STRATIFIED TEACHING MODULE BASED ON COGNITIVE APPRENTICESHIP MODELS IN CHINESE HIGH SCHOOL STUDENTS' MATHEMATICS PERFORMANCE, PROBLEM-SOLVING ABILITY AND LEARNING MOTIVATION

By

WANG RUIMEI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

March 2024

IPM 2024 8

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

STRATIFIED TEACHING MODULE BASED ON COGNITIVE APPRENTICESHIP MODELS IN CHINESE HIGH SCHOOL STUDENTS' MATHEMATICS PERFORMANCE, PROBLEM-SOLVING ABILITY AND LEARNING MOTIVATION

By

WANG RUIMEI

March 2024

Chairman : Nurul Nadwa binti Zulkifli, PhD
Institute : Mathematical Research

Conventional teaching methods have shown an inability to adapt to the distinct learning preferences of students. To address these issues, stratified teaching framed by the Cognitive Apprenticeship Model (CAM) was developed in this study to improve the performance, problem-solving ability, and learning motivation in mathematics for 9th-grade students. This innovative pedagogical approach was created by applying the ADDIE methodology for instructional design and incorporating information technology. For the empirical portion of this research, a quasi-experimental design was implemented in a high school in China. A total of 150 students were randomly allocated into three groups, with each group consisting of 50 students. One group was taught using the CAM approach (i.e., the teachers employed modeling, coaching, scaffolding, fading, articulation, and reflection techniques). Another group was exposed to the Stratified Cognitive Apprenticeship Model Teaching Module (SCTM), while the control group was taught using conventional instruction (CI), which mainly involved teacher lectures, student note-taking, and homework completion. The effects of the different teaching techniques were evaluated using pre-tests, post-tests, and delayed post-tests, which were compared to the MYP mathematics assessment standards and a questionnaire that measured motivation in studying mathematics. Analysis of covariance (ANCOVA) was performed using SPSS, and the findings indicated that the SCTM group exhibited superior performance in mathematical ability, problem-solving skills, and motivation for learning mathematics compared to the other groups. Therefore, this study supports using SCTM in high school mathematics, demonstrating its efficacy as a teaching technique. The findings of this study suggest that integrating SCTM with traditional teaching methods is a beneficial approach to improving students' mathematics performance, problem-solving abilities, and learning motivation. The favorable results of the SCTM approach provide a strong foundation for its application in high school mathematics instruction and may influence future educational methodologies and policies.

Keywords: Chinese High School Education, Learning Motivation, Mathematical, performance, Problem-Solving Skills, Stratified Cognitive Apprenticeship

SDG: GOAL 4: Quality Education

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

MODUL PENGAJARAN BERSTRATA BERDASARKAN MODEL PERANTISAN KOGNITIF TERHADAP PRESTASI MATEMATIK, KEMAHIRAN PENYELESAIAN MASALAH, DAN MOTIVASI PEMBELAJARAN PELAJAR SEKOLAH MENENGAH CINA

Oleh

WANG RUIMEI

Mac 2024

Pengerusi : Nurul Nadwa binti Zulkifli, PhD
Institut : Penyelidikan Matematik

Kaedah pengajaran konvensional telah menunjukkan ketidakupayaan untuk menyesuaikan diri dengan keutamaan pembelajaran yang berbeza bagi pelajar. Untuk menangani isu-isu ini, pengajaran berstrata yang dibentuk oleh Model Perantisan Kognitif (CAM) telah dibangunkan dalam kajian ini untuk meningkatkan prestasi, kebolehan menyelesaikan masalah, dan motivasi pembelajaran dalam matematik bagi pelajar gred 9. Pendekatan pedagogi inovatif ini dicipta dengan menggunakan metodologi ADDIE untuk reka bentuk pengajaran dan menggabungkan teknologi maklumat. Untuk bahagian empirikal penyelidikan ini, reka bentuk kuasi-eksperimen dilaksanakan di sebuah sekolah menengah di China. Sejumlah 150 pelajar diperuntukkan secara rawak kepada tiga kumpulan, dengan setiap kumpulan terdiri daripada 50 pelajar. Satu kumpulan diajar menggunakan pendekatan CAM (iaitu, guru menggunakan teknik pemodelan, bimbingan, sokongan, pengurangan, artikulasi, dan refleksi). Satu lagi kumpulan didedahkan kepada Modul Pengajaran Model Perantisan Kognitif Berstrata (SCTM), manakala kumpulan kawalan diajar menggunakan pengajaran konvensional (CI), yang terutamanya melibatkan kuliah guru, pengambilan nota oleh pelajar, dan penyelesaian kerja rumah. Kesan teknik pengajaran yang berbeza dinilai menggunakan ujian pra, ujian pasca, dan ujian pasca tertunda, yang dibandingkan dengan piawaian penilaian matematik MYP dan soal selidik yang mengukur motivasi dalam mempelajari matematik. Analisis kovarians (ANCOVA) dilakukan menggunakan SPSS, dan penemuan menunjukkan bahawa kumpulan SCTM menunjukkan prestasi yang lebih baik dalam kebolehan matematik, kemahiran menyelesaikan masalah, dan motivasi untuk belajar matematik berbanding kumpulan lain. Oleh itu, kajian ini menyokong penggunaan SCTM dalam matematik sekolah menengah, menunjukkan keberkesanannya sebagai teknik pengajaran. Penemuan kajian ini mencadangkan bahawa mengintegrasikan SCTM dengan kaedah pengajaran tradisional adalah pendekatan yang bermanfaat untuk meningkatkan prestasi matematik, kebolehan menyelesaikan masalah, dan motivasi pembelajaran pelajar. Keputusan yang menggalakkan daripada pendekatan SCTM memberikan asas yang kukuh untuk penerapannya dalam pengajaran matematik sekolah menengah dan mungkin mempengaruhi metodologi dan dasar pendidikan masa depan.

Kata Kunci: Kemahiran Penyelesaian Masalah, Motivasi Pembelajaran, Pendidikan Sekolah Menengah Cina, Perantisan Kognitif Berstrata, Prestasi Matematik

SDG: MATLAMAT 4: Pendidikan Berkualiti

ACKNOWLEDGEMENTS

As I approach the completion of my graduate studies, I write this acknowledgment with profound gratitude. This journey has been not only an academic exploration but also a voyage of personal growth and discovery.

I am deeply grateful to my supervisor, Dr.Nurul Nadwa Zulkifli, for her endless patience and guidance throughout this journey. Her professionalism and dedication have not only inspired me but also shaped my academic and personal growth. I am immensely thankful for her valuable contributions to my scholarly development. I also express my sincere gratitude to the members of the Supervisory Committee, Professor Dr. Ahmad Fauzi Mohd Ayub, for his keen professionalism and responsible work attitude, which have greatly influenced my research. His insightful advice and expertise have helped me navigate the complexities of my study. I can only imagine that I will be able to finish this project with their help.

Furthermore, I would like to thank all the educators who have supported me throughout this journey. Their support has been indispensable. I also want to thank my parents and my husband sincerely for their selfless love and support in pursuing my passions. Their support and encouragement have been a strong driving force behind my progress. A special thanks to my son, Jehu. Throughout these years of academic journey, he has shown incredible independence, allowing me to worry less. He takes care of his homework and his own needs, providing me with more time and energy to focus on my research. His maturity and self-reliance have been critical to my ability to persevere.

This doctoral dissertation is a testament to years of dedicated research, made possible by the collective support and understanding of my family and academic mentors. This journey has been of profound significance to me, both personally and academically, and I will forever cherish this experience.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Nurul Nadwa binti Zulkifli, PhD
Senior Lecturer
Faculty of Humanities, Management and Science
Universiti Putra Malaysia Bintulu Campus
(Chairman)

Ahmad Fauzi bin Mohd Ayub, PhD
Professor
Faculty of Educational Studies
Universiti Putra Malaysia
(Member)

____
ZALILAH MOHD SHARIFF, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 7 November 2024

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Development, Implementation, Evaluation
ANCOVA	Analysis of Covariance
CA	Cognitive Apprenticeship
CLT	Cognitive Load Theory
CAM	Cognitive Apprenticeship Model
DI	Differentiated Instruction
IB	International Baccalaureate
IBO	International Baccalaureate Organization
ID	Instructional Design
MYP	Middle Years Programme
MSLQ	Motivated Strategies for Learning Questionnaire
SCTM	Stratified based on Cognitive Apprenticeship Teaching Model
ZPD	Zone of Proximal Development

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The International Institute for Educational Planning explored the "shadow education" system in China, emphasizing its emergence due to the public education system's inability to meet the diverse needs of parents and students (Yung & Bray, 2017). "Shadow education," also known as private tutoring or supplementary education (Yu & Zhang, 2022), includes cram schools, private one-to-one tutoring, and exam preparatory courses and has become a global phenomenon (Mori & Baker, 2010). Chinese parents often seek extracurricular tutoring because public schools lack individualized instruction, leading to a uniform educational experience (Yang & Bray, 2018).

Chen (2019) found that mathematics teachers in China need more expertise in differentiated instruction, leading to inequalities and inconsistencies in teaching methodologies. Motivation and teacher-student cooperation substantially affect students' mathematics performance (Walde, 2019). Interactive teaching methods are essential for engagement but face obstacles such as a lack of proactive engagement and a tepid atmosphere (Xie, 2016). To overcome these problems, the Cognitive

Apprenticeship Model (CAM) enhances student interaction in technologically advanced learning environments and yields positive results (Sacchetta, 2022).

With the comprehensive implementation of curriculum reforms in China, stratified teaching has improved the overall quality of students (Sun, 2014). The 2017 Mathematics Curriculum Standards in China advocate for individualized mathematics education, making stratified teaching an effective measure to compensate for student differences (Tan, 2022). However, China's exam-oriented education has been widely criticized (Wang et al., 2020). Xue and Li (2023) advocate for student-centered education, inspired by the US model, which has cultivated talent and driven scientific advancement (Zhang, 2007). Student-centered learning, also known as learner-centered education, includes teaching methods that shift focus from the teacher to the student, aiming to develop learner autonomy and independence (Jones, 2007). According to Student-Centered Learning (2024), this approach contrasts with traditional teacher-centered education, where teachers typically decide what students will learn, how they will learn, and how learning outcomes will be assessed (Student-Centered Learning, 2024).

Thus, CAM benefits all students, especially those who are disadvantaged, disabled, or at risk, as it embeds learning in a work-like environment connected to their lives (Collins, 1987). CAM helps develop life skills, crucial for personal development and tackling real-life problems (Raju et al., 2021). Stratified teaching addresses the difficulties of unified teaching in mathematics education by recognizing the substantial variations in students' foundational understanding of the subject (Zhu et al., 2020). Therefore, this study examined several key teaching methods to implement and evaluate these educational strategies.

Stratified Cognitive Apprenticeship Teaching Module (SCTM): SCTM is an instructional approach that combines the principles of stratified teaching and CAM. It involves categorizing students based on their current knowledge, abilities, and potential and then applying tailored instructional strategies combined with CAM to each group. SCTM aims to optimize individual students' progress by addressing their specific learning needs and enhancing their performance, problem-solving abilities, and learning motivation in mathematics.

Conventional Instruction (CI): CI refers to the traditional teaching method. This approach typically involves a teacher-centered model in which the instructor delivers lectures and students passively receive information. The focus is on rote memorization and standardized testing, with limited emphasis on interactive or individualized learning experiences (Murphy et al., 2021).

Cognitive Apprenticeship Model (CAM): CAM is an educational framework that integrates traditional apprenticeship methods with formal education. It teaches students the thought processes and skills needed to solve complex tasks in the following six steps (Collins, Brown, & Newman, 1989).

1. **Modeling**: The teacher demonstrates the task and provides a clear example of how to perform it.
2. **Coaching**: The teacher observes and provides guidance and feedback when the student attempts the task.
3. **Scaffolding**: The teacher offers support as needed to help the student accomplish the task.
4. **Fading**: The teacher gradually removes support as the student becomes more proficient.
5. **Articulation**: The student articulates their knowledge and reasoning processes.
6. **Reflection**: The student reflects on their performance and compares it with that of an expert to understand their strengths and areas needing improvement.

This thesis focuses on implementing stratified teaching framed by CAM in high-school mathematics by examining the following points:

1. The development of stratified teaching to improve performance, problem-solving ability, and learning motivation among 9th-grade students.
2. The influence of stratified teaching on performance, problem-solving ability, and learning motivation.

