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Performance paper

Learning through the eyes of another

Online Instruction of Craft Skills Using Eye-Tracking Technology

ABSTRACT

Over the past decade, rapid technological advancements and budget constraints have increased the demand for online education (Martin et al., 2020). Furthermore, the COVID-19 pandemic has vastly accelerated this trend, compelling almost all education providers to migrate their courses to online learning platforms (Theelen & Van Breukelen, 2022). In view of other profound crises that affect mobility, such as climate change, political instabilities and future pandemics, it is safe to assume that online learning will remain in demand, even in a post-pandemic world) (Bayne et al., 2020). In this context, while educational research has made significant progress in establishing design principles that ensure effective online teaching and learning, the main focus of this scholarly work is on the acquisition of declarative knowledge and cognitive skills. Moreover, since very little is known about the online teaching and distance learning of psychomotor skills (Kouhia et al., 2021; Lehtiniemi et al., 2023), this paper and exhibition explore how eye-tracking technology (ETT) creates unique opportunities to improve craft education in hybrid and distant learning settings.

Keywords:
Craft pedagogy, eye-tracking technology, distance learning, hybrid learning.

THE POTENTIAL OF ETT TO ENHANCE CRAFT PEDAGOGY

Craft pedagogy

Contemporary craft pedagogy is based on four principles: 1) *observational learning* (Bandura, 1986), where students learn from observing and imitating expert models performing manual tasks (Sennett, 2009); *2) deliberate practice* (Schwartz et al., 2016), where students engage in focused and rigorous practice to automatise their skills and develop expertise; 3) *experiential and embodied learning* (Kolb, 1984; Sennett, 2009), where students learn through and about sensory experiences while working with materials and tools; and *4) reflection* (Schön, 1987), where students learn from reflecting *in* and *on* processes and products, both individually and in collaboration with teachers and fellow learners.

Although the social aspects of contemporary craft pedagogy take place in hybrids of digital and physical spaces (Pelman, 2022), the actual instruction of manual skills occurs in person in a rather traditional way in most cases. However, even in such a setting, students and teachers often find the communication of craft knowledge challenging, as students are unable to see through the teacher's eyes and feel what their teacher feels while working on a craft (Wood et al., 2009).

Distance learning in craft education

Research on distance learning in formal contemporary craft education programmes is still very limited, having expanded mainly due to the enforced shift to distance learning formats during the COVID-19 pandemic (Kouhia et al., 2021). During this time, in most cases, all social interactions were moved into digital tools—synchronous interactions were moved to platforms such as Zoom, Microsoft Teams and WhatsApp, while asynchronous interactions were moved to online platforms such as collaborative whiteboards, messaging platforms and video tutorials (Dreamson, 2020).

Video tutorials have continued to be the most popular online resource for craft education (Lehtiniemi et al., 2023), as they have enabled learners to revisit recorded instructions as many times as required, while also allowing them to control the speed and zoom into areas of interest. Furthermore, instructors can select and highlight important information and crucial aspects of tasks and techniques through annotations, control the speed of the video to allow focused attention on the subject matter and record a task from multiple perspectives, including their own, thus allowing students to view exactly what the expert sees while performing the task. In this context, recent advancements in ETT have enabled the creation of video tutorials that can augment information drawn from the learner's gaze while demonstrating a task (Van Gog, 2014).

The potential of utilising ETT in craft education

The primary rationale behind adding gaze visualisations to instructional videos is that they constitute a specific type of visual clue that can help observers attend to and select relevant information at the right time (Canham & Hegarty, 2010; Van Gog, 2014), especially when they aid in clarifying the verbal references and explanations that accompany a demonstration. Let us consider, for example, an expert silversmith demonstrating the appropriate way to cut a tiny sheet of copper while operating with different tools (such as a clamp and saw). This action requires fine coordination between hands, tools and materials. In such a case, gaze data can help make the expert's verbal explanations and references ("here", "in this place", "the upper part", etc.) more understandable and easier to follow. A second reason for adding gaze visualisations is that they can reveal the expert's perceptual strategies that would otherwise be inaccessible to learners or that are difficult to report through verbal explanations (e.g. Krebs et al., 2019; van Wermeskerken et al., 2018). Continuing the previous example, when sawing the copper sheet, the expert silversmith uses specific gaze patterns – going back and forth between the current and the next position of the saw – that are crucial for successful task completion. Experts are often unaware of their own expert viewing patterns and therefore rarely report them (Emhardt et al., 2023). ETT-augmented videos address this issue by illustrating a precise strategy for achieving the necessary accuracy in hand movements through the expert's eye movement patterns (Coen-Cagli et al., 2009).

