Enhancing the Metacognition of Nursing Students Using Eye Tracking Glasses

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ABSTRACT

Practical simulation is increasingly used to develop reasoning skills during learning. The analysis of the scene and the correct execution of actions require an awareness of the situation and the activities performed by the student. Eye-tracking feedback (i.e., a video recording of the practical simulation with an overlay of the gaze point) can allow students and teachers to enhance the skills of analysis and execution of the practical activities performed. In this article, we present the implementation of an innovative pedagogical process for nursing students in Switzerland. It involves the use of eye-tracking glasses to improve learning through the enhancement of metacognition after a simulation. The results of a first test session done with 15 undergraduate students are reported.

KEYWORDS

eye-tracking, metacognition, education, nursing, simulation

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1 INTRODUCTION

Education is undergoing a digital transformation with new technologies offering unprecedented opportunities. In nursing, simulation has become an essential tool to develop clinical reasoning, clinical judgement and decision-making. These decisions are made through a series of automatic mechanisms that may be conscious or unconscious [Mitchell et al. 2013]. Yet, watching the video recording of their simulation does not allow students for differentiating what was observed, what captured their attention and what was forgotten. Eye-tracking can fill this gap, allowing students to analyse more closely the cognitive processes related to learning during simulation. Eye-tracking can be beneficial for both training and learning [Jarodzka et al. 2020], and more specifically in the medical field [Ashraf et al. 2017], but we are not aware of any such use in Switzerland.

This article introduces the implementation of a new pedagogical process for nursing students using eye-tracking glasses in a school of health science in French-speaking Switzerland. An intelligent tool based on eye-tracking with automatic detection of fixed areas of interest (AOI) has been developed. An interface was also implemented to guide the students towards a finer analysis of their simulation.

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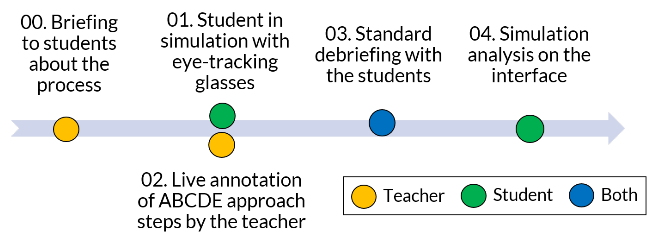

Figure 1: Timeline of the global pedagogical process

2 THE PEDAGOGICAL PROCESS

2.1 Context and Goal

The health science school has developed a clinical reasoning technique using a systematic approach to assess and treat the patient's Airway, Breathing, Circulation, Disability, and Exposure (ABCDE) [Verdon and Menoud 2022]. Nursing students should therefore learn and use this approach. Integrating eye-tracking into the existing pedagogical process should facilitate the analysis and identification of the cognitive mechanisms (i.e., metacognition) that led the students to apply correctly (or not) this ABCDE approach during the simulation. The aim is that the students improve the application of this systematic ABCDE approach throughout their curriculum through a better understanding of their metacognition.

The procedure of the overall pedagogical process is shown in Figure 1 and is further explained in detail.

2.2 Before and During the Simulation

A few weeks before the test day, the students were informed about the introduction of eye-tracking glasses in the pedagogical process. On the day of the simulation, the Pupil Invisible eye-tracking glasses and their software were used to collect the video and the gaze position from the first-person point of view. The students were instructed on the situation with the simulated patient and were equipped with the glasses, which were calibrated before the phone was locked. The simulation lasted between 10 and 15 minutes.

Meanwhile, the teachers were in the video control room. They annotated the beginning and end of each ABCDE phase, based on the student's words and actions. This was done through buttons on a custom interface implemented in Python. The latter also allowed them to start and stop the recording remotely.

2.3 After the Simulation

At the end of the simulation, a standard debriefing session was carried out. A few days later, the students analysed their simulation on a second custom interface also implemented in Python, which led them through different pages:

(1) filling in the Nurse Clinical Reasoning Survey (NCRS) [Liou et al. 2016].
(2) annotation of their simulation according to the ABCDE approach (same task as the teacher).
(3) global analysis of the simulation with a timeline of their ABCDE annotations, eye-tracking metrics and questions on metacognition.
(4) analysis of a sub-phase of the ABCDE approach selected by the student. Same content as in *(3)*, but also the videos of the annotated sub-phases (with the gaze and the AOIs displayed dynamically on top).
(5) comparison of the student's and teacher's timelines.
(6) general metacognition questioning on the simulation.
(7) filling in the NCRS [Liou et al. 2016].

On pages 3 and 4, three relevant metrics of situation awareness describing the students' gaze distribution over different AOIs and periods of the simulation were displayed: fixation rate, fixation time in AOI, and percentage of time spent in AOI [Zhang et al. 2020]. To calculate them, the AOIs were dynamically detected by the YOLOv5 (You Only Look Once, 5th version) object detection model [Jocher 2020] in the video recorded by the glasses. 5 classes were identified as relevant to be recognized as an AOI during the simulation (i.e., a patient examination): the head, the arm, the legs, the chest, and the medical trolley. The primary data source to train the model was a video of 18 minutes recorded at the simulation centre in which a patient is in a hospital bed and a nurse visits him equipped with eye-tracking glasses. To make the model as generic as possible, images from TV series, Youtube videos, and Google images were scrapped from the net and included in the dataset. The latter contained 437 images and was annotated on Roboflow by two persons. The small version of YOLOv5 was trained and achieved a mean average precision (mAP) of 0.89, a precision of 0,92 and a recall of 0,87.

3 RESULTS AND DISCUSSION

15 students responded to a separate questionnaire to assess the quality of this new pedagogical process. The results of these initial feasibility tests are presented below.

Each item was assessed on a 5-point Likert scale, with the mean score reported. The glasses were easy to use (4.73) and most students forgot that they wore glasses during the simulation (4.33). The graphical interface was clear and easy to use (4.47), as well as the instructions and the video tutorial to use it (4.8). However, the annotation of the ABCDE approach phases (4), and the accuracy of the eye-tracking metrics related to AOIs should be improved (3.66). Most students felt that they learned about the identification of elements for their patient's nursing (4.33) and their cognitive reasoning (4.33), that eye-tracking has enhanced their learning (4.2), and that this exercise will favourably change their next intervention (4.46).

Their user experience (UX) with the pedagogical process was evaluated with the short French version of the User Experience Questionnaire [Schrepp et al. 2017]. The pragmatic and hedonic qualities were rated 1.72 and 2.32 out of 3 respectively, giving an average of 2.02. The UX is thus considered to be *excellent* regarding the benchmark set by the authors' questionnaire. The confidence intervals are high with only 15 respondents, but the preliminary results are encouraging for the further development of this innovative pedagogical process in Switzerland.

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