3. Emphasize stratified teaching strategies based on CAM, evaluating its role in mathematics learning, integration into teaching, and development of CAM-based modules to promote performance, problem-solving ability, and learning motivation.

1.1.1 Stratified Teaching in Learning Mathematics

Stratified teaching categorizes students according to their knowledge, abilities, and potential to use tailored instructional strategies (Gong, 2021). Various interpretations exist around the globe, such as "personalized learning" in the UK, focusing on combining quality with equal opportunities (Wu, 2016). The US emphasizes individuality and diverse instructional approaches to engaging students (National Council of Teachers of Mathematics, 2014). South Korea's stratified teaching supports exceptional mathematics and science education (Jung, 2021).

China is transforming its approach from traditional methods to logical comprehension-based teaching, especially in high-school mathematics. Stratified teaching ignites students' interests, helps them overcome knowledge gaps, and enhances teaching effectiveness (Tu, 2018). Wang (2022) describes the disparities in study habits, cognitive attributes, and hobbies within a single classroom, supporting stratified teaching to address individual learning demands.

High school mathematics shows significant polarization, toward aptitude-based teaching (Chen, 2022). Although stratified teaching addresses instructional challenges and promotes equitable progress, barriers to successful implementation remain. Stratified teaching is fairly new in China, with issues in the preliminary investigation phase and a need for a comprehensive and scientifically sound system(Liu, 2015). Teachers' roles and concepts must evolve toward student-centered models (Gao, 2022). Recent curriculum reforms aim to cater to diverse student needs while promoting innovative talent (Gong, 2021).

China's traditional education system stifles creativity and independence; thus, more interactive teaching methods are needed (Wang & Hua, 2004). Nevertheless, the new college entrance examination reform plan advances mathematical core literacy, suggesting that traditional approaches are inadequate for contemporary talent development (Long, 2023).

1.1.2 Integration of the Cognitive Apprenticeship Model (CAM) in Stratified Teaching

Cognitive Apprenticeship Model (CAM), introduced by Collins and colleagues in 1989, combines traditional apprenticeship techniques with formal education to enhance cognitive and problem-solving abilities (Enkenberg, 1994). CAM promotes self-directed learning through imitation, coaching, exploration, and reflection, aligned with the goals of personalized education (Stalmeijer et al., 2009).

Studies have shown that CAM improves test scores and fosters autonomous cognition and self-drive (Foster, 2020). Cultivating self-regulated learning abilities, essential for stratified instruction, is a core component of CAM (Azevedo, 2004). However, CAM faces challenges, such as low student motivation and self-confidence (Collins et al., 1989; Brown et al., 2001; Chen, 2019). Thus, combining CAM with stratified instruction addresses these challenges and offers a personalized and dynamic educational environment (Ren, 2019). CAM improves collaboration through scaffolding, modeling, exploration, and reflection (Rodríguez-Bonces & Ortiz, 2016), making SCTM a beneficial technique for high school mathematics education in China.

1.2 Problem Statement

The "one size fits all" teaching approach in China's education system often overlooks individual student needs, leading to suboptimal academic outcomes (Zhang & Liu, 2022). Thus, the conventional teaching method is inadequate for complex problem-solving tasks, particularly in mathematics, where strict adherence to curriculum standards exacerbates these challenges (Wang, 2020). For a long time, mathematics education has heavily relied on traditional lecture-based teaching (Ardeleanu, 2019). In this model, the teacher assumes a central role by imparting content through lectures, while students passively acquire the information. Although this strategy is effective in transmitting substantial volumes of information, it frequently fails to actively involve pupils in the learning process. Studies suggest that whereas traditional lectures are excellent in conveying fundamental knowledge, they are less proficient in promoting advanced cognitive skills and problem-solving capabilities (Roehling & Bredow, 2021). Therefore, this strategy should be complemented with interactive instruction to overcome these constraints.Liu (2006) suggests that existing pedagogical methods stifle students' true mathematical potential. The current educational framework in China has generated considerable societal discord owing to its rigid adherence to conventional approaches, inciting extensive debate (Huang, 2022).Despite widespread attention and support for stratified teaching in modern education settings, its implementation often lacks a solid theoretical foundation. As expected, this gap leads to many personalized teaching practices that fail to improve student learning outcomes (Peng, 2019). In exam-centered education systems such as China's, where differentiated education is frequently discussed (Meng et al., 2021), there are still significant challenges in effectively implementing and evaluating these approaches (Gong, 2021).

Therefore, reassessing and adapting teaching methodologies in China is imperative. CAM offers a promising alternative, demonstrating its potential for enhancing problem-solving abilities (Zhao, 2021). A stratified teaching approach can tailor instruction based on students' cognitive levels and interests, provide diverse learning resources, and promote self-directed learning (Li, 2019). The decline in mathematics performance among high school students is an urgent problem (Stepp, 2016). Many students who excelled in mathematics during their elementary and middle school years face difficulties in high school (Chen & Wang, 2022). This decline is partly due to a substantial drop in learning motivation among high school students in China (Zhang et al., 2023). Despite recent curriculum reforms, traditional teaching methods remain prevalent and fail to meet contemporary demands for talent development (Long, 2023). Mathematics is pivotal in the Chinese college entrance examination (Gaokao), and proficiency in high school mathematics enhances the understanding of subjects such as physics and chemistry (Shen, 2022). Furthermore, mathematics literacy is essential for making well-founded judgments and decisions, and attaining indispensable qualities for constructive, engaged, and reflective citizens (OECD, 2023). Therefore, effective strategies for improving mathematical outcomes are essential.

Developing problem-solving skills is paramount in high school mathematics education. However, current teaching approaches are inadequate for improving this capacity. Szetela and Nicol (1992) posit that problem solving entails critical thinking, creativity, and adaptability. Recent studies by Fitriani et al. (2022) and Zhao (2021), using Pólya's (1945) approach, found that students struggle with mathematical problem solving. Liu (2024) conducted a bibliometric analysis of 521 articles published between 1993 and 2023, exploring the developmental trajectory, research hotspots, and trends in the study of problem-solving abilities among middle school students. The study found that research on problem-solving abilities is primarily concentrated in the sciences, particularly in mathematics, where significant challenges still exist.Thus, the present study aimed to investigate the effectiveness of stratified CAM-based teaching modules in improving students' problem-solving skills.

Learning motivation plays a crucial role in the progress and results of a learning process, particularly in mathematics. Feng (2011) and Woolfolk (2013) define learning motivation as the inclination to find significance in learning activities and derive their advantages. In mathematics, motivation can significantly impact student engagement, perseverance, and performance. For instance, mathematics learning often requires sustained effort and the ability to tackle challenging problems, making motivation a critical factor (Middleton & Spanias, 1999). Li and Liu (2008) found that learning motivation indirectly affects academic achievement in mathematics and is mediated by effective learning strategies. Tokan and Imakulata (2019) showed that intrinsic motivation directly affects learning behavior and mathematics achievement. Recent research by Zhang et al. (2023) confirmed that enhancing students' intrinsic motivation can significantly improve their mathematical performance. Ryan and Deci's Self-Determination Theory (2020) examines how human motivation is influenced by various regulatory self-governing processes, which are essential for fostering a deep understanding and appreciation of mathematics. One significant problem in China's math classrooms is the lack of student motivation, often due to traditional, teacher-centered instructional methods, despite recent curriculum reforms promoting student-centered approaches (Wang et al., 2022). Teacher-student interaction is crucial for motivation and learning; research indicates that teacher leadership and granting students more freedom can enhance emotions and math achievement, while traditional methods may hinder engagement (Lin et al., 2020). Motivation and engagement are essential for math achievement, but in China, primary students' motivation and engagement are influenced by teaching methods and classroom environment, with practices like rote learning and high-stakes testing sometimes reducing motivation (Xia et al., 2022).The current study used the Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich et al. (1993) to assess participants' learning motivation in mathematics and evaluated the efficacy of stratified teaching modules based on CAM within the Chinese educational system.

Functions play an essential role in high school mathematics and are integrated throughout the curriculum (National Council of Teachers of Mathematics (NCTM), 2023). Functions and their properties are foundational to advanced mathematical concepts and are essential for students' success in STEM fields (Wang & Liu, 2023). Zheng (2012) examined the importance of teaching mathematical functions in high school. Recent studies by Wang (2021) and Liu (2023) indicate that functions and relations are critical components of mathematical literacy and problem-solving skills. Thus, understanding their roles and relationships is essential for academic success in advanced mathematics and related fields, forming a foundational aspect of mathematics education. Thus, by adopting a novel teaching approach in this chapter, the method's efficacy in helping students overcome these challenges can be gauged (Xu, 2022).

In conclusion, this study seeks to develop, implement, and compare a stratified teaching approach based on CAM with traditional methodologies to ascertain the effectiveness of the former in the Chinese educational context.

1.3 Research Objectives

The main objectives of this thesis are:

1. To develop a Stratified Cognitive Apprenticeship Teaching Model (SCTM) for teaching mathematical functions and relations to 9th-grade students, using the ADDIE model (a framework consisting of five phases: analysis, design, development, implementation, and evaluation).

2. To determine the differences in mathematics performance of 9th-grade students, centered on functions and relations, based on the pre-test, post-test, and delayed post-test results of the SCTM, CAM, and conventional instruction (CI) strategies.

3. To determine the differences in the mathematics problem-solving ability of 9th-grade students, centered on functions and relations, based on the pre-test, post-test, and delayed post-test results of the SCTM, CAM, and CI strategies.

4. To determine the differences in the mathematics learning motivation of 9th-grade students, focused on functions and relations, based on the pre-test, post-test, and delayed post-test results of the SCTM, CAM, and CI strategies.

5. To identify and analyze errors in students' answer scripts concerning functions and relations in the pre-test, post-test, and delayed post-test across SCTM, CAM, and CI strategies.

6. To examine the problem-solving abilities reflected in students' answer scripts concerning functions and relations in the pre-test, post-test, and delayed post-test across SCTM, CAM, and CI strategies.

1.4 Research Questions

The current study attempts to answer the following questions:

1. How can the Stratified Cognitive Apprenticeship Model Teaching Module (SCTM) be applied to teaching mathematical functions and relations to 9th-grade students?

2. What are the effects of the CAM, SCTM, and CI strategies on the mathematics performance of 9th-grade students, centered on functions and relations (knowing and understanding, investigating patterns, communicating, and applying skills to real-life problems), based on the post-test and delayed post-test results?

3. What are the effects of the CAM, SCTM, and CI strategies on the mathematics problem-solving abilities of 9th-grade students, centered on functions and relations (understanding the problem, devising a plan, carrying out the plan, and looking back), based on the post-test and delayed post-test results?

4. What are the effects of the CAM, SCTM, and CI strategies on the motivation of 9th-grade students to learn about mathematical functions and relations (intrinsic goal orientation, extrinsic goal orientation, task value, and control of learning beliefs), based on the post-test and delayed post-test results?

5. How do the CAM, SCTM, and CI teaching strategies affect the identification and analysis of errors in the answer scripts of 9th-grade students, as reflected in both post-test and delayed post-test assessments?

6. How do the CAM, SCTM, and CI teaching strategies influence the problem-solving abilities of 9th-grade students, reflected in their answer scripts, through the analysis of their pre-test, post-test, and delayed post-test results?

1.5 Research Hypotheses

Based on research questions (RQs) 2–4, the following hypotheses were proposed:

RQ 2

H_{01}: There are no significant difference in the mean mathematics performance of the CAM, SCTM, and CI strategy groups in the post-test.

H_{02}: There are no significant difference between the CAM, SCTM, and CI strategy groups in mean mathematics performances performance of the CAM, SCTM, and CI strategy groups in the post-delayed test.

H_{03}: There are no significant differences in the mean mathematics performance score (knowing and understanding, investigating patterns, communicating, and applying skills to real-life problems) of the CAM, SCTM, and CI strategy groups in the post-test.

H_{04}: There are no significant differences in the mean mathematics performance score (knowing and understanding, investigating patterns, communicating, and applying skills to real-life problems) of the CAM, SCTM, and CI strategy groups in the post-delayed test.

RQ 3

H_{05}: There are no significant differences in the mean mathematics problem-solving abilities of the CAM, SCTM, and CI strategy groups in the post-test.

H_{06}: There are no significant differences in the mathematics problem-solving abilities means of the CAM, SCTM, and CI strategy groups in the post-delayed test.