Empirical research on the advantages of using ETT for learning, which has increased significantly in the past decade, has identified its positive effects on learning perceptual skills, visual tasks and visuomotor tasks (e.g., Salmerón & Llorens, 2019; Jarodzka et al., 2013). However, most of these studies have focused on tasks from specific domains, mainly STEM education, physical education/sports and medicine (Emhardt et al., 2023), with craft education receiving almost no attention (an exception is a recent study by Ye et al., 2022). Moreover, existing research focuses exclusively on student learning from the teacher's recorded demonstration, whereas the potential for teachers' learning from the students' demonstrations has largely been ignored. *Learners'* eye gaze data and videos that are recorded from their perspectives may provide teachers with valuable information for evaluation and formative purposes. For example, learners can record themselves performing a craft task while their gaze data is augmented onto these recordings. Subsequently, they can share these recordings with their teacher. By analysing the learners' hand-eye coordination and observing the patterns in their gaze location, teachers can easily identify the stages of the task during which the students encounter difficulties. Moreover, seeing a task "through the students' eyes" may have a long-lasting and expansive effect not only on the teachers' pedagogical observations and vision (Seidel et al., 2021; Van Es & Sherin, 2022), but also on their behaviour, such as contributing to the introduction of subtle changes in their subsequent modelling behaviour, explanations and emphases during instruction. Furthermore, the application of ETT has experienced a significant reduction in cost over the past decade (Dalmaijer, 2014) due to its increased demand in various sectors, including the military, assistive communication and gaming (Rahul, K., 2018; Rogers, 2019). While research-standard devices may still be quite expensive, general-purpose eye trackers can now be purchased for less than $100, making the pedagogical implications of this technology sufficiently scalable. Moreover, with further developments in wearable eye-tracker devices that limit the need for calibration, the use of ETT is expected to become simpler and easier.

THE EXHIBITION

An exhibition was organised to demonstrate the potential of ETT in enhancing the online learning of craft skills by allowing both teachers and learners to look through each other's eyes. As a case study, we conducted a training session on some metal sheet sawing techniques used in silversmithing. The exhibition involved a screen and a working station for the purpose of carrying out a live demonstration.

The screen displayed a recorded instructional video from the instructor's point of view. Augmented with gaze data and the sound of material interaction, the recording demonstrated the instructor performing the task while narrating the different aspects of the process, such as hand-eye relationships, interpretation of sounds created by material interactions, haptic sensations and embodied knowledge, as well as emotional experiences (see the right side of Figure 1). The audience was able to evaluate the effectiveness of the gaze data and other aspects of the video, such as the camera angle, sound, annotation and narration.

