middle school students with innovative capabilities and comprehensive literacy in the contemporary era, posing novel challenges to mathematics education in junior high schools. The traditional lecture-based teaching methodology, which is teacher-centric, tends to constrain students' subjectivity and individualized development. Moreover, the discussion-based approach is prone to misinterpretation and superficial learning, potentially leading to incorrect knowledge comprehension. Consequently, educators have realized that striking a balance between classroom instruction and student self-study and discussions is pivotal for enhancing students' mathematics learning efficiency. Against this background the PAD Class teaching philosophy, a novel educational concept that seamlessly integrates traditional and discussion-based teaching, has garnered significant attention from primary and secondary educators. This paper aims to explore the implementation strategies and practical application of the PAD Class teaching model in middle school mathematics, thereby offering valuable insights for frontline teachers in their teaching research and reform efforts.

2. The secondary mathematics teaching model based on PAD Class

2.1 Introduction to PAD Class

In 2014, Professor Zhang Xuexin, a Psychology Department faculty member at Fudan University and a Princeton University Ph.D. holder, introduced a novel localized educational approach known as PAD Class (Zhang, 2014). This teaching model seamlessly integrates the strengths of both discussion-based and lecture-based teaching methods. At the heart of PAD Class lies its dual-part structure, with half the class dedicated to teacher-led instruction and the other half to student-led discussions. Fundamental PAD Class comprises three primary stages: Presentation, Assimilation, and Discussion. Furthermore, based on the duration of instructional hours, PAD Class can be categorized into in-class assimilation and interclass assimilation. In the in-class assimilation mode, presentation, assimilation, and discussion occur within the same class session. Conversely, in

the interclass assimilation mode, the content is split into two classes, with the assimilation phase primarily conducted after the first class, while more presentation and discussion take place during the second class. Upon its introduction, this innovative teaching concept garnered widespread support from education reformers due to its exceptional adaptability and groundbreaking nature (Zhao, 2017; Wang, 2021). PAD Class has gained significant popularity, particularly in the teaching of professional courses at colleges and universities (Qin, 2024; Zhang, 2024). However, there is a paucity of references regarding the implementation of PAD Class in middle school mathematics teaching, particularly in terms of instructional case studies.

2.2 Secondary mathematics teaching model based on PAD Class

Given the current situation of numerous subjects and limited preview time for middle school students, especially when facing complex mathematical knowledge points, students' spontaneous preview may be inefficient or even confusing. Therefore, the PAD class teaching model, which focuses on review and summary rather than preview, can precisely address this challenge. Furthermore, considering that middle school students are in a critical stage of forming mathematical thinking and literacy, teachers need to encourage students' independent innovation and exploration while also providing timely correction and supplementation. To this end, we have strengthened the "Conclusion" session as a supplement to the PAD classroom, aiming to ensure sufficient time to correct students' thinking deviations, eliminate the impact of incorrect methods, and strengthen correct thinking patterns.
Additionally, given the characteristics of dense knowledge points and fast teaching progress in middle school mathematics classrooms, many basic knowledge points need to be completed within limited class hours, which limits the comprehensive application of the PAD Class model. In this case, we recommend selecting specific knowledge points that require calculation, reasoning, and in-depth understanding for in-class PAD Class teaching.

Table 2-1 Secondary mathematics teaching model based on PAD Class

Teaching process	Roles of teachers and students	Teaching tasks	Duration (minutes)
Presentation	Teacher-led	Teacher explains the key and difficult points, knowledge framework, and pose appropriate questions.	15
Assimilation	Students-led	Students are required to think critically, analyze independently, and provide responses to the questions posed by the teacher.	5
Discussion	Students-led, Teacher-guided	Members in group take turns to make statements, summarize and form group opinions; The group representatives present the group opinions to the class in turn; Group members provide answers to the questions posed by other groups.	15
Conclusion	Teacher-led	Teacher correct and supplement the results of class discussions, improve the knowledge framework, and emphasize "precautions."	10

Based on the above analysis, the application of the PAD class model in secondarySecondary mathematics teaching undoubtedly has positive significance, but it needs to be flexibly adjusted based on actual teaching conditions. Therefore, we propose the following four-step PAD classroom teaching model for secondary mathematics teaching.

3. Secondary mathematics teaching practice based on PAD Class model

Taking "Parallelogram Judgment (the first lesson)" as an example, we implement the secondary mathematics teaching practice based on the PAD Class, which consists of four stages: Presentation, Assimilation, Discussion and Conclusion.

