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As you sow, so shall you reap: Is there a “golden standard” to teach histology?

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Letter

Preamble: *At the University of Eastern Finland (Kuopio, Finland) we implemented teaching methods with our medical and dental students that show effectiveness through objective and subjective measures. Our strategic vision and mission for education is summarized in Supplementary File 1. The question discussed below is: What teaching methods, systems, and approaches ensure the most effective knowledge transfer and class conditions for medical and dental graduates during histology education?*

A new, more effective and thought-evoking teaching program to medical and dental students was adopted in the Institute of Biomedicine, University of Eastern Finland, Kuopio, Finland in 2016. According to our study, histology learning and participation improved compared to traditional microscope-based teaching when virtual microscopy was combined with a student-centered approach (Felszeghy *et al*. 2017). The following salient points from this article promote student engagement and learning: student centered learning, collaborative learning, peer-to-peer learning and peer-to-peer teaching (Felszeghy *et al*. 2019). These points that have been made since the publication of the *MedEdPublish* article are broadly applicable and warrant a response to generate further discussion.

Dr. Ronald M Harden points out the online method used by Felszeghy *et al*. (2017) is a method promoting student-centered learning (Felszeghy *et al*., 2017; Felszeghy *et al*., 2019). The advantages of this have been previously noted and it has been successfully applied in a virtual environment and the majority of students exposed to this methodology excelled on the final exam (Kukolja-Taradi *et al*., 2008). Additionally, students expressed increased satisfaction with the virtual learning environment for the following reasons: improved quality of communication

with peers and tutors, better assessment, increased flexibility with their learning environment, and more convenient and seamless access to course materials. The study concluded that virtual learning may be a successful model for promoting a student-centered curriculum (Kukolja-Taradi *et al.*, 2008). Another study examined the gap between current medical curricula and optimal learning opportunities indicating virtual learning methods increased student-centered clinical learning (Changiz, Yamani and Shaterjalali, 2019). In summary, virtual learning is inherently student-centered and thus should be given more consideration in educational practice.

Harden and Jennings suggest virtual learning promotes collaborative learning. Similar to student-centered learning, the benefits of collaborative learning have been noted (Laal and Ghodsi, 2011). Cole *et al.* observed virtual learning supported collaborative learning and may develop critical appraisal skills (Cole *et al.*, 2017). Their study noted different groups developed a preference for the way they worked collaboratively. Virtual learning platforms were used in ways facilitating students` learning. Further, authors noted virtual learning promoted collaboration leading to positive principles of case-based learning. Additionally, collaborative learning coupled with virtual learning was considered to have the potential to be a meaningful way of identifying high-quality, relevant, context-specific resources for student learning. Wihlborg and Friberg (2016) demonstrated that virtual learning enables faculty to collaborate internationally. Faculty working internationally and created an opportunity for students at two universities to collaborate resulting in students' learning about activities, such as patient safety, from another perspective (Wihlborg and Friberg, 2016).

A 2005 study demonstrated virtual learning also had a positive effect on self-directed learning (Thomas and Storr, 2005). In this study, students participated in a virtual bulletin board, providing an additional tool for problem solving. Academic gains seen in this study were consistent with knowledge building on Bloom's Taxonomy (Thomas and Storr, 2015). Gains at the knowledge level were the type of gains seen in Felszeghy *et al.*'s study (Felszeghy *et al.*, 2017). In a different study, Benedict *et al.* (2013) demonstrated students overwhelmingly supported self-directed learning (Benedict, Schonder and McGee, 2013). The majority of students noted using virtual patient cases allowed them to complete cases prior to class and that the virtual patient cases promoted self-directed learning when they replaced lectures. The same study also observed that virtual learning promoted learning through repeating self-directed study. Benedict *et al.* concluded that using virtual learning to replace lectures aligns with several accreditation standards and educational outcomes in terms of health science education, expecting their programs to promote opportunities to develop lifelong learning skills and provide opportunities for students to transition from dependent to active, self-directed learners (Medina *et al.*, 2013). In short, Felszeghy *et al.* histology teaching method further demonstrated the effectiveness of self-directed learning (Felszeghy *et al.*, 2017).

Lastly, Jennings and Wan noted the virtual learning method used in Felszeghy *et al.* (2017) also promotes student engagement. In a study by Hussain et al. researchers found when virtual learning was used, student engagement correlated positively with assessment scores (Hussain *et al.*, 2018). Previous literature indicates the more engaged students are in their own learning, the better they perform on assessments (Carini, Kuh and Klein, 2006; Fredin, Fuchsteiner and Portz, 2016; Korobova and Starobin, 2015). The increase in engagement in a course using virtual learning may be due to increased access to course content and course participation when compared to lecture-based courses (Hussain *et al.*, 2018). In this study, students who were not as engaged in the course tended to have lower scores on the first assessment and tended to not be in the virtual learning group. Virtual landscape and gamification appear to be at least as effective, and in many studies, more effective for improving interest, knowledge, skills, and satisfaction, reviewed by McCoy *et al.* (McCoy, Lewis and Dalton, 2016).

Keywords: Collaborative learning; Dental education; Medical education; Histology education; Knowledge retention; Whole-slide imaging platform

Notes On Contributors

Contributions

Designed the letter: F. Sz; GE. G and they contributed equally to this work. Wrote the draft version of the manuscript: F. Sz; GE. G; AK, P. N; D. M. All authors read and approved the final version of the manuscript.

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Declarations

The author has declared that there are no conflicts of interest.

Ethics Statement

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