Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.15, No.2, 2024

A study of mathematics teaching models of high schools based on Kolb's learning style inventory

Qin Yang *
The First High School of Yancheng City, Yancheng, Jiangsu 224055, China
* E-mail of the corresponding author: matheorist@126.com

The research is financed by Yancheng Educational Science Planning Project in 2021. No. 2021-L-136

Abstract

The high school mathematics teaching model is investigated from the aspect of students' learning styles. The Kolb learning styles inventory was applied to questionnaire survey. A comparison of results from group teaching shows significant differences ($P<0.05$) in the academic performance and monthly test scores of students with different learning styles. 32.24% of students with a convergent learning style achieved the highest exam scores, while 17.54% of those with a divergent learning style had the highest monthly scores. It shows that learning styles have a certain degree of influence on high school mathematics performance and should be organically combined with learning styles, teaching models, and mathematics performance.

Keywords: learning style, Kolb's inventory, high school mathematics, teaching model

DOI: 10.7176/JEP/15-2-01

Publication date: February 28th 2024

In the realm of education, the concept of customized education emerges as an innovative model that integrates student-centric approaches with traditional teaching practices to nurture essential student qualities. This approach significantly emphasizes the importance of learning styles, which are characterized by specific methods, preferences, and tendencies unique to individuals while engaging with a particular subject. Among various subjects, high school mathematics is recognized for its critical role at the secondary education level. It demands students to not only grasp accurate learning techniques but also cultivate rigorous logical reasoning and advance their capacity for abstract thought. Given these requirements, the personalization of mathematical teaching according to the distinctive learning styles of students is deemed especially vital. This tailored approach aims to optimize educational outcomes, ensuring that teaching methodologies resonate with the diverse learning preferences of students, thereby fostering a more engaging and productive learning environment in high school mathematics.

1. The concept and meaning of learning styles

David A. Kolb (1984) proposed the well-known Experiential Learning Model, in which he defined four learning styles: Accommodator, Diverger, Assimilator, and Converger, and designed a learning styles questionnaire, that is, the "Kolb learning styles inventory." The inventory consists of 12 questions, each containing four options, representing four stages of learning: concrete experience (CE), reflective observation (RO), abstract concepts (AC), and active experience (AE). The four learning sessions are combined in two or two. That is, four different types of learning styles are formed, including divergent styles based on experience and reflective observation, assimilation styles based on reflective observation and abstract concepts; convergent styles based on active practice and abstract concepts; and adaptive learning styles based on concrete experience and active experience.

Neil D Fleming (2001) designed the VARK model, which represents four primary learning styles: Visual, Auditory, Reading/Writing, and Kinesthetic. Howard Gardner (1983) proposed the theory of multiple intelligences, which assumes that humans have several relatively independent intelligences that reflect individual learning preferences. Anthony F. Gregorc (1985) proposed his learning style model, which is divided into four types: Concrete Sequential, Abstract Sequential, Abstract Random, and Concrete Random. The model proposed by Felder and Silverman (1988) emphasizes the learning styles of STEM students, dividing learning styles into active/passive, sensing/intuitive, visual/verbal, and sequential/global.

Various scholars used this inventory to conduct research related to learning styles, such as Kim (2018) who used the inventory to investigate students' learning styles and concluded that students with different learning styles have

different learning behaviors and have different effects on collaborative learning. Iqbal (2021) also investigated feedback on students' learning in an online learning environment and the variability in time to complete learning tasks based on the Kolb learning styles inventory.

In this paper the Kolb learning styles inventory is used to conduct a questionnaire survey on students within a general high school. Its purpose is to understand the current students' mathematical learning styles, and conduct targeted teaching methods according to the characteristics of different types of learning styles, to investigate in depth the relationship between their mathematical learning styles and mathematical performance, and to provide a basis for the formulation of future mathematics teaching strategies.