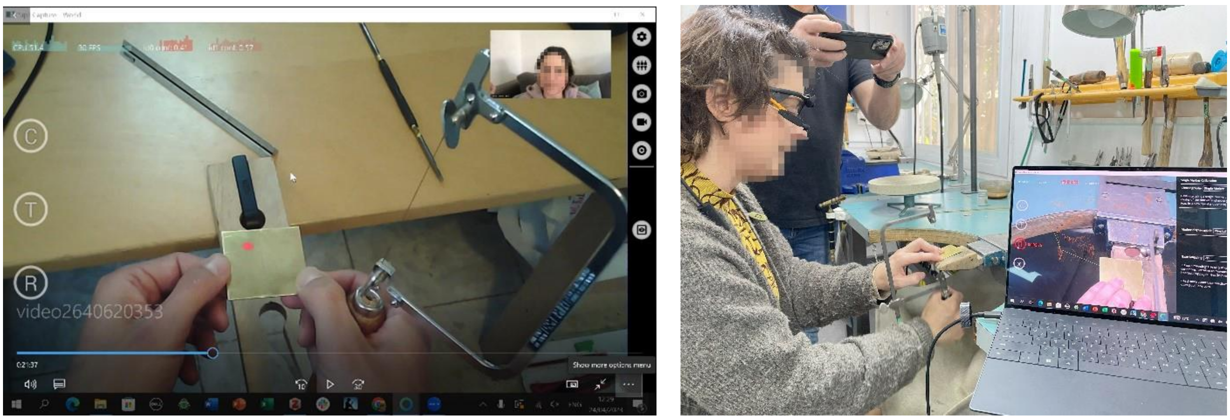

FIGURE 1. Images from our preliminary study at Bezalel. On the right, the expert is recording a video tutorial from her point of view while using augmented gaze data. On the left, the student is wearing an eye-tracking device, while the expert instructs him over the internet in real time.

At the working station, a live demonstration session was conducted in which a silversmith craftswoman located in Israel synchronically instructed a learner participating in the Biennial International Conference for the Craft Sciences (BICCS). The learner wore a special headset that included a "world camera" pointed at the direction of the learner's gaze and two cameras pointed at the eyes. A special software calculated the gaze location from the eye cameras and augmented it onto the video being recorded by the world camera. As a result, the Zoom platform was able to live stream the video, audio and gaze data to the instructor in Israel. The instructor then directed the learner accordingly and commented on every step undertaken by the learner.

Through this exhibition, we demonstrated the ways in which students and teachers can communicate throughout a session, overcome challenges and craft knowledge barriers and take advantage of the opportunities offered by this novel approach. The left side of Figure 1 presents a screenshot of one such Zoom lesson in which the learner's view and gaze movement were visible to the instructor while the former was executing the task.

REFERENCES

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs.

Bayne, S., Evans, P., Ewins, R., Knox, J., Lamb, J., Macleod, H., O'Shea, C., Ross, J., Sheail, P., Sinclair, C., & Johnston, K. (2020). *The Manifesto for Teaching Online.* The MIT Press. https://doi.org/10.7551/mitpress/11840.001.0001

Canham, M., & Hegarty, M. (2010). Effects of knowledge and display design on comprehension of complex graphics. *Learning and Instruction, 20*(2), 155–166. https://doi.org/10.1016/j.learninstruc.2009.02.014

Coen-Cagli, R., Coraggio, P., Napoletano, P., Schwartz, O., Ferraro, M., & Boccignone, G. (2009). Visuomotor characterization of eye movements in a drawing task. *Vision Research, 49*(8), 810–818. https://doi.org/10.1016/j.visres.2009.02.016

Dalmaijer, E. (2014). *Is the low-cost EyeTribe eye tracker any good for research?* PeerJ PrePrints. https://doi.org/10.7287/peerj.preprints.585v1

Dreamson, N. (2020). Online design education: Meta-connective pedagogy. *International Journal of Art & Design Education, 39*(3), 483–497. https://doi.org/10.1111/jade.12314

Emhardt, S. N., Kok, E., van Gog, T., Brandt-Gruwel, S., van Marlen, T., & Jarodzka, H. (2023). Visualizing a Task Performer's Gaze to Foster Observers' Performance and Learning-A Systematic Literature Review on Eye Movement Modeling Examples. *Educational Psychology Review, 35*(1), 23. https://doi.org/10.1007/s10648-023-09731-7

Jarodzka, H., van Gog, T., Dorr, M., Scheiter, K., & Gerjets, P. (2013). Learning to see: Guiding students' attention via a Model's eye movements fosters learning. *Learning and Instruction, 25*, 62-–70. https://doi.org/10.1016/j.learninstruc.2012.11.004

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* Englewood Cliffs.

