 

# The Challenges of Informationization Teaching in Mathematics Classrooms

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**Abstract**

In the era of digital disruption and artificial intelligence revolution, the effective integration of digital information technologies has enormous potential to revitalize traditional mathematics-teaching strategies in terms of knowledge transmission and skill acquisition. Meanwhile, educators must adopt appropriate digitalization strategies to support and promote the development of the students' core competencies such as abstraction, deduction, intuition, and imagination. This paper aims to illustrate the opportunities and challenges arising from the application of informationization teaching in the mathematics classrooms, evaluate the knowledge visualization strategies under different scenarios, and provide practical advice for the comprehensive development of both teachers and students.

**Keywords:** Digital Resources; Digital Transformation; Educational Equity; Informationization Teaching

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## 1. Introduction

With the development of information technologies such as the internet, media and streaming, the digital transformation of education and the sharing of educational resources (Dillenbourg 2016) have been the causes for concern following the worldwide trends of public education reform and smart teaching innovation. Abstraction can be inherent to mathematics and the educators therefore should take advantage of the digital resources or technologies to better visualize and concretize the mathematical questions in the classrooms, which we referred to as informationization teaching or information-based education (Eisenberg and Small 1993). Informationization teaching aims to promote the development and utilization of information resources in the field of education at all levels, and to digitize, network, personalize and intelligentize the learning content, learning mode and learning process of the educated (i.e. students). In 2025, the educators (teachers) might also, for instance, use large language models (LLM) like ChatGPT to recommend appropriate resources and materials that would support traditional teaching, which is an emerging trend of informationization teaching (Memarian, 2023; García-López et al., 2025).

The implementation of modern education means, however, must be rational and efficient, with the aim to improve the student experience. The role of teachers has also changed in the process of education too, which would somehow involve more supporting and collaborating responsibilities. Can students' learning be more efficient after the digital transformation of mathematics education? Can schools cultivate more independent-minded and innovative talents who are capable of mathematical thinking? Can the toolkit of artificial intelligence renovate conventional mathematics teaching? To address these questions and concerns, the design of informationization teaching should take account of three objectives as follows:

- **Provide technical assistance to both students and teachers**

While digital transformation and LLM provide learners with abundant resources and convenient learning environment irrespective of time and space, this must be more personalized and tailor-made. Depending on the demands of students and teachers, in any case, exploratory informationization teaching must focus on the quality and efficiency, as the technology is there to support, not to replace teaching. It has to complement some degree of traditional classroom activities and engagements, support students in autonomous learning, and facilitates inquiry-based learning (Sailer et al., 2021).

- **Promote the free assimilation of information and knowledge**

Informationization teaching can break through the boundaries of time and space, aiming to improve the whole process of knowledge assimilation. By encouraging active engagement of students and teachers, informationization teaching has the potential to deepen the students' understanding of the all-round connections between mathematical knowledge and the real world, and therefore enable them to observe the world through a mathematical lens and express their thoughts in mathematical language. Through online cooperation and communication with other learners, students are able to search, screen, integrate and utilize information. As such, the information would be free shared between internet users and the learners outside schools or colleges might have access to knowledge too, via internet and social media. Informationization teaching should also help students to evaluate the credibility and accuracy of information too, as well as the effectiveness of applying mathematics to real life.

- **Stimulate the development of creative and critical thinking**

Informationization teaching is not only an alternative of teaching and learning, but also a virtual platform or forum for students to express tentative ideas, debate on mathematical questions, and develop their self-learning ability. Similar to the previous objective, as the students participate in these discussion and team work, they have an opportunity to develop their problem solving and creative thinking skills. Furthermore, in the process of learning, the extended scope and huge volume of knowledge online would invite students to explore comprehensively, think thoroughly, analyze critically, so that they can brainstorm and judge whether the acquired information is correct or not.

## 2. Demonstration of Informationization Teaching: Digitalization and Visualization of Knowledge

As we have argued in Section 1, informationization teaching (if conducted appropriately) can make abstract mathematical knowledge much easier to comprehend. For mathematics, there are plenty of ways to make concepts and textual notions visualized and pictorialized, especially in the study of geometry. In the face of complicated geometric shapes and relationships, informationization teaching is just able to make up for the shortcomings of the students' weak geometric intuitive or imaginative skill, which would in turn enhance the learning process. Below we will discuss three cases.

**Case 1:** The positional relationship between a plane and a sphere (see Figure 1). To illustrate that mathematical knowledge often originates from real life, the teacher can show a video of sunrise at the beginning of the class. Then, the teacher should abstract the positional relationship between a transverse (horizontal) plane and a sphere in a three-dimensional space. Through the preprepared visual presentation of GeoGebra (see https://www.geogebra.org/ for more details), the sphere moves up and down so that the relationship between the plane and the sphere would change over time in a vivid manner. As a result, the students will have a deep understanding of the concepts of separation, intersection and tangent plane.

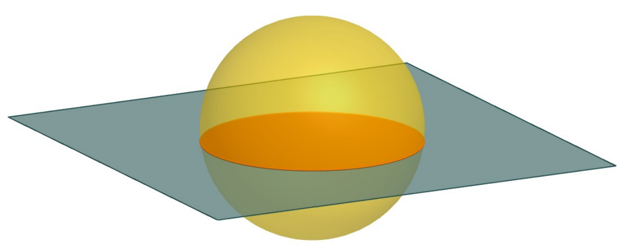

Figure 1. The diagram of the positional relationship between a plane and a sphere

**Case 2:** The three-dimensional curvature of trigonometric functions that link the independent variable X to the dependent variables Y, Z (Figure 2). Trigonometric functions are the basics of geometry, which we can apply to quantify the relationship between two variables. By learning through the concepts and textual expressions, it could be difficult for the students to imagine its forms under different scenarios. The teacher should therefore draw the three-dimensional curve of these functions, so as to visualize them on the blackboard. It would be even better to teach students to draw these functions themselves in a practical session, as the teacher show how to write the code with a conventional programming language (e.g. MATLAB in this case). The students should consequently be given exercise time to draw trigonometric functions for different ranges of the independent variable.

