Research on cultivating students' information literacy in the teaching of advanced mathematics in colleges

Lei Dong[1,a], Jiong Chen[1,b,*]

[1]*Department of Artificial Intelligence, Shanxi Polytechnic College, Taiyuan, China*
[a] *email: dongleizjz@126.com,* [b] *email:379470373@qq.com*
[*]*corresponding author*

Abstract:*Cultivating the information literacy of college students is essential for their comprehensive development in higher education institutions. This article begins by analyzing the meaning of information literacy and then highlights the necessity of cultivating information literacy in advanced mathematics teaching in colleges. Finally, it proposes several strategies, including developing multimedia courseware, stimulating students' interest in learning, enhancing the information literacy of vocational college mathematics teachers, organizing mathematical modeling competitions, integrating information literacy education into mathematical modeling education, and emphasizing the cultivation of students' information ethics.*

Keywords: *Higher mathematics; Information literacy; Cultivation research; Mathematical modeling*

1.Introduction

In today's society, characterized by the abundance of information, information literacy has become an essential skill necessary in various fields and industries[1] . Whether it is for work, study, or everyday life, possessing a strong level of information literacy is vital for effectively acquiring, understanding, and applying information. Information literacy allows students to access, assess, and utilize information resources efficiently, thereby enhancing their educational outcomes. Furthermore, it empowers students to filter and distinguish the validity and dependability of information, protecting them from misinformation. This competency carries immense significance for both their current student phase and future employment prospects. Therefore, as a college mathematics instructor, it is crucial for the writer to investigate techniques for fostering students' information literacy in advanced mathematics education.

2.The development process of the definition of information literacy

The concept of information literacy was first proposed by Paul Zurkowski, the President of the American Information Industry Association, in 1974. It is defined as the ability and skills of individuals in utilizing information to solve problems[2]. It is a diversified and hierarchical concept category based on information technology. It is a comprehensive literacy that integrates knowledge and skills in information technology, information awareness and consciousness, information ethics and morality, and creative thinking and problem-solving skills using information technology. Its connotation is dynamic and developmental. UNESCO and numerous researchers in Europe have continuously understood and deepened the concept of information literacy. However, the understanding of information literacy as a set of technical and skills-based competencies was maintained until the publication of the Prague Declaration in 2003, The declaration has provided a more specific positioning of its technical and skills aspects, considering information literacy as the ability to identify, locate, evaluate, organize, utilize, and communicate information based on needs. It is regarded as a societal responsibility and fundamental survival requirement for citizens, serving as a prerequisite for effective participation in the information age[3]. Subsequently, The American Library Association (ALA) (2011) defines information literacy as the ability to locate, evaluate, and effectively use information based on individual needs[4]. Pombo, Carlos defined information literacy as the ability of individuals to effectively identify information, search for information, and integrate information to solve problems[5]. In the same year, Feng, Jih-Lian defined information literacy as the ability of individuals to acquire, search, integrate, and communicate information[6]. They also mentioned the significance of information literacy in various aspects such as

social, economic, educational, and human development. Recently, Johnson, Tawfik defined information literacy as the ability to effectively identify, search, and integrate information, enabling individuals to efficiently recognize, search for, and integrate information to solve problems they encounter[7]. The development history of "Information Literacy" concept is shown in Table 1.

Table 1: The development history of "Information Literacy" concept.

Time	Definition	Source
1974	The ability and skills of individuals in utilizing information to solve problems	Zurkowski [2]
2003	The ability to identify, locate, evaluate, organize, utilize, and communicate information based on needs. It is regarded as a societal responsibility and fundamental survival requirement for citizens, serving as a prerequisite for effective participation in the information age	Declaration [3]
2011	The ability to locate, evaluate, and effectively use information based on individual needs	Committee [4]
2016	The ability of individuals to effectively identify information, search for information, and integrate information to solve problems	Pombo, Carlos [5]
2016	The ability of individuals to acquire, search, integrate, and communicate information.	Feng, Jih-Lian [6]
2022	The ability to effectively identify, search, and integrate information, enabling individuals to efficiently recognize, search for, and integrate information to solve problems they encounter	Johnson, Tawfik [7]

3.The necessity of cultivating students' information literacy in the teaching of advanced mathematics in colleges

3.1.It is beneficial for improving students' efficiency in learning mathematics.