Kouhia, A., Kangas, K., & Kokko, S. (2021). The effects of remote pandemic education on crafts pedagogy: Opportunities, challenges, and interaction. *Center for Educational Policy Studies Journal, 11*(Sp.Issue). https://doi.org/10.26529/cepsj.1126

Krebs, M.-C., Schüler, A., & Scheiter, K. (2019). Just follow my eyes: The influence of model-observer similarity on Eye Movement Modeling Examples. *Learning and Instruction, 61*, 126–137. https://doi.org/10.1016/j.learninstruc.2018.10.005

Lehtiniemi, P., Kokko, S., Syrjäläinen, E., & Palojoki, P. (2023). Teachers' experiences of using ICT in teaching practical skills in adult education. *Techne Serien - Forskning i Slöjdpedagogik Och Slöjdvetenskap, 30*(1), 18–30. https://doi.org/10.7577/TechneA.4926

Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers & Education, 159*, Article 104009. https://doi.org/10.1016/j.compedu.2020.104009

Pelman, B. (2022). Architectural prototyping in architectural education: How design knowledge is constructed within physical-digital hybrid environments. *The Design Journal, 25*(3), 481–489. https://doi.org/10.1080/14606925.2022.2053421

Rahul, K. (2018). *Eye Tracking Market Global Opportunity Analysis and Industry Forecast, 2018-2024.* Allied Market Research. https://www.alliedmarketresearch.com/eye-tracking-market

Rogers, S. (2019). *Seven reasons why eye-tracking will fundamentally change VR*. Forbes. https://www.forbes.com/sites/solrogers/2019/02/05/seven-reasons-why-eye-tracking-will-fundamentally-change-vr/

Salmerón, L., & Llorens, A. (2019). Instruction of Digital Reading Strategies Based on Eye-Movements Modeling Examples. *Journal of Educational Computing Research, 57*(2), 343–359. https://doi.org/10.1177/0735633117751605

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* Jossey-Bass Publishers.

Schwartz, D. L., Tsang, J. M., & Blair, K. P. (2016). *The ABCs of how we learn: 26 scientifically proven approaches, how they work, and when to use them* (Illustrated edition). W. W. Norton & Company.

Seidel, T., Schnitzler, K., Kosel, C. et al. (2021). Student Characteristics in the Eyes of Teachers: Differences Between Novice and Expert Teachers in Judgment Accuracy, Observed Behavioral Cues, and Gaze. *Educ Psychol Rev 33*, 69–89. https://doi.org/10.1007/s10648-020-09532-2

Sennett, R. (2009). *The craftsman*. Penguin.

Theelen, H., & Van Breukelen, D. H. J. (2022). The didactic and pedagogical design of e-learning in higher education: A systematic literature review. *Journal of Computer Assisted Learning, 38*(5), 1286–1303. https://doi.org/10.1111/jcal.12705

van Es, E.A., Sherin, M.G. (2021). Expanding on prior conceptualizations of teacher noticing. *ZDM Mathematics Education, 53*, 17–27. https://doi.org/10.1007/s11858-020-01211-4

van Gog, T., Verveer, I., & Verveer, L. (2014). Learning from video modeling examples: Effects of seeing the human model's face. *Computers & Education, 72*, 323–327. https://doi.org/10.1016/j.compedu.2013.12.004

Van Wermeskerken, M., Litchfield, D., & Van Gog, T. (2018). What am I looking at? Interpreting dynamic and static gaze displays. *Cognitive Science, 42*(1), 220–252. https://doi.org/10.1111/cogs.12484

Wood, N., Rust, C., & Horne, G. (2009). A tacit understanding: The designer's role in capturing and passing on the skilled knowledge of master craftsmen. *International Journal of Design, 3*(3), 6–78. http://www.ijdesign.org/index.php/IJDesign/article/view/559/275

Ye, L., Yang, S., Zhou, X., & Lin, Y. (2022). Supporting traditional handicrafts teaching through eye movement technology. *International Journal of Technology and Design Education, 33*, 981–1005. https://doi.org/10.1007/s10798-022-09748-z