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Original Article

User Experience Evaluation of the EPAs-Based e-Portfolio System and an Analysis of Its Impact

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Background: To carry out competency-based medical education, this study has established five Entrustable Professional Activities (EPAs) for the emergency medicine residents. The EPAs involve substantial data collection, which requires integration and analysis for the final interpretation. Therefore, the "EPAs-Based e-Portfolio System" has been developed for assisting users to perform ad-hoc assessment, recording of a discussion, teaching, and feedback. The purpose of this study is to examine, from the perspective of the Technology Acceptance Model, residents and clinicians' experience of the EPAs-Based e-Portfolio System, including the use of functions such as recording, feedback, and assessment, as well as the impact thereof.
Methods: This study uses in-depth interviews as a means of data collection. The interviewees are from emergency medicine training hospitals in north, central, and south Taiwan—11 resident doctors and nine medical teachers.
Results: The interviewees agree that (1) the EPAs-Based e-Portfolio System provides users with a complete learning trajectory record through cloudization and ease of use; (2) it can assist users to gain feedback, case review, and reflection; (3) information on user status can reflect their learning progress, competencies, and performance; (4) other potential functions that can be added include shortcut keys, initiation of assessment sheets by a learner, feedback to teacher's comment, and voice/picture input.
Conclusions: The results of this study indicate that the easier a system is for users to use, the more helpful they will consider it and the more positive they will be, which will then translate into greater willingness to use the system and higher frequency of actual use. The system can authentically reflect trainees' professional capabilities if the ad-hoc teaching and feedback in the clinical setting connect strongly with the online assessment and recording.

Key words: *Entrustable Professional Activities (EPAs), EPAs-Based e-Portfolio System, user experience evaluation*

Introduction

Medical education in the twenty-first century emphasizes continuity and integrity, and focuses on the development of core competencies. Therefore, an endorsement of competency-based medical education (CBME) can transform core competencies into professional capabilities for medical tasks, thus enabling independent practice in medical work. How to pursue this trend of medical education in the new millennium has become an important issue in promoting CBME. In this regard, Entrustable Professional Activities (EPAs) provide an assessment of the integrity and

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uniformity of clinical tasks. An EPA usually requires multiple core competencies to accomplish tasks, and clinical teachers must assess the level of supervision required for residents' clinical activities to decide whether they can administer medical treatment independently.

EPAs determine the level of entrustment based on the extent to which a resident needs supervision,[1] i.e., in a clinical education and training environment, clinical teachers indicate the degree of trust on a resident by assessing the level of supervision required for his/her daily medical activities. The lower the degree of supervision, the higher the trust, which means the EPAs, by transforming core competencies into actual medical behavior, clearly describe the clinical tasks performed by physicians.[2]

To carry out CBME, this study has established five EPAs for emergency medicine residents based on the framework provided by Professor Olle ten Cate. However, the EPAs involve substantial data collection, which requires integration and analysis for the final interpretation. Therefore, the "EPAs-Based e-Portfolio System" (otherwise known as the EPAs Information Assistance System) has also been developed for assisting users to perform ad-hoc assessment, recording of a discussion, teaching, and feedback. We aim to reduce the barriers in the implementation of EPAs and increase user willingness to stick with the plan.

This study uses the Technology Acceptance Model (TAM) to analyze the important factors concerning users' general acceptance of technological products as well as users' needs and experience of the EPAs-Based e-Portfolio System, and to understand user attitudes and behaviors.[3] Thus, subsequent corrections of system functions can be better tailored to users' needs to ease the promotion of EPAs in the future. Overall, the study's purpose is to explore, from a TAM perspective, residents' and clinicians' experience and the impact of EPAs-Based e-Portