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Analyzing Ecological Factors Leading to Similarities and Differences in Mathematics Learning in Public and International High Schools in China

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Abstract: There are frequent discussions about China's public and international high school educational systems nowadays. This paper will discuss ecological factors that lead to the similarities and differences between the subject of mathematics in the two educational systems. In this work, the theory of behavioristic, cognitive, and constructive learning approaches will be mentioned to analyze the existence of the two educational systems. Then, this paper will analyze how teachers' teaching habits, textbook designs, and family involvement ecologically affect students' mathematics learning. The paper compares and contrasts public and international educational systems through the lens of analyzing mathematical learning in Chinese high schools, providing a reference for researchers interested in Chinese education.

Keywords: Chinese education, international schools, learning approaches

1. Introduction

Having experienced a sense of conflict in ideologies and values, students often felt the vast differences between international education and public education strongly after transferring from a public school to an international school, including the languages used, the styles of lessons, and the activities encouraged to organize. One of the most significant differences that stood out is the teaching style of the subject mathematics.

The different teaching methods proposed by the two educational systems show the schools' different ideologies about how students should learn mathematics. Chinese public schools tend to train the students by adapting the methods of behaviorism and cognitivism, while Chinese international schools use more Westernized educational practices, including cognitivism and constructivism. Therefore, the two types of schools have similarities and differences in math teaching.

This paper will compare and contrast different educational methods the public and international schools praise and how they affect the students' learning methods. It will discuss the principles behind how other academic systems shape students' learning processes and their final learning outcomes in mathematics. This perspective sees public high schools' preferences in behaviorism and international high schools' preferences in constructivism, while they share a similar approach to practicing cognitivism. This analysis is significant because it gives us a more apparent cognition of

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public and international education in China and to what extent educational ideologies will affect students' learning.

2. Analyzing a Common Policy, Practice, or Resource Using a Learning Theory as a Lens

The public high school believes in behaviorism and tends to use it to train the students in mathematics problem-solving. In behaviorism, rewards and punishments play significant roles because they drive people to either adopt or abandon the behaviors; this is because people are willing to repeat behaviors that potentially conform to their desires and are reluctant to practice behaviors that oppose their wishes [1]. Putting this statement into the mathematics teaching context, the students will repeat the behavior of listening carefully to the teachers and practicing math problems because they had the experience of receiving the rewards (for example, gaining praise and approvals from their parents and teachers and earning top grades in the year group). More specifically, this mechanism is called extrinsic rewards, meaning that people pursue activities because of the promise of external rewards [1]. As public school students are cultivated to adapt to extrinsic rewards, the schools should have built a system of rewards and penalties to constantly meet the demands of the students and emphasize the students' cognition of practicing and following the instructions during class. This action is called reinforcement, referring to the external environmental feedback that can help maintain the strength of the behaviors for an extended period [2].

The international schools, however, prefer to apply constructivism due to the influence of Western culture when teaching the students mathematical classes. Constructivism is a fairly recent learning theory that suggests that learners will construct knowledge by themselves through their learning processes; it claims that learning should be active, involve learning to learn, and need motivation as a key component [3]. As most international schools believe in this idea, international school math teachers tend to create a relatively free and encouraging learning environment to stimulate students' subjective learning initiative. Unlike the teachers in public schools, international school teachers assign more group projects and organize more group discussions; they also use textbooks that demonstrate to students the solution approaches step-by-step from the basic math principles instead of simply showing students the answers. When the students engage in group discussions and presentations, they are asked to do the research on their own and explain the sense they are making from their personal thinking perspectives. Moreover, the students who are capable of this learning-and-teaching process are also required to understand other students' explanations, which will promote their learning from multiple perspectives [4]. Through guided instructions from the teachers, international school students are more likely to construct unique and systematic mathematical knowledge individually.