Many college students struggle with a weak foundation in mathematics, making it difficult for them to keep up with traditional classroom instruction. As a result, they often need to actively utilize educational software and online teaching resources as supplements to their in-class learning.

Having strong information literacy skills can greatly benefit students in their pursuit of acquiring new mathematical knowledge. When students possess a high level of information literacy, they are more likely to actively seek out and utilize diverse learning resources and materials that facilitate their study of mathematics. They can easily locate online tutorials, interactive exercises, and educational websites that provide additional explanations and practice problems, helping them reinforce their understanding of mathematical concepts.

On the other hand, a lack of information literacy skills greatly hampers students' ability to gather and organize information effectively. Without these skills, they may struggle to find appropriate learning resources and be unable to distinguish between reliable and unreliable sources of information. This can significantly diminish their capacity for self-learning and motivation, as they may become overwhelmed by the vast amount of information available and struggle to navigate through it.

In today's contemporary society, students who possess proficient information literacy skills have a unique advantage. They are able to comprehend the knowledge provided by various sources of information, whether it be textbooks, academic journals, or online articles. With the ability to critically evaluate and analyze information, they can develop their own perspectives and construct novel frameworks of knowledge. This not only enhances their learning efficiency but also encourages independent thinking and creativity in the field of mathematics.

In conclusion, having strong information literacy skills is crucial for college students, particularly in the field of mathematics. It allows them to actively seek out and utilize educational software and online teaching resources to supplement their in-class learning. Moreover, proficient information literacy skills enable students to comprehend and analyze information, fostering independent learning and enhancing their overall educational experience.

3.2.Information literacy contributes to improving students' mathematical literacy.

One of the primary goals of college mathematics education is to nurture students' mathematical proficiency. This proficiency encompasses both epistemological and methodological thinking, incorporating elements such as conceptualization, abstraction, and formalization. Individuals who possess mathematical proficiency have the ability to apply conceptual reasoning and problem-solving techniques to understand real-world phenomena. It encompasses fundamental components like logical thinking, standard techniques, and practical applications. These three aspects are interconnected, and the ability to integrate them closely is a crucial criterion for evaluating the effectiveness of mathematics instruction.

Information plays a vital role in bridging these three aspects of mathematical proficiency. The extraction, optimization, and generation of information have a positive impact on the development of mathematical proficiency. By extracting relevant information from various sources, students can gain a deeper understanding of mathematical concepts and theories. They can then optimize this information by critically evaluating its validity and relevance to solve mathematical problems effectively. Furthermore, the ability to generate new information allows students to construct their own unique perspectives and approaches to solving mathematical problems.

In order to effectively cultivate students' mathematical proficiency, it is important for teachers to incorporate the principles and objectives of information literacy into the mathematics curriculum. Information literacy refers to the ability to locate, evaluate, and effectively use information from various sources. By integrating information literacy into mathematics instruction, teachers can help students develop the necessary skills to extract, optimize, and generate information that contributes to their overall mathematical proficiency.

Teachers can emphasize the importance of critically evaluating information sources and utilizing reliable and credible resources in mathematics learning. They can also encourage students to actively seek out diverse learning materials, such as textbooks, scholarly articles, and online resources, to enhance their understanding of mathematical concepts. Moreover, teachers can provide opportunities for students to engage in collaborative problem-solving activities that require the integration of information from multiple sources.

By incorporating information literacy principles into the mathematics curriculum, educators can empower students to become independent learners who possess strong mathematical proficiency. This approach not only enhances students' problem-solving abilities but also equips them with essential skills for lifelong learning and success in their future careers.