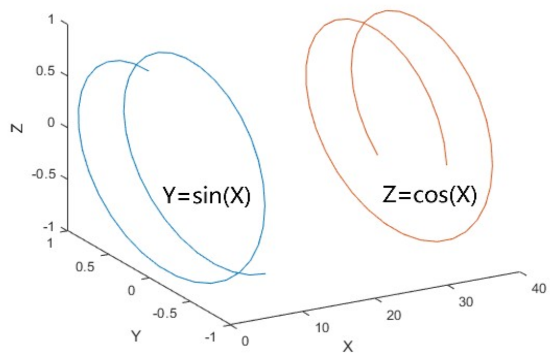


Figure 2. The diagram of the three-dimensional curvature of two trigonometric functions

**Case 3:** The empirical distribution of the standard Normal distribution (Figure 3). When students learn the application of statistics and random sampling, the teacher can first instruct the students to review the theory of probability, and think about how to predict the probability of random events. The student should therefore learn the idea of Monte Carlo simulation as well as the approximation of Normal (Gaussian) distribution. In the practical session, the teacher can show how to draw a simple random sample of, for instance, size 1000 from a standard Normal distribution.

This can be programmed, for instance, in the R environment in this case, as the data should be visualized then. Thus, the students will see the difference between the empirical distribution of the random sample and the theoretical distribution (the curve in Figure 3). As such, with the help of programming and data visualization, the learning process of designing and running Monte Carlo simulations would promote the students to develop their own thinking and then practice with data. The teacher can also exercise and cultivate the students' innovation and experimental skills.

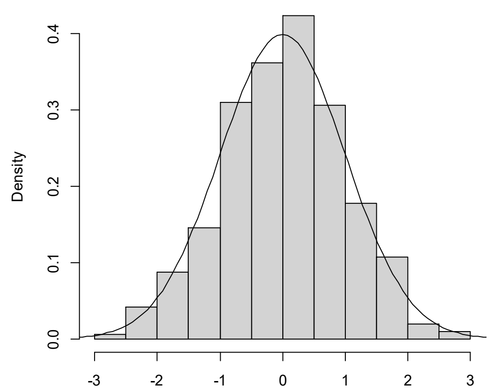


Figure 3. The diagram of the empirical distribution of the standard Normal distribution

## 3 Challenges for Informationization Teaching

### *3.1 Below-Average Quality of Informationization Teaching and Learning*

Although there are a large number of learning resources on the internet, the quality of these resources varies. Some of them may not be particularly applicable to educational scenarios, and even contain statements that are wrong in principle. In this regard, even with the recommendation support of LLM, mathematics teachers must take the time to screen and evaluate whether the corresponding teaching resources are reasonable or feasible case by case. The students, having been exposed to resources of varying quality, must distinguish and decide what they really need to learn. At the very least, they should avoid erroneous or misleading information when they study mathematics. Hence, there must be some balance between online self-learning and onsite learning in the classroom.

After all, there is still a long way to go in this digital transformation. Blind and excessive adoption of technology may lead to pitfalls and that do not always facilitate the process of knowledge internalization. There are obstacles to the promotion of digital transformation or informationization teaching in the mathematics classroom. The schools need to invest in the infrastructure and provide training to their teachers. Sometimes they may need help from external institutes or local authorities. Some students, on the other hand, might have difficulties with informationization learning, especially when they study themselves. There could be a lot of distractions on the internet, so that the students could be less focused when they watch microlectures online and even use electronic devices for entertainment purposes instead of informationization learning. As a result, conventional teaching in the classrooms cannot be easily replaced by distance learning and self-learning. The teachers have to keep relatively close contact with the students and intervene whenever the students lose their focus.

### *3.2 Imbalanced distribution of digital resources*

Even though the application of information technologies has created tremendous opportunities for mathematics education, the unequal imbalanced allocation of digital resources has likewise limited the opportunities for many students to fully benefit from informationization learning. In terms of hardware imbalance, stable connection to the internet is not guaranteed in remote rural areas, particularly in the developing countries. Schools might not have sufficient funds for new equipment investments too, and even if they do, informationization teaching might not be on their list of priorities. More importantly, in terms of software imbalance, not all the digital resources are free despite the lower costs of production and online sharing. Many times, the high-quality and relevant digital resources are behind a paywall that the average schools cannot afford. There could be some language barriers too (even if automatic translation is offered), as the students and teachers could struggle to understand written materials and conversations in other languages. As a result of imbalance, depending on the socioeconomic background of schools and students, inequalities in education exist in all walks of life and the disadvantaged groups are very likely to have fewer chances to enjoy informationization learning.

The imbalance in digital resources similarly affects the pedagogical approach of teachers, who may have to cope with the challenges on, for instance, how to teach students of different socioeconomic characteristics. The schools also have to decide how to allocate teachers to teach different groups of the students. Hence, if the students are treated differently, there would questions on the morality and equality of education too. Whereas more resources sharing and cooperative schooling might help to some extent, the imbalanced distribution of resources is a complex social concern that would require concerted joint efforts of all the stakeholders to address.

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