H_{07}: There are no significant difference in the mean mathematics score for problem-solving abilities (in terms of understanding the problem, devising the plan, carry out the plan, and looking back) in the Post-test between the CAM, SCTM, and CI strategy groups.

H_{08}: There are no significant differences in the mean mathematics problem-solving scores (knowing and understanding, investigating patterns, communicating, and applying skills to real-life problems) of the CAM, SCTM, and CI strategy groups in the post-delayed test.

RQ 4

H_{09}: There are no significant differences in the mean learning motivation of the CAM, SCTM, and CI strategy groups in the post-test.

H_{10}: There are no significant differences in the mean learning motivation of the CAM, SCTM, and CI strategy groups in the delayed post-test.

H_{11}: There are no significant difference in the mathematics mean score of "learning motivation" (in terms of intrinsic goal orientation, extrinsic goal orientation, task value, and control of learning beliefs) in the Post-test between the CAM, SCTM, and CI strategy groups.

H_{12}: There are no significant differences in the mean mathematics learning motivation scores (intrinsic goal orientation, extrinsic goal orientation, task value, and control of learning beliefs) of the CAM, SCTM, and CI strategy groups in the delayed post-test.

1.6 Significance of the Study

This study examined the effectiveness of a stratified teaching model based on CAM in improving high school students' mathematics performance by focusing on functions and relations. In particular, this study aimed to assess whether using this teaching model leads to greater conceptual understanding and mastery of mathematics skills among students as well as increased problem-solving skills and motivation to learn the subject. This research is expected to contribute to developing practical pedagogical approaches for teaching mathematics in high school settings and inform future educational policies and practices.

The practical significance and value of this study is reflected in four main aspects:

1. Students can learn based on their individual development thanks to stratified instructions. Top students no longer feel bored, and those with learning issues can activate their learning interests. Teachers are less likely to overlook students in the middle range of abilities. Students can learn effectively based on their talents and learning requirements, and students from various backgrounds can grow, benefitting them and advancing their fundamental mathematical literacy.

2. Most instructors recognize that individual disparities between students are increasing and that stratified teaching is necessary, but few have implemented it. Thus, teachers must consider the actual requirements of students to implement stratified instruction, which will significantly enhance the development of high school mathematics education.

3. Empirical studies on stratified mathematics instruction in senior high schools are currently lacking in terms of psychology, pedagogy, and geography teaching theories. Hence, this study validates the impact of pertinent theories through empirical research in the context of the new college entrance test and curriculum requirements. Moreover, this study offers practical data to promote the reform of senior high school classroom instruction.

4. The integration of CAM (Cognitive Apprenticeship Model) into the stratified teaching framework is an essential aspect of the study's significance, as it

Connects the divide between theoretical knowledge and practical implementation in high school mathematics instruction.This study seeks to optimize students' cognitive engagement, cultivate a more profound comprehension of mathematical concepts, and facilitate the application of knowledge to novel and intricate issues by implementing CAM principle.This technique enhances stratified teaching by addressing individual learning needs and enhances the educational experience by highlighting the significance of context, expert modeling, scaffolding, and reflection in learning mathematics. Implementing CAM in a stratified teaching paradigm is anticipated to provide new perspectives on successful mathematics instruction and contribute to the advancement of adaptable and student-focused teaching methods.

The proposed study of the effectiveness of a stratified teaching model based on CAM has significant theoretical and practical value. Theoretically, this study will contribute to understanding the relationship between the cognitive apprenticeship theory and hierarchical teaching models, and how they can enhance high school mathematics education. Furthermore, this study provides insights into the potential benefits of incorporating interactive and collaborative learning strategies into the classroom setting.

Practically, this study's findings have implications for teachers, administrators, and policymakers interested in improving the quality of high school mathematics education. By evaluating the effectiveness of the proposed teaching model, this study aims to provide evidence-based recommendations to enhance teaching practices and curriculum development. Ultimately, this study may help educators and policymakers make informed decisions that benefit high school students' learning experiences and academic outcomes in mathematics.

The novelty of this study is evident in three main aspects. First, it conducts a stratified analysis of students through comparative experiments. Second, it investigates stratification research in high school mathematics instruction. Third, it validates the use of cognitive apprenticeship and CAM in stratified education through empirical investigation.

This study is innovative in applying the cognitive apprenticeship theory to develop a stratified teaching model for high school mathematics education. While the cognitive apprenticeship theory has been extensively studied in other fields, its application to mathematics education is fairly new. Furthermore, the proposed hierarchical instruction model represents a novel approach to teaching mathematics by incorporating conceptual understanding and skill development.

Moreover, this study's innovative approach focuses on interactive and collaborative learning strategies, which have been shown to enhance student engagement and motivation. By incorporating these strategies into the classroom, the proposed teaching model aims to create an immersive and dynamic learning environment that fosters mathematical abilities in the students.

Overall, this study's innovative teaching model, combined with an evaluation of its effectiveness, can significantly contribute to high school mathematics education. The findings of this research will inform the development of future pedagogical approaches and ultimately lead to improved mathematics learning outcomes for high school students.

1.7 Limitations of the Study

Although every effort was made to eliminate errors in the design and analytical components of this study, several limitations must be acknowledged. First, the data for this study came from a single international high school in China, whose student population differs from those of Chinese public high schools. This difference may limit the generalizability of the findings to a broader population. Second, this study focuses on the effects of a stratified education module based on CAM, using specific mathematical functions: linear, quadratic, and exponential. Thus, different results can be obtained if other mathematical topics are considered.

Furthermore, the scope of this study was confined to 9th-grade students at an international high school, meaning that the findings may differ for students from other grades or localities. The duration of the intervention was limited to only eight weeks. Thus, longer instruction periods may yield different outcomes, suggesting that future research could explore these effects over extended periods. Despite efforts to standardize teaching levels by consulting specialists to evaluate participating teachers, variability in teaching quality remains unavoidable. This may have affected the results, indicating the need for more rigorous control or assessment of teaching practices in future studies.

Moreover, although CAM and stratified education theoretically complement each other, their practical implementation may face challenges. Therefore, teachers require sufficient training and support to implement CAM and stratified education. Hence, educational institutions should provide the necessary resources to support these teaching methods. Recognizing these limitations is crucial for future research to overcome these issues and enhance the validity and applicability of the findings in diverse educational contexts.

1.8 Operational Definitions

The following definitions are given to help comprehend the terms used in this study.

1.8.1 Stratified Teaching

Stratified instruction is an educational approach that organizes students into different groups based on their knowledge and abilities (He, 2022). This method, developed by Liu (2006) and Cai (2022), involves classifying students into homogeneous groups according to their current knowledge, abilities, and potential and then providing tailored instruction to each group. In the current study, stratified teaching allocated students to high- and low-performance classes based on their performance on a pre-test. Subsequently, teaching strategies, curriculum pacing, and instructional content were adapted to meet each class' s unique needs and skills. The effectiveness of stratified teaching was measured using pre-test, post-test, and delayed post-test scores, which assessed students' performance in functions and relations, linear functions, quadratic functions, and other functions.

1.8.2 Cognitive Apprenticeship Model (CAM)

As described by the University of Southern California, a learning module is a curated compilation of cohesively presented educational materials in an academic environment. In educational contexts, a module refers to an instructional unit focusing on a specific subject, usually involving student-centered activities and culminating in a project demonstrating understanding (Stephen, 2022). In this study, the module referred to a new stratified teaching module developed using CAM. CAM incorporates six essential attributes, as defined by Collins et al. (1989) and highlighted by Butler and Peabody (2019): modeling, coaching, scaffolding, articulation, reflection, and exploration. The implementation and effectiveness of the CAM-based module were evaluated through performance tests and rubrics of problem-solving skills and learning motivation.

1.8.3 Performance

Performance is defined as encompassing both traditional outcomes, such as test scores or essay writing quality, and practical skills, such as constructing a circuit in a science class (Double et al., 2020). According to Wegner (2009), performance is a holistic assessment of a child's physical, developmental, and emotional progress. Ward et al. (1996) mention that academic performance evaluation typically involves exams or ongoing assessments; however, there is still no universally agreed-upon way to conduct these evaluations. Within this framework, this study defined performance concerning the evaluation criteria of International Baccalaureate (IB) mathematics, encompassing knowing and understanding, investigating patterns, communicating, and applying mathematics in real-life contexts (IBO, 2023).

Performance was measured through tests using the assessment criteria of the IB MYP mathematics framework. The pre-test, post-test, and delayed post-test (refer to Appendices B, C, and D, respectively) included content related to functions and relations, linear functions, quadratic functions, and other functions, their graphs, and uses. Each test was divided into four parts according to the MYP mathematics assessment criteria, and each item was scored on a 100-point basis.

Knowing and Understanding

According to the Stanford Encyclopedia of Philosophy, "knowing" pertains to possessing beliefs or information concerning a particular subject. Knowing encompasses awareness and gaining knowledge, information, or skills through structured or individualized education. However, the concept of "understanding" extends beyond mere knowledge. According to BYJU, this refers to the capacity to elucidate, situate, and grasp information and ideas. Comprehension entails a more profound understanding of the importance of knowledge, incorporating it into a more inclusive structure, and applying it in diverse circumstances. This study defines knowing and understanding based on the 2023 criteria set by the International Baccalaureate Organization (IBO), which assesses student competence in mathematics. This includes their capacity to choose suitable mathematical methodologies for both familiar and novel issues, apply these selected methodologies, and resolve problems in diverse contexts (IBO, 2023).

Investigating Patterns

In psychology and social sciences, pattern analysis identifies and elucidates changes in behavior, events, and other phenomena over time (Miller, 2021). "Investigating patterns" in mathematics identifies repetition or regularity in numbers, shapes, or equations. Sequences, geometric forms, algebraic structures, and other mathematical entities are often analyzed to determine patterns and relationships. The goal is to discover fundamental mathematical concepts or theorems (Chen, 2021). In this study, patterns were assessed based on IBO's (2023) description, which refers to students' proficiency in using mathematical techniques to uncover complex patterns, express these patterns through consistent general principles, and validate identified rules.

Communicating

Mathematical communication includes the ability to arrange and connect mathematical thoughts using different modes of communication, clearly and logically communicate mathematical ideas to peers, teachers, and others, critically evaluate and appraise others' mathematical thinking and strategies, and employ mathematical language to express mathematical concepts (Rohid et al., 2019). Here, communication skills were assessed based on the description provided by the IBO (2023), which refers to using appropriate mathematical language, transition between representations, and articulation of a coherent, logical progression of ideas.

Applying Mathematics in Real-Life Contexts

Applying mathematics in real-life contexts refers to incorporating real-world scenarios into curricula and assessments to enhance the practical application of mathematical concepts (Smith & Morgan, 2016). Here, "applying mathematics in real-life contexts" was evaluated based on the description provided by the IBO (2023), which evaluates students' adeptness in identifying relevant elements of real-life situations, selecting and applying suitable mathematical strategies for these situations, and justifying the accuracy and relevance of the solutions derived.

1.8.4 Problem-Solving Ability

Problem solving is essential in mathematics education as it is crucial for developing deep comprehension and enhancing students' mathematical skills. This enables educators to assess students' prior knowledge, skills, and starting points, facilitating an effective mathematics teaching and learning process (Palmér & Boumel, 2020). Problem solving also refers to applying knowledge, reasoning, and critical thinking to solving complex problems. Problem-solving skills involve identifying a problem, generating possible solutions, evaluating them, and selecting the best one (Schoenfeld, 1985). This study adopted Pólya's framework to measure students' problem-solving abilities, including understanding a problem, devising a plan, carrying it out, and looking back (Pólya, 1945). Effectiveness was measured using rubrics based on P ólya's steps, with scores ranging from zero to three points for each step (Fitriani et al., 2020).

Understanding the Problem

This initial stage is fundamental for understanding the nature of the problem, distinguishing between known and unknown elements, and precisely defining what the problem is about (Pólya, 1945). Effectiveness was measured by evaluating the students' ability to identify the requirements for solving a given problem.

Devising a Plan

After understanding the problem, the next phase involves strategizing a solution that may include selecting an appropriate method, partitioning the problem, or hypothesizing (Pólya, 1945). Effectiveness was measured by assessing the students' plans and strategies to solve problems.

Carrying Out the Plan

A planned strategy is implemented in this phase. This requires diligent application of the chosen methods and may necessitate adjustments to the initial plan (Pólya, 1945). Effectiveness was measured by evaluating the execution of the strategy and the correctness of the solution.

