

Research on the Four-Stage Progressive Teaching Model for Data Visualization Courses in Vocational Education Oriented by Digital Literacy

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Abstract: Digital literacy has become a core goal of talent development in vocational education. To address the common problem in data visualization courses in vocational education, where too much emphasis is placed on tool operation while cognitive development is neglected, a four-stage progressive teaching model oriented toward digital literacy has been proposed. This model follows a teaching path of data observation, tool practice, scenario migration, and innovative application. It aims to systematically develop students' data sensitivity, logical analysis ability, visual storytelling ability, business modeling ability, and innovation transfer ability. Teaching practice has shown that this model can effectively improve students' learning engagement, data thinking skills, and knowledge application ability. It provides a practical and replicable solution for teaching reform in data visualization courses in vocational education.

Under the strategic backdrop of the deepening digital economy, digital literacy, especially the ability to use data for effective analysis and decision-making, has become a fundamental core skill for high-tech talent. In recent years, ministries such as the Cyberspace Administration of China and the Ministry of Human Resources and Social Security have introduced a series of policies, including the Key Points for Improving National Digital Literacy and Skills in 2024 and the Action Plan for Accelerating Digital Talent Development to Support Digital Economy Development (2024-2026), with the goal of comprehensively enhancing national digital literacy and cultivating Interdisciplinary Digital Skilled Talents on a large scale^[1, 2]. Guided by national strategy and industrial transformation, vocational education, which plays a major role in supplying digital skilled talent, must carry out teaching reforms in related courses.

The course Data Analysis and Visualization has become an important platform for cultivating students' digital literacy in Vocational Education because of its essential role in data interpretation and presentation. However, current teaching methods at the higher vocational level face two major challenges. First, the teaching content is insufficiently integrated with real industry scenarios, and skills are often taught without practical context. This makes it hard for students to use what they have learned. Second, the teaching approach focuses too much on software operation skills, which overemphasizes tools instead of thinking skills. Because of this, the development of students' higher cognitive abilities such as data sensitivity, logical thinking, and innovative application is often

overlooked. These problems make it difficult for graduates to deal with real world data analysis and visualization challenges in their jobs.

Although existing research has made some progress in areas such as digital literacy cultivation models^[3], collaborative mechanisms^[4], training pathways^[5], and framework development^[6], most of these results remain theoretical or relate only to general academic fields. There is still a lack of teaching models that are both systematically redesigned and highly practical, especially ones suited to the unique characteristics of vocational education. In particular, for highly practical courses like Data Analysis and Visualization, integrating the development of thinking skills throughout the entire teaching process remains a major research gap. This area requires further in-depth study.

To address the challenges mentioned above, this study uses a digital literacy oriented approach to create a new four stage progressive teaching model designed for vocational education. The model follows a step by step teaching path from data observation to tool practice, then to scenario transfer, and finally to innovative application. It is designed to closely combine real industry needs with the key parts of digital literacy. The course structure has been carefully redesigned to not only teach technical skills but also to help students develop data-driven thinking and innovation ability. This study explains the model's theoretical basis, design principles, implementation process, and application results. It aims to provide a practical and adaptable example for data visualization and other similar information technology courses as part of teaching reform in higher vocational education.

1. Definition of Digital Literacy in the Context of Data Visualization Courses in Vocational Education

Digital literacy is a multi-dimensional concept that does not have a universally accepted definition. In China, most scholars view digital literacy from a single-skill perspective, considering it as a set of digital competencies [7]. Some scholars suggest that digital literacy includes not only the ability to access digital resources, but also the capacity to create or assign meaning to them [8]. As a core competency for citizens in a digital society, the ability to use digital technologies creatively has become a basic skill for training high-quality technical and skilled professionals in the new era [9]. Developing digital literacy requires students to play an active role as creators and builders [10].

In this study, the specific context is the Data Visualization course within the field of vocational education teaching reform. This setting influences how digital literacy is defined for the research. The definition is based on the general concept of digital literacy but also focuses on a key problem in vocational education, which is that too much attention is paid to tool operation while critical thinking skills are underdeveloped. It aligns with the basic goal of developing high-quality technical and skilled professionals. Therefore, in this study, digital literacy specifically means a systematic way of thinking that students should develop step by step as they learn data visualization. This way of thinking helps them recognize the value of data, use data tools, follow data logic, and finally make decisions based on data and support innovation. It acts as an important connection between practical skills and professional ability.

Based on the goals of applied talent development in vocational education and the teaching practice of the Data Visualization course, this study proposes a working definition of digital literacy. Specifically, within the context of this research, digital literacy includes five related core dimensions. These are data sensitivity, logical analysis capability, visual storytelling capability, business modeling capability, and innovation transfer capability.

