The Study on Teaching Strategies for Conic Sections in High School Mathematics Based on the ARCS Motivation Model

Qizhen Ren，Qi Ge
Department of mathematics, College of science, Yanbian University, Yanji, China.
*Corresponding author email id: geqi9688@163.com

***Abstract* - This paper analyzes the application of the ARCS model of motivation in the learning teaching of conic sections of high school math, attempting to arouse students' motivation to learn, eliminate the difficulty to learn, and improve the teaching efficiency. Nowadays most of the students usually lack the enthusiasm to learn mathematics so as to acquire a weak comprehension on the concept of conic sections; and teachers experience problem including single teaching modes and a rough assessment system. By adopting ARCS model and the attention attracting, attention activating and the strategies of creating relevance, gaining confidence and experiencing success, this paper aims to arouse the students' learning enthusiasm and enhance the learning effectiveness. Furthermore, this model not only completes the theory system about motivation research in mathematics education, but also supplies the systematical strategies for teaching practice and it has high theoretical and practical values.**

***Keywords* - ARCS motivational model; high school mathematics; conic sections; teaching strategies**

I. INTRODUCTION

Introduction After the speed-up of educational reform, the problems of improving teaching effectiveness of class and motivating students to learn urgently call for teachers' new ideas. Mathematics as a basic course serves an indispensable role to cultivate students' logical ability, practical creative ability, ability, all-around ability. Its topics are taught particularly difficult, such as the problems of conic sections of high school mathematics, whose content is relatively abstract and more complicated in calculation. The traditional teaching method has not only failed to arouse students' interest in learning but also achieved poor teaching effects.

With the dramatic progress of information technology at the 21 century, it has been transforming the educational world in an unprecedented pace, promoting modernization of China's school system fast in teaching, influencing and making differences on the learning of student as well as motivation. Motivation to learn has been an urgent problem to stimulate and maintain it. It can provide new theoretical basis and methods for motivating students for learning in recent years. American psychology John Keller developed in 1987 the ARCS motivation model which can systematically stimulate and maintain students' motivation for learning of four dimensions (Attention, Relevance, Confidence, and Satisfaction) and has achieved promising results in various fields.

In this paper, we investigated using ARCS motivation model to teach conic sections, which is the regular content for students in senior high schools and is relatively abstract and difficult to understand, so it really confuses students when they first learn it. Using the ARCS model—Attention, Relevance,

Confidence and Satisfaction—can enable teachers to attract students attention by presenting students with real-world situations, increase students relevance by considering problems of everyday life, make students progressively have confidence through teacher assistance and satisfaction felt by proper problem solving, which can cultivate students learning interests and enhance teaching efficiency. Education reform and new curriculum standard system offers a solid guarantee for this strategy.[1]

II.First, definition of the ARCS motivation model

ARCS motivation model is an instructional design model well-studied in the educational psychology circle in the domestic and international realm that centers on learners' motivation. It has been widely used on different subjects, with the four dimensions of Attention, Relevance, Confidence and Satisfaction to induce and maintain the students' motivation of learning.

A. *Attention.*

Attention can be achieved by attracting students' visual attention, triggering interest by provoking their curiosity, and creating variation. By engaging students' curiosity, attraction is created by novel or uncommon events or examples. For example, an interesting role for conic sections in architectural design can be illustrated using multi-media. Inquiry-induced arousal refers to provoking inquiries to stimulate students and arouse their sense of initiative in learning such as proposing, "What's the relation between conic sections and the trajectories of people's daily life?" Diversification refers to making teaching contents, ways, and methods diversified, such as setting up competitive classes among groups and role-playing games in order to sustain students' enthusiasm for knowledge learning.

B. *Relevance.*

An emphasis is on the relevance of the knowledge to students' background knowledge, their needs and life experience. Simplification is explaining new knowledge on students' familiar concept, e.g., using the path of a thrown ball to explain a parabola. To clarify learning goal and values, students can understand the application of the study of conic section to solving real-world problems and learning of future course. Moreover, customized or personalized tasks are used depending on students' traits so as to cater their diverse learning needs.[2]

C. *Confidence.*

This approach is oriented toward helping students build learning confidence. The expectation of success helps students clearly understand the requirements of assignments and evaluations, as well as the teachers' expectations. By designing challenging scenarios that incorporate tasks with a moderate level of difficulty, students can experience success through their own efforts. Furthermore, employing correct attribution methods assists students in attributing their academic success to their abilities rather than luck, and their failures to a lack of sufficient effort rather than to intelligence.

D. *Satisfaction.*

Our approach seeks to support a meaningful, positive and enjoyable learning experience for students. Of course naturally occurring outcomes (such as making it practical for students to apply conic sections to physics experiments) are critical, but, so too, are outcomes arising from positive engagement (such as promoting, reinforcing and rewarding student success).Sixth, fairness results make sure the teacher's grades for students appear fair, so they could maintain belief in the process.