3.1 Presentation：teacher-led guided or framed teaching

The first part of the PAD Class teaching model is guided or framed teaching. Teachers can utilize visual aids, such as flowcharts and mind maps, to highlight the instructional objectives, key concepts, and challenging areas

of the lesson, thus aiding students in building their own knowledge frameworks. During the presentation, teachers should intentionally leave gaps for the specifics of key concepts and guide students to actively explore the interconnections between new and prior knowledge. This is a crucial aspect in transitioning teachers' role from an authority figure to a facilitator.

Taking "Parallelogram Judgment (the first lesson)" as an instance, the key points of this lesson are centered around the following two theorems and their respective proofs: (1) A quadrilateral is a parallelogram if its two sets of opposing sides correspound and are equal; (2) A quadrilateral is a parallelogram if its two sets of opposing angels correspound and are equal. The challenge lies in exploring the technique and rationale behind utilizing auxiliary lines in proving these two theorems. During the teaching process, educators should prioritize the analysis of proof strategies and facilitate students' self-discovery of knowledge.

For the first proof, teachers can guide students from identifying equal opposing sides in a quadrilateral, to constructing congruent triangles, subsequently deducing the alternate interior angles' equality, and ultimately confirming the parallelism of the two opposing sides. As for the second proof, teachers can prompt students to consider: given that the sum of a quadrilateral's interior angles is 360° and its diagonal angles are equal, through calculations, it can be determined that the consecutive interior angles are supplementary, thereby proving the parallelism of the two opposing sides.

After providing pivotal guidance on thinking strategies, students are expected to individually prove both theorems as Problem 1 and Problem 2. Lastly, Problem 3 is designated for advanced students to explore whether auxiliary lines were essential in the aforementioned proofs and delve into the reasons behind their usage, aiming to enhance their analytical skills and satisfy their curiosity in geometric concepts.

3.2 Assimilation: students-led independent learning and thinking

Highlighting students' independent learning and assimilation is the unique feature of the PAD class, which is also the key to ensuring effective and successful classroom discussions. Students' internalization is guided and achieved with the tool of "problems". Teachers should comprehensively consider whether these problems have the function of guiding students to grasp the key and difficult points of knowledge, inspiring students to discover problems, and stimulating students to unleash their intellectual potential.

To illustrate, we consider the teaching of "Parallelogram Judgment (the first lesson)" as an example. Following the teacher's guidance in the previous section, students embark on independent exploration in this segment, contemplating the proof procedures for Problem 1 and Problem 2. Although they do not engage in peer-to-peer communication, they can undertake individual learning activities like information retrieval. Later, students utilize mind maps or flowcharts to solidify key concepts and build a personalized mathematical knowledge structure. Finally, students articulate their own proof concepts or proof processes on scratch paper for subsequent group discussion. As for Problem 3, academically capable students can ponder the significance and methodology of incorporating auxiliary lines into the proof process through repeated attempts at constructing them.

3.3 Discussion: students-led communication and sharing

Classroom discussion is a crucial component of the PAD classroom. The primary process of classroom discussion includes intra-group discussion, presentation of group opinions by a representative, and inter-group discussion. Therefore, the key to enhancing the effectiveness of discussion lies in the design of groups and control of rhythm. To facilitate efficient discussion within a group, teachers should carefully consider the composition of group members, providing individualized assistance based on students' varying learning levels. During students' self-presentation, teachers, as facilitators of the activity, should not remain detached. Teachers must not only control the rhythm of the discussion but also provide timely encouragement and guidance to students, ensuring the smooth progress of the discussion.

To enhance the efficacy of classroom discussions within this teaching case, we have deliberately structured three discussion groups, each comprising five academically proficient students, ten average-performing students, and five students requiring additional guidance. Our objective is to foster profound student-to-student interaction and personalized learning support, achieved through the tutoring of outstanding students to average students, and the subsequent assistance of average students to those requiring aid.