Data sensitivity means that students are aware and able to identify, understand, and interpret the value of data. Logical analysis capability is shown through careful work in cleaning, organizing, and connecting data, as well as in making causal inferences. Visual storytelling capability is the skill of turning complex data into clear visual forms and communicating it in a convincing way. Business

modeling capability refers to the ability to turn unclear real-world business issues into specific problems that can be solved using data analysis and visualization models. Finally, innovation transfer capability measures how well students can use what they have learned in new situations to solve problems they have not seen before. These five dimensions together form a progressive cognitive development framework that moves from the cultivation of awareness to the internalization of abilities, and finally to Innovative Application. This framework provides specific theoretical guidance and measurable evaluation criteria for designing the "Four-Stage Progressive" instructional pathway.

2. Construction of the Four-Stage Progressive Teaching Model for the Vocational Education Data Visualization Course

This study is guided by the goal of developing digital literacy. It creates a teaching framework for the Vocational Education Data Visualization course that focuses on building competencies and is centered on cognitive training.

(1) Goal Orientation of the Four-Stage Progressive Teaching Model

This Teaching Model moves away from the traditional focus on software tool operation and instead makes the development of digital literacy its main goal. This goal guides the design principles of the Teaching Model. Specifically, all teaching activities are designed and implemented to help students change from being mere tool operators to becoming analytical thinkers. The ultimate aim is to prepare them to take on data-driven decision making and innovation tasks.

This goal is achieved by developing five key competencies. The first is improving students' data sensitivity so they can clearly recognize the value of data. The second is building their logical analysis capability to ensure accuracy and depth throughout the data processing process. The third is strengthening their visual storytelling capability to communicate analysis results effectively. The fourth is developing their business modeling capability to help turn real-world problems into data-driven models. The fifth is fully enabling their innovation transfer capability so they can respond flexibly to new and complex challenges and achieve integrated knowledge use and creative application. The development of these five key competencies matches the five core dimensions of digital literacy defined earlier in this study. Together they form the complete goal framework of this Teaching Model.

(2) Construction of the Four-Stage Progressive Teaching Model

To support the core goal of developing digital literacy, this study create a Four-Stage Progressive Teaching Model. The overall framework is shown in Fig.1. This model closely follows the principles of vocational skill development and cognitive growth. It organizes the teaching process into four stages that follow in order and increase in difficulty step by step. These stages are designed to ensure the organized development of students' digital literacy, moving from basic perception to deeper understanding, and from imitation to innovation.

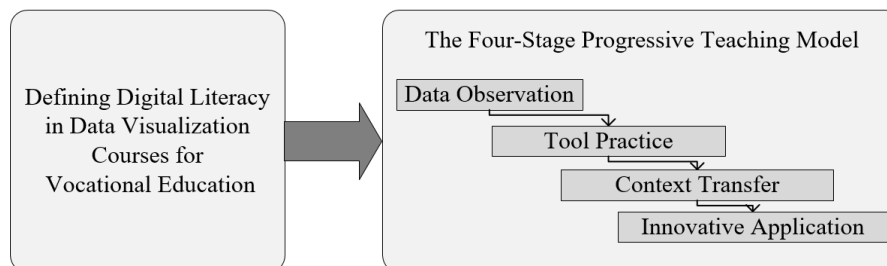


Fig.1 The framework of the Four-Stage Progressive Teaching Model based on digital thinking

The first stage focuses on data observation. It aims to develop students' awareness of data. Through activities such as studying good examples of data visualization works and exploring patterns and

features in data sets, this stage is designed to spark students' interest in learning and build their basic sensitivity to data.

The second stage emphasizes practical use of tools. Its main goal is to help students master key operational skills for data analysis and visualization tools. During instruction, special attention is given to explaining the meaning and value of each technical step within the larger data analysis process. This helps avoid focusing only on isolated skills training.

The third stage centers on scenario-based application. Here, students work together in groups to complete full practical tasks. These tasks involve understanding data, choosing analysis methods, and creating visualizations. They use real enterprise data that has been anonymized or realistic industry cases. This approach helps turn the operational skills learned in the second stage into logical analysis and modeling abilities for solving real business problems.

The fourth stage focuses on innovative application. Students are expected to independently choose topics or join real projects. They complete a full task that involves creative data analysis and visualization, and present their results through methods such as project defenses. This stage is designed to fully develop their visual storytelling skills and ability to apply knowledge in new situations, ultimately strengthening their overall digital literacy.

