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Original Article

Developing competency-based medical education for dental education in Taiwan: A pilot study of tooth extraction entrustable professional activities

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Abstract *Background/purpose:* This study aimed to evaluate the initial implementation of competency-based medical education (CBME) through entrustable professional activities (EPAs) in Taiwan dental education, focusing on tooth extraction EPAs across undergraduate year (UGY), postgraduate year (PGY), and oral and maxillofacial surgery-residency (OS-R) levels.
Materials and methods: Using the Delphi method, an advisory team developed and validated three levels of trial EPAs, which were implemented through the Emyway platform. A structured

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Emyway platform;
Taiwan

questionnaire was used to evaluate teachers' and students' experiences and satisfaction with Emyway and the EPAs. Data were collected from the participants at two university-affiliated hospitals in Taiwan. Statistical analyses comparing teachers' and students' experiences and satisfaction were conducted.

Results: The EQual rubric scores for the EPAs were high across all levels (UGY: 4.80, PGY: 4.78, R: 4.79) with no significant differences. The demographic characteristics and Emyway experiences were similar among 7 teachers and 17 students. No significant difference was observed in terms of satisfaction with EPA design and usage between the teachers and students. For the teachers and students, the overall Emyway satisfaction scores were 3.86 and 3.76 and the EPA content satisfaction scores were 4.00 and 3.71, respectively, with no significant differences.

Conclusion: The study successfully introduced EPAs into Taiwan dental education, demonstrating high EQual rubric scores and moderate satisfaction. Emyway is a convenient and effective platform for EPA implementation. Future efforts should focus on the expansion of EPAs to other dental specialties and integration of CBME into Taiwan dental education to align with international standards.

Introduction

Competency-based medical education (CBME) has gained considerable attention worldwide as a transformative approach to training healthcare professionals. This model, which focuses on achieving specific competencies rather than time-based training, has been implemented in various medical schools and training programs across different countries.[1] In 2005, Olle ten Cate introduced entrustable professional activities (EPAs) as a concept in CBME.[2] EPAs were defined as observable and measurable tasks performed in a work-based setting, which could be entrusted to a trained student or doctor who has demonstrated competence.[3] First introduced in postgraduate medical education, EPAs have since been expanded to undergraduate education worldwide.[4] In 2014, the Association of American Medical Colleges initiated a pilot project to evaluate the feasibility of implementing 13 EPAs for entry into residency within undergraduate medical education.[5,6] The Royal College of Physicians and Surgeons of Canada and the College of Family Physicians of Canada have integrated EPAs into their residency training programs.[7] In the Netherlands, EPAs were fully integrated into undergraduate and postgraduate medical training.[8] In 2020, an EPA framework for intern year in Ireland[9] and for postgraduate specialist training for anesthesiology and radiology[10] was developed. Other countries, such as Germany,[11,12] Singapore,[13] Japan,[14] and Brazil,[15] have also explored and adapted EPAs to fit specific educational contexts.[16] This global shift to EPAs ensures that graduates are well prepared for clinical practice.

The application of EPAs to otolaryngology training in Taiwan followed a four-phase process.[17] The first phase (2016) involved pilot projects to establish milestones and build consensus. The second phase (2020–2021) saw the creation of an EPA framework with 11 EPAs, 21 subcompetencies, and 368 milestones. The third phase (2021) focused on the development and testing of the Emyway platform (Emyway) by the Joint Commission of Taiwan in 11 hospitals, collecting over 1,210 assessments. The fourth phase (2022) involved the implementation of Emyway across all training hospitals and the integration of EPA results into the accreditation system. In 2017, a working group of experts in emergency medicine developed EPA descriptions.[18] Similarly, other medical specialties in Taiwan are adopting and adapting EPA frameworks, incorporating international practices for refinement.

In worldwide dental education, EPA is progressing and exhibiting difference from undergraduate, postgraduate, and specialist training levels. In the United States, a preliminary set of EPAs for predoctoral dental education was developed through a consensus-building process in 2021.[19] To advance this initiative, a core EPA workgroup was formed in 2023.[20] Future effort will be needed to establish standardized EPAs for pediatric dentistry in residency programs.[21] In the Netherlands, 14 EPAs have been developed in a student-run dental clinic.[22] In 2018, the Faculty of Dentistry, University of Toronto, launched the first exam, which included eight stations designed as EPAs to objectively assess the technical skills of the graduating residents of its oral and maxillofacial surgery specialty program.[23] In Germany, the iMED DENT curriculum at the University Medical Center Hamburg-Eppendorf has defined an EPA catalog.[24] In Taiwan, the implementation of CBME in dental education remains in its early stages. However, the development of EPA has not yet been initiated. This study aimed to evaluate the initial implementation of CBME by focusing on a specific EPA within Taiwan dental education.