III. Secondly, the current situation of teaching conic sections in high school mathematics

Set in the context of continuous deepening of education reform, all-round development of the quality education, and the continuous improvement of the college entrance examination evaluation system, the high school mathematics teaching has new opportunities and new challenges. Among them, as a major

part of middle school mathematics, conic section also not only helps students develop a mathematical way of thinking, arithmetic ability, and space imagination, but it is also often one of the subjects of college entrance examination, thus the teaching quality of conic section teaching has an immediate impact on college entrance examination and students' mathematical literacy. Nevertheless, abstract concept, numerous formulas and multi-varied problem solving methods of conic sections generally make it a difficult topic for the students and difficult for the teachers too to get good teaching results.[3]

A. *Insufficient Learning Motivation.*

The traditional teaching method of mathematics mainly stresses the explanation of the knowledge and the training of the students' learning motivation is overlooked, which makes the teaching content far away from the actual student's life needs, doesn't help to show the real use value contained in the concept of the conic sections, thus it shows that the interests and the motivation of the students are low. As an illustration, in teaching what an ellipse is, if the discussion remains strictly at the level of "definition and formulas" in the textbook while ignoring the common-place examples in the everyday life of an ellipse, students would quickly feel bored.

Academics attempt to build a clearer teaching system by systematically analyzing the teaching situation. Wu Jian's research points out that the close connection between conic section and natural science and social science, which proposes that conic section teaching can be used as the entry point to interdisciplinary teaching. The core lies in linking the conic sections with real life, as it tries to activate the students' motivational drive and arouses the students' learning interest, which is breaking away from the single-discipline conception teaching of conic sections and is an important new vitalized force in the teaching of conic sections. [4]

B. *Monolithic Teaching Methods.*

Conic section teaching difficulties are high degree of abstraction and operation. But nowadays, "oversees" and "teaching methods" mechanical imparts the method, in fact, the conic section teaching is learned as tedious, their basic principles of knowledge learning also has an impact. In the instruction segment of the hyperbola course, instructors only pay attention to the properties of hyperbola and the step-by-step method of question solving but let the students receive knowledge by summing up passively without themselves being able to think or explore, which is unable to master the essence of the content. According to Ye Shan's research, students could comprehend the original concepts covered in the class, but they have a problem of applying the concepts flexibly to solve the real problems.

This phenomenon reveals an underlying contradiction between teaching methods and students' cognitive characteristics. Lu Liyu further analyzed this contradiction, arguing that the traditional "didactic" teaching model neglects the individual needs of students, resulting in a lack of effective strategies when they confront comprehensive problems.[5]

C. *Imperfect Evaluation System.*

The influence of teaching evaluation system on instruction is a topic that researchers are starting to pay some attention to. Due to the existing evaluation system overly focuses on grades and over-simplifies the learning process and the learning experiences of the students. One assessment approach can hardly help teachers know the learning situation of students well, thereby not making precise teaching methods -- which is not good for the development and cultivation of students as well as the learning.

Liang Muxing remarked that the current teaching and learning assessment of a mathematical course tends to emphasize more on the result rather than on the process and the examination is spent too much on teaching by rote, one simply recalls a set of fixed methods of solving problems to respond to exams. [6] This assessment guide itself shall restrict students' learning capabilities and impacts the

implementation of the teaching reform in the long run. To this end, Zhou Yan suggested adopting a new evaluation method of building a diverse evaluation system to integrate student inquiry ability, cooperation ability, innovative awareness into the evaluation system.[7]

In brief, the problem of teaching conic sections in the senior high school math class has multiple layers, ranging from the natural learning problems and psychological dilemmas of students to the problems existing on teachers' teaching strategies and the selectivity. The blended teaching design base on the ARCS motivational model provides new viewpoints and approach to solve these problems.

Therefore, when introducing the ARCS motivation model (Attention, Relevance, Confidence, Satisfaction) as an innovation, we can expect to rationally implement it in teaching through reinforcing the practical connection of the teaching content, designing the exploratory work task at different levels and adopting the ideal formative assessment mechanism. This could motivate students' learning and arouse their learning interest. Through this, their learning effect and learning satisfaction are further enhanced and the teaching path about conic section is restructured, then not only is the teaching of high school mathematics promoted, but also a technical solution for the teaching mode of overcoming the teaching defects of conventional methods is offered.

