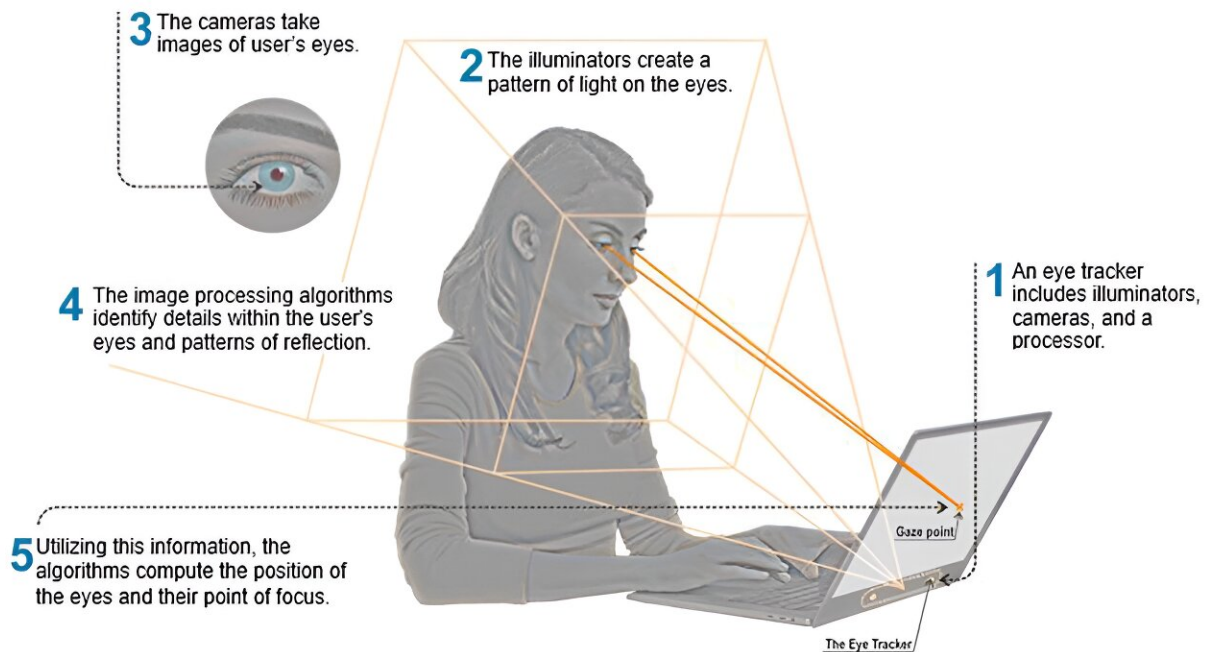


Eye-tracking study provides valuable insights into learning mathematics

August 2 2024



Eye tracking implementation diagram (adapted by Ugwitz et al., 2022). Credit: *Frontiers in Education* (2024). DOI: 10.3389/feduc.2024.1386487

Eye tracking allows studying aspects that cannot be seen, for example, the thinking processes of a student solving a mathematical problem. Researchers at Kaunas University of Technology (KTU) are the first in Lithuania to integrate eye tracking into education and are using the technology to radically improve the teaching of mathematics.

Eye tracking creates the possibility for researchers to observe a subject's attention shifts based on where they fix their gaze or how they move it. This helps researchers understand various emotional, thinking and [cognitive processes](#) that happen in response to the environment.

"By applying this technology in mathematical education, it is possible to monitor the individual activity of students and see the cognitive processes they undergo when solving mathematical tasks," says Dr. Irina Klizienė, a professor at the KTU Faculty of Social Sciences, Arts and Humanities.

A [study](#), published in *Frontiers in Education*, by Klizienė and her Ph.D. student Asta Paškorskė shows that the research carried out using eye-tracking equipment can indicate the difficulties a child encounters while solving a mathematical problem.

Reveals significant details that go by unnoticed

"Eye-tracking studies with children reveal the strategies they use to process visuals in mathematical tasks, and the gaze patterns identified show the difficulties they experience in each problem-solving step. It is a great advantage to be able to observe the decision-making processes without interfering with their work," says Prof. Klizienė.

Klizienė and Paškorskė's systematic literature review analyzed the possibilities of applying eye-tracking methodology to identify the strategies used by primary school students to solve mathematical problems.

The eye-tracking data reveals which steps of problem-solving are the most challenging or which elements of the task are more difficult to understand. These are important details that usually go unnoticed in mathematics classes, as students are not always able to identify them.

"Eye tracking makes it possible for us to see where a child is focusing their gaze when solving a mathematical problem. It helps to identify which problem-solving steps are the most difficult, how the child selects and processes information, and where the child focuses his or her attention," says Paškorské.

By analyzing this data, teachers can suggest more effective teaching methods while students can adopt better learning habits.

Provides valuable insights into the learning process

Prof. Klizienė, who researches the impact of the educational environment on students' achievements in mathematics, says that, compared to other methods, eye tracking provides essential data on mathematics learning—not only on the results of the learning process. This method provides insights into students' cognitive processes.

The eye-tracking research uses special non-invasive eye trackers and software. These devices are not harmful to the human eye and are designed to be used in the subject's natural environment.

They normally consist of three parts: a light source (usually [infrared light](#)), a gaze-tracking camera that captures flashes of the visible image reflected in the cornea and the center of the pupil, and a processor with eye-tracking software.

Eye-tracking research provides information and allows studying cognitive processes that reflect in eye movements and could otherwise not be consciously observed and explained.

"Monitoring the [mathematical problem](#)-solving process—its strategies, cognitive load, attention span and shifting—is made possible by tracking and recording eye movements, the patterns (consistency, repetition) of

task reading, fixations and areas of interest," says Klizienė.

Could be used to improve mathematical tasks

The use of [eye-tracking](#) technology can help to improve student's academic achievements and make the learning process more productive. Having identified the patterns of task reading, educators can adapt the learning material to make it more understandable.

"By observing where students focus their gaze, we can optimize the layout of the teaching material so that the most important parts of the task are seen first. For example, if a child often skips a certain part of a task, the teaching material can be made to draw their attention to that part," comments Paškovskė.

The learning process can be personalized by determining the level of cognitive load children experience while solving mathematical tasks and optimizing and reducing it. This helps to improve learning efficiency.

"Eye-tracking research provides valuable data to improve the learning process, making it more personalized, effective and engaging," says the KTU Ph.D. [student](#), a co-author of the study.

The researchers claim that research-based assessment of students' motivation allows them to identify which learning methods encourage students to be more engaged in the learning process. They hope that their research will not only improve the teaching of mathematics but also contribute to improving students' academic performance and learning experiences.

Eye-tracking technology is becoming an important tool in education, enabling a deeper understanding of the learning processes and the development of more effective teaching methods to improve children's

acquisition of mathematical knowledge and skills.

More information: Asta Paskovske et al, Eye tracking technology on children's mathematical education: systematic review, *Frontiers in Education* (2024). [DOI: 10.3389/feduc.2024.1386487](https://doi.org/10.3389/feduc.2024.1386487)

Provided by Kaunas University of Technology

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