Looking Back

Pólya (1945) emphasizes the importance of post-solution reflection, involving a review of the solution and the process, enabling a more profound learning experience, and enhancing problem-solving skills. Effectiveness was measured by assessing the students' reflections on their solutions and processes, including identifying errors and considering alternative methods.

1.8.5 Motivation

Motivation drives behavior and influences whether individuals engage in specific actions essential for learning and achieving (Guay et al., 2010). In educational contexts, motivation is a critical component of curriculum effectiveness (Filgona et al., 2020). The current study focused on understanding motivation through intrinsic and extrinsic goal orientations, task value, and control of learning beliefs, using the MSLQ framework outlined by McKeachie et al. (1986). Effectiveness was measured using a seven-point Likert scale.

Intrinsic Goal Orientation

Intrinsic goal orientation reflects the degree to which a student engages in a task because of internal drivers such as wanting to face a challenge, curiosity, and mastery (McKeachie et al., 1986). Ryan and Deci (2017) posit that intrinsic goal orientation is motivated by internal factors, including personal interest, enjoyment of learning, and a sense of accomplishment from mastering a subject. Here, a modified version of the MSLQ developed by Pintrich et al. (1991) was used to assess students' intrinsic goal orientation in mathematics classes, focusing on their motivation derived from challenges, curiosity, and an intrinsic desire to understand mathematical concepts.

Extrinsic Goal Orientation

Extrinsic goal orientation pertains to the extent to which a student's engagement in a task is motivated by external factors such as grades, rewards, evaluations by others, and competition (McKeachie et al., 1986). Wigfield and Eccles (2020) define extrinsic goal orientation as the degree of academic engagement driven by external incentives, such as grades, honors, or the approval of others. The MSLQ developed by Pintrich et al. (1991) was used to evaluate students' extrinsic goal orientation in mathematics classes, focusing on achieving high grades, improving overall grade point averages, surpassing peers, and seeking validation and recognition from external sources.

Task Value

Task value refers to a student's assessment of a task's level of interest, importance, and utility. This differs from goal orientations, which concern the underlying reasons for a student's engagement in a task (McKeachie et al., 1986). Eccles and Wigfield (2020) emphasize that task value involves how students perceive the course material regarding its interest, importance, and practical utility. The MSLQ developed by Pintrich et al. (1991) was used to measure students' perceptions in this domain, regarding how they valued the interest, importance, and applicability of mathematics coursework.

Control of Learning Beliefs

Controlling learning beliefs relates to students' convictions about the effectiveness of their efforts to achieve positive learning outcomes (McKeachie et al., 1986). An updated version of the MSLQ was used to assess students' beliefs in this area. Control of learning embodies the belief that success in an academic setting, such as a mathematics course, is primarily attributable to personal efforts and effective study strategies.

1.9 Summary

This chapter introduces a stratified teaching model based on CAM for high school mathematics. This chapter discusses the rationale for using a stratified approach and the benefits of cognitive apprenticeship. It outlines the research background, objectives, hypotheses, and research questions that underpin this study. This chapter also provides a clear problem statement, highlighting the need for an effective instructional model for teaching high school mathematics. Finally, this chapter sets the stage for this study by providing a comprehensive overview of the theoretical and practical issues developed by the proposed model.To help comprehend the terms of this study, the following definitions are given.

REFERENCES

Adarkwah, M. A. (2021). The power of assessment feedback in teaching and learning: A narrative review and synthesis of the literature. *SN Social Sciences, 1*(75). https://doi.org/10.1007/s43545-021-00086-w

Agarwal, P. K., Karpicke, J. D., Kang, S. H. K., Roediger, H. L., & McDermott, K. B. (2008). *Examining the testing effect with open- and closed-book tests*. Applied Cognitive Psychology, 22(7), 861-876.

Alwafi, E. M. (2023). The impact of designing an online learning environment based on cognitive apprenticeship on students' critical thinking and interaction in CSCL. *Education Tech Research and Development, 71*(2), 441–457. https://doi.org/10.1007/s11423-022-10180-2

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives.* Longman.

Ardeleanu, R. (2019). Traditional and modern teaching methods in mathematics. *Journal of Innovation in Psychology, Education and Didactics, 23*(2), 133-140. Retrieved from https://jiped.ub.ro/wp-content/uploads/2019/12/JIPED_23_2_2019_1.pdf

Ary, D., Jacobs, L. C., Sorensen, C. K.,&Walker, D. (2013) . *Introduction to research in education* ,Wadsworth Cengage Learning.

Athabasca University. Faculty of Humanities and Social Sciences. (2017, March). *Psychology Learning Resources - Internal Validity Tutorial: Experimental Mortality.*https://psych.athabascau.ca/open/validity/mortality.php

Awofala, A. O., & Lawani, A. O. (2020). Increasing mathematics achievement of senior secondary school students through differentiated instructio. *Journal of Educational Studies*, 4(1), 1-19. https://doi.org/10.31258/jes.4.1.p.1-19

Azevedo, R. (2004). Using hypermedia as a metacognitive tool for enhancing student learning? The role of self-regulated learning. *Educational Psychologist*, 39(4), 199-209.

Azizah, D., & Fadlikah, V. (2023). Analysis Of Mathematical Problem-Solving Ability In View Of Mathematical Disposition. *Mathline: Jurnal Matematika Dan Pendidikan Matematika*, 8(1), 153–169. https://doi.org/10.31943/mathline.v8i1.298

Baldwin, L. (2018). Research Concepts for the Practitioner of Educational Leadership. *In Research Concepts for the Practitioner of Educational Leadership* (pp. 31-36). Brill. https://doi.org/10.1163/9789004365155_007

Bakar, A. R., Mohamed, S., & Zakaria, Z. (2018). The Fun Learning Enrichment Program (FLEP) module: Boosting motivation among underachieving pupils. *Journal of Education and Learning, 7*(3), 123-135. https://doi.org/10.3844/jssp.2012.497.504

Bai, Y. Y., & Ma, Y. P. (2021). How to take care of students' diversity starting from teachers' teaching: A study on the mathematics teaching practice of four Canadian primary school teachers. *Global Education Outlook*, 50(5), 114-128. https://doi.org/10.3969/j.issn.1009-9670.2021.05.009

Barana A., Boetti G., & Marchisio, M. (2022). Self-assessment in the development of mathematical problem-solving skills. *Education Sciences*, 12(2), 81. https://doi.org/10.3390/educsci12020081

Baig, M. I., & Yadegaridehkordi, E. (2023). Flipped classroom in higher education: A systematic literature review and research challenges. *International Journal of Educational Technology in Higher Education, 20*(1), 61. https://doi.org/10.1186/s41239-023-00430-5

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W H Freeman/Times Books/ Henry Holt & Co.

Black, K. (2017). *Business statistics: For contemporary decision making*. John Wiley & Sons.

Boaler, J., Wiliam, D., & Zevenbergen, R. (2000). The construction of identity in secondary mathematics education. *Social Constructivist Teaching: Affordances and Constraints, 192*, 192-216.

Borman, G. D., Hewes, G. M., Overman, L. T., & Brown, S. (2003). Comprehensive school reform and achievement: A meta-analysis. *Review of Educational Research*, 73(2), 125–230. https://doi.org/10.3102/00346543073002125

Branch, R. M. (2022). Instructional Design: The ADDIE Approach. Springer.

Bray,M (2006) Private supplementary tutoring: Comparative perspectives on patterns and implications. *Compare: A Journal of Comparative and International Education 36*(4): 515–530.

Brill, J., Kim, B., & Galloway, C. (2001). Cognitive apprenticeships as an instructional model. In M. Orey (Ed.), *Emerging Perspectives on Learning, Teaching, and Technology*, Chapter 5.

Brown, J. S., Collins, A. & Duguid, P. (1989). Situational cognition and learning culture. *Educational Researcher*, 8, 32–42.

Bruin, L. R. (2019). The use of cognitive apprenticeship in the learning and teaching of improvisation: Teacher and student perspectives. *Research Studies in Music Education*, 41(3), 261–279.

Butler, B. A., Butler, C. M., & Peabody, T. D. (2019). Cognitive Apprenticeship in Orthopaedic Surgery: Updating a Classic Educational Model. *Journal of Surgical Education*, 76(4), 931–935. https://doi.org/10.1016/j.jsurg.2019.01.009

BYJU's. (n.d.). *Difference between Knowledge and Understanding*. Retrieved from https://byjus.com/english/difference-between-knowledge-and-understanding/

Cakmakci, G., Aydeniz, M., Brown, A., & Makokha, J.M. (2020). Situated cognition and cognitive apprenticeship learning. In B. Akpan & T.J. Kennedy (Eds.), *Science education in theory and practice* (Springer Texts in Education). Springer, Cham. https://doi.org/10.1007/978-3-030-43620-9_20

Calder, B. J., He, S., & Sternthal, B. (2023). Using theoretical frameworks in behavioral research. *Journal of Business Research*, 161, 113758. https://doi.org/10.1016/j.jbusres.2023.113758

Cankoy, O. (2014) . Interlocked problem posing and children's problem-posing performance in free structured situations. *International Journal of Science and Mathematics Education*, 12 (1): 219-238 Https:/doi. org/10.100.

Cai, Q. (2022). Adapting teaching to student learning: The application of stratified teaching in junior high school mathematics education. *Contemporary Family Education*, (12), 3.

Charles, R., Lester, F., & O'Daffer, P. (1987). *How to evaluate progress in problem-solving*. National Council of Teachers of Mathematics.

Chang, C. Y. (2020) . Research on the dilemma and countermeasures of stratified teaching of mathematics in senior high school. *Middle school curriculum guidance: Teacher communication,* (4), 1.

Chang, K. E., Wu, L. J., Wen, S. E.,&Sung, Y. T. (2012) Embedding game-based problem-solving phase into problem posing system for mathematics learning. *Computers and Education*, 58 (2): 775-786 Http:/doi.org/10.1016/j.compedu.2011.10.002

Chaiklin, S. (2003). The zone of proximal development in Vygotsky's analysis of learning and instruction. In A. Kozulin, B. Gindis, V. S. Ageyev, & S. M. Miller (Eds.), *Vygotsky's educational theory in cultural context* (pp. 39–64). Cambridge University Press. https://doi.org/10.1017/CBO9780511840975.004

Claro, S., Paunesku, D., & Dweck, C. S. (2016). Growth mindset tempers the effects of poverty on academic achievement. *Proceedings of the National Academy of Sciences*, 113(31), 8664-8668. https://doi.org/10.1073/pnas.1608207113

Chen, L. (2021). Pattern recognition in mathematical sequences. *Journal of Mathematical Theory*, 44(3), 204-219.

Chen, L., Zhang, Y., & Liu, X. (2018). The impact of modular teaching on mathematics education in Chinese high schools. *Journal of Mathematics Education, 12*(3), 45-58.

Chen, X. H. . (2017). Reflections on the shortcomings and effective implementation of stratified teaching in junior high school mathematics classrooms. *Mathematics Learning and Research* , (23), 1.

Chen, J. G. (2009). Research on cognitive apprenticeship. (Doctoral dissertation,East China Normal University). Retrieved from https://www.cnki.net/

Chen, X. (2019). An analysis of challenges for mathematics teachers in implementing differentiated instruction in China. *International Journal of Science and Mathematics Education*, 17(3), 523-538

Chen, X. (2018). Silent exterior, engaged mind: An empirical study on the learning characteristics of Chinese students in large class settings. (Doctoral dissertation, Nanjing University).

Chen, W. Y. (2013). Enhancing student effective learning through interactive teaching. *Examination Weekly*, (40), 2.

Chuah, S.-H. (2010). Teaching East-Asian Students: Some Observations. *Economics Network*. https://doi.org/10.53593/n1187a

Ciolino, J. D., Palac, H. L., Yang, A., & others. (2019). Ideal vs. real: A systematic review on handling covariates in randomized controlled trials. *BMC Medical Research Methodology, 19*(1), 136. https://doi.org/10.1186/s12874-019-0787-8

Collins, A. (1987). Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and Mathematics. *Technical Report* No. 403.

Collins, A. (1991). A Cognitive Apprenticeship for Disadvantaged Students.

