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Research on the design of micro-course in secondary vocational mathematics by ARCS model

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Abstract: *With the widespread adoption of internet technology in the information age, diverse forms of teaching have garnered attention from educators and learners. Micro-lessons, characterized by their precision and brevity, have emerged as a dominant teaching format for sharing instructional resources. The development of vocational education in the new era presents an opportune moment, as micro-lessons offer a new pathway for cultivating high-quality skilled talents. In the context of mathematics education in secondary vocational schools, there is a need to emphasize a shift in teaching approaches. This article utilizes the ARCS model to design micro-lessons, facilitating teachers' ability to incorporate innovation, distinctiveness, and highlights into their instruction. By implementing this approach in regular classroom teaching, where the design of the lessons is clearly structured, students at different proficiency levels can experience growth, enabling them to truly embrace the desire to learn and enjoy the process. As a result, this method effectively enhances students' learning outcomes and increases their confidence.*

Keywords: *Vocational education; Mathematics instruction; Micro-lessons; ARCS motivation model*

1. Introduction

1.1 Research Background

The Internet has permeated every aspect of our lives, bringing about numerous opportunities for development and reducing the information asymmetry that exists. It provides effective solutions to the challenges of admission, teaching, and learning in vocational education. Since China entered the new era, there has been a strong emphasis on the cultivation of vocational education students. In recent years, China has issued documents such as the "National Vocational Education Reform Implementation Plan" and the revised Vocational Education Law, all of which emphasize the importance of nurturing high-quality technical talents, filling key technical positions, improving employment rates in vocational schools, and expanding the development space of vocational education through the acquisition of professional knowledge and skills.

The new era is also an era of information, where the way knowledge is transmitted is constantly changing. Teaching methods are not limited to physical classrooms but extend to the virtual space of the internet. The informatization and modernization of education are essential paths for the growth of vocational education. Han Xibin (2019) believes that the integration of the Internet and vocational education promotes the deep integration of technology and teaching, facilitating the sharing of quality educational resources. Liu Jun (2020) points out that informatization is one of the important means to promote rural revitalization, targeted poverty alleviation through education, and narrowing the urban-rural gap.

The development of the Internet has greatly facilitated our learning and daily lives. It is worth noting that the rise of short videos has also brought new ideas to teaching, and micro-lessons have gradually appeared in everyday instruction. Scholars have different interpretations of micro-lessons. Some researchers see micro-lessons as a supplementary approach to traditional classrooms, considering them as a form of flipped classroom. Other scholars view micro-lessons as a way to present knowledge in a "precise, concise, and convenient" manner, allowing learners to complete knowledge acquisition within a specific timeframe without constraints of time and location. Micro-lessons play an important role in the transformation of vocational education and bring enormous opportunities to its development [1-3].

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1.2 Theoretical Foundation of Micro-lessons

In 2010, during the curriculum resource collection and evaluation event for primary and secondary schools in Guangdong, China, Hu Tiesheng first defined micro-lessons as instructional activities conducted through video presentations. Since then, micro-lessons have gradually been integrated into teaching practices, enriching teaching methods and innovating the forms of knowledge delivery. This unique instructional approach has gained favor among educational researchers and teachers, receiving recognition for its effectiveness in teaching. Moreover, aligned with our modern educational needs, micro-lessons provide a platform for teacher professional growth and facilitate the sharing of educational resources [4].

Initially, micro-lessons were designed to assist students in their learning, with teachers taking the lead in planning and delivering instructional activities. Teachers develop teaching plans based on curriculum standards and objectives, delivering concise video lessons of approximately 10 to 20 minutes in length. These videos focus on fundamental knowledge, highlighting key and challenging points. Students, according to their own needs, set learning goals and choose the appropriate courses to complete within a specified time frame. If students still have questions after completing their learning, they can revisit the instructional videos for further review.