3.3.It is conducive to bridging the gap between teachers and students and building a harmonious teacher-student relationship.

A harmonious relationship between teachers and students plays a crucial role in enhancing students' connection with the teaching efforts and promoting their active engagement in learning activities. However, in vocational colleges and universities, teachers often have a heavy workload, which limits

their opportunities for communication with students during class. It is vital, therefore, to focus on improving communication between educators and learners to build a harmonious teacher-student relationship.

In traditional educational settings, when students face challenges in learning mathematics, they tend to rely on their classmates, textbooks, or the Internet for assistance rather than seeking help from the teacher. However, with the rapid advancement of information and communication technology, access to information has become more accessible, and the role of teachers has shifted from authoritative figures to facilitators who aim to establish egalitarian and friendly relationships with students. Teachers are now expected to provide inspiration and guidance to students, helping them navigate through complex problems during their learning journey.

Modern technology, particularly if students possess the necessary information literacy skills, can be effectively utilized by both teachers and students to expand communication channels. For example, teachers can employ various online platforms such as email, QQ, WeChat, or social media to enhance communication with students. Through these platforms, teachers can assess students' learning progress and difficulties more promptly and adjust and optimize their teaching strategies accordingly. The frequent interaction facilitated by technology can foster an emotional bond between teachers and students.

By actively utilizing technology and ensuring effective communication, teachers can create a supportive learning environment where students feel comfortable seeking help and guidance from their instructors. This not only strengthens the teacher-student relationship but also encourages students' engagement in the learning process. Ultimately, a harmonious teacher-student relationship can significantly contribute to students' academic success and overall personal development.

4.Strategies for cultivating students' information literacy in college mathematics teaching.

4.1.Develop multimedia courseware to stimulate students' interest in learning.

Interest is a powerful motivator for college students, especially when it comes to learning mathematics. However, traditional teaching methods often fail to capture students' attention and enthusiasm for the subject. To address this issue, we can leverage modern technology and create multimedia educational materials that are engaging and interactive. For example, when teaching the concept of definite integrals, we can employ Flash technology to develop visually appealing educational materials. These materials not only provide immediate feedback but also encourage student participation. Before introducing definite integrals, we can first explain the concept of using limits to estimate the area of irregular shapes using regular polygons.

To make the learning experience more interesting, we can incorporate the story of Zu Chongzhi, an exceptional mathematician from the era of the Southern and Northern Dynasties in China. Zu Chongzhi used the areas of inscribed regular polygons to approximate the area of a circle. We can animate Zu Chongzhi's portrait, making his eyes move, which adds a captivating element to the educational materials. This visual representation helps students develop a connection with the ancient mathematician and reminds them of the importance of grasping the concept of limits. The materials can also include animations that demonstrate how the approximation to the circle improves as the number of sides of the regular polygon increases. Students can interact with these animations by manipulating buttons to control the number of sides and observe the changes in the approximation. This hands-on approach allows students to explore and understand the concept better. Furthermore, the educational materials can include interactive quizzes that provide immediate feedback. After completing the assessments, students can click the submit button to view their scores and see the correct answers. This prompt feedback helps students gauge their understanding and identify areas for improvement. By integrating various elements into the multimedia educational materials, we create a vibrant and interactive learning environment that stimulates students' interest in mathematics. They are not just passive learners but active participants in the learning process. This approach fosters a deeper understanding of advanced mathematical concepts and facilitates more efficient teaching in college classrooms.

Overall, by leveraging modern technology and adopting a multimedia approach, we can enhance students' interest in mathematics and create a more engaging and effective learning experience.

4.2.Enhancing the information literacy of College mathematics teachers

In order to enhance students' information literacy, it is essential for mathematics educators in colleges to improve their own information literacy skills. This process involves updating outdated educational concepts and continuously improving their information technology abilities during the instructional process. By doing so, they can create a supportive environment that promotes students' information literacy.

