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The long road to learn the meaning of p-value in medical schools: challenges for a research methodology training in medical schools

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BACKGROUND

The movement towards evidence-based medicine has been highly successful (Fregni, 2019). Clinicians understand the need to practice based on solid and unbiased evidence. However, the pathway towards full use of evidence-based medicine (EBM) has not been completed. There is still a long way to go. One of the main obstacles to the better use of EBM in clinical practice is the lack of research methodology training. It is clear that there is not enough time in the curriculum of medical students to cover the complex field of research methodology (Fregni, 2019). Also, the current methods of teaching have been far from optimal, and therefore, students usually tend to dislike statistics and epidemiology early on, which provides them fewer tools to use EBM in their clinical profession effectively. In this editorial, we convened a group of clinicians and educators (from the Teaching, Learning and Innovation Initiative) from several countries to briefly discuss some of the main challenges we see in medical students' current education that applies to EBM teaching.

Learning How to Learn

The first important point is that students need to be motivated to learn. Unfortunately, the suboptimal and inconsistent use of intrinsic motivation and the reliance on extrinsic motivation in research methodology courses have resulted in missed opportunities to promote reflection and long-lasting learning. Opposite to students' well-known extrinsic motivation, intrinsic motivation is driven by personal, internal rewards instead of external incentives. How can this be applied to research methodology training? Research methods are taught, in many universities, in the very early semesters, sometimes even with heterogeneous groups (Fregni, 2019). The educator needs to spend time explaining to students how research and evidence-based data can make them better clinicians, ultimately impacting their future patients (Fregni, 2019). As several research methodology courses finalize with a research project, teachers may foster autonomy by letting students focus their projects on topics that they are most passionate about. All of these activities must be followed by timely feedback for the work done, allowing students to confirm if they are mastering the subject (Fregni, 2019). Direction, autonomy, and mastery might be the secret key to making students fall in love with the dreaded statistics and epidemiology and be more inclined to evidence-based practice. Most research methodology teachers focus on content instead of inspiring students to improve.

Another important concept and challenge to implementation of research-based critical thinking programs is involving students in the learning process.

Students do not typically participate actively in research activities, which could be fundamental in understanding research methodology (Chang & Ramnanan, 2015). Another critical point is to ensure that students can assess their learning process and correct the process as needed. That being said, enhancing critical thinking should be a goal. Critical thinking is not just a common jargon but also a well-based set of characteristics that allow an individual to reflect on a concrete problem and offer a practical and feasible solution (Halpern, 1998). According to Halpern (1998), "knowing how to learn and knowing how to think…will provide the best education for citizens of the 21st century." Critical thinking leads to self-awareness and confidence. It is a real student-centered method in which the student has full responsibility for his or her learning. It is no wonder that there is a metacognitive component to Halpern's four-part model for teaching critical thinking. Metacognition is classically defined as "what we know about what we know" and is a result of the student's effort to identify the problem, discuss solutions, formulate arguments and finally reach a goal with the full awareness that self-understanding is a fundamental part of his or her own learning process. Furthermore, metacognitive abilities might enhance the most powerful force to have students effectively engaged in research: their intrinsic motivation (Ommering et al., 2019).

Teaching How to Teach

Training teachers is also essential. Teaching is dynamic, and teachers need to undergo the same learning journey as their learners. For the educator and philosopher Paulo Freire, critical teaching practice involves doing and thinking about doing in a dialectical movement (Freire, 1996). In this critical reflection of the practice, in which experiences, knowledge and emotions are considered, the teacher technically deepens in the teaching process. This can strengthen them as responsible agents, open to changes, and able to accept the dissenting and the new and be confident about his role and performance (Freire, 1996). Reflecting, studying, and sharing with partners might improve teachers' knowledge, skills, and behaviors, and this enabling environment and culture might happen in formal scheduled programs organized by institutions and informal opportunities. In communities of practice, faculty from different places could openly discuss their experiences and support one another in their continuing development (Steinert et al., 2016). Faculty development strategies can be routine, such as workshops and seminars, or longitudinal programs, being some examples: peer coaching, learner feedback, structured online and workplace sessions (Steinert et al., 2016). Engagement of professionals is a challenge, and technology could be an ally, some examples being: faculty performance analytics-based strategies, in which faculties receive feedback about different aspects of their performance; virtual communities of practice; and interactive videos (Yilmaz et al., 2020). Teacher development proposals that are relevant and meaningful to teachers, based and applicable in practice and that generate opportunity for feedback and reflection should be encouraged.