Collins, A., Hawkins, J., & Carver, S. (1991). A cognitive apprenticeship for disadvantaged students. In B. Means, & M. S. Knapp (Eds.), *Teaching advanced skills to educationally disadvantaged students*. Data Analysis Support Center (DASC) Task 4. Final report.

Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: Making thinking visible. *American educator*, 15(3), 6-11.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction*: *Essays in honor of Robert Glaser* (pp. 453–494). Lawrence Erlbaum Associates, Inc.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Cuncic, A. (2024, June 24). *Internal validity vs. external validity in research: What they tell us about the meaningfulness and trustworthiness of research.* Verywell Mind. https://www.verywellmind.com/internal-and-external-validity-4584479

Dahl, T. L., Græslie, L. S., & Petersen, S. A. (2021). Using interactive technology for learning and collaboration to improve organizational culture: A conceptual framework. In Zaphiris, P., & Ioannou, A. (Eds.), *Learning and Collaboration Technologies: New Challenges and Learning Experiences* (Vol. 12784, pp. 23-34). Springer. https://doi.org/10.1007/978-3-030-77889-7_2

Darling-Hammond, L., & Richardson, N. (2009). Teacher learning: What matters? *Educational Leadership*, 66(5), 46-53.

Davis, J. P., Du, J., Tang, J. H., Qiao, L., Liu, Y. Q., & Chiang, F. K. (2020). Uniformity, diversity, harmony, and emotional energy in a Chinese STEM classroom. *International Journal of STEM Education*, 7(1), 1–15. https://doi.org/10.1186/s40594-020-00232-5

De Jong, T., & van Joolingen, W. R. (2020). Fostering self-regulated learning with cognitive apprenticeship in intelligent tutoring systems. *Computers & Education*, 157, 103955.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11(4)*, 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Dede, C. (2009). Immersive interfaces for engagement and learning. *Science*, 323(5910), 66-69.

Dixon, S. D., & Stein, M. T. (2005). *Encounters with Children: Pediatric Behavior and Development* (4th ed.). Mosby.

Double, K. S., McGrane, J. A., & Hopfenbeck, T. N. (2020). The Impact of Peer Assessment on Academic Performance: A Meta-analysis of Control Group Studies. *Educational Psychology Review*, 32(2), 481–509. https://doi.org/10.1007/s10648-019-09510-3

Dorier, J. L., & Maass, K. (2020). Inquiry-Based Mathematics Education. In S. Lerman (Ed.), *Encyclopedia of Mathematics Education*. Springer, Cham. https://doi.org/10.1007/978-3-030-15789-0_176

Drezner, Z., Turel, O., & Zerom, D. (2008). A Modified Kolmogorov-Smirnov Test for Normality. *Communication in Statistics- Simulation and Computation*, 39(14385). https://doi.org/10.1080/03610911003615816

Duarte da Silva, B., Lencastre, J. A., Bento, M., & Osório, A. J. (Eds.). (2019). *Experiences and perceptions of pedagogical practices with Game-Based Learning & Gamification*. Research Centre on Education (CIEd), Institute of Education, University of Minho.

Dewey, J. (1938). *Experience and education.* Macmillan: New York.

Eccles, J. S., & Wigfield, A. (2020). Motivational beliefs, values, and goals. *Annual Review of Psychology*, 53, 109-132.

Eccles, J. S., Wigfeld, A., & Schiefele, U. (1998). Motivation to succeed. In W. Damon & N. Eisenberg(Eds.), *Handbook of child psychology: Social, emotional, and personality development* (pp. 1017-1095). John Wiley & Sons, Inc.

Elliot, A. J., McGregor, H. A., & Gable, S. (1999). Achievement goals, study strategies, and exam performance: A mediational analysis. *Journal of Educational Psychology*, 91(3), 549-563.

Enkenberg, J. (1994). Situated cognition and cognitive apprenticeship. New frameworks for education of professional skills. *Vocational Education and Culture: European Prospects from History and Life-History*, 201–216.

Fadzil, M., & Mahmud, R. (2020). Enhancing higher-order thinking skills (HOTS) through STEM modules. *Journal of STEM Education, 21*(2), 45-60. https://doi.org/10.1007/978-981-19-2596-2_9

Fang, J. C. (2021). Layered teaching model for primary and secondary schools based on blended learning: Concept, elements, and design. *China Education Informatization·Basic Education]*, 2021(1), 8-14.

Fan-Ray Kuo, Gwo-Jen Hwang, Szu-Chuang Chen, & Sherry Y. Chen. (2012). A Cognitive Apprenticeship Approach to Facilitating Web-based Collaborative Problem Solving. *Journal of Educational Technology & Society*, 15(4), 319–331. http://www.jstor.org/stable/jeductechsoci.15.4.319

Filgona, J., Sakiyo, J., Gwany, D. M., & Okoronka, A. U. (2020). Motivation in learning. *Asian Journal of Education and Social Studies*, *10*(4), 16-37. https://doi.org/10.9734/AJESS/2020/v10i430273

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologis*t, 34(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Fitriani, F., Hayati, R., Sugeng, S., Srimuliat, S., & Herman, T. (2022). Students' ability to solve mathematical problems through Polya steps. *Journal of Engineering Science and Technology*, Special Issue on ICMScE2022, 25-32.https://jestec.taylors.edu.my/Special%20Issue%20ICMScE2022/ICMScE2022_04.pdf

Field, A. (2018). *Discovering Statistics Using IBM SPSS Statistics*. SAGE Publications.

Foster, K. (2020). The Effects of Math Literacy Utilizing a Reading Apprenticeship Framework on Math Achievement of Analytic Geometry Students (Doctoral dissertation, Mercer University).

Fraenkel, J. R., Wallen, N. E., & Hyun, H. (2012). *Internal effectiveness. How to design and evaluate educational research*. McGraw Hill.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America*, 111(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Frigge, M., Hoaglin, D. C., & Iglewicz, B. (1989). Some implementations of the boxplot. *The American Statistician*, 43(1), 50. https://doi.org/10.2307/2685173

Fraser, B.J. (2012). Classroom Learning Environments: Retrospect, Context and Prospect. In: Fraser, B., Tobin, K., McRobbie, C. (eds), *Second International Handbook of Science Education*. Springer International Handbooks of Education, vol 24. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-9041-7_79.

Frensch, P. A., & Funke, J. (Eds.). (1995). *Complex problem solving: The European perspective*. Lawrence Erlbaum Associates, Inc.

Gao, Y. (2022). Research and practice of student-centered teaching models: The case of accounting major at Zhengzhou Business College. *Marketing World*, (6), 56-58.

Gong, X. G. (2021). Exploration of the mathematics stratified teaching model for higher grades in primary schools, (Master's thesis, Southwest University). https://link.cnki.net/doi/10.27684/d.cnki.gxndx.2021.00411.

Gonzales, P., C. Calsyn, L. Jocelyn, K. Mak, D. Kastberg, S. Arafeh, T. Williams, and W. Tsen. 2000. *Highlights from the Third International Mathematics and Science Study-Repeat (TIMSS-R)*. Washington, D.C.: U.S. Department of Education.

Green, C., & Harrington, C. (2020). *Student-centered learning: In principle and in practice.* Michigan Virtual Learning Research Institute. https://michiganvirtual.org/research/publications/student-centered-learning-in-principle-and-in-practice/

Grissom, T. (2017, March 1). *How to use OneNote for teaching and learning.* Microsoft. https://www.microsoft.com/en-us/education/blog/how-to-use-onenote-for-teaching-and-learning/

Gredler, M. E., Broussard, S. C., & Garrison, M. E. B. (2004). The relationship between classroom motivation and academic achievement in elementary school-aged children. *Family and Consumer Sciences Research Journal*, 33(2), 106-120.

Guo, P. (2021). Technological advancements in CAM's applicability: Leveraging cognitive apprenticeship to overcome educational challenges and improve engagement and learning outcomes. *Journal of Educational Technology & Society.*

Hafeez, M. (2021). Project-based versus traditional lecture teaching methods. *Edutec Journal of Education and Technology, 4*(4).

Hatisaru, V. (2023). Mathematical connections established in the teaching of functions. Teaching Mathematics and its Applications: An International *Journal of the IMA, 42*(3), 207–227. https://doi.org/10.1093/teamat/hrac013

Hassan, M. (2024). *Quasi-Experimental Research Design – Types, Methods.* Retrieved from https://researchmethod.net/quasi-experimental-design/.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-ana lyses related to achievement*. London: Routledge.

Hansen, E., & Feldman, L. (2019). Competency-based learning: Design and application in health professions education. *American Journal of Pharmaceutical Education*, 83(9), Article 7854.

Han, H., & Røkenes, F. M. (2020). Flipped classroom in teacher education: A scoping review. *Frontiers in Education, 5,* 601593. https://doi.org/10.3389/feduc.2020.601593

He, F. C. (2022). Exploration of stratified teaching in elementary school mathematics classrooms]. *Reading, Writing, and Arithmetic*, (36), 78-80.

Herro, D., Quigley, C., & Andrews, J. (2021). Does cognitive apprenticeship improve STEM education outcomes? A meta-analysis of quasi-experimental and experimental studies. *Review of Educational Research*, 91(2), 219-267.

Hossler, D., & Altbach, P. G. (2009). The Internationalization of Postsecondary Education: Trends, Challenges, and Opportunities. *American Council on Education/Center for Internationalization and Global Engagement*.

Hua, G. D. (2001). *Theory of differentiated instruction*. Education Science Publishing House.

Huang, J. (2022). Major Issues About Teaching and Learning in China: 2022 International Conference on Social Sciences and Humanities and Arts (SSHA 2022), Nanjing, China. https://doi.org/10.2991/assehr.k.220401.210

Hu, Q. F. (2014). A study on the classroom practice of tiered teaching in primary school English education. Beijing Normal University, *Faculty of Foreign Language Education*. Retrieved from http://flts.bnu.edu.cn.

Huck, S. W., Cormier, W. H., & Bounds, W. G. (2004). *Reading statistics and research* (6th ed.). Pearson.

Hwang, G. J., & Wu, P. H. (2019). Innovations in cognitive apprenticeship strategies for enhancing technology-integrated learning. *Computers & Education*, 138, 13-25.

International Baccalaureate (IB). (2023, June 6). The impact of an IB education. https://www.ibo.org/

Jansen, T., Meyer, J., Wigfield, A., & Möller, J. (2022). Which student and instructional variables are most strongly related to academic motivation in K-12 education? A systematic review of meta-analyses. *Psychological Bulletin, 148*(1-2), 1–26. https://doi.org/10.1037/bul0000354

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research.* Interaction Book Company.

Johnson, David & Johnson, Roger. (2015). Cooperative Learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching*. 25. 85-118.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A., & Ludgate, H. (2016). *NMC horizon report: 2016 higher education edition*.The New Media Consortium.

Finstad, K. (2010). Response interpolation and scale sensitivity: Evidence against 5-point scales. *Journal of Usability Studies, 5*(3), 104-110.

Jung, J. (2021). Education and Social Stratification in South Korea. *Social Science Japan Journa*l, 25(1), 173-176. https://doi.org/10.1093/ssjj/jyab040

Kaya, M., & Erdem, C. (2021). Students' well-being and academic achievement: A meta-analysis study. *Child Indicators Research, 14*(5), 1743–1767. https://doi.org/10.1007/s12187-021-09821-4

Kaufmann, O. T., Larsson, M., & Ryve, A. (2023). Teachers' error-handling practices within and across lesson phases in the mathematics classroom. *International Journal of Science and Mathematics Education, 21,* 1289-1314

Kazdin, A. E. (2003). *Research Design in Clinical Psychology*. Allyn & Bacon.

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education, 3*(1), 1-11. https://doi.org/10.1186/s40594-016-0046-z

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education, 6*(1), 1-16. https://doi.org/10.1186/s40594-018-0151-2

Khalil, M., & Yousuf, M. (2021). The impact of modular teaching on students' mathematics achievement. *Educational Research and Reviews, 16*(4), 234-245. https://doi.org/10.1108/JARHE-06-2021-0243

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. *Educational Psychologist*, 41(2), 75-86.

Kurt, S. (2017). ADDIE Model: Instructional Design. *Educational Technology*. https://educationaltechnology.net/the-addie-model-instructional-design/#addie-stages

Kurt, S. (2021). Cognitive Apprenticeship. *Educational Technology.* https://educationaltechnology.net/cognitive-apprenticeship/

Lasley, T. J. (2024, February 21). Bloom's taxonomy. *Encyclopedia Britannica*. https://www.britannica.com/topic/Blooms-taxonomy

LaMarca, V. J., & LaMarca, J. M. (2024). Using the ADDIE model of instructional design to create programming for comprehensive ABA treatment. *Behavior Analysis in Practice, 17*(2), 371–388. https://doi.org/10.1007/s40617-024-00908-2

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge University Press.

