DEVELOPMENT AND PRACTICE OF A-STEM CURRICULUM BASED ON PRIMARY MATHEMATICS

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Abstract

This study intends to test the effectiveness and extent of mathematics curriculum development for primary school students under the STEM education concept by incorporating the A-STEM education concept into the teaching of primary school mathematics. In this study, Classes 1 and 2 of Grade 5 of Primary School A in L city were selected as the subjects of the study, and an experimental study on the effectiveness of primary school mathematics teaching based on the A-STEM education concept in enhancing the development of mathematical thinking skills was conducted using an experimental method. Firstly, the current situation of the mathematical thinking ability of the two classes was investigated through a pre-test paper. The findings showed that the experimental and control classes had comparable levels of mathematical thinking ability, with the highest level of analytical ability, followed by evaluative ability and the worst being creative ability. The experimental class was then taught primary school mathematics based on the concept of STEM education, while the control group was taught in a traditional way. After a semester of teaching experiments, post-test papers were distributed in both classes for post-testing, and the recovered data were collated and analysed. The study concluded that: firstly, the teaching method under the STEM education concept was more effective in promoting the development of primary school students' mathematical thinking skills than the traditional education teaching method; secondly, the STEM education concept could promote the development of primary school students' analytical and evaluation skills; thirdly, the STEM education concept was not effective in the development of creative skills.

Keywords: A-STEM education concept; primary school students; mathematical thinking skills.

Introduction

Statement of the problems

The Mathematics Curriculum Standards for Compulsory Education (2011 Edition) divides the Mathematics curriculum into four modules: "Number and Algebra", "Graphs and Geometry", "Statistics and Concepts" and "Integration and Practice". The four modules are "Integration and Practice". In practice, teachers should aim to link and integrate these modules so that they become an organic whole. However, in practice in ethnic areas, the "Integrated and Practical" curriculum is not effectively implemented and is often alienated or even neglected in teaching.

A-STEM is an educational concept formed on the basis of STEM based on Chinese educational practices and the absorption of American STEM educational concepts. It has various characteristics of STEM education, but also inherits the traditional characteristics of Chinese

education, and is an emphasis and derivation of STEAM in the Chinese humanistic context.

Its main emphasis is on the humanistic approach, which is based on a deep understanding and internalisation of what is learnt. Its main aim is to enable students to truly understand the practical meaning and connotations of what is learnt in textbooks, and to apply what is learnt to everyday life and to appreciate the usefulness of mathematics. The approach to teaching and learning can be based on Chinese cultural activities and intellectual heritage, and also suggests the integration of knowledge, i.e. the integration of other disciplines in the teaching process, as well as the integration of science, art, etc. with mathematics.

Research questions

"The integrated practical curriculum is a very important element of the junior secondary mathematics curriculum. Its teaching objective is to improve the transfer and application of mathematical knowledge through a multi-dimensional integrated practical curriculum and the creation of student-oriented integrated activity contexts that allow students to use theirhands and brains,

A-STEM, on the other hand, offers students the possibility to break down disciplinary boundaries and learn relevant knowledge and skills experientially in a context close to their lives. Through A-STEM interdisciplinary learning, students build up a sense of real-world patterns and thus develop their own perceptions of the world and society, which are rich in intellectual learning and emotional experiences.

Both "Integrated and Practical" and A-STEM education involve interdisciplinary learning and application, and both value students' ability to identify, analyse and solve problems. They have unique value and role as highly innovative educational models in developing students' core literacy in mathematics and provide a platform for implementing core literacy in mathematics.

Research Objectives

An analysis of the A-STEM Education based 'Instructional Design' to bring the A-S TEM education concept into the mathematics classroom. It links mathematics with science to cultivate students' spirit of scientific exploration; mathematics with technology to cultivate students' creative imagination; mathematics with engineering to cultivate students' hands-on skills; and mathematics with humanities to cultivate students' humanistic sentiments. It makes the mathematics classroom more lively, guides students to learn more actively and proactively, promotes the comprehensive development of students' core mathematical literacy, and better adapts to the modern social living environment.