2. Research subjects and methods

2.1 Research subjects

Eight science classes with a total of 500 students in a general high school were selected for this study. They have then divided into two groups: the control group consisted of 265 students in classes 1-4; the experimental group consisted of 235 students in classes 5-8. There was no significant difference ($p<0.05$) in the age and other subject scores of the students in the two groups.

2.2 Research methods

2.2.1 Questionnaire design

On the basis of the Kolb learning styles inventory, this study combined the characteristics of the subject of high school mathematics to design the questionnaire, which was modified by several rounds of expert consultation to form the official questionnaire. Before the formal research, 50 students were selected for a pre-study to assess the reliability of the questionnaire. The pre-study Cronbach's alpha value was 0.898 (>0.7), indicating that the questionnaire has some credibility.

2.2.2 Questionnaire distribution

A total of 500 questionnaires were distributed to students in the experimental and control groups, and 456 valid questionnaires were collected by excluding invalid questionnaires with a response rate of less than 100%.

2.2.3 Comparison of teaching in groups

Students were taught in targeted groups in the mathematics curriculum based on the Kolb learning styles inventory. Mathematics grades were assessed with a total score of 120 points, including an exam grade (100 points) and a regular grade (20 points), where the regular grade came from quizzes on in-class math problems.

2.2.4 Statistical analysis methods

SPSS 22.0 software was used to process the data, t-tests and variance.

3. Results

3.1 Students' learning styles status

The statistics of students' learning styles of 456 valid questionnaires are shown in Table 1.

Table 1. Statistics of students' learning styles

learning styles type	Number of person/person	Ratio /%
Adaptive	126	27.63
Dispersed	80	17.54
Assimilative	103	22.59
Aggregative	147	32.24

A total of 235 Kolb learning styles inventory were distributed to students in the test group, and 210 valid questionnaires were returned, with an effective rate of 89.36%. The results of the study are shown in Table 2, in which convergent learning styles had the highest number of students with 77 students (36.67%), and divergent learning styles had the lowest number of students with only 35 students (16.67%).

Table 2. Learning styles of students in the test group

learning styles type	Number of person/person	Ratio /%
Adaptive	58	27.62
Dispersed	35	16.67
Assimilative	40	19.05
Aggregative	77	36.67

A total of 265 Kolb learning styles scales were distributed to the control group, and 246 valid questionnaires were returned, with an effective rate of 92.83%. The results of the study are shown in Table 3. Convergent learning styles had the highest number of students with 70 students (28.46%), while divergent learning styles had the lowest number of students with 45 students (18.29%).

Table 3. Learning styles of students in the control group

learning styles type	Number of person/person	Ratio/%
Adaptive	68	27.64
Dispersed	45	18.29
Assimilative	63	25.61
Aggregative	70	28.46

3.2 The impact of student learning styles on high school mathematics performance

The results of the analysis of variance on students' learning styles and math scores for the experimental and control groups are shown in Table 4, where students' test scores and regular scores differed due to different learning styles. The students with convergent learning styles had the highest test scores, with an average score of 89.63. Still, the lowest average score of 8.32, indicating that convergent learning styles help high school students to develop integrated thinking in mathematics learning and to have the ability to integrate and understand the theoretical knowledge and solution steps of mathematical exercises taught by teachers. However, it limits students' ability to draw inferences and apply them flexibly to mathematical problems. On the contrary, although the average score of divergent students' test scores was only 72.53, the usual score of this type of student was the highest, up to 10.53. This suggests that divergent students are not good at integrating and reviewing lesson mathematical formulas and exercises. Still, they have strong creative thinking about mathematics and are able to master and apply new knowledge in a short time.