In the era of the new age, vocational education has attracted significant attention due to its immense development potential. Micro-lessons have seen increasing applications in vocational education. They provide vocational school students with the opportunity to independently choose courses, study and consolidate their learning according to their own pace, and exhibit a strong sense of autonomy. Micro-lessons not only activate students' enthusiasm for learning but also sustain their learning motivation, while also requiring learners to possess strong self-control. Students' learning motivation and self-control are influenced by their interest in the subject matter, their awareness of the importance of the knowledge, and its relevance to their own lives. Furthermore, the students' ability to understand and apply the knowledge, and their confidence in applying what they have learned to solve problems, play significant roles in enhancing their learning outcomes.

2. Introduction to the ARCS Motivation Model

The ARCS Motivation Model was developed by Keller, a psychology professor at Florida State University, based on a synthesis of various motivational theories such as self-actualization and achievement. The model explains the four factors that contribute to the generation and maintenance of students' learning motivation: attention, relevance, confidence, and satisfaction. By utilizing these four factors, the ARCS Motivation Model enhances instructional efficiency, guides teachers in implementing effective teaching practices, and promotes students' learning motivation and outcomes.

This article focuses on discussing the impact of the ARCS [5] Motivation Model on students' learning motivation from the perspective of instructional design in vocational mathematics micro-lessons.

Attention: It refers to students' ability to concentrate and actively engage in class, as well as whether the teaching content can capture students' attention, guide them to pay deliberate attention to the knowledge being taught, and progressively develop their mathematical interests.

Relevance: The teaching content should be related to students' life experiences, cognitive structures, learning habits, and psychological characteristics. Teachers should establish connections between the instructional content and real-life examples, enabling students to perceive the relevance of their learning to their own lives.

Confidence: It involves the affirmation and self-affirmation of students' abilities. Students need to believe in their own capabilities to achieve set goals. Teachers should provide encouragement and set appropriate goals to help students build confidence in their abilities [6].

Satisfaction: Satisfaction includes both satisfaction with the learning process and satisfaction with the learning outcomes. Both aspects of satisfaction influence students' learning motivation.

The application of the ARCS Model in micro-lessons enhances instructional effectiveness by guiding teachers to design student-centered micro-lessons from the perspective of the learners. Teachers consider students' concerns, stimulate their motivation, and help them achieve the intended learning objectives..

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3. Exponential Function Micro-lesson Design Based on the ARCS Motivation Model

Both micro-lessons and traditional classrooms are instructional activities centered around students. However, the difference lies in the fact that traditional classrooms focus more on achieving teaching objectives through teacher-student interaction, while micro-lessons primarily rely on teacher-led instruction. Therefore, designing a micro-lesson that can stimulate students' motivation, trigger their inquiry mindset, and sustain their learning interest becomes crucial.

This article primarily adopts the Front-End Analysis designed by Liang Leming (2013), which includes learner characteristics analysis, instructional task analysis, and learning content analysis. It also covers micro-lesson elements and design, encompassing curriculum content design and instructional support service design, as well as evaluation and feedback [7].

3.1 Front-End Analysis

The mathematics curriculum in secondary vocational schools is a compulsory foundational course for students in various majors. It serves the fundamental task of fostering moral character and promoting quality education. The mathematics curriculum possesses characteristics such as fundamentality, developmental nature, practicality, and vocational relevance. Compared to students in regular high schools, secondary vocational students generally lack strong logical thinking and computational skills. However, their thinking is often active and sensitive, and they possess a strong desire for knowledge, along with unique insights in many aspects. Traditional teaching methods are no longer sufficient to meet the learning requirements and development of secondary vocational students. This research aims to explore micro-lesson instructional design for the exponential function topic in the "Basic Modules (Volume II)" of vocational mathematics.

Firstly, this study involves establishing instructional objectives that take into account the weak mathematical foundation and poor computational abilities of secondary vocational students. Secondly, based on the "zone of proximal development," achievable goals should be set for students with effort. Therefore, the formulation of instructional objectives should adhere to the principles of "comprehensiveness," "reasonableness," and "feasibility."

1) Comprehensiveness of instructional objectives: The ultimate goal of teaching is student cultivation, so instructional objectives must be formulated from a holistic perspective. Instructional objectives should not be detached from the three-dimensional goals and should be based on the development of mathematical core competencies.