Improving the information literacy of mathematics teachers in vocational colleges can provide targeted support for advancing students' information literacy in advanced mathematics studies. To achieve this, there are several key strategies that can be employed. Firstly, it is crucial to strengthen the development of information technology application competencies among school leaders. School leaders should serve as examples by effectively utilizing information technology themselves. By demonstrating their skills and knowledge in using technology, they can inspire and motivate mathematics teachers to enhance their own information literacy. Secondly, the training of regular mathematics educators should focus on enriching their understanding of information technology and information concepts. By providing comprehensive training in these areas, educators can gain the necessary knowledge and skills to effectively integrate information technology into their teaching practices. Collaborative research on information technology applications within teacher groups can further contribute to the enhancement of information literacy among mathematics teachers. Additionally, organizing information technology competitions, such as contests for multimedia teaching software, can be an effective way to encourage mathematics teachers to improve their information literacy. By offering awards to winning educators and providing preferential treatment in professional advancement assessments, the teacher community can create a competitive and motivating environment that fosters continuous improvement in information literacy skills.

In conclusion, enhancing the information literacy of mathematics educators in colleges is crucial for promoting students' information literacy. By updating educational concepts, improving information technology abilities, and fostering a supportive environment, mathematics teachers can effectively support students in developing their information literacy skills.

4.3.Organizing mathematical modeling competitions and integrating information literacy education into mathematical modeling education

Mathematical modeling is a powerful technique that utilizes mathematical language and methods to address practical problems by simplifying and abstracting them. At the university level, participating in mathematical modeling competitions can greatly benefit students in terms of their comprehension of information, creative thinking abilities, and application of mathematical knowledge to solve real-world problems. Based on the author's extensive teaching experience, it has been observed that students who participate in mathematical modeling competitions demonstrate heightened awareness of information, familiarity with information, and proficiency in handling information compared to those who do not partake in such competitions.

The topics selected for mathematical modeling competitions typically derive from practical problems in engineering and management sciences. These problems are carefully simplified and processed to make them suitable for competition settings. Participants are not required to possess extensive professional knowledge beforehand; they only need to study advanced courses in mathematics, which equip them with the necessary tools to effectively engage in mathematical modeling.

One of the compelling aspects of mathematical modeling competition problems is that they do not have predetermined solutions, providing participants with ample room to showcase their originality and creativity. To tackle these problems, it is crucial to refer to relevant literature, analyze and extract mathematical problems based on real-life issues, construct appropriate mathematical models, and solve them. Throughout the process of mathematical modeling, it is essential to process, discuss, and

transform the gathered information. This fosters the development of important skills in students, such as information integration and creativity. Moreover, participating in mathematical modeling competitions enhances students' ability to rapidly acquire and analyze information and data.

In conclusion, mathematical modeling competitions offer significant benefits to university students. They not only deepen students' understanding of information but also enhance their ability to think creatively and apply mathematical knowledge to solve practical problems. By engaging in these competitions, students gain valuable experience in problem-solving and develop skills that are highly valuable in various academic and professional pursuits.

4.4.Emphasis on cultivating students' information ethics.

In today's information age, characterized by rapid advancements in science and technology and an abundance of emerging phenomena, the internet has become the primary source of information for individuals. However, the internet possesses numerous complex attributes that require careful discernment. Many students are exposed to a vast amount of data on a daily basis, yet they often lack the ability to filter and recognize valuable information. Instead, they tend to indulge in gaming and entertainment activities, overlooking the educational potential of the internet. Therefore, it is crucial for mathematics instructors to educate students about ethical discernment and the critical evaluation of internet information. They should guide students in selecting material that enhances learning outcomes while rejecting false, unreliable, and harmful information.

In our digital existence, it is essential to cultivate our own moral and ethical values. We should avoid becoming overly dependent on the internet and instead strike a balance between online and offline activities. It is important to adhere to relevant laws and regulations governing cyberspace, ensuring that our online behavior is lawful and responsible. Indiscriminate dissemination of unverified data should be avoided, as it can contribute to the spread of misinformation and falsehoods. Believing in or spreading rumors should also be refrained from, as it undermines the integrity of information and can lead to harmful consequences. Engaging in rumor-mongering is counterproductive and goes against the principles of ethical communication.