Table 4. Effect of students' learning styles on math performance

learning styles	n（%）	Exam results（x±S）	Usual grades（x±S）
Adaptive	126（27.63）	67.96±9.29	9.73±4.52
Dispersed	80（17.54）	72.53±6.38	10.53±1.68
Assimilative	103（22.59）	80.45±8.68	9.57±3.89
Aggregative	147（32.24）	89.63±7.85	8.32±2.71

3.3 Comparison of results of teaching in groups

Combining the results of ANOVA on learning styles and math scores, the two groups of students were taught in small groups with different teaching styles. In the mathematics class, the theoretical teaching models were used for the aggregative and assimilative students in the experimental group, while the teaching models such as group discussion and flipped classroom were used for the adaptive and divergent students. For the students in the control group, the traditional teaching models were still used. After 4 months, the math scores of the two groups were compared, and the results of the statistical analysis are shown in Table 5. The total math scores of the students in the experimental group were significantly higher than those of the control group, and there was a significant difference ($p < 0.05$). The math test scores of the experimental group were significantly higher than those of the

control group, but there was no significant difference (P > 0.05). The usual scores of the test group were significantly higher than those of the control group, and there was a significant difference (P < 0.05).

Table 5. Comparison of teaching performance of subgroups

Group	n/ person	Total mathematics score （x±S）	Exam results （x±S）	Usual grades （x±S）
Control group	246	95.71±10.29	82.39±8.68	11.43±7.18
Test group	210	104.53±9.49	90.89±8.41	13.52±4.15
t/F value		3.064	0.831	4.937
P-value		0.017	0.936	＜0.001

4 High school mathematics teaching models improvement suggestions

4.1 Mastering students' learning styles for group learning in mathematics lessons

As shown in Table 5, the math scores of students in the experimental group were significantly higher than those of the control group under the intervention model of group teaching, indicating that individualized formulation of group teaching models according to students' learning styles has a great contribution to improving students' learning performance and developing logical thinking and abstract generalization ability. Therefore, in the teaching process of high school mathematics lessons, we should first conduct a detailed investigation and research on the mathematics learning styles of students in the class. Then, students are divided into learning groups according to their own learning styles, and they are taught according to the characteristics of each group's learning styles and guided to think independently. In practice, mathematics teachers can implement group learning in the lesson according to the characteristics of the four learning styles and the learning level of each group of students so as to ensure that students in each group can fully utilize the characteristics of their own mathematics learning styles to promote mutual progress.

4.2 Using diverse mathematics teaching methods according to students' learning styles

As can be seen from Table 1, the highest percentage of aggregation and adaptation types among the interviewed high school students indicates that students generally prefer teaching models that combine theoretical lectures and practice and prefer to perceive mathematical knowledge through practical experience and abstract understanding. Therefore, combined with the findings in Table 4, high school mathematics teachers can focus on the innovative points of mathematical formulas and exercises for the students of the aggregation group in their lessons in response to their usual poor performance. Students' ability to use mathematics flexibly can be improved by transforming examples, formula deformation, reverse push, algorithm deformation, analogical association, and other diversified divergent thinking. In order to address the poor test scores of students in the dispersion group, the analysis and synthesis method and the generalization method can be used in the mathematics lesson to emphasize key formulas and exercises to enhance students' ability to integrate and use them in the test. For adaptive and assimilative students, high school mathematics teachers can use diverse teaching methods in the lesson, such as observation and experimentation, and the combination of number and shape, in order to highlight the interesting nature of mathematics in learning and change the monotonous and boring subject properties of traditional mathematics, so as to stimulate students' interest in learning mathematics and enable them to gain satisfaction and identity in the process of learning.

4.3 Focus on students' individual differences and develop students' logical thinking in mathematics

The essence of mathematics learning is to use mathematical knowledge to solve mathematical problems. In students' learning of high school mathematics knowledge, good mathematical logic thinking is the prerequisite and foundation for effective learning. From Tables 2 and 3, it can be seen that there is a large variability in learning styles among different groups of students. From Table 5, it can be seen that teaching in groups based on learning styles has a significant effect on students' performance in mathematics. Consequently, teachers should pay attention to students' individual characteristics and adopt different teaching methods in order to guide students to develop good study habits in the learning process. During the practical mathematics teaching process, teachers should start by cultivating students' basic ability to learn mathematical knowledge and develop their ability to use mathematical thinking to solve problems according to the characteristics of mathematics subjects. It is up to the

students to explore and discover the correlation between mathematical information. Once the problem is clearly identified, the thinking and methods for transforming between the phenomena and the essence of mathematics are identified, and the students' ability to use mathematical thinking, as well as the acuity and efficiency of their thinking, is improved through continuous practice.