Finally, we need to ask ourselves the question: what are our aims in teaching? What do health care professionals, including those in general and assistance practice, that may have no interest or love for developing research themselves, need to know? In other words, what needs to be taught to everyone? Should we really be teaching students how to calculate odds ratios and check whether or not the correct test is used, how to operate statistics programs, and so on? Or should we perhaps focus on notions such as multiple analysis correction and its importance, the logic behind scientific reasoning that empowers EBM, how to interpret probabilities, and how to correlate p values with effect size and study generalizability? Recently in Nature, a series of articles have been published that should be mandatory reading for those immersed in the world of EBM. They debate the true value of p, often abused since Ronald Fisher's definition that if 1 every 20 trials fail, it is reasonable to assume the results on the other 19 are not due to change – from there, the 5% fail rate or $p = 0.05$ (Heping, 2019). Maybe teaching more about bias than contingency tables and encouraging more debate on what should be done with a $p = 0.06$ and the effects of sample size on generalizability and p calculation are in order (Amrhein et al., 2019; "It's time," 2019).

Nowadays, "what to teach" may be as important as "how to teach on the XXI century?" It is widely known that human beings are wired to learn through communication and to share their experiences (Hari et al., 2015; Wu et al., 2020). Thereby, most educators and institutions have applied mentorship and coaching strategies to enhance students' learning process, engagement, and diversity throughout the academic environment (Burgess et al., 2018; Henry-Noel et al., 2019; Wilcha, 2020). In this context, it is important to highlight how mentoring and coaching strategies can be affected and how they impact student engagement

(Tabatabai, 2020). Educators have to compete with other sources of attention in the student home-environment (Wu et al., 2020). Also, socioeconomic aspects play a major role for both students, who sometimes cannot afford this technology, and for higher education institutions as well, that fail to implement these new demands (Sharma et al., 2020; Alsoufi et al., 2020). Distance and virtual mentoring are essential and a possible reality through the active student-centered method's transference to the online world (Lin et al., 2019). Using technology to enhance extrinsic motivators will guide students to achieve their professional goals and support intrinsic motivators (Ommering & Dekker, 2017; Wu et al., 2020; Wilcha, 2020).

Understanding Differences and Inequality in EBM Implementation

One of the most important challenges in developing countries is the shortage of healthcare professionals, and this is especially true for rural areas, where a large proportion of the population lives. Al-Shamsi (2017) discusses in their review that this issue is still prevalent in developing countries as the current solutions may not be practical because of the limited resources.

Learning in most developing countries is still traditional and characterized by a teacher-centered approach in which the teacher is the main protagonist during the program. New and better teaching methods should emphasize the student-centered approach where the students facilitate the course and are encouraged to take more responsibility under the supervision of teachers (Fregni, 2020).

Another important aspect of medical education in developing countries is the relative lack of EBM application. Failure to understand the basic principles of EBM constitutes a major obstacle to motivate students to learn about their future application as professionals, and this leads to a vicious cycle as professionals also do not encourage future students to apply EBM. This also relates to the decreased exposure of students to clinical research laboratories in developing countries, as they may be relatively non-existent in some areas. Clinical research then becomes a far reality for those students, decreasing their motivation to learn about this important topic.

The social disparity in poor countries is visible in medical schools. One important aspect that directly impacts student performance in the first year of the course is high school background education and economic status. Students from public schools and poor families have more difficulty keeping up with their courses. In recent years, the Brazilian Government has increased funding for poor students in an effort to improve the disparity.

Digital education to address shortcomings in teaching EBM?

New methods of providing information to medical students have gained space in the past 30 years. More specifically, internet-based distance learning has emerged as one alternative to provide good content with flexibility, lower costs, and possibly, asynchronous learning at the student's convenience. Moreover, considering that traditional higher education methods are being questioned, it is reasonable to think that online learning is an interesting alternative to offer new tools to assist students in the learning process. However, it is important to highlight that simply recording and transferring old PowerPoint lectures to the internet is not the solution. A systematic review and meta-analysis comparing online versus offline learning effectiveness in medical education has shown conflicting results with no difference in pre-post test score gains between groups (Pei & Wu, 2019). On the contrary, new methodologies such as the flipped classroom approach, the provision of pre-class materials, and frequent quizzes during classes yielded a significant improvement in student learning compared to the traditional approach in a recently published meta-analysis (Ding et al., 2019). It is noteworthy that included studies adopted online material to provide information and other educational resources. Therefore, it seems that online lectures do not seem to be the solution by themselves, but a useful tool to help to provide effective methods of teaching and learning.