Research hypothesis

(1) Does the teaching of mathematics under the A-STEM education concept promote the development of mathematical thinking skills of primary school students?

(2) Does the teaching of mathematics under the A-STEM education concept promote the development of primary school students' analytical, evaluative and creative skills and do they differ in the extent to which they develop in different dimensions?

Scope and limitations of the study

In the first semester of my first year of study, I decided on the content of my research with the help of my supervisor, and in my second year of study, I spent the rest of my time reading the relevant literature and considering how to complete the teaching design of "synthesis and practice" of junior high school mathematics based on the A-STEM education concept, with a view to finding a I hope that I can find a teaching concept that is suitable for teaching mathematics in ethnic areas and apply it to the actual teaching process, instead of taking it for granted based on my own experience and ideas. It is hoped that this study will address the following issues.Concept and theory

Literature Reviews

Connotations of the A-STEM Education Concept

A-STEM education is an education in the five fields of Soienoe, Technology, Engineering, Mathematics and Art. Compared to countries such as the United Kingdom and the United States, our society as a whole is showing a growing tendency to place more emphasis on science than on the arts. The report of the 18th Party Congress has once again made the establishment of moral education a fundamental task of education in China. In response to the shortcomings of STEM/STEAM education, Dr Zou Xiaodong took the lead in proposing the concept of A-STEM education in 2016. A-STEM education is a humanities-led education paradigm based on Chinese educational traditions, with science education as the core and art as the wing, hoping to have a coherent understanding of scientific knowledge and a humanistic assimilation of the scientific spirit, and ultimately to form a "Chinese education" that integrates science and humanities. It is hoped that a coherent understanding of scientific knowledge, a humanistic assimilation of the scientific spirit, and ultimately a "Chinese programme" of education for a new era will emerge.

Theoretical foundations

Confucius, a great thinker and educator in ancient China, once said, "Those who know are better than those who are good, and those who are good are better than those who are happy." It was also Confucius who first advocated the idea of heuristic teaching, and since then Confucianism has always focused on heuristic teaching, inducing students to take the initiative to think about problems and develop their ability to learn independently and think creatively. The main idea of heuristic teaching is that the teacher transmits knowledge to the students in an inducing way, introducing them to the subject by asking questions, guiding them but not leading them, allowing them to be the masters of their own learning and to take the initiative to think through their own problems. Actively encouraging students without allowing them to be repressed into submission creates an enjoyable learning environment for them. By enlightening rather than indoctrinating, students can be trained to think independently and seek their own answers. Efforts should be made to ensure that students do not shy away from learning, take pleasure from learning, and think easily and independently. For heuristic teaching ideas, we emphasise three points: firstly, the holistic and dialectical nature of the relationship between teaching and learning; secondly, the comprehensiveness of the

training objectives; and thirdly, the advocacy of teacher-led teaching with meaningful activities. The idea of heuristic teaching has been a guiding force in the development of education in ethnic and national minority areas in China, especially in the development of Mathematics education. In junior high school mathematics "synthesis and practice", activity lessons can draw on heuristic teaching ideas to do the following: First, make clear to students the premise of teaching objectives, a comprehensive and accurate grasp of students' existing mathematical cognitive structure, and then reconstruct the structure of mathematical knowledge, pay attention to revealing the essential features of mathematical knowledge and internal links, so that knowledge has a holistic and systematic; Second, in the The teaching process does provide students with guidance on thinking strategies and stimulate their learning initiatives. The real purpose of the integration of disciplines mentioned in the A-STEM teaching philosophy is also to reveal the essential features and intrinsic connections of mathematical knowledge, so that knowledge is holistic and systematic. Therefore, heuristic teaching ideas provide theoretical guidance and reference for integrating A-STEM education concepts into the mathematics classroom.