Materials and methods

The present study protocol was approved by the Institutional Review Board of Taipei Medical University Hospital (approval no.: N202408052).

Team organization

We assembled a diverse and expert team to initiate the CBME project for the development of EPAs in Taiwan dental education. A core advisory group (CAG, $n = 12$) was formed

within the Taiwan Association of Dental Education, bringing together educational and clinical expertise from various fields, including general dentistry, oral and maxillofacial surgery, orthodontics, periodontics, and dental educators. The team consisted of nine educators from eight dental schools in Taiwan and three CBME specialists with experience in designing EPAs for medical education.

The Delphi method: tooth extraction entrustable professional activities

During the CAG discussions, the members deliberated and voted on a dental professional task to be the topic of this trial EPA, ultimately selecting tooth extraction as the focus. Tooth extraction was a fundamental task across all stages of dental training, namely, undergraduate year (UGY), postgraduate year (PGY), and oral and maxillofacial surgery-residency (OS-R). The learners were trained to perform extractions of varying complexities depending on their level. The CAG decided to design three different levels of trial tooth extraction EPAs: EPA-UGY, EPA-PGY, and EPA-R. After completing the content description of these three EPAs, two major types of *ad hoc* assessment forms were developed:

1. Student assessment forms: These formers are divided into UGY, PGY, and OS-R. They cover sections such as title, task description, failure risks, core competencies, required knowledge, skills, attitudes, assessment-related information, and expectations for independent performance. Each level features a distinct content.
2. Teacher assessment forms: Categorized into UGY, PGY, and OS-R, these forms include elements, such as the topic, context description, assessment criteria, supervision levels and reference items for assessment. Each level features a distinct assessment.

The trial tooth extraction EPAs were refined and validated using the Delphi method,[25] which involves multiple rounds of surveys and feedback from the CAG. The discrete activity subscales of the EQual rubric were employed to evaluate the quality of these EPAs.[26] Iterative revisions were made based on the CAG input until consensus was reached.

Use of Emyway

Emyway is a digital platform designed by the Joint Commission of Taiwan (JCT) and has been established for 3 years with a comprehensive test of validity and reliability.[17] This platform has been used in this study. It includes systematic data collection, analysis, and feedback of participant performance data, ensuring a streamlined and efficient trial process. The system features distinct components for both students and teachers. For students, the platform includes functionalities, such as learning objectives, learning records (e.g., case logs), assessment evaluations, and competency reports. Teachers could access tools such as the Clinical Competency Committee (CCC). After executing an EPA, students input their learning records into Emyway, whereas teachers use it to conduct assessments and provide qualitative feedback.

Questionnaire design

The CAG designed a questionnaire with 24 questions divided into five sections: demographic information of participants (2), the experience of using Emyway (2), teachers' and students' satisfaction with the data entry in Emyway (5), teachers' and students' satisfaction with Emyway (4), and assessment of the overall satisfaction with both EPA and Emyway (8) on a Likert scale from 1 to 5. The reliability of the questionnaire was evaluated by administering a pretest and kappa test. The tests yielded a score of 0.75 for the participants. After the pretest, the participants were randomly selected.

Sampling

For the trial execution, two oral and maxillofacial surgery (OS) departments from eight university-affiliated hospitals in Taiwan were randomly selected. The participants were randomly sampled within these departments from UGYs, PGYs, OS-Rs, and clinical teachers. The trial involved 7 teachers and 17 students in two hospitals. The participants were given a comprehensive explanation about the research, and the trial duration was set for 2 months, from June 1 to July 31, 2024. After completing the EPA pilot in Emyway, the participants anonymously filled out the questionnaires with informed consent. Data were collected only from those who voluntarily agreed and signed the consent form. The next steps involved the analysis and summary of the results.