However, public high schools and international high schools share a similar approach to the practice of metacognition, the ability to alter or monitor people's cognitive processes that help them to learn knowledge or behaviors [5]. In public schools, students will form the math learning schema that consists of note-taking, lectures, and piles of workbooks, because these are the tools or methods they use to learn mathematics; On the other hand, international students may form a different schema of math learning that includes research, discussions, and group work, because these practices are commonly used by the students. Moreover, both types of schools cultivate the students' self-regulation skills that refer to people's integration of "cognitive, affective, motivational and behavioral components" to alter their aims and actions to achieve their desired results [5]. Although international schools focus more on the student's individual development, public schools also encourage students to ask teachers questions and learn by taking notes on their own; both types of schools demonstrate their approaches to cultivating disciplined and flexible students who work most efficiently by forming their learning cognitions. In addition, it is also suggested that such

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metacognitive experiences are more likely to occur in conditions that require intensive conscious thinking- which is a characteristic of math lessons [6].

3. Problematizing the Learning Theory Embedded in the Chosen Policy, Practice, or Resource

Seen through these lenses, both adaptations of behavioristic and constructivist learning methods in math classes can shape and promote students' math learning. In public schools, strict behavioristic controls can increase students' math performances, especially when teachers are familiar with this teaching style and the students are obedient. Although earning a good grade sounds desirable, the mechanism of behaviorism in math lessons may become less valid when the students have already found other rewards motivating [1]. For example, students may prefer practicing behaviors that provide instant rewards, like playing video games or watching TikTok productions. When training students, the teachers' crucial task is to control the students from unexpected stimuli; they have to be skillful in perceiving their needs and making progress [2]. Therefore, teachers with a higher level of professionalism will affect the public school students' learning outcomes strongly and thus are required intensive training, which is one of the reasons why public school parents pay overly high attention to teachers' past experiences and educational backgrounds. What is more, constantly practicing behaviorism will decrease students' creativity and critical thinking skills because it is a practice that narrows students' cognitive focus [1]. This may affect the student's future development as they cannot suggest new ideas.

On the other hand, international schools should focus on finding a suitable extent to encourage them to investigate independently. Truly students can learn when they see the knowledge can be figured out over time. Yet, they can only discover within a limited range of new information assisted by their previous knowledge and recognition [3]. International school teachers must know students' learning capacity and adjust the teaching instructions based on students' performances. Another requirement for teachers is to find ways to engage the students as much as possible, which means they should give students the freedom to use as many resources as they can acquire; at least, they should listen to their students explain their thoughts [4]. In math classes that involve engaging students using constructivist theories, teachers must be attentive and caring, supporting students from a more recognizant perspective. While such a method might be useless to students who have inadequate prior knowledge and feel shameful presenting their potentially wrong thoughts to others. If the students are unwilling to participate in the interactions, the effect of constructivist teaching will weaken. Opposing behavioristic teaching, international school students may feel uncertain about their conclusions as their rewards (seeing the answer directly) are less definite than those of public school students. The learning attitudes and values of the students, thus, should necessarily be guided by teachers.

4. Conclude by Making a Call for Research into Alternative Approaches

The conflicts between the educational ideas held by Chinese public schools and international schools have remained controversial for decades, while public schools are criticized significantly more than international ones. In China, public schools are commonly seen as educational institutions supporting behavioristic teaching methods, meaning that they train students by providing them with desirable rewards [1]. The students will be asked to listen to every sentence the teacher said during the class, take down notes, and practice as many mathematical problems as they can. They are not allowed to make simple mistakes such as calculation mistakes or forgetting to write down their correct answers, because "earning one mark will exceed a playground of students' scores" during the formal exams. Yet international schools claim to use constructivist approaches

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more commonly, inspiring students' interests and encouraging them to form their system of knowledge [3]. Teachers provided students with formula sheets instead of asking them to take notes; Students are also told to only do a small packet of math problems every day and no one would blame them for their small mistakes. Although behaviorism is a relatively old learning theory, there are justified reasons for public schools to adopt it: it is effective, easy to be carried out, and conservative. There is also no evidence that international school students perform better in math than public school students. Although Chinese people gradually shift their educational values from behaviorism to recent constructivism and international schools provide good guidance for students' math learning, it is undeniable that public schools are also capable of producing students' math learning outcomes. Thus, this leads to a question: What factors contribute to the differences in learning approaches between Chinese public and international high schools?