2) Reasonableness of instructional objectives: Reasonableness refers to the design of instructional objectives not being overly ambitious but tailored to the students' learning situation. Objectives should be set that students can achieve through their own efforts. The ARCS Motivation Model emphasizes the importance of considering students' "zone of proximal development" to enhance their learning motivation. Therefore, when formulating instructional objectives, attention should be given to: (1) whether the instructional objectives can be achieved through the joint efforts of teachers and students, and (2) whether most secondary vocational students can build confidence after achieving the instructional objectives.

3) Relevance of instructional objectives: The relevance of instructional objectives refers to the close connection between the objectives and students' existing knowledge. As indicated in the ARCS Motivation Model, if students perceive the newly acquired knowledge as closely related to themselves, it contributes to increasing their interest and motivation to learn. Therefore, when formulating instructional objectives, attention should be given to: (1) whether the objectives are closely connected to students' prior knowledge, (2) whether students perceive the newly acquired knowledge as valuable for their future lives, and (3) whether students' values align with the values taught by the teacher.

Table 1: Analysis Table of Exponential Functions.

S.L	Textbook Analysis	Analysis of Students' Learning Situation	Instructional Objectives
1	Course Standard Analysis	Analysis of Previous Experience	Knowledge and Skills
2	Teaching Content Analysis	Analysis of Understanding Difficulties	Processes and Methods
3	Teaching Content Analysis	Analysis of Learning Motivation	Emotions, Attitudes, and Values

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Based on the analysis above, this study concludes that in order to help students improve and sustain their learning motivation, it is essential to establish instructional objectives that are comprehensive, reasonable, and relevant. To achieve this, the study designs and presents a Front-End Analysis for the exponential function topic in the "Basic Modules (Volume II)" of vocational mathematics Table, shown in Table 1.

3.2 Curriculum Content Design

Due to the overall weak learning foundation, lack of self-discipline, and low learning motivation among students in vocational schools, with only a few students showing interest in the course content, this study decided to select the exponential functions section of the vocational mathematics textbook "Basic Module (Volume 2)" and utilize the "ARCS" model to design micro-lessons. The aim is to help students improve their learning efficiency. The specific course content design is presented in Table 2 below.

Table 2: Curriculum Content Design for Exponential Functions

<table>
<tr><th>Micro-Lesson Titl</th><th colspan="3">Exponential Functions</th></tr>
<tr><th>Teaching Segment</th><th>Teaching Content</th><th>Design Intention</th><th>"ARCS" Strategy</th></tr>
<tr><td>Scenario Introduction (2 minutes)</td><td>If a certain virus undergoes replication, where 1 virus divides into 2, 2 viruses divide into 4, and 4 viruses divide into 8, according to this pattern of division, what is the relationship between the number of cells y obtained after x divisions?
Clearly, the number of viruses and the number of divisions exhibit a functional relationship as follows:
$y = 2^x, \quad x \in N^*$
2 is referred to as the base, and x is the independent variable.</td><td>Creating problem scenarios with real-life examples triggers students' active thinking, motivates their engagement, and enhances their interest in learning.</td><td>"A" strategy involves using real-life examples to help students achieve a more intuitive understanding of the subject matter.

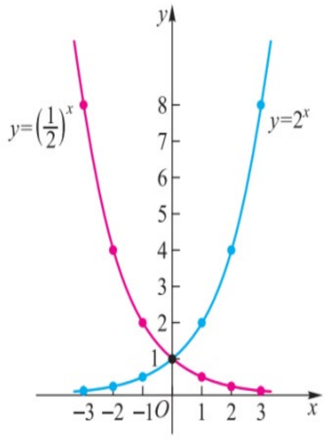
"R" strategy aims to establish connections between the instructional content and what students have learned in junior high school.</td></tr>
<tr><td>Exploration of New Knowledge (5 minutes)</td><td>In general, a function of the form $y = a^x$ ($a > 0$, $a \neq 1$) where a is the base and x is the independent variable, is called an exponential function. Analyze the properties of exponential functions through their graph. Plot the graph of $y = 2^x$, $y = 0.5^x$