Statistical analysis

Statistical analyses were conducted using SPSS Statistics (version 19.0, SPSS, Chicago, IL, USA). Differences in EQual rubric scores, which were based on a Likert scale from 1 to 5, among the EPA-UGY, EPA-PGY, and EPA-R groups were evaluated using a Kruskal—Wallis test. Furthermore, differences in the experiences and satisfaction with Emyway, including data entry and EPA assessments, between the teachers and students were assessed using the Mann—Whitney *U* Test, with significance set at $P < 0.05$.

Results

EQual rubric score for tooth extraction entrustable professional activities design

Table 1 presents the EQual rubric scores for the tooth extraction EPAs at three levels: 4.80 for UGY, 4.78 for PGY, and 4.79 for R. The test results indicated no significant differences between the groups.

Demographic characteristics of the participants

Table 2 summarizes the characteristics of trial participants. Among the 7 teachers, 5 were women and 42.9 % were aged 31—40 or 41—50 years. Meanwhile, among the 17 students, the gender distribution was nearly equal, all were aged

Table 1 EQual rubric score for tooth extraction entrustable professional activities (EPAs) design (Likert scale 1–5).

14 Questions	EPA-UGY (n = 10)		EPA-PGY (n = 10)		EPA-R (n = 10)		Kruskal–Wallis test
	Mean	SD	Mean	SD	Mean	SD	
1. This EPA has a clearly defined beginning and end	5	0	5	0	5	0	1
2. This EPA is independently executable to achieve a defined clinical outcome	4.75	0.62	4.75	0.45	4.75	0.45	0.93
3. This EPA is specific and focused	4.75	0.45	4.75	0.45	4.83	0.39	0.91
4. This EPA is observable in process	4.83	0.39	4.75	0.45	4.75	0.45	0.91
5. This EPA is measurable in outcome	4.83	0.39	4.92	0.29	4.75	0.45	0.72
6. This EPA is clearly distinguished from other EPAs in the framework	4.66	0.49	4.42	0.67	4.5	0.52	0.68
7. This EPA describes work that is essential and important to the profession	4.92	0.29	4.92	0.29	5	0	0.59
8. Performing this EPA leads to recognized output or outcome of labor	4.92	0.29	4.83	0.39	4.83	0.39	0.89
9. The performance of this EPA in clinical practice is restricted to qualified personnel	4.58	0.67	4.66	0.49	4.83	0.39	0.67
10. This EPA addresses professional work that is suitable for entrustment	4.92	0.29	5	0	4.92	0.29	0.59
11. This EPA requires the application of knowledge, skills, and/or attitudes (KSAs) acquired through training	4.58	0.51	4.58	0.51	4.58	0.51	1
12. This EPA involves application and integration of multiple domains of competence	4.75	0.45	4.75	0.45	4.66	0.49	0.91
13. The EPA title describes a task, not qualities or competencies of a learner	4.92	0.29	4.75	0.45	4.83	0.39	0.72
14. This EPA describes a task and avoids adjectives (or adverbs) that refer to proficiency	4.83	0.39	4.83	0.39	4.83	0.39	1
Total	4.80	0.13	4.78	0.16	4.79	0.14	

$P < 0.05$; SD = standard deviation.

Table 2 Demographic characteristics of the participants.

Characteristic	Number	Percentage (%)
Teacher (n = 7)		
Gender		
Male	2	28.6
Female	5	71.4
Age (y/o)		
31-40	3	42.9
41-50	3	42.9
51-60	1	14.2
Student (n = 17)		
Gender		
Male	9	52.9
Female	8	47.1
Age (y/o)		
<31	17	100
Position		
UGY	8	47.1
PGY	6	35.3
Resident	3	17.6

UGY = undergraduate year; PGY = postgraduate year.

below 31 years, and 47.1 %, 35.3 %, and 17.6 % were undergraduates, postgraduates, and residents, respectively.

Experience of using Emyway

Table 3 presents no significant difference (P = 0.79) in the experience of using Emyway between the teachers (42.8 %) and students (58.8 %). Both groups mainly used Emyway less than five times (71.4 % of the teachers, 82.4 % of the students), and the difference was not significant (P = 0.74). Whereas 29.4 % of the students were extremely unfamiliar with Emyway, no teachers were unfamiliar with it, although this was not significant (P = 0.3). In addition, no teachers found EPAs to be very unclear, whereas 5.9 % of the students found them to be unclear, but the difference was not significant (P = 0.28). Overall, the teachers and students exhibited no significant differences in the experience in the use or understanding of Emyway.