5. Presenting Research on Alternatives to the Policy, Practice, or Resource

This research question is highly based on learning ecological theories, referring to the idea that learning is developed across time and settings under the physical, social, and cultural context [7]. This question is valuable as it will verify the validity of learning ecology and will emphasize the cultural influences on learning outcomes. Most importantly, as the environment will shape students' learning outcomes [7], factors affecting learning will not be limited to the teaching methods; rather, the student's learning approaches will be influenced by a wider range of factors, consisting of the teachers' teaching habits, textbook designs, and family involvements.

International schools in China refer to schools where Chinese students receive an international education, which means no local curriculum will be offered [8]. International schools often offer international courses such as International Baccalaureate, IB, or Advanced Placement, AP, that prepare students for their future global university applications. Adapting more constructivism and cognitive approaches to learning, international high schools are also known as more Westernized. Thus, it is reasonable to assert that international high schools and US high schools adopt similar educational approaches. The connection between international and US high schools will not be repeated in the following paragraphs.

Next, factors affecting students' learning will be listed and discussed, analyzing the reasons behind students' different learning approaches.

5.1. Teachers' Teaching Habits

Teachers with higher professions are more able to guide students' learning processes and make learning relevant and stimulating [9]. Therefore, it is worthwhile to discuss the influences of teachers' teaching habits on public high school students and international high school students.

Public school math teachers are trained to have a stronger knowledge of the math subject specifically and better understand the level of the syllabus students had learned and would learn in the future. Public school teachers are more focused on the details of the syllabus content than on teaching methods [10]. This means comparing to international school teachers, public school teachers have a more profound knowledge of high school mathematical knowledge and textbook contents. As their teachings are more knowledge-specific, public school teachers may prefer to aim at delivering math knowledge by emphasizing the importance of memorization and practicing to the students. What is more, public school teachers are also proven to be more effective in giving definite instructions to the students, as their instructions directly affect students' motivations and creativity [10]. Behavioristic learning approaches are thus more commonly used than constructivist learning approaches in public schools because teachers want to use their instructions to let students repeat behaviors that will potentially improve their desired outcomes- exam grades [1].

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On the other hand, international school teachers are better at carrying out broader educational concepts. Unlike public school teachers, they are trained to learn knowledge of more general issues like child development, learning theories, and classroom management [10]. They better understand how to teach the knowledge, yet they have less understanding of the specific knowledge in secondary mathematics content. Therefore, international high school teachers are more likely to adopt constructivist approaches while teaching- they encourage students learning to learn by investigating mathematical problems and having group discussions more constantly [4]. Moreover, as international schools consist of teachers from different countries, math teachers in international high schools are more likely to present multiple perspectives of math learning to the students. This means students must understand different teachers' teaching styles, which meets the requirement for constructivism, as this will promote their learning from multiple perspectives [4].

5.2. Textbook Designs

Textbooks are a source of fundamental knowledge and often explain differences in students' knowledge at different levels of the educational system [11]. As the textbook syllabus is deeply connected with students' learning outcomes or achievements, it is valuable to discuss how different textbooks influence public high school and international high school students' learning approaches.

There was less variety in the textbooks used in public schools: all Chinese provinces except Shanghai and Zhejiang were required to adopt a few textbooks that were developed and modified since the 1980s [12]. This uniformity helps develop students' behavioristic learning approaches as it is a practice that narrows students' cognitive focus [1]. In contrast, the usage of textbooks in international schools is diverse, including common US textbooks such as Bennett et al. and Larson et al., and international textbooks such as IB syllabus and AP textbooks. Various mathematical textbooks provide multiple perspectives to the students, enhancing the constructivist approach as such diversity enables students to think critically and look for the textbook that suits them the best [4].