IV. THIRD, TEACHING STRATEGY PRINCIPLES

A. *Student-Centered Principle.*

Put students into the center, ARCS-based teaching was an idea proposed, which requires teachers to fully pay attention to the needs and characteristics of students, make effective participation by students as well as teamwork their teaching activities, develop students' abilities in autonomous learning and teamwork, etc. During the teaching activities of conic sections, the teacher should lead the students to develop the ability to explore conic sections' properties on their own, carry out small-group discussion, exchange learning experience, make students have a sense of success and confidence during learning.[8]

B. *Goal-Oriented Principle.*

Firstly, teaching goals can guide the teaching activities. Teaching teachers must revolve around the conic sections teaching goals. In the conic sections teaching, the knowledge is not simply imparted to the students, but also should establish an autonomous learning ability and arouse students' interest and self-confidence. Being oriented on the goal, then not only improves the teaching effectiveness and quality, it can also play a maximized role. In designing teaching objectives for parabolas, apart from objectives of knowledge and skills, there should be objectives for improving the students' observation, analysis and synthesis abilities as well as affective objectives for increasing their interests towards mathematical research.

C. *Principle of Diversity.*

Implementing diverse teaching methods and abundant teaching methods of teaching to arouse students' learning interest. When teaching the conic section, the teacher can adopt different methods and means like telling stories, demonstrations and mathematical experiments to present the related knowledge from different aspects and dimensions in order to improve learning effects. To take another example, where the optical properties of conic sections were taught, animations were used so that students could watch how light ray bounces back from the cone shape.

D. *Principle of Flexibility.*

In real classroom teaching, teachers are required to have enough flexibility and imagination, which includes being able to scientifically adjust their teaching content, teaching methods or process, etc. according to changes in students' learning quality or teaching environment, etc. This guarantees that different learning needs of students can be reflected fully, which provides favorable conditions for

improving their activeness and initiative of learning. For example, students' limited understanding of the definition of conic section would cause teacher immediately put real-life examples or made the arrangement of the course plan make more reflective and assimilation time.[9]

V. Forth, analysis of teaching strategies

A. *Attention-Capturing Teaching Strategies.*

The teacher can relate the math topic of conic sections to our daily world with some interesting and easy examples, such as a parabolic design of a bridge, arousing interests and knowledge. And the multimedia images make the abstract concept easier to understand. And using thrilling problems to arouse students' exploration and creativity, such as using string and thumbtacks to draw the ellipse. The teacher can carry out conic section exercise in group, stimulating students' exchange and communication. And during group work, the teacher's timely prompt enhances student's confidence and helps them keep working on improving.

B. *Teaching Strategies Directly Relevant to Learners.*

Second, teachers are encouraged to take students' level into consideration when designing teaching. For instance, when teaching the subject of conic sections, teachers may draw an analogy between the concepts of conic sections and students' understanding of quadratic functions and apply some concrete and common examples in real life such as planetary orbits or basketball paths and inspire students' interest and practical experience in daily life.

Teaching should be differentiated: better students are challenging, poorer students have adaptive tutorial and drill support (e.g. grouped) learning. Teachers need to be aware in real time, provide appropriate support, understand challenges, and celebrate successes to aid motivation and self-monitoring.

C. *Principle of Flexibility.*

Teachers design a class open, nonthreatening and engaging, promoting inquiry and adventure. In the collaborative environment, team peers will remove threats and enhance confidences. From Vygotsky's model of learning, teacher models demanding but accessible goals to enhance skills and self-efficacy. Teachers transfer the emphasis to the learning activity, to a focus on positive outlooks, good study strategies and mutual encouragement. Project-based learning and modern technologies stimulate the transfer of knowledge and problem solving ability.

D. *Strategies for Fostering Learning Satisfaction.*

The different modes of resources, such as textbook video lectures, online course, interactive exercise, etc. are being given to satisfy different students' learning demands and let them enjoy the learning process as they like. Students may get satisfied via online course, teaching video or some tools (such as dynamic geometry software) to consolidate their knowledge. Conic sections are moderately difficult tasks and open problems encourage students to work by themselves and in groups to solve them successfully, creatively and practically. And teachers provide immediate and enthusiastic positive feedback with each solved problem to students to understand what were good, what could be done well and how to be improved. Each lesson in the classroom is conducted in a loose, friendly environment that improves student activity, discussion and partnership between them which, in return, improve learning satisfaction.

VI. Fifth, application of arcs motivational model-based strategies in teaching conic sections

A. *Introduction of New Knowledge.*

How the instructor demonstrated intuitive graphics, dynamic simulations, in plain English, that rotating the curves will generate the elliptical, the parabolic, the hyperbolic and their geometry and

physical importance were shown. The correlation between their actual application in real-life such as satellite and airplanes was explained. This procedure improved students interest, self-confidence and problem-solving abilities.