(3) Multidimensional Evaluation Design Based on the Four-Stage Progressive Teaching Model

To ensure the teaching model is effective and to support continuous improvement, a diverse evaluation system has been developed. This system matches the teaching goals and methods. It goes beyond traditional measures like final products or exam scores by offering a multidimensional assessment of teaching outcomes. It evaluates industry alignment, digital literacy internalization, and innovation transfer.

Industry alignment is used as a summative evaluation indicator. It assesses whether students' final outputs meet industry standards in terms of technical correctness, process completeness, and overall quality. This reflects how solid their skills are.

Digital literacy internalization serves as a formative evaluation indicator. It focuses on how well students understand and apply digital literacy during the learning process. This is measured through classroom observations, analysis reports, reflection notes, and interviews. It looks at how students have internalized key concepts such as data awareness and logical thinking.

Innovation transfer acts as a developmental evaluation indicator. It emphasizes originality, problem-solving effectiveness, and how well students apply knowledge in new situations during the innovation phase. This helps evaluate their higher-order thinking skills.

These three aspects work together to form a complete evaluation framework. This approach not only gives a full and fair view of how students are developing digital literacy, but also provides useful data to help teachers improve their teaching methods.

3. An Analysis of the Practice and Effectiveness of the Four-Stage Progressive Teaching Model

To test the practical use and initial effectiveness of the digital literacy oriented Four-Stage Progressive Teaching Model, a class of big data technology majors from a vocational college was chosen for practical implementation. A data visualization teaching practice was carried out using FineBI as the main tool. The practice was centered on the topic of visual analysis of book sales data and fully covered three teaching stages from data observation to scenario transfer. Due to limited time, the Innovative Application stage was completed as a data visualization solution design project.

The teaching process followed the established teaching model framework closely. In the data observation stage, instructors guided students to analyze a sample book sales dataset, examine data distribution patterns, and think about business implications. During the tool practice stage, the training focused on helping students perform data cleaning, transformation, and create different types

of visualization charts. In the scenario transfer stage, each group independently developed a book sales analysis report using a desensitized real business dataset. The report covered data understanding, analytical modeling, and visual presentation. Throughout the process, systematic classroom observation and formative assessment of student work were done based on the evaluation system designed for this model.

After the teaching practice, interviews with the participating students showed that they generally had a positive view of this new teaching model. The effectiveness of the model was mainly seen in the following three areas.

First, students showed noticeably greater interest in learning and higher classroom participation. Several students mentioned that analyzing real data cases and solving practical problems made learning goals clearer and increased their sense of achievement. This indicates that the four-stage progressive structure successfully stimulated their learning interest.

Second, students began to develop initial data-driven thinking. Those interviewed said they now actively consider the business meaning behind each data field and possible analytical biases when working with data, instead of just performing tasks mechanically. This shows that the teaching method helped shift their focus from simply using tools toward thinking based on business logic.

Finally, students improved their ability to integrate and apply knowledge. During group work in the scenario transfer stage, students mentioned that repeated discussions on choosing the right types of charts and when to use them improved their understanding of visual representation. This suggests a growing ability in data storytelling and better collaborative problem-solving skills.

4. Conclusion and Outlook

This study addresses the core issue of focusing too much on skills and not enough on thinking in the Data Visualization course in vocational education. It does so by creating a teaching model that aims to build digital literacy, using a four-stage progressive method. First, the meaning of digital literacy for the Data Visualization course in vocational education is explained. It includes five key parts: data sensitivity, logical analysis capability, visual storytelling capability, business modeling capability, and innovation transfer capability. These parts set clear learning goals for the teaching model design.

Following this, a step-by-step teaching path was designed, moving from data observation to tool practice, then to scenario transfer, and finally to innovative application. This approach clearly shows the teaching focus at each stage and the logical progression for building relevant skills. To support the teaching model's implementation and evaluation, a complete assessment system was also developed. This system combines industry alignment, skill internalization, and innovation application.

Teaching practice shows that the Four-Stage Progressive Teaching Model effectively increases students' learning interest, helps develop data-driven thinking, and strengthens their ability to apply knowledge. These results confirm that the teaching model is both practical and effective. It provides a useful example for changing vocational education data visualization courses from tool-oriented training to cultivating thinking and analytical abilities.

Although progress has been made, this study is limited in its duration and scope, indicating that more research is needed in the future. Future work could extend the implementation time of the model to a full semester or even multiple semesters. This would allow a quantitative evaluation of its long-term effects on the development of students' digital literacy. In addition, with the fast development of technologies like generative artificial intelligence, future research could explore how to incorporate new tools such as AI into the four-stage progressive teaching model. For example, AI tools could be used to support personalized learning and automate process evaluation. This would help to further improve the adaptability and scalability of the teaching model.

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