Teachers' and students' satisfaction with data entry in Emyway

Table 4 shows the teachers' and students' satisfaction with data entry in Emyway. The interface clarity was rated 3.71

Table 3 Experience of using Emyway

Variable	Teacher ($n = 7$)		Student ($n = 17$)		Mann–Whitney *U* Test
	Number	Percentage (%)	Number	Percentage (%)	*P*
Usage of Emyway before					
No	3	42.8	10	58.8	0.79
Yes	4	57.2	7	41.2	
Explanation before using Emyway					
No	3	42.8	8	47.1	1
Yes	4	57.2	9	52.9	
Frequence of using Emyway					
<5	5	71.4	14	82.4	0.74
6-10	2	28.6	2	11.7	
11-20	0	0	1	5.9	
>21 (times)	0	0	0	0	
Familiarity with using Emyway					
Very unfamiliar	0	0	5	29.4	0.3
Unfamiliar	1	14.3	4	23.5	
Fair	5	71.4	6	35.3	
Familiar	1	14.3	2	11.8	
Very familiar	0	0	0	0	
Understanding of EPAs					
Very unclear	0	0	1	5.9	0.28
Unclear	0	0	5	29.4	
Fair	4	57.2	8	47.1	
Clear	3	42.8	3	17.6	
Very clear	0	0	0	0	

$P < 0.05$; EPAs = entrustable professional activities.

Table 4 Teachers' and students' satisfaction with data entry in Emyway (Likert scale 1–5).

	Teacher ($n = 7$)		Student ($n = 17$)		Mann–Whitney *U* Test
	Mean	SD	Mean	SD	*P*
The Emyway provides a clear usage interface	3.71	0.49	3.53	0.62	0.77
Easy to find Emyway function	3.71	0.49	3.47	0.62	0.99
Emyway is prone to operational errors	2.57	0.53	2.59	0.71	0.68
Short learning time for Emyway	3.71	0.75	3.76	0.75	0.88
Emyway is easy to use	3.86	0.69	3.88	0.86	0.66

$P < 0.05$; SD = standard deviation.

and 3.53 ($P = 0.77$); function accessibility, 3.71 and 3.47 ($P = 0.99$); operational errors, 2.57 and 2.59 ($P = 0.68$); learning time required, 3.71 and 3.76 ($P = 0.88$); and ease of use, 3.86 and 3.88 ($P = 0.66$) by the teachers and students, respectively. Overall, no significant differences were observed in the teachers' and students' satisfaction.

Teachers' and students' satisfaction with Emyway usage

Table 5 summarizes the participants' satisfaction with Emyway usage. The teachers rated the learning records 3.57, learning assessment 3.71, competency report 3.86, and suitability for resident training 3.71. Meanwhile, the students rated learning records 3.76, case logs 3.71, competency reports 3.71, and suitability for personal progress tracking 3.65.

Teachers' and students' satisfaction with the entrustable professional activities and Emyway

Table 6 summarizes the satisfaction of the participants with EPAs and Emyway. The teachers and students did not exhibit significant differences in their ratings of the EPA design, assessment method, fairness of the assessment method, or extra workload. Although the students found operation of the EPA to be time-consuming compared with the teachers, the difference was nearly significant but not statistically. Overall satisfaction with Emyway was rated 3.86 and 3.76 and with the EPA content 4.00 and 3.71 by the

Table 5 Teachers' and students' satisfaction with Emyway usage (Likert scale 1–5).

Teacher (n = 7)			Student (n = 17)		
Factor	Mean	SD	Factor	Mean	SD
The learning records of Emyway can help students to get diverse knowledge	3.57	0.53	The learning records of Emyway can help recording paperwork.	3.76	0.56
The learning assessment of Emyway can help evaluating students' learning situations	3.71	0.49	The case log of Emyway can help case collection	3.71	0.77
The competency report of Emyway can help tracking students' monitoring progress	3.86	0.69	The competency report of Emyway can help tracking training progress	3.71	0.59
Emyway is suitable for guiding resident doctors' training	3.71	0.75	Emyway is suitable for recording personal training progress	3.65	0.49

$P < 0.05$; SD= standard deviation.

Table 6 Teachers' and students' satisfaction with the entrustable professional activities (EPAs) and Emyway (Likert scale 1–5).