B. *Problem Investigation.*

In this stage, teachers enable students to participate in expressive and critical cognition by producing critical divergent questions that engage students in content issues to explore knowledge boundaries, such as "What kind of curves belong to the conic sections?" allows for exploring geometric logic issues, and "Why all ellipses, hyperbolas, and parabolas belong to conic sections?" is a question about revealing mathematical connections issues, which helps to promote the synthesis of ideas. Moreover, it is interesting to examine general geometric characteristics of conic sections, from the new perspective, which connects the learning of new concepts with that of well-known conic sections to facilitate the smooth transference and cognitive upgrade.

C. *Consolidation and Application.*

During consolidation stage, teachers can appreciate and reward the innovative thinking of students with well-defined assessments, focusing not so much on the question, as much as on the solution that puts value in the process and not only in the answer itself. This goes hand in hand in developing creativity as well as logic while forming hypotheses, analyzing the problem and modeling. More flexible approaches such as group work and problem-based learning become the outlet for abstract ideas behind the theories of conic sections and exercise them further toward greater understanding and cooperation for the development of problem-solving.

D. *Strengthening Motivation.*

Positive feedback through the teachers, positive words, commendatory remarks and timely recognition of a child's achievement could provide the required push for the child to gain confidence and develop a learning attitude. For instance, acknowledging a students understanding of conic sections not just a milestone or a memory but also, an encouragement to learn.

Using the ARCS model in conic section instruction increases engagement and sparks interest in mathematics, supporting a deeper understanding and aiding teaching reform both theoretically and practically.

VII. Conclusion

In this paper, we adopted ARCS motivation model to high school conic section teaching and offered the innovative teaching strategies to conic section. We gave the new point of view and the ideas in conic section teaching and aroused the motivation of students and improved students' learning interest and learning effects, enriched the theoretical system of the motivation model of math teaching. It also offered some realistic implications for the math teaching practice.

Teachers need to integrate the ARCS model of motivation completely when they are teaching, by deep comprehension of learners' needs, design and planning the teaching activities and apply different teaching means and methods flexibly, Besides, the teachers should pay attention to learners' learning process and emotional feelings and adjust the teaching strategies continuously so that they can obtain satisfactory teaching effects. On the other hand, the educational administration department and the school should improve the training of the teachers and advocate the teachers applying ARCS motivational model into teaching so as to work on the improvement of the high school education on mathematics and build up a solid basis for training the high-caliber talent with novel ideas and practical skills.

References

[1] Zu Bingchou, He Yunseng, Chen Feng, et al. Design and Application Research of a Flipped Classroom Based on the ARCS Motivation Model: A Deep Learning Perspective [J]. Chinese Journal of Medical Education Technology, 2022, 36(03):259–

263. (in Chinese)
[2] Zeng Duxue. Humanizing Classroom Instruction and Integrating Life Resources into the Curriculum—A Brief Analysis and Pedagogical Reflection on the Standardized Primary School Moral and Legal Education Textbook [J]. Gansu Education, 2022, (03):15–18. (in Chinese)
[3] Luo Qian. Insights and Reflections on Conic Sections Teaching in the Context of Gaokao Mathematics [J]. Shenzhou (Early Issue), 2020, 000(018):94. (in Chinese)
[4] Wu Jian. Analysis and Research on the Current Situation of Teaching Conic Sections in High School Mathematics [J]. Mathematics Learning and Research, 2014, (21):55. (in Chinese)
[5] Lu Liyu. Analysis and Research on the Current Situation of Conic Sections Teaching in High School Mathematics [J]. Gaokao, 2020, (18):105. (in Chinese)
[6] Liang Muxing. Analysis and Research on the Current Situation of Conic Sections Teaching in High School Mathematics [J]. Examination Questions and Research, 2018, (24):134. (in Chinese)
[7] Zhou Yan. Analysis and Research on the Current Situation of Conic Sections Teaching in High School Mathematics [J]. Learning in Mathematics, Physics, and Chemistry (Senior Three Edition), 2014, (11):55. (in Chinese)
[8] Jiang Canyan, Renagul A'budureheman, Liu Hongmei, et al. Research on High School Chemistry Experimental Instruction from the Perspective of ARCS Motivation [J]. Chemical Engineering Design Communications, 2024, 50(08):76–79. (in Chinese)
[9] Chen Ali. Teaching with a Main Line, Methods, and Direction—A Practical Study on Main-Line Instruction [J]. Shaanxi Education (Teaching Edition), 2024, (Z2):6–8. (in Chinese)

AUTHORS' PROFILE

First Author
Qizhen Ren, 18860676788@163.com,female, Shandong Province, China, born in May 2001, studying at Yanbian University, as a graduate student in mathematics education.

Third Author
Qi Ge, Yanji City, Jilin Province, China, born in September 1975, teaching at Yanbian University, as a professor, and master tutor. Research direction: Theory of mathematics teaching.