During the intra-group deliberations, the teacher observed attentively and identified three primary challenges as follows: (1)Numerous students encountered difficulties in constructing congruent triangles through the addition of auxiliary lines while solving Problem 1; (2) A segment of students struggled with calculating the sum of interior angles for Problem 2; (3) Students often tend to directly apply the proof methodology employed for

Problem 1 to Problem 2, overlooking the inherent differences between the two, leading to frequent failures. To address these challenges, the teacher intervened appropriately during the discussions, collaborating with students to explore solutions, elucidating the techniques for constructing auxiliary lines, discussing methodologies for calculating the sum of interior angles, and analyzing the reasons why the auxiliary line construction method for Problem 1 is inapplicable to Problem 2. This teacher involvement significantly bolstered students' enthusiasm for engaging in discussions.

Subsequently, through the presentations of group representatives, the teacher observed that, while the fundamental proof concepts among groups were largely similar, the specific proof processes exhibited distinct variations. To further refine and optimize these proof processes, the teacher encouraged continued inter-group collaboration and discussions, aiming to enhance overall learning outcomes.

3.4 Conclusion: teacher-led correction and conclusion

Taking into account the distinctive characteristics of secondary math classrooms, the inclusion of “Conclusion" is proposed as a complementary element to the fundamental PAD Class framework. During this segment, teachers precisely discern students' learning deficiencies by critically evaluating their participation in group discussions and presentations, and accordingly rectify any misconceptions. Additionally, teachers comprehensively consolidate the key knowledge concepts and challenges presented in the lesson, emphasizing the pivotal points and strategic solutions encountered during the problem-solving process.

In this particular case of practice, teacher has observed a notable deficiency in the utilization of logical connectors, such as "because" and "therefore," in students' proofs of problems 1 and 2, which has led to a diminished level of logical coherence in their arguments. To address this shortcoming, teacher developed standardized proof templates and emphasized the importance of normative and logical symbolic language in mathematical proofs. Furthermore, teacher cautioned against the indiscriminate introduction of auxiliary lines in the proof of problem 2, as this practice can inadvertently lead to the division of angles, thereby complicating the proof process.

Teacher synthesized techniques for demonstrating parallelism in geometry based on the results from group discussion. Some conclusions were made as follows: (1) If opposite sides of a quadrilateral are equal，students can construct congruent triangles with using auxiliary lines to prove parallel relationships; (2) Calculating consecutive interior angles when quadrilateral angles are equal in order to establish parallelism; (3) Employing reasonable auxiliary line constructions without splitting entire angles if direct proofs are not feasible. Finally, the teacher emphasized that during the process of proof, students should strictly adhere to the normativity of proof language and flexibly apply the mathematical knowledge they have learned, such as congruent triangles and complementary alternate interior angles, to effectively prove the parallel relationship. This summary not only facilitates students' deeper understanding of the knowledge points but also lays a foundation for their flexible application in subsequent learning.

4. Conclusion

The PAD Class is a new-type teaching model that can stimulate students' critical thinking and enhance their comprehensive analytical abilities. The author has applied the PAD Class teaching mode to secondary mathematics instruction, integrating it with the specific characteristics of the middle school mathematics classroom. Within the fundamental framework of classroom instruction, internalization, and discussion, the author suggests incorporating teacher “Conclusion" as a complement to the PAD Class in order to assist middle school students in correcting any misconceptions they may have. In practical application, middle school mathematics educators should grasp the essence of the PAD Class and strategically plan its instructional trajectory while designing assignments that align with both mathematical curriculum requirements and developmental needs for enhancing students' core mathematical literacy. This will enable teachers to effectively prepare for promoting efficient student learning.

References

Ministry of Education(2022), People's Republic of China. Mathematics Curriculum Standard for Compulsory Education (2022 edition) [M]. *Beijing: Beijing Normal University Press*.

Zhang John Xue-xin(2014). PAD Class:A New Attempt in University Teaching Reform[J], *Fudan Education Forum*, 12，5-10.

Zhao Wanli(2017). Realizing the right and Responsibility of teachers and students in Divided classroom [J].

China Education Tribune, 09:106.

Wang Xinchun(2021). A Practical Research on the Application of "Divided Classroom" Teaching Model to the Teaching of Mathematics Teaching Theory [J]. *Science and Technology Horizon*, 36:94-97.

Qin Anlan(2019). "Internet + Paired classroom" : The practice of teaching model oriented on the improvement of graduate students' innovation ability [J]. *Journal of Heilongjiang Teacher Development College*, ,43(05):81-84.

Zhang Hanchang(2024). Application of "Divided classroom" teaching Model in Public Administration courses of colleges and universities [J]. *Road to Success*,13:21-24.