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The use of eye tracking in mathematics education

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Eye tracking in mathematics education literature

Strohmaier, A. R., MacKay, K. J., Obersteiner, A., Reiss, K. M., Eye-tracking methodology in mathematics education research: A systematic literature review, *Educational Studies in Mathematics* (2020) 104, pp. 147–200.

Yang, F.-Y., Tsai, M.-J., Chiou, G.-L., Lee, S., W.-Y., Chang, C.- C., Chen, L.-L., *Journal of Educational Technology & Society*, (2018) 21, pp. 28-45.

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Strohmaier et al. (2020)

“The eyes play a pivotal role in decoding visual information. Thus, the observation of eye movements can offer **insights into cognitive processing**.” (p. 147)

“With the development of new eye-tracking hardware and data analysis software, the **possibilities of data collection and interpretation** have become increasingly manifold.” (p. 148).

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Strohmaier et al. (2020)

“Studying people’s eye movements during mathematical activities (e.g., reading of mathematical proofs) may require different or modified approaches than those applied successfully in other domains (e.g., text reading or science education). However, these **specific affordances** of the eye-tracking method in studying mathematics **are not well understood**.” (p. 148)

“The number of studies in mathematics education that made use of eye tracking has increased rapidly in the last decade and continues at a rate of **around 20 studies published per year**.” (p. 164)

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Strohmaier et al. (2020)

“It became clear that eye tracking not only offers a wide range of possibilities for qualitative and explorative analyses but also provides data suitable for various quantitative analyses. In general, most eye-tracking studies in mathematics education claimed that the method allows for the **assessment of cognitive processes that would otherwise not be observable**, for example, because they are subconscious. One of the most crucial challenges in eye-tracking research is to **properly link eye movements** to these assumed **underlying cognitive processes**.” (p. 165)

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Yang et al. (2020)

"With the rapid development of digital technologies such as the Internet, multimedia and mobile devices, the conventional learning environments with the blackboard as the main presentation platform have gradually evolved into **electronic classrooms**. The infusion of technologies into teaching and learning has given rise to **new paradigms of learning**, including multimedia learning, web-based inquiry learning, computer supported collaborative learning, game-based learning, e-learning, mobile learning and so forth." (p. 28)

Yang et al. (2020)

“Although numerous studies related to the use of technologies in classrooms have been reported, there are scholars who have **questioned the effectiveness** of the use of technologies in assisting teaching and learning. [...] To address this issue, researchers who study the use of digital technologies in classrooms are paying attention to not only whether these technologies can **improve students’ learning performance**, but also to how they can **assist student learning**.” (p. 28)

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Yang et al. (2020)

“Instructional suggestions: it is recommended that the basic design of the digital instruction for science learning should follow the design principles suggested by the theory of multimedia learning, such as **placing related text and graphics near each other** and employing **only one type of verbal mode of information** (either written or spoken). The verbal explanations should be carefully written to **uncover explicitly the conceptual knowledge embedded in the graphical information**.” (p. 33)

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Yang et al. (2020)

“To help science learners to effectively integrate relevant information, instructional guidance encouraging **back and forth scanning between different representations** should be provided. In addition, effective use of **visual cueing** or **labeled pictures** will **enhance learners’ attention** and promote information integration. Giving learners a **prediction task prior to the learning task** will affect the allocation of learners’ cognitive resources and enhance learning performance.” (p. 33)

Yang et al. (2020)

“As far as the use of animations is concerned, since it has been reported that **animations may cause extraneous cognitive load** and **require more time** to be processed in depth, additional instruction or explanation of the goal and content of the animation needs to be given to guide learners’ attention.” (p. 33)

Yang et al. (2020)

“Since science learning performance is also mediated by personal factors such as **background knowledge**, **cognitive ability**, and **learning style** as discussed in the study, another research agenda in the future should be [...] taking into consideration **personal factors** and exploring the **patterns of eye movements associated with better learning outcomes**. These patterns may serve as references for providing individual feedback in the **adapted learning systems**. (p. 36)

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Coming next:
student attention, cognitive, and emotional engagement