By promoting ethical discernment and responsible internet usage, mathematics instructors can help students navigate the vast sea of information available online. This will not only empower students to make informed decisions but also equip them with the necessary skills to critically evaluate information and distinguish between reliable and unreliable sources. Developing these abilities is fundamental in an era where information is abundant but not always trustworthy. As responsible digital citizens, we must actively contribute to the creation of a credible and reliable online environment.

5.Conclusion

The rapid advancement of information technology calls for corresponding adjustments in the teaching of advanced mathematics in higher vocational colleges. It is essential to prioritize the development of information literacy among students in order to adequately prepare them for the demands of an information-oriented society. To achieve this, a variety of methodologies should be employed in higher mathematics education to enhance students' abilities to acquire, filter, and manipulate information, thereby establishing a solid foundation for their overall growth.

Incorporating information literacy into the instruction of advanced mathematics involves equipping students with the necessary skills to navigate and utilize the vast amount of information available to them. This includes teaching them how to effectively search for relevant resources, critically evaluate the credibility and reliability of sources, and analyze and synthesize information to solve complex mathematical problems. By employing diverse teaching approaches such as project-based learning, problem-solving tasks, and collaborative activities, students are encouraged to actively engage with real-world mathematical problems and apply their information literacy skills in practical contexts.

Furthermore, incorporating technology into the teaching of advanced mathematics is vital in enhancing students' information literacy. Utilizing online platforms, educational websites, mathematical

software, and data visualization tools can provide students with opportunities to explore a wide range of mathematical concepts and applications. This not only improves their technical proficiency but also fosters their ability to effectively navigate digital resources and extract meaningful information.

In addition to technical skills, fostering information literacy in advanced mathematics education also emphasizes the development of critical thinking and analytical skills. Students should be encouraged to evaluate and interpret mathematical information critically, identify biases or inconsistencies, and draw logical conclusions. By integrating reflective and metacognitive practices into their learning process, students can develop a deeper understanding of mathematical concepts and strategies, enabling them to make informed decisions and solve complex problems.

Ultimately, the cultivation of information literacy in advanced mathematics education in higher vocational colleges aims to empower students with the necessary tools to thrive in an information-oriented society. By equipping them with the ability to effectively access, evaluate, and apply mathematical information, they are better prepared to tackle the challenges of their future academic and professional endeavors. Moreover, this enhances their overall growth and equips them with essential skills for lifelong learning in an ever-evolving digital landscape.

References

[1] Adair, H.F., A.B. Crane, and E.A.J.P.J.o.E. Gross, Information Literacy in Context: Skill Development in Pre- and In-Service School Librarians[J]. 2023. 98(1): p. 132-157.

[2] Zurkowski, P.G., The Information Service Environment Relationships and Priorities. Related Paper No. 5. 1974.

[3] Declaration, P.J.U.h.p.u.o.c.e.f.P.p.P.p., Towards an information literate society. 2003.

[4] Committee, E.I.f.E., Information literacy standards for teacher education: Approved by the ACRL Board of Directors, May 11, 2011. J College Research Libraries News[J]. 2011. 72(7): p. 420-436.

[5] Pombo, L., et al., Edulabs for the Integration of Technologies in Basic Education--Monitoring the AGIRE Project. J International Journal of Research in Education[J]. 2016. 2(1): p. 16-29.

[6] Feng, L., H. Jih-Lian, and T. Education, Effects of teachers' information literacy on lifelong learning and school effectiveness. J Eurasia Journal of Mathematics, Science[J]. 2016. 12(6): p. 1653-1663.

[7] Johnson, B.T., A.A. Tawfik, and development, First, second, and third-order barriers to information literacy and inquiry-based learning for teachers in poverty contexts. J Educational technology research[J]. 2022. 70(4): p. 1221-1246.