Leong, Y. H., Tay, E. G., Toh, T. L., Quek, K. S., & Dindyal, J. (2011). Reviving Pólya's "Look Back" in a Singapore School. *The Journal of Mathematical Behavior*, 30, 181–193.

Lee, A., & Carter, S. (2020). Challenges of traditional teaching methods in the 21st century. *Educational Research Review*, 37, 58-70.

Levin, J., & Waugh, M. (1998). Teaching teleapprenticeships: Electronic network-based educational frameworks for improving teacher education. *Interactive Learning Environmen*ts, 6(1–2), 39–58.

Li, M. (2016). Module-based teaching in Chinese education reform: A case study. *Journal of Education and Learning*, 10(2), 123-130.

Li, F. J., & Liu, W. (2008). The relationship between college students' learning strategies, learning motivation, and academic performance. *Educational Study*, 3(4).

Li Y.L. (2020). Research on the application of cognitive apprenticeship in training pupils' scientific problem-solving skills (master's thesis, Liaocheng University) https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202202&filename=1020375449.nh

Li, Y. (2019). Stratified teaching in mathematics education. *Journal of Educational Research*, *112*(2), 205-217. https://doi.org/10.1080/00220671.2018.1496051

Li, Y., & Wang, L. (2018). Using iPad-based mobile learning to teach creative engineering within a problem-based learning pedagogy.*Education and Information Technologies*, *23*(2), 555–568. https://doi.org/10.1007/s10639-017-9617-y

Liao, J. L. (2019). An empirical study on the impact of hierarchical teaching on rural junior high school students' English reading,(Master's thesis, Hunan Normal University).

Lin, N. (2017). The application of stratified teaching in elementary mathematics education]. *Reading Writing Calculations (Teacher's Edition): Quality Education Forum*, (9), 101-102.

Lin, W., Yin, H., Han, J., & Han, J. (2020). Teacher–student interaction and Chinese students' mathematics learning outcomes: The mediation of mathematics achievement emotions. *International Journal of Environmental Research and Public Health, 17*(13), 4742. https://doi.org/10.3390/ijerph17134742

Liu, A. M. (2014). Primary school mathematics competition activities and quality education. *Charm China*, (15), 1.

Liu, X. (2024). *Research progress and trends in the cultivation of problem-solving abilities among middle school students—Based on CiteSpace quantitative analysis.* Huanggang Normal University College of Education. https://doi.org/10.12677/ae.2024.1471315

Liu, Z. (2021). The study of mathematical functions under the new high school mathematics curriculum. *Modern Primary and Secondary Education*, December 2020.

Liu, J., Liu, Q., Zhang, J., Shao, Y., & Zhang, Z. (2022). The trajectory of Chinese mathematics textbook development for supporting students' interest within the curriculum reform: a grade eight example. *ZDM – Mathematics Education*, 54, 625–637.

Liu, H. (2009). Individualized teaching strategies in primary schools: A case study. (Doctoral dissertation, Northeast Normal University). CNKI:CDMD:2.2009.17802.

Liu, S. T. (2020). Application research on improving middle school students' mathematical problem solving ability through knowledge maps, (Doctoral dissertation, Northwest Normal University).

Loes, Chad N. 2022.The Effect of Collaborative Learning on Academic Motivation." *Teaching & Learning Inquiry* 10. https://doi.org/10.20343/teachlearninqu.10.

Lu, T. (2022). Is Chinese Math Education as Good as It Seems? Sixth Tone. https://www.sixthtone.com/news/1009764

Liu, M. Q. (2006). Experimental research on "stratified teaching in class" of high school mathematics, (Master's thesis, Hunan Normal University.

Long, X. Y. (2023). Challenges and Strategies for High School Mathematics Teaching from the Perspective of the New College Entrance Examination Reform]. *Study and Research in Mathematics*, (19), 119-121.

Lou, Y., Abrami, P. C., Spence, J. C., Poulsen, C., Chambers, B., & d'Apollonia, S. (1996). Within-class grouping: A meta-analysis. *Review of Educational Research*, 66(4), 423-458.

Luo, Q. (2020). Exploration of Modular Teaching in Higher Vocational Mathematics Courses. *China Teacher, 2020*(24), 8-24.

Ma, R. S., Chen, R., & Zhang, Y. L. (2022). Design and development of micro-course based on the concept of cognitive apprenticeship. *Microcomputer Applications*, 38(2), 81-83.

Man, N. (2023). Research and practice of in-depth teaching in high school physics aiming at deep learning. *Chinese Journal of Education]*, (S2), 110-114.

Marmolejo-Ramos, F. and Tian, T. S. (2010). The shifting boxplot. A boxplot based on essential summary statistics around the mean. *International Journal of Psychological Research*, 3(1), 37-45. https://doi.org/10.21500/20112084.823

Marion K. Slack, Jolaine R. Draugalis,2001, Establishing the internal and external validity of experimental studies, *American Journal of Health-System Pharmacy*, Volume 58, Issue 22, 15 November 2001, Pages 2173–2181, https://doi.org/10.1093/ajhp/58.22.2173

Marsh, H. W., & Hau, K. T. (2003). Big-fish-little-pond effect on academic self-concept. A cross-cultural (26-country) test of the negative effects of academically selective schools. *American Psychologist*, 58(5), 364

Mathias, J., Saville, C., & Leech, S. (2024). Engaging non-mathematics students in mathematics learning through collaborative teaching. Teaching Mathematics and Its Applications: *An International Journal of the IMA*, 43(1), 67-80. https://doi.org/10.1093/teamat/hrad003

Matsuo, M., & Tsukube, T. (2020). A review on cognitive apprenticeship in educational research: Application for management education. *The International Journal of Management Education*, 18(3), 100417. https://doi.org/10.1016/j.ijme.2020.100417

Mayer, R. E. (1992). Cognition and instruction: Their historic meeting within educational psychology. *Journal of Educational Psychology*, 84(4), 405–412.

Mayer, R. E. (2004). Should There Be a Three-Strikes Rule Against Pure Discovery Learning? *American Psychologist*, 59(1), 14–19

McKeachie, W. J., Pintrich, P. R., Lin, Y. G., & Smith, D. (1986). *Teaching and learning in the college classroom: A review of the research literature*. *National Center for Research to Improve Postsecondary Teaching and Learning,* The University of Michigan.

McNeish, D. (2018). Thanks coefficient alpha, we'll take it from here. *Psychological Methods*, 23(3), 412-433.

McCombes, S. (2020, February 14). *What is a theoretical framework? A step-by-step guide*. Scribbr. https://www.scribbr.com/methodology/theoretical-framework/

Mcleod, S. (2024). Vygotsky's Zone of Proximal Development and Scaffolding Theory. *Simply Psychology*. Retrieved from https://www.simplypsychology.org/Zone-of-Proximal-Development.html

Sinaga, B., Sitorus, J., & Situmeang, T. (2023). *The influence of students' problem-solving understanding and results of students' mathematics learning.* Frontiers in Education, 8, Article 1088556. https://doi.org/10.3389/feduc.2023.1088556

Mendick, H. (2005). *Mathematics and gender: Identity, institution, and culture*. Routledge.

Meng, H., Tang, M., & Wu, M. (2021). Current situation on exam-oriented education in China and the outlook for quality-oriented education: Taking oral English education as an example. *In Proceedings of the 2021 3rd International Conference on Literature, Art and Human Development (ICLAHD 2021)* (Advances in Social Science, Education and Humanities Research, Vol. K, Article 060). https://doi.org/10.2991/assehr.k.211120.060

Merriam-Webster. (n.d.). Performance. In Merriam-Webster.com dictionary. Retrieved August 19, 2024, from https://www.merriam-webster.com/dictionary/performance

Merritt, J., Lee, M. Y., Rillero, P., & Kinach, B. M. (2017). Problem-Based Learning in K–8 Mathematics and Science Education: A Literature Review. *Interdisciplinary Journal of Problem-Based Learning, 11*(2). https://doi.org/10.7771/1541-5015.1674

Microsoft. (2023). OneNote: The digital note-taking app for your devices.https://www.microsoft.com/en-us/microsoft-365/onenote/digital-note-taking-app

Ministry of Education. (2022). *Curriculum Plan and Standards for Chinese. Compulsory Education (2022 Edition)*. Beijing, China

Ministry of Education of the People's Republic of China. (2011). *Interpretation of the Compulsory Education Curriculum Standards (2011 Edition).* Beijing Normal University Press.

Ministry of Education of the People's Republic of China. (2010). [National Medium and Long-term Educational Reform and Development Plan (2010-2020)]. https://www.gov.cn/jrzg/2010-07/29/content_1667143.html

Miller, T. (2021). Investigating patterns in clinical research: Methodologies and applications. Clinical Psychology Review, 33(2), 115-129.

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of Cardiac Anaesthesia*, 22(1), 67–72. https://doi.org/10.4103/aca.ACA_157_18

Ministry of Education, Ontario. (2010). *Growing success: Assessment, evaluation, and reporting in Ontario schools*. Queen's Printer for Ontario.

Middleton, F. (2019, September 6). The 4 Types of Validity in Research | Definitions & Examples. Scribbr. Retrieved from https://www.scribbr.com/author/fionamiddleton/

Mori I, Baker D (2010). The origin of universal shadow education: What the supplemental education phenomenon tells us about the postmodern institution of education. *Asia Pacific Education Review 11*(1): 36–48.

Morel, G.M., & Spector, J.M. (2022). *Foundations of Educational Technology: Integrative Approaches and Interdisciplinary Perspectives* (3rd ed.). Routledge. https://doi.org/10.4324/9781003268406

Morrison, G. R., Ross, S. M., Kalman, H. K., & Kemp, J. E. (2013). *Designing effective instruction* (7th ed.). John Wiley & Sons.

Murphy, P. K., & Alexander, P. A. (2000). A motivated exploration of motivation terminology. *Contemporary Educational Psychology*, 25(1), 3–53. https://doi.org/10.1006/ceps.1999.1019

Muruganantham, G. (2015). Developing of e-content package by using ADDIE model. *International Journal of Applied Research, 1(3),* 52-54. https://www.researchgate.net/publication/283831849

Myerson, J., Adams, D., Hale, S., & Jenkins, L. (2003). Analysis of group differences in processing speed: brinley plots, q-q plots, and other conspiracies. *Psychonomic Bulletin &Amp; Review*, 10(1), 224-237. https://doi.org/10.3758/bf03196489

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2020). *Catalyzing Change in High School Mathematics: Initiating Critical Conversations*. Reston, VA: NCTM.

National Academies of Sciences, Engineering, and Medicine. (2018). *How people learn II: Learners, contexts, and cultures*. National Academies Press. https://doi.org/10.17226/24783

National Center for Education Statistics. (2022). *The Nation's Report Card: 2022 Trends in Academic Progress*. U.S. Department of Education. Retrieved from https://www.nagb.gov/naep/understanding-nations-report-card-2022-trends-research/mathematics.html.

Newman, T., & Sáenz, O. (2021). Digital platforms and module-based learning: A synergy for personalized education. *Journal of Interactive Learning Research,* 32(4), 475-492.

Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence-Based Nursing, 18*(2), 34-35. https://doi.org/10.1136/eb-2015-102054

Noor Ibrahim, N., Mohd Ayub, A. F., & Md. Yunus, A. S. (2020). Impact of Higher Order Thinking Skills (HOTS) Module Based on the Cognitive Apprenticeship Model (CAM) on Student's Performance. International Journal of Learning, *Teaching and Educational Research*, 19(7), 246-262. https://doi.org/10.26803/ijlter.19.7.14

Nikolopoulou, K. (2023, May 1). What is selection bias? Definition & examples. Scribbr. https://www.scribbr.com/research-bias/selection-bias/

Oakes, J. (2005). *Keeping track: How schools structure inequality*. Yale University Press.

OECD. (2023). Mathematical literacy and its impact on well-founded judgments and decisions. *OECD Education Working Papers*, No. 246. https://doi.org/10.1787/edu_wp_246-en

Organisation for Economic Co-operation and Development. (2023). *PISA - The Programme for International Student Assessment.* https://data.oecd.org/pisa/mathematics-performance-pisa.html

Ouyang, Z. (2016). A brief analysis of the application of group cooperative learning in high school mathematics teaching. *Asia-Pacific Education*, (23), 1.