4.4 Improving teacher literacy and implementing personalized high school mathematics teaching models

As can be seen from Table 5, there is a significant difference in the mathematics performance of students in the experimental and control groups, and the underlying reason for this differential result is that the different teaching styles of mathematics teachers can have a positive effect on the learning effectiveness of students with different types of learning styles. Therefore, it is a major factor in improving teachers' overall literacy so that they can flexibly change teaching models according to the characteristics of the types of learning styles. This requires teachers to have comprehensive and profound knowledge of the subject of mathematics, to have their own unique insights into the connotations of mathematics, and to be able to adopt flexible and varied teaching methods according to the characteristics of the subject of mathematics, so as to overcome the problems of tedium, ponderous problems and complex formulas under traditional teaching models.

Since mathematics is a scientific, logical, creative and imaginative subject, teachers are required to use positive thinking in the lesson to understand the subject constantly and to be able to use multimedia teaching techniques to carry out teaching. Using multimedia methods such as animation and video to display abstract knowledge of complex mathematical graphs and functions vividly will contribute to the development of logical thinking and abstract understanding of adaptive and convergent students. Cultivating learning styles allows students to improve and succeed in their "nearest development zone," develop their potential, and develop their personalities in a comprehensive and healthy way.

In addition, teachers need to strengthen their own professionalism, not only to find ways to make students aware of their mathematical learning styles and the good and bad mathematical learning strategies they consistently apply but also to focus on the educational concept of "teaching to the students' abilities" in every aspect of teaching. The concept of "teaching to the student's ability" is integrated into every aspect of teaching, including the design of teaching, the teaching process, the assignment of homework, the reflection of teaching, etc., to motivate students and enhance their sense of ownership fully.

5 Conclusion

Among human resources development, high school is an important stage for knowledge transfer, personality development, and quality improvement. High school mathematics is a major subject that is strongly rational thinking and requires students to have strong abstract overview ability. Learning styles is an important factor affecting students' learning methods and academic performance. Only by organically combining learning styles, teaching models, and mathematics performance can the quality of mathematics teaching be significantly improved. Hence, on the basis of the existing teaching models in high school, we should grasp students' learning styles and teach them in groups according to their learning styles, enrich the teaching methods in teaching, pay attention to students' individual differences, and cultivate students' logical thinking in the lesson. On top of that, teachers should pay attention to improving their own quality and use modern educational technology to improve the quality of teaching in the mathematics lesson so that students can get recognition and a sense of value in the learning process, thus making them a high school student with good theoretical and practical skills.

References

David A Kolb. (1984). Experiential learning: Experience as the source of learning and development. Englewood Cliffs: Prentice-Hall.

Neil D Fleming. (2001). Teaching and Learning Styles: VARK Strategies. Honolulu, Hawaii: VARK-Learn.

Howard Gardner. (1983). Frames of mind: The theory of multiple intelligences. New York: Basic Books.

Anthony F Gregorc. (1985). Inside styles: Beyond the basics. Columbia, Columbia: Gregorc Associates.

Richard M Felder, Linda K Silverman. (1988). Learning and teaching styles in engineering education. *Engineering Education* 78(7), 674-681.

Kim, Nayu, Lee Hee chul. (2018). A Study on the Validity of the English Learning Style Scale for Korean High School Students in a Native Teacher's Class Based on Multimedia. *STEM Journal* 19(4), 149-165.

Muhammad Zafar Iqbal Hydrie, Naqvi Syed Muhammad Zulfiqar Hyder. (2021). Assessing learning styles of medical students using Kolb's learning style inventory and their association with preferred teaching methodologies. *Journal of the Pakistan Medical Association* 71(4), 1-13.