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Commentary

EEG Training in the Context of Competency-Based Learning: When is Enough, Actually Enough?

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Background

Electroencephalogram (EEG) interpretation skills are an integral part of epilepsy training. In Canada, a national EEG exam administered by the Canadian Society of Clinical Neurophysiologists (CSCN) requires candidates to complete a minimum of 6 months of training in an established high-volume EEG laboratory for eligibility. This remains in effect until 2025, after which the eligibility criteria transitions to a competency-based model requiring candidates to have interpreted and generated written reports for at least 500 EEGs, diversified across various ages, with at least half of them being abnormal [1]. Elsewhere around the world, the Accreditation Council for Graduate Medical Education (ACGME) in the United States (US) require a minimum of 3 months dedicated to reading and interpreting EEG and videoEEG (V-EEG) monitoring, including a minimum of 50 routine EEGs and 20 V-EEG monitoring, reporting them as the primary reviewer [2]. The International Federation of Clinical Neurophysiology overseeing EEG education in Europe, the Middle East, and Africa suggest EEGs interpreted independently, under supervision, be a minimum of 1,000 recordings, with a mix of ages [3]. With the transition towards a competency based framework in EEG exams and the significant variability world-wide in competency-based requirements, we review the existing literature on EEG education to gather insight and inform future directions of EEG education.

EEG education in established international training programs

Most research on EEG education has been at the neurology residency training level, with very limited data at the fellowship training level. A 2020 survey of American neurology program directors revealed that EEG rotations for residents lasted an average of 1.7 months, with only 35% of programs providing exposure to more than 40 EEGs per rotation [4]. In contrast, a survey of European program directors showed even greater variability, with

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training durations ranging from 0 to 6 months and half of the programs offering exposure to more than 40 EEGs per rotation [5]. A study focused on pediatric neurology residency programs reported that EEG training in North America typically lasts about 7.3 weeks, with residents interpreting between 16 and 45 EEGs during the rotation [6]. Seventy-seven percent of whom were enrolled in a one-year fellowship and 23% in a two-year fellowship. Despite some variability, due to the fact that some fellows were also simultaneously training in electromyography, most fellows report feeling adequately trained at the end of the program [7]. Based on the reviewed literature, EEG exposure reported in most neurology training programs is unlikely to be sufficient to attain EEG exam eligibility.

Current perceived gaps in EEG education

Further confirming this have been studies exploring perceptions of EEG competency among trainees and neurologists. These studies have identified an important recurring theme - insufficient exposure and hands-on experience in EEG and the association of lower self-reported confidence and proficiency levels. In the US, a 2016 nationwide survey identified one in three fourth-year residents were unsure about interpreting common EEG abnormalities, and nearly half had difficulty recognizing normal variants [8]. Similarly, at the 2017 American Academy of Neurology (AAN) Congress, only 37% of graduating neurology residents responded to feeling confident in interpreting routine EEGs independently [9]. International studies corroborate these concerns. In Turkey, a group of 11 neurology residents with 3-4 months of EEG training showed a wide range of knowledge, with correct answers varying from 17% to 50% [10]. Similarly, a survey in Brazil revealed that approximately 70% of neurology residents were not confident in composing independent EEG reports, and nearly half felt inadequate in interpreting EEGs even under supervision. Many residents suggested that increased exposure to EEGs, as well as dedicated hours for interpretation, would be beneficial. A significant portion of the residents believed that reviewing at least 50 EEGs would be necessary to develop competence [11].

Addressing gaps

Studies where educational interventions to address this gap exist but are few. One study by Nascimento et al. demonstrated that neurology residents who had completed more than 9 weeks of EEG training performed similarly to clinical neurophysiologists in a routine EEG examination, highlighting the importance of sufficient hands-on experience [12]. Passiak et al. recently evaluated their 4-week EEG curriculum based on ACGME milestones for

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neurology residents, which included epilepsy monitoring unit rotations, interactive modules, lectures, and assessments. The study, involving 33 residents (12 adult and 21 child neurology), showed significant improvement in post-rotation test scores, with an average increase of over 17% [13]. Similarly, Fernandez et al. reported on a synchronous and asynchronous EEG education program supported by the American Epilepsy Society from 2019 to 2021, which also demonstrated significant improvement in test scores among 56 participants in the synchronous course [14].

Accurately interpreting EEG is crucial in preventing misdiagnoses of epilepsy and requires adequate education. A review of the available literature confirms a paucity of evidence to support minimum number EEGs for competency, especially at the fellowship training program where this data would be most valuable. For neurology residents interested in writing an EEG qualification exam, tailored enhanced EEG training beyond a standard curriculum is likely required as within existing EEG training paradigms, a significant proportion of trainees endorse feeling that they are not adequately trained to read EEGs [7,9].

Future reflections

Thematically, existing research suggests that the more exposure there is, the more competence increases [6,11], especially with dedicated EEG educational initiatives, where post-course test scores are statistically higher than pre-course scores [13,14]. However, as suggested by Fernandez et al., no single course will be able to replace hands-on EEG reading [14]. This likely reflects the multifaceted and diverse characteristics of EEG training programs and the overall learning process. To date, there remains very little data on impact measures of such training programs based on board certification success rates, interrater reliability, and peer-to-peer assessments. Future efforts in defining a competency-based framework need to integrate aspects including the number of EEGs reviewed, the duration of training, the complexity of EEGs and the extent of responsibility. In addition, any training program should integrate a process to evaluate the different levels of competency achieved during the course of training. The exact minimal numbers, duration, extent of complexity and responsibility still needs to be fully defined and validated. We hope this commentary will inform future research in this field and urge educational and credentialing programs to recognize the paucity of evidence as the competency-based framework develops and evolves. Future education research in this field has the potential to form the foundation of a more

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evidence-informed, higher-impact, competency-based EEG curriculum applicable to programs around the world.

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Conflicts of Interests

The authors have no relevant financial or non-financial interests to disclose for the present manuscript.

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Statement of authorship

EB conceived the study. GDO reviewed the literature and wrote the first draft of the manuscript. All the authors have critically revised the final version of the manuscript.

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