	Teacher (n = 7)		Student (n = 17)		Mann–Whitney U Test
	Mean	SD	Mean	SD	P
The design of the EPA assessment is reasonable	4	0.57	3.71	0.69	0.26
The EPA assessment is helpful for learning clinical skills	3.86	0.69	3.76	0.75	0.62
Assessment method fair in evaluating professional activities	4.14	0.69	3.76	0.83	0.18
Emyway provides guidance to the EPA assessment	4.14	0.69	3.65	0.7	0.11
Operating the EPA is time-consuming	2.29	0.95	3	0.71	0.07
Operating the EPA adds extra workload	2.71	0.76	3.06	0.75	0.15
Overall satisfaction with Emyway	3.86	0.38	3.76	0.66	0.34
Overall satisfaction with the EPAs content and method	4	0.58	3.71	0.59	0.23

$P < 0.05$; SD = standard deviation.

teachers and students, respectively, with no statistically significant differences observed (P = 0.34 and P = 0.23, respectively).

Discussion

The main objective of this study was to introduce the first EPA for Taiwan dental education. Similar efforts have been made in the United States to integrate EPAs into dental education, focusing on the development of core sets for predoctoral and postgraduate levels.[19,27] However, our study differentiates itself by concentrating on tooth extraction—a fundamental dental professional task across all dental training stages.

The EQual rubric scores for our EPAs were consistently high across all training levels, indicating a strong consensus on clarity, specificity, observability, and measurability. This finding is consistent with those from other studies that emphasized the importance of qualities in EPA design.[28] The teachers generally rated the clarity and design of both Emyway and the EPA higher than the students, although the differences were not significant. The teachers found the EPA to be less time-consuming and reported less extra workload than the students, with the differences being nearly significant. This discrepancy may be due to the teachers' and students' differing roles and experiences. Teachers often have a broader perspective on the educational benefits and practical applications of Emyway. Simultaneously, students are likely more concerned with immediate usability and the learning curve associated with the system.

The teachers viewed Emyway and EPA assessments more favorably than the students, with no significant differences in the overall satisfaction. The relatively low overall satisfaction ratings could be attributed to several factors, including the first time to use Emyway, its inherent complexity, the learning curve associated with new technology, and integration challenges. While Emyway provides valuable functionalities, its effectiveness and user satisfaction may be influenced by its ease of use, its interface clarity, and the support provided during its implementation. One strength of our study is the use of a well-established digital platform (Emyway) and a rigorous Delphi method for the development and validation of EPAs. Therefore, Emyway is a convenient and effective platform for EPA implementation. However, our study also has limitations, including the small sample size. However, this pilot study in dental education using the EPA demonstrates high learning performance and moderate participant satisfaction, providing valuable evidence for future comparative studies. Future studies could benefit from larger sample sizes and longitudinal assessments.

In terms of future applications in dental education, future development of EPAs should focus on strategic expansion and integration. A fundamental shift involves the reduction of reliance on traditional milestones and emphasis on a more dynamic, competency-based

evaluation framework through EPAs. The incorporation of essential CBME components, such as CCCs and Program Evaluation Committees (PEC), can further enhance the effectiveness of CBME. Future development of EPAs in Taiwan dental education should focus on designing a predoctoral core EPA set that introduces clinical operations before the start of clinical training. During PGY training, diverse EPAs in different specialties will ensure broad-based general practice learning. For specialized training, several EPAs in each specialty will facilitate advanced skill development. A top-down approach, with collaboration between government and educational institutions, is imperative for setting performance indicators and supporting EPA adoption. The refinement of EPA frameworks and incorporation of feedback will enhance the quality and effectiveness of dental training programs.

This project marks the pioneering effort to develop a trail of EPAs for dental education in Taiwan. Immediate goals involve selection one EPA in each dental specialty. The validation and refinement of the EPA framework by engaging diverse stakeholders, including representatives from dental schools and practicing clinicians. This process requires clear government execution policies and involves the promotion and reeducation of stakeholders nationwide about CBME and EPAs to build national consensus. Midterm goals include implementing CBME programs and establishing three to five EPAs for each dental specialty. Long-term goals focus on the evaluation of the effectiveness of the EPAs and expansion of EPAs to all dental education and specialties training systems, and align with the international dental education development.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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