Research on other aspects of STEM education

In addition to the above research themes, some other scholars in China have also done research on other aspects of STEM education. For example, in the article "Content and Strategies of STEM Education Evaluation", Bai Yi selected the lesson example "Parachute" from the First Middle School in Taicang, Jiangsu Province, and used it as a platform to conduct a profound In this article, the example "Parachute" was selected from the first middle school in Taicang, Jiangsu Province, and used as a platform to conduct a profound discussion and analysis on the evaluation of STEM education.

All in all, A-STEM education is receiving more and more attention in China. Based on the study of A-STEM education abroad, especially in the United States, and drawing on their experience in implementing A-STEM education, scholars in China are studying the various complex and difficult problems encountered in the process of localising A-STEM education in China, with a view to finding a new way out for China's education reform.

Research Methodology

Population and Sample Sizes

Based on a review of the literature on mathematical thinking skills, the evaluation indicators of mathematical thinking skills were determined in relation to the characteristics of primary school students' mathematical thinking, the "Primary School Students' Mathematical Thinking Skills Test Paper I" was compiled based on the evaluation indicators, the test papers were distributed, the study participants were identified and their current levels were understood, and then the design of primary school mathematics teaching based on the A-STEM education concept and its concrete implementation were carried out in the experimental class for A semester- long teaching of mathematics based on the A-STEM education concept was conducted in the experimental class, while traditional teaching was adopted in the control class. At the end of the experiment, the Primary School Students' Mathematical Thinking Ability Test Paper II was distributed and the data were collated and analyzed.

Data collection

(1) re-experimental preparation: Firstly, we conducted a literature review and summary as well as specific educational practice observation, and discussed with our supervisor to determine the research topic and the purpose of the experimental study; secondly, based on the literature review,

(2) Experimental implementation: This phase is mainly for the specific implementation process, which was carried out from September 7, 2020 to January 8, 2021, with specific classroom teaching in the experimental classes based on the teaching design designed based on the A-STEM education concept, while the control classes were taught in the traditional way, and in the process, based on the mathematical thinking skills assessment index, the Primary School Students The development and refinement of the Mathematical Thinking Skills Test for Primary School Students Paper 2 is based on the assessment indicators.

(3) Experimental collation: This stage mainly involves the distribution and collection and collation of the Primary School Students' Mathematical Thinking Ability Test Paper 2, scoring the collected test papers according to the Corresponding Levels of the Higher Order Thinking Assessment Scale in Mathematics, collating and analysing the collected data using SPSS 26.0, examining the difference analysis of the A-STEM education concept for the experimental and control groups, as well as the before and after tests to test its effectiveness in promoting the development of primary school students' mathematical thinking skills.

Statistics and data analysis

In order to verify the scientific validity of the results measured and to illustrate the internal consistency of the results measured in this test paper, the statistical software SPSS 26.0 was used to analyse the reliability of the pre-test data from the experimental and control classes, with the following results. As can be seen from Table 3-2: the Cronbach coefficient of this test paper is 0.791, according to the evaluation index of reliability, the reliability coefficient is greater than 0.7 and less than 0.8 is acceptable, therefore, the reliability of this test paper is acceptable and the data measured can be studied. Meanwhile, as can be seen from Table 3-2, the Cronbach coefficients of the items that have been deleted for each question are all greater than 0.7, indicating that all questions have the need to be retained, and further verifying that the reliability of this test paper is good, the data measured are reliable, and the results of the data measured can be used for research.

Results

Situation analysis of the current situation in the experimental and control classes Primary School A, Grade 5 Class 1 (experimental class) and Grade 5 Class 2 (control class) were the subjects of this experimental study. In the preliminary classroom observation, it was found that students' thinking was more active in the classroom teaching process, and the teaching style of erudition, good guidance, generosity and joyful teaching had cultivated students' active thinking. After identifying the subjects of the study, "Primary Students' Mathematical Thinking Ability Test Paper I" was distributed in the experimental and control classes for recycling and collation After the study, the experimental class (Year 5 Class 1) was taught mathematics based on the A-STEM education concept, while the control class was

taught mathematics in a traditional way for one semester. This section focuses on the collation and analysis of the recovered Pupils' Thinking Skills Test Paper I and Pupils' Thinking Skills Test Paper II.Comparative analysis of pre- and post-tests of assessment ability in the fifth grade class