Where to go From Here

With the increasing development and use of technology, teaching and learning have recently acquired new forms, making everything more easily accessible to students. During the onset of the COVID-19 pandemic, the education system started to implement a more innovative approach with remote lectures and interactive online materials. However, this new era of online learning is also accompanied by some challenges. The COVID-19 pandemic initiated digital transformation of higher education, and with limited time to establish this methodology, changes were made quickly.

One evident flaw in the online learning system is the dependency on technological devices and internet, which presents a real challenge for some communities in underdeveloped areas. One study published in 2020 pointed out the plight of students in low-income households in the United States with lower internet access during this Covid-19 pandemic (Fishbane & Tomer, 2020). Student, and even teachers, with poor internet availability/connection may not be able to access this method of online leaning, potentially creating a disparity in learning and education across the country and perhaps around the world.

Additionally, (Adedoyin & Soykan, 2020) elaborated that while there was a rapid migration toward online learning at the onset of the pandemic, the communities that experienced more poverty had lower rates of internet access and subsequently were put at immediate disadvantage and the transition was more difficult. Other challenges included the teachers themselves not being prepared to instruct remotely, personal life interruptions, digital competence, and compatibility with an online model of learning (Adedoyin & Soykan, 2020).

In one study published this year at the University of Benghazi, students shared their perspectives on the shift to remote learning (Maatuk et al., 2021). The majority opinion was that the introduction to e-learning was difficult and the biggest obstacle to smooth application was the low-quality internet service. At the same time, students acknowledged the usefulness of online learning, explaining that it improved their academic standards (Maatuk et al., 2021). Taking these different aspects into account, it seems that online learning could be beneficial if the necessary resources and training are given to students and teachers to develop this methodology with success.

One of the positive aspects of this pandemic could surely be that it represents a big step towards a better state-of-the-art online educational system. In the near future, we may witness additional implementations, such as other teaching methods, like the flipped classroom, to give students more chances to be the center of the teaching and learning process. Even though online learning has been increasingly put into practice in recent times, there is still the need to have more interactive, student-centered, specific, and efficient teaching strategies that should be at the same pace as the progress made in any other scientific field and have the same number of new findings, research papers, and teaching approaches.

CONCLUSION

In summary, there is a steep slope ahead to improve clinical research methodology teaching in medical schools. The main challenge is not a specific one, but instead, it is the relative lack of strong teaching methods using a more applicable student-centered methodology in general. The problem then is worsened to research methodology as students are generally less motivated to learn it, and faculty are not trained to enhance their motivation skills. Finally, students remain with the mindset of grading as the main benchmark of success instead of deep learning. Thus, there is still a long road to train students in meta-cognition skills to enhance their learning. Learning of clinical research is critical, but until teaching is improved in medical schools, students will continue receiving their medical degree not knowing the meaning of the p-value.

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Conflict of Interest

Dr. Fregni is the editor-in-chief of the Principles and Practice of Clinical Research journal. Therefore, he excused himself from the peer-review process and followed the journal guidelines for peer-reviewing when an editor co-authors a manuscript. He did not

influence the editorial process and final publication decision.

REFERENCES

Adedoyin, O.B. & Soykan, E. (2020) Covid-19 pandemic and online learning: the challenges and opportunities. Interactive Learning Environments. DOI: 10.1080/10494820.2020.1813180.

Al-Shamsi M. (2017). Addressing the physicians' shortage in developing countries by accelerating and reforming the medical education: Is it possible? Journal of advances in medical education & professionalism 5(4), 209-212.

Also, A., Alsuyihili, A., Msherghi, A., Elhadi, A., Atiyah, H., Ashini, A., ...Elhadi, M. (2020). Impact of the COVID-19 pandemic on medical education: Medical students' knowledge, attitudes, and practices regarding electronic learning. PloS one, 15(11), e0242905. doi:10.1371/journal.pone.0242905.

Amrhein, V., Greenland, S., & McShane, B. (2019). Scientists rise up against statistical significance. Nature, 567, 305-307. doi:10.1038/d41586-019-00857-9.

Burgess, A., van Diggele, C., & Mellis, C. (2018). Mentorship in the health professions: a review. The clinical teacher, 15(3), 197–202. doi:10.1111/tct.12756.

Chang, Youjin & Ramnanan, Christopher. (2015). A Review of Literature on Medical Students and Scholarly Research. Academic Medicine, 90(8), 1162–1173. DOI: 10.1097/ACM.0000000000000702.

Ding, C., Li, S. & Chen, B. (2019). Effectiveness of flipped classroom combined with team-, case-, lecture- and evidence-based learning on ophthalmology teaching for eight-year program students. BMC Med Educ, 19, 419. doi:10.1186/s12909-019-1861-y.