Figure 1: Graph of Exponential Functions
Observing the above graph, we can deduce the following properties:
1.The function graph lies above the X-axis.
2.The function graph passes through the point (0, 1).
3.When a > 1, the function is monotonically increasing; when a < 1, the function is monotonically decreasing.</td><td>Inducing concepts, emphasizing normative expressions, and relevant considerations, through comparing the overall characteristics of exponential function graphs in two scenarios, facilitate accurate sketching.</td><td>"A strategy" visually presents mathematical concepts or methods to students in an intuitive manner.

"C strategy" involves setting a goal for students that can be achieved through their own efforts.</td></tr>
</table>

Analysis of Example Problems (3 minutes)	Example: Compare the sizes of the numbers in the following sets. (1) 2^3 and $2^{3.1}$ (2) 0.3^3 and 0.3^{-3} Solution: (1) In the exponential function, as it is a monotonically increasing function, and 3 < 3.1, then the relationship holds. $2^3 < 2^{3.1}$. (2In the exponential function, as it is a monotonically decreasing function, and -3 < 3, then the relationship holds. $0.3^3 < 0.3^{-3}$ Method Summary: When comparing two exponential functions with the same base, the answer can be directly obtained using the functions' monotonicity.	Reinforce the properties of exponential functions by guiding students to independently complete example problems, thus solidifying their understanding of exponential functions.	"C" strategy: Presenting students with an appropriate amount of slightly easier example problems to help build their confidence. "S" strategy: Introducing slight variations after completing the conceptual explanation.
Consolidation Exercises (2 minutes)	Exercise: Compare the sizes of the numbers in the following sets. (1) 1.8^3 *and* $1.8^{3.5}$ (2) 0.2^2 *and* 0.2^{-3}	Through practice, timely grasp the students' level of comprehension, and conduct appropriate checks and corrections to fill any gaps in their understanding.	"S" strategy: After students complete their exercises, provide praise and positive feedback. "C" strategy: Offer students simple exercises to boost their confidence.
Summary and Conclusion (1 minute)	Acknowledging students' learning achievements, reviewing the concept of exponential functions, and revisiting the graph and properties of exponential functions.	Foster students' ability to summarize the learning process.	"C" strategy: Guide students to self-summarize the knowledge they have learned. "R" strategy: Praise students for their actions to enhance their confidence.

3.3 Design of Teaching Support Services

In this micro-lecture, the author adopts a combination of PowerPoint presentation and oral narration. The author utilizes a geometric drawing board to illustrate function graphs, employs Bandicam software for course recording, and utilizes Pr software for post-production editing to complete the micro-lecture recording [8].

3.4 Testing and Evaluation

Testing and evaluation primarily target learners' assessments of the course after its use. The effectiveness of micro-lectures lies in whether students' learning motivation has improved and if learning objectives have been achieved post usage. Exceptional micro-courses need to adhere to learners' cognitive patterns and have comprehensive course designs. From the perspective of the ARCS model, the micro-course interface should allow learners to capture the key content presented by the course at first glance. Emphasizing page layout and reasonable formatting enhances the interface's aesthetics and usability, further engaging and motivating students to actively explore and achieve the learning objectives.

4. Conclusion

In comparison to traditional classrooms, micro-lectures possess innovative forms and convenient usage. In the design of exceptional micro-courses, it is crucial to align with the characteristics of modern education, focusing on how to stimulate students' learning motivation and guide them towards achieving learning objectives. The ARCS model suggests that micro-lectures serve as beneficial complements to traditional math classes. When based on the ARCS motivation model, mathematical micro-lectures effectively address learners' attention, relevance, confidence, and satisfaction factors. By using problem-based approaches, they foster students' abilities to discover and solve problems and encourage a spirit of bold innovation. Maximizing and sustaining students' learning motivation to the fullest extent bears significant significance for education and teaching in the new era.

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