Textbooks are often defined as a sentence containing concept that includes examples, conditions, and synonyms. Public school textbooks have a relatively large number of conceptual definitions, meaning students often learn mathematics by acquiring conceptual knowledge that fits into their math schema and helps them practice math problems [12]. As a result, the reinforcement of such behavioristic learning approaches designed by public school textbooks can help maintain the strength of students' behaviors for an extended period [2]. On the contrary, conceptual definitions appear much less constantly in international high school textbooks; rather, more procedural demonstrations are found in them [12]. Such demonstrations encourage the constructivist approach, as looking at the procedures, the students are going to actively construct knowledge by themselves through their learning processes and they are learning to learn [3].

5.3. Family Involvements

Speaking under the context of mathematical learning, family involvements include participation in parent-teacher communications, building up educational expectations and parent-student relationships, and the level of cognition of the student's performance at school [13]. As family still plays an essential role in teenagers' learning process, it is necessary to consider family involvement while discussing factors that affect students' mathematical learning approaches.

Public school parents always do not highly participate in school-related activities, yet they are closely involved in their children's academic education and achievements [13]. Public school parents commonly prioritize children's exam scores over children's other performances at school, such as activity participation or social situations. Therefore, public school students have a higher

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possibility of receiving positive extrinsic rewards (oral or physical awards) from their parents when they get a good score on the math exam. Such positive external environmental feedback can encourage students to work even harder and help maintain the strength of their hard work for an extended period, which corresponds to public schools' behavioristic learning approach [2]. However, parents' over-emphasizing on math exam scores may also pose too much pressure on the children, increasing the possibility of adolescent depression and other mental illnesses; narrowing the standard of "good students" down to a good transcript also ignores other values that are also important for students' development.

On the other hand, international school parents tend to pay attention to their children's characteristics; this means they weigh children's transcript, participation, and social circle as equally important- at least more equal than the thoughts of public school parents. Therefore, international school students have fewer chances of being awarded simply because of their outstanding mathematical scores, yet they have higher chances of earning praise from different aspects such as organizing a charity activity successfully or being nice people to others, which are the aspects that seem to not correlate with math learning. Parents' implicit encouragement of letting their children study on their own will enable children to construct knowledge by themselves through their learning processes; unlike public school students, international school students' learning is more active, involving learning to learn and have personal initiative when dealing with math problems, which is what constructivists want to achieve [3]. However, if parents let their children go too much, it is also possible to cause devastating effects on children's learning as children are still young adults who cannot control their laches fully.

6. Conclusion

This paper compares and contrasts the educational approaches to math learning adopted by public schools and international schools in China. The paper states that public schools prefer to use the behavioristic approach and international schools prefer to use the constructivist approach. In contrast, both two types of schools use the cognitive approach in math learning. Next, this paper uses ecological approaches to investigate factors that cause and deepen the differences in educational approaches between the two types of schools, including teachers' teaching styles, textbook designs, and family involvement.

This paper is valuable because it arranges and applies major learning theories into the context and re-emphasizes the importance of these educational concepts by analyzing the phenomenon in Chinese high schools. It successfully compares and contrasts different situations and their influences on forming different learning approaches. Referring to this paper, people will have a better understanding of Chinese international and public school education, which is beneficial to future educational investigations and applications.

The limitation of this paper is that it lacks original and raw data that helps support the author's conclusion, as the paper is highly theoretical, providing insights and perspectives solely based on previous educational research and studies. Further investigations on factors affecting learning approaches could be done through questionnaires or case studies, which will increase ecological validity and provide real-life examples to support the ideas presented.

Lastly, the theoretical framework of this paper could also be adapted to compare and contrast other educational systems or to analyze other factors that shape the learning approaches. Such research will be beneficial for researchers to learn more about the complexity of educational systems and will provide them with opportunities to modify and design better educational systems in the future.

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