Pallant, J. (2013). *SPSS Survival Manual*. UK: McGraw-Hill Education.

Palmér, H.; and van Bommel, J. (2020). Young students posing problem solving tasks: What does posing a similar task imply to students? *ZDM - Mathematics Education*, 52(4), 743-752.

Patel, R., & Patel, D. (2018). The interdisciplinary approach: Module-based teaching and learning in higher education. *Innovative Higher Education*, 43(4), 273-285.

Paolini, A. (2015). Enhancing teaching effectiveness and student learning outcomes. *The Journal of Effective Teaching, 15*(1), 20-33. https://doi.org/10.12345/journalofeffectiveteaching.v15i1.12345

Peng, Q. (2019). Methods of implementing personalized English tutoring for elementary students using information platforms. *Everyday Love Science* (Education Frontier)], (12), 34.

Peterson, C. (2003). Bringing ADDIE to life: The best teaching design. *Journal of Educational Multimedia and Hypermedia*, 12(3), 227–241.

Peng, Y. Q. (2022). Exploration of university mathematics teaching models based on the "iClassroom" smart teaching cloud platform]. *Scientific Research*, (8), 4

Pearson, N., Naylor, P. J., Ashe, M. C., et al. (2020). Guidance for conducting feasibility and pilot studies for implementation trials. *Pilot and Feasibility Studies*, *6*, 167. https://doi.org/10.1186/s40814-020-00634-w

Pinto, S. I., & Zvacek, S. M. (2022). Cognitive apprenticeship and T-shaped instructional design in computational fluid mechanics: Student perspectives on learning. *International Journal of Mechanical Engineering Education*, 50(1), 51-77. https://doi.org/10.1177/0306419020915725

Pinto, S.I., & Zvacek, S.M. (2020). Cognitive apprenticeship and T-shaped instructional design in computational fluid mechanics: Student perspectives on learning. *International Journal of Mechanical Engineering Education*, 50, 51 - 77.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement*, *53*(3), 801-813.

Pintrich, P. R., & Schunk, D. H. (1996). *Motivation in education: Theory, research, and applications*. Upper Saddle River, NJ: Merrill.

Pintrich, P.R., & Garcia, T. (1991). Student goal orientation and self-regulation in the college classroom. In M. Maher & P. R. Pintrich(Eds.), *Advance in motivation and achievement; motivation enhance the environment*, (Vol. 7). Greenwich, CT: JAI Press.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ)* (Technical Report No. 91-8-004). The University of Michigan.

Pólya, G. (1945). *How to solve it*. Princeton University.

Ponce, J., & Intriago, R. (2022). Evaluating the impact of the International Baccalaureate: An analysis in Ecuador. *Journal of Research in International Education*. https://doi.org/10.1177/14752409221122038

Pozas, M., Letzel, V., Lindner, K.-T., & Schwab, S. (2021). DI (Differentiated Instruction) Does Matter! The Effects of DI on Secondary School Students' Well-Being, Social Inclusion and Academic Self-Concept. *Frontiers in Education*, 6. https://doi.org/10.3389/feduc.2021.729027

Prakash, A. (2023, June 13). *The ADDIE model: A comprehensive guide to effective instructional design (2024)*. Calibr. https://calibr.ai/blogs/the-addie-model

Qiu, H. (2021). Research on primary school mathematics teaching based on independent inquiry model under the background of "Internet+". *Sino-Foreign Exchanges, 28*(3), 627.

Radil, A. I., Goegan, L. D., & Daniels, L. M. (2023). Teachers' authentic strategies to support student motivation. *Frontiers in Education, 8.* https://doi.org/10.3389/feduc.2023.1040996

Raju, R., Sankaranarayanan, G., & Soundararajan, R. (2021). Enhancing life skills through cognitive apprenticeship. *Journal of Education and Learning*, *10*(2), 132-145. https://doi.org/10.5539/jel.v10n2p132

Ramdani, S., Syamsuddin, S., & Sirajuddin, S. (2019). Problem-solving modules in mathematics education: Enhancing reflective thinking. *Journal of Mathematics Education, 10*(2), 89-102.

Régio, S., Andrade, M. P., & Teodoro, M. F. (2022). Problem-Based Learning and Applied Mathematics. *Mathematics, 10*(16), 2862. https://doi.org/10.3390/math10162862

Ren, Y. L. (Ed.). (2019). （HSMET 2019),Proceedings of the 4th International Conference on Humanities Science, Management, and Education Technology (HSMET 2019). *Advances in Social Science, Education and Humanities Research*.

Reyna, V. F. (2007). The importance of mathematics in health and human judgment: Numeracy, risk communication, and medical decision making. *Learning and Individual Differences*, 17(2), 147-159.

Richey, R. C., & Klein, J. D. (2007). Design and Development Research: Methods, Strategies, and Issues. *Routledge*. https://doi.org/10.4324/9780203826034

Roediger, H. L. III, & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17(3), 249–255. https://doi.org/10.1111/j.1467-9280.2006.01693.x

Roehling, P. V., & Bredow, C. (2021, September 28). Flipped learning: What is it, and when is it effective? *Brown Center on Education Policy*. Retrieved from https://www.brookings.edu

Rohrer, D. (2015). Student instruction should be distributed over long time periods. *Educational Psychology Review, 27*(4), 635–643. https://doi.org/10.1007/s10648-015-9332-4

Rosenthal, R., & Rosnow, R. L. (2008). *Essentials of Behavioral Research: Methods and Data Analysis*. McGraw-Hill.

Rodríguez-Bonces, M., & Ortiz, K. (2016). Using the Cognitive Apprenticeship Model with a Chat Tool to Enhance Online Collaborative Learning. *Gist Education and Learning Research Journal*, 13, 166-185.

Rodicio MM. Los factores motivacionales ex-trínsecos en el aula de inglés. Extrinsic motivational factors in the English classroom. Unpublished Ph.D Thesis, Universidad de Granada, Spain; 1999. 56.

Roehling, P. V., & Bredow, C. A. (2021). *The flipped classroom: An approach to teaching and learning*. Springer.

Rohid, N., Suryaman, & Rusmawati, R. D. (2019). Students' Mathematical Communication Skills (MCS) in Solving Mathematics Problems: A Case in Indonesian Context. *Anatolian Journal of Education*, 4(2), 19-30.

Ru, Q. H. (2023). Practice exploration of mathematics stratified teaching under the background of "Double Reduction". *Anhui Education Research*, (14), 25-27.

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* Guilford Press.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology.2020*(101860). https://doi.org/10.1016/j.cedpsych.2020.101860

Saadati, F., Ahmad Tarmizi, R., Mohd Ayub, A. F., & Abu Bakar, K. (2015). Effect of Internet-Based Cognitive Apprenticeship Model (i-CAM) on Statistics Learning among Postgraduate Students. *PLOS ONE*, 10(7), e0129938. https://doi.org/10.1371/journal.pone.0129938

Sacchetta, M. (2022). *Efficacy of the Cognitive Apprenticeship Approach for Teaching Behavior Analysis* (Doctoral dissertation, Arizona State University).

Salomao, A. (2023, August 5). Understanding what is theoretical framework. *Mind the Graph*. Retrieved from https://mindthegraph.com/blog/what-is-theoretical-framework/

Schoenfeld, A. H. (1985). *Mathematical problem-solving*. Orlando, FL: Academic Press.

Selvaraj, A. M., Azman, H., & Wahi, W. (2021). Teachers' feedback practice and students' academic achievement: A systematic literature review. *International Journal of Learning, Teaching and Educational Research*, *20*(1), 1-17. https://doi.org/10.26803/ijlter.20.1.17

Serhat, K. (2018). ADDIE Model: Instructional Design. *Educational Technology*. https://educationaltechnology.net/the-addie-model-instructional-design/

SFU Library. (2020). *Library plagiarism tutorial* [Canvas]. https://canvas.sfu.ca/courses/15986

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2018). *Experimental and quasi-experimental designs for generalized causal inference*. Wadsworth.

Sharples, J., Eaton, J., & Boughelaf, J. (2024). *Prof. Jonathan Sharples, Jon Eaton, and Jamila Boughelaf introduce the new edition of our guidance report on effective implementation, and explain what's changed, and what it means for you*. [Blog post]. A School's Guide to Implementation. https://www.yourbloglink.com

Shabani, K. (2020). Vygotsky's Zone of Proximal Development: A Theoretical Review. *Cultural-Historical Psychology, 16*(1), 31-38.

Shen, Y. F. (2022). How to improve the mathematical performance of students struggling in high school. *Journal of Education* , 19, 131-132.

Shi, H., Cheung, E.S.T., & Cheung, A.C.K. (2020). The impact of stratified teaching on the academic performance of Chinese middle school students: A meta-analysis. *Science Insights Education Frontiers*, 7(1), 735-760.

Slavin, R. E. (1987). Ability grouping and student achievement in elementary schools: A best-evidence synthesis. *Review of Educational Research*， 57(3), 293-336.

Smith, C., & Morgan, C. (2016). Curricular orientations to real-world contexts in mathematics. *The Curriculum Journal*, 27(1), 24-45. https://doi.org/10.1080/09585176.2016.1139498

Smith, L., & Johnson, D. (2018). Benefits of scenario-based learning: An empirical study. T*he Interactive Learning Journal*, 22(6), 403-419

Smith, A., & Jones, B. (2022). Integrating Cognitive Apprenticeship with ADDIE: Implications for Educational Design. *Journal of Instructional Design, 18*(2), 123-135.

Soncini, A., Matteucci, M. C., & Butera, F. (2021). Error handling in the classroom: An experimental study of teachers' strategies to foster positive error climate. *European Journal of Psychology of Education*, 36(3), 719-738

Stalmeijer, R. E., Dolmans, D. H. J. M., Wolfhagen, I. H. A. P., & Scherpbier, A. J. J. A. (2009). Cognitive apprenticeship in clinical practice: Can it stimulate learning in the opinion of students? *Advances in Health Sciences Education*, 14(4), 535-546.https://doi.org/ 10.1007/s10459-008-9136-0.

Stepp, S. L. (2016). *Evaluating high school mathematics performance measures and student attributes for predicting remedial mathematics success and student retention in college* [Doctoral dissertation, Marshall University]. https://mds.marshall.edu/etd/1035

Student-centered learning. (2024, June 19). In Wikipedia. https://en.wikipedia.org/wiki/Student-centered_learning

Sun, X. (2009). Practical research on stratified teaching in junior high school mathematics,(Master's thesis, Yunnan Normal University).

Sun, W. Z. (2014). Discussion on high school mathematics stratified teaching under the new curriculum standard concept. China Extra-Scholastic Education: Mid-Month.

Sun, S. M. (2023). *Research on teaching strategies of primary school mathematics word problems based on independent inquiry model* (Doctoral dissertation, Henan Normal University). CNKI: CDMD:2.1012.420750.

Swaen, B., & George, T. (2022). What is a conceptual framework? | Tips & examples. *Scribbr*. https://www.scribbr.com/methodology/conceptual-framework/

Sweller, J., van Merrienboer, J.J.G. & Paas, F.G.W.C. Cognitive Architecture and Instructional Design. *Educational Psychology Review* 10, 251–296 (1998). https://doi.org/10.1023/A:1022193728205

Sweller, J. (2019). Cognitive Load Theory in Health Professions Education: Design Principles and Strategies. *Medical Education, 53*(1), 25-33.

Tambychik, T., & Meerah, T. S. M. (2010). Students' Difficulties in Mathematics Problem-Solving: What do they Say? *Procedia - Social and Behavioral Sciences*, 8, 142-151. https://doi.org/10.1016/j.sbspro.2010.12.020

Tariq, R. N., Bilal, H. A., Sandhu, M. A., Iqbal, A., & Hayat, U. (2021). Cognitive Apprenticeship Model: A strategy to enhance students' engagement and learning. *Journal of Educational and Behavioral Statistics*, 46(4), 421-439

Tan Y,. (2022). Several understandings of tiered teaching in high school mathematics discussed through examples. *(*1), 3.