Fishbane, L., & Tomer, A. (2020). As classes move online during COVID-19, what are disconnected students to do? Brookings Institute Blog – The Avenue.

Fregni, F. (2019). Critical Thinking in Teaching & Learning: The Nonintuitive New Science of Effective Learning. Independently published.

Fregni, Felipe. (2020). Evidence-based Analysis of Technology in Teaching & Learning: The Real Effect of Technology-based Methods in Educational Programs. Kindle Edition.

Freire, P. (1996). Pedagogia da Autonomia: saberes necessários à prática educativa/ Paulo Freire. Paz e Terra, 166.

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Disposition, skills, structure training, and metacognitive monitoring. American psychologist, 53(4), 449-455. DOI: 10.1037/0003-066X.53.4.449.

Hari, R., Henriksson, L., Malinen, S., & Parkkonen, L. (2015). Centrality of Social Interaction in Human Brain Function. Neuron, 88(1), 181–193. doi:10.1016/j.neuron.2015.09.022.

Henry-Noel, N., Bishop, M., Gwede, C. K., Petkova, E., & Szumacher, E. (2019). Mentorship in Medicine and Other Health Professions. Journal of cancer education: the official journal of the American Association for Cancer Education, 34(4), 629–637. doi:10.1007/s13187-018-1360-6.

It's time to talk about ditching statistical significance: Looking beyond a much used and abused measure would make science harder, but better. (2019). Nature, 567, 283. DOI: 10.1038/d41586-019-00874-8.

Lin, J., & Reddy, R. M. (2019). Teaching, Mentorship, and Coaching in Surgical Education. Thoracic surgery clinics, 29(3), 311–320. doi:10.1016/j.thorsurg.2019.03.008.

Maatuk, A.M., Elberkawi, E.K., Aljawarneh, S. et al. (2021). The COVID-19 pandemic and E-learning: challenges and opportunities from the perspective of students and instructors. J Comput High Educ. DOI: 10.1007/s12528-021-09274-2.

Ommering, B. & Dekker, F. W. (2017). Medical students' intrinsic versus extrinsic motivation to engage in research as preparation for residency. Perspectives on medical education, 6(6), 366–368. doi:10.1007/s40037-017-0388-3.

Ommering, B., van Blankenstein, F. M., Wijnen-Meijer, M., van Diepen, M., & Dekker, F. W. (2019). Fostering the physician-scientist workforce: a prospective cohort study to investigate the effect of undergraduate medical students' motivation for research on actual research involvement. BMJ Open, 9(7), e028034. Doi: 10.1136/bmjopen-2018-028034.

Pei, L., & Wu, H. (2019). Does online learning work better than offline learning in undergraduate medical education? A systematic review and meta-analysis. Medical education online, 24(1), 1666538. doi:10.1080/10872981.2019.1666538.

Sharma, D., & Bhaskar, S. (2020). Addressing the Covid-19 Burden on Medical Education and Training: The Role of Telemedicine and Tele-Education During and Beyond the Pandemic. Frontiers in public health, 8, 589669. doi:10.3389/fpubh.2020.589669.

Steinert, Y., Mann, K., Anderson, B., Barnett, B. M., Centeno, A., Naismith, L., Prideaux, D., Spencer, J., Tullo, E., Viggiano, T., Ward, H., & Dolmans, D. (2016). A systematic review of faculty development initiatives designed to enhance teaching effectiveness: A 10-year update: BEME Guide No. 40. Medical teacher, 38(8), 769–786. doi:10.1080/0142159X.2016.1181851.

Tabatabai S. (2020). COVID-19 impact and virtual medical education. Journal of advances in medical education & professionalism, 8(3), 140–143. doi:10.30476/jamp.2020.86070.1213.

Wilcha R. J. (2020). Effectiveness of Virtual Medical Teaching During the COVID-19 Crisis: Systematic Review. JMIR medical education, 6(2), e20963. doi:10.2196/20963.

Wu, H., Li, S., Zheng, J., & Guo, J. (2020). Medical students' motivation and academic performance: the mediating roles of self-efficacy and learning engagement. Medical education online, 25(1), 1742964. DOI: 10.1080/10872981.2020.1742964.

Yilmaz, Y., Lal, S., Tong, X. C., Howard, M., Bal, S., Bayer, I., Monteiro, S., & Chan, T. M. (2020). Technology-Enhanced Faculty Development: Future Trends and Possibilities for Health Sciences Education. Medical science educator, 1–10. Advance online publication. doi:10.1007/s40670-020-01100-1.

Zang, Heping. (2019). Stats: P values akin to 'beyond reasonable doubt.' Nature, 569, 336. DOI: 10.1038/d41586-019-01530-x.