Table 4-1 Paired samples t-test for assessment ability in Year 5 class

Dimension	Average	Mean	Sig.	T
Judgement	Post-test -	1.3	0.013	-2.605
Judging	Post-test -	1.48	0.003	-3.157
Evaluation	Post-test -	2.78	0.001	-3.723

From Tables 4-1, we can see that before and after the experiment, students' mean differences are all positive, which means that after the experiment, students' evaluation ability has a significant improvement in terms of mean values; from the p-value, Sig is less than 0.05, which means that there is a significant difference in students' assessment, judgement and evaluation ability before and after the experiment, which means that the improvement effect is statistically significant, combining the mean values, significant differences and changes in the number of students at each The combined mean, significant difference and change in the number of students at each level indicate that there is a significant positive effect on the students' evaluation ability after the experiment.

The mean difference between the experimental and control classes on all dimensions of mathematical thinking ability was positive, indicating that A-STEM education is effective in promoting students' higher-order thinking development. effective. The p-values showed that there were significant differences in analytical ability, evaluative ability, and p-values less than 0.05. There was no significant difference in creative ability. Specifically, the P-values for the six secondary indicators of clarifying structure, attributing, differentiating, judging, evaluating and proposing are all less than 0.05, with significant differences, while the P-values for the three dimensions of proposing, making up and designing are greater than 0.05, with no significant differences, indicating that A-STEM education is not significantly different from traditional teaching in this aspect of creativity, but it is still effective through the mean values; while in the The other dimensions are effective and significantly different, thus the significant difference after the experiment can be attributed to the promotion of the A-STEM education concept.

Chapter Conclusions and recommendations

A-STEM education concepts promote the development of primary school students' mathematical thinking skills more than traditional teaching methods

After a semester of teaching mathematics based on the A-STEM education concept, students' mathematical thinking skills were developed and improved significantly. The effect of this experimental study was effective as evidenced by the mean and frequency distributions

as well as by the t-test of independent samples tested before and after; compared to the traditional mathematics teaching approach, the improvement effect of the control class was not as good as that of the experimental class, therefore, compared to the The A-STEM education concept is more effective in promoting higher-order thinking development in mathematics than the traditional mathematics teaching approach. A-STEM education concepts can promote the development of analytical and evaluative skills of primary school students The paired-samples t-test on the analytical ability, evaluation ability, creative ability and each sub-dimension of primary school students before and after the experiment shows that there are significant differences in analytical ability and evaluation ability, and no significant differences in creative ability, but there is still a certain effect, only the effect is not significant, after the mathematics teaching of A-STEM education concept, the development of students' thinking ability in each.

References

Zhao, Zhongjian (authored). (2017). Research on STEM education in primary and secondary schools in the United States [M]. Shanghai: Shanghai Science and Technology Education Press, 1-23, 23-25.

Li, Jianxing. (1985) Tomorrow's science education [M]. Taipei: Kindergarten Teacher Cultural Business Press, 22-23.

Liao, Boqin. (2009). Science Pedagogy [M]. Beijing: Science Education Press, 16.

Wei, Hong-Sen, Zeng, Guo-Ping. Systems theory [M]. Beijing: World Book Publishing Company, 90-97.

Lorraine, W., & Anderson et al. (2009). Translated by Jiang Xiaoping and proofread by Luo Xingkai. Bloom's taxonomy of educational objectives: learning and teaching and its evaluation in a taxonomic perspective [M]. Beijing: Foreign Language Teaching and Research Press.

Jane, J. (2011). A study on the construction of digital learning environment and its practice to support higher-order thinking development [D]. Changchun: Northeast Normal University.

Feng, Rui. The creation of problem situations in high school mathematics from the perspective of higher-order thinking cultivation [D].