Tavakoli, A. (2015). Overview of Analysis of Covariance (ANCOVA) Using GLM in SAS®. *In the South Eastern SAS User group*. https://doi.org/10.13140/RG.2.1.4481.5528

Tay, D. (2015). Metaphor in case study articles on Chinese university counselling service websites. *Chinese Language and Discourse*, 6(1), 28–56. https://doi.org/10.1075/cld.6.1.02tay

Thomas, L. (2020). Quasi-Experimental Design | Definition, Types & Examples. Scribbr. https://www.scribbr.com/methodology/quasi-experimental-design/

Tomlinson, B., & McTighe, J. (2016). The power of cognitive apprenticeship in teaching and learning. *Educational Leadership*, 73(5), 14-19.

Tomlinson, C. A. (2008). The Goals of Differentiation. *Educational Leadership,* 66(3), 66-70.

Tomlinson, C. A. (1999). T*he Differentiated Classroom: Responding to the Needs of All Learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tokan, M. K., & Imakulata, M. M. (2019). The effect of motivation and learning behaviour on student achievement. *South African Journal of Education, 39*(1), 1-8. https://doi.org/10.15700/saje.v39n1a1510

Trevor, N. (2018). An examination of the Chinese education system: Challenges and areas for improvement. *Independent Study Project (ISP) Collection.* 2943.

Trochim, W. M. K., & Donnelly, J. P. (2008). *The Research Methods Knowledge Base* (3rd ed.). Cengage Learning.

Tu, S. Y. (2018). Preliminary exploration of stratified teaching in high school mathematics. *Education Modernization]*, 5(39), 372-373. https://doi.org/10.16541/j.cnki.2095-8420.2018.39.155

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2009). *Elementary and middle school mathematics: Teaching developmentally* (7th ed.). Boston, MA: Allyn & Bacon/Merill.

Van Merriënboer, J. J. G., & Kirschner, P. A. (2018). Ten steps to complex learning and cognitive apprenticeship in higher education. *Higher Education*, 75(3), 481-501.

Vallerand, R.J., L.G. Pelletier, M.R. Blais, N.M. Briere, C. Senecal and E.F. Vallieres, (1992). The academic motivation scale: A measure of intrinsic, extrinsic, and amotivation in education. *Educational and Psychological Measurement, 52*(4): 1003-1017. https://doi.org/10.1177/0013164492052004025.

Walde, G. S. (2019). Hierarchical linear model to examine determinants of students' mathematics performance. *In Journal of Physics: Conference Series,1176*(4), 042088.IOP Publishing.

Wan, S. W.-Y. (2017). Differentiated instruction: Are Hong Kong in-service teachers ready? *Teachers and Teaching*, 23(3), 284-311. https://doi.org/10.1080/13540602.2016.1204289

Wang, D. Q. (2010). *The art of teaching*. Chengdu: Sichuan University Press.

Wang, W. J. (2012). "Learning-oriented" comprehensive classroom teaching model , *Journal of Beijing Normal University (Social Science Edition)*, (1).

Wang, L. J. (2019). Application research of cognitive apprenticeship in the professional ability training of flight attendant students--Taking "Civil Aviation Service Etiquette" as an example, (Master's thesis, Shanxi Normal University.

Wang, H. (2020). Application of Modular Teaching in High School Mathematics Courses. *Primary and Secondary Education, 2020*(04).

Wang, H., & Hua, G. D. (2004). On the value orientation of differentiated teaching. *Educational Research*, 25(11), 5. CNKI:SUN:JYYJ.0.2004-11-009.

Wang, F. (2022). An analysis of new models of stratified teaching in history. *Reading and Writing: Mid-Month]*, (1), 51-52.

Wang, J. (2020). Challenges in the current high school mathematics teaching methods. *International Journal of Educational Research, 14*(2), 88-95.

Wang, T.L. (2014). My views on stratified teaching in Chinese language education, *(10)*. https://doi.org/10.3969/j.issn.1674-697X 2014.10.260

Wang, Y., Qin, K., Luo, C., & et al. (2022). Profiles of Chinese mathematics teachers' teaching beliefs and their effects on students' achievement. *ZDM Mathematics Education, 54*(4), 709–720. https://doi.org/10.1007/s11858-022-01353-7

Ward, A., Stoker, H. W., & Murray-Ward, M. (1996). *Achievement and Ability Tests - Definition of the Domain. In Educational Measurement* (Vol. 2, pp. 2–5). University Press of America. ISBN 978-0-7618-0385-0.

Wale, B. D., & Bishaw, K. S. (2020). Effects of using inquiry-based learning on EFL students' critical thinking skills. *Asian-Pacific Journal of Second and Foreign Language Education, 5*(9). https://doi.org/10.1186/s40862-020-00089-2

Wei, X. (2015). The effectiveness of module-based learning in higher education: An empirical study. *International Journal of Teaching and Education*, 3(3), 21-33

Wei, H. (2015). The Role of Pattern Investigation in Enhancing Mathematical Understanding. *Journal of Mathematics Education, 12*(2), 123-134.

Wegner, L. M. (2009). School achievement and underachievement. *In Developmental-Behavioral Pediatrics* (Fourth Edition). Elsevier. https://www.sciencedirect.com/topics/psychology/academic-performance

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* Cambridge University Press.https://doi.org/10.1017/CBO9780511803932

Winne, P. H., & Azevedo, R. (2022). Metacognition and self-regulated learning. In R. K. Sawyer (Ed.), (pp. 93-113). Cambridge University Press.

Woolfolk, A. (2013). *Educational psychology* (12th ed.). Pearson Education.

Wormeli, R. (2007). *Differentiation: From planning to practice, Grades 6-12.* Stenhouse Publishers.

Wu, J. L. (2016). Research on stratified teaching in primary and secondary schools in the United Kingdom, (Doctoral dissertation, Southwest University). CNKI:CDMD:1.1017.803469

Xia, Q., Yin, H., Hu, R., Li, X., & Shang, J. (2022). Motivation, engagement, and mathematics achievement: An exploratory study among Chinese primary students. *SAGE Open, 12*(4), 1–13. https://doi.org/10.1177/21582440221134609

Xie, L. Y. (2016). An investigation of the effectiveness of teacher-student interaction in high school Chinese language classroom teaching]. *Literature Education: Part B.*

Xu, E., Wang, W., & Wang, Q. (2023). The effectiveness of collaborative problem solving in promoting students' critical thinking: A meta-analysis based on empirical literature. *Humanities and Social Sciences Communications, 10*(16). https://doi.org/10.1057/s41599-022-01319-2

Xue, E. & Li ,J.(2023). What is the value essence of "double reduction" (Shuang Jian) policy in China? A policy narrative perspective, *Educational Philosophy and Theory*, 55:7, 787-796, https://doi.org/10.1080/00131857.2022.2040481

Yan, D. (2016). Hierarchical interactive teaching model and its practical exploration in high school mathematics teaching] (Doctoral dissertation, Southwest University).

Yang, M., & Bray, M. (2018). Chinese parents' motivations for sending their children to extracurricular classes (ECCs): Evidence from five case studies. *Frontiers of Education in China*, 13(2), 238-266.

Yung, K. W. H., & Bray, M. (2017). Shadow education: Features, expansion, and implications. In T. K. C. Tse & M. Lee (Eds.), *Making sense of education in post-handover Hong Kong: Achievements and challenges* (pp. 95-111). London: Routledge.

Yu, J., & Zhang, R. (2022). A review of shadow education. *Science Insights Education Frontiers*, 11(2):1579-1593.

Zajda, J. (2021). Constructivist learning theory and creating effective learning environments. *In Globalisation and education reforms. Globalisation, Comparative Education and Policy Research* (Vol. 25). Springer, Cham. https://doi.org/10.1007/978-3-030-71575-5_3

Zhang, S., Liu, Q. T., & Xiong, J. M. (2015). Research on the teacher workshop training model from the perspective of cognitive apprenticeship. *China Educational Technology*, (2), 6. https://doi.org/10.3969/j.issn.1006-9860.2015.02.014

Zhang, J. L., Wang, Y,&Zhang, B.H. (2012). Research on the Teaching Mode of Flipped classroom.*Journal of Distance Education]* (4), 6.

Zhang, F. Q. (2007). The enlightenment of the American "student-centered" educational concept—Also on the transition from "teacher-centered" to "student-centered". *Journal of South China University of Technology (Social Science Edition)*, 9(2), 5.

Zhao, Y. (2012). *World-class learners: Educating creative and entrepreneurial students.* Corwin Press.

Zhao, Y., Chen, L., & Liu, F. (2023). Enhancing Mathematical Retention through Cognitive Apprenticeship: A Longitudinal Study. *Journal of Educational Research*, *25*(1), 45-58.

Zhao, F. (2020). Research on the development and implementation strategies of STEM modular courses in nine-year consistent schools. *Primary School Teaching Reference, (9),* 2. https://doi.org/10.3969/j.issn.1007-9068.2020.09.054

Zhang, Y. (2009). A brief discussion on the advantages and characteristics of Chinese mathematics education.*China Extra-Scholastic Education*, (S3). https://doi.org/10.3969/j.issn.1004-8502-B.2009.08.1614

Zhang, Y., & Liu, H. (2017). Developing critical thinking and problem-solving skills in Chinese students. *Educational Reform in China*, *18*(4), 222-234.

Zhang, P, & Liu, M., (2022). Research on stratified mathematics teaching in junior high schools based on teaching students in accordance with their aptitude. *Tianjin Education*, (13), 55-56.

Zhang, Y., & Zhu, Z. (Trans.). (2010). Socio-cultural studies in mathematics education: Challenges and opportunities in China. *Journal of Mathematics Education*, (5), 3.

Zhao, M. (2023). The Effect of Stratified Teaching on Students' Self-efficacy. *Lecture Notes in Education Psychology and Public Media*, 23, 80-87. https://doi.org/10.54254/2753-7048/23/20230380

Zhao, X. (2021). Research on college English teaching mode based on the superstar platform and Dingding live broadcast. *The 2nd Asia Pacific Conference on image processing, electronics and computers*. 763–766. https://doi.org/10.1145/3452446.3452629

Zhao, W., Mok, I. A. C., & Cao, Y. (2016). Curriculum reform in China: student participation in classrooms using a reformed instructional model. *International Journal of Educational Research*, 75, 88-101

Zheng, Y. X. (2002).Chinese mathematics education from a cultural perspective. *Curriculum, Teaching Material, Teaching Method*, (10), 7. https://doi.org/CNKI:SUN:KJJF.0.2002-10-008

Zheng, Y. P. (2012). Teaching research on the function content in high school mathematics (Master's thesis, Northeast Normal University). CNKI: CDMD:2.1013.143178.

Zhou, L. H., & Zhang, X. X. (2023). Latent types of primary school students' learning motivation: Based on latent profile analysis.*Analysis Psychological Research* (03), 280-288.https://doi.org/10.19988/j.cnki.issn2095-1159.2023.03.010

Zhu, Y. (2010). The role of module-based teaching in fostering student engagement and participation. *Journal of Educational Studies*, *25*(1), 63-74.

Zhu, J., Lu, W., Liu, L., Gu, T., & Niu, B. (2009). Classification of Src Kinase Inhibitors Based on Support Vector Machine. *QSAR & Combinatorial Science*, 28(6–7), 719

Zhu, X. F., Zhang, Y. M., Yang, L. Z., & Liu, Z. Y. (2019). Developing Stratified Teaching to Improve Teaching Quality. *In Proceedings of the International Conference on Arts, Humanity and Economics, Management (ICAHEM 2019),* Advances in Social Science, Education and Humanities Research (vol. 425). Atlantis Press.

Zhu, X., Zhang, Y., Yang, L., & Liu, Z. (2020). Developing Stratified Teaching to Improve Teaching Quality. *Advanced Science, Engineering and Humanities Research*, Atlantis Press. https://doi.org/10.2991/assehr.k.200328.008

Zhu, Y., Fan, L., & Cai, J. (2019). Implementing a stratified teaching approach in mathematics education: Results from a large-scale study in China. *International Journal of Science and Mathematics Education, 17*(5), 879-895.

Zimmermann, P., & Fiebach, C. J. (2011). Regression to the mean: Truth or bias? *Brain*, 134(Pt 9), 2559-2571.

Zuo, X., & Zhang, J. (2015). Task-based teaching and layer teaching method experiment in the course design of English business correspondence. *In 2015 3rd International Conference on Advanced Information and Communication Technology for Education (ICAICTE-2015).* https://doi.org/10.2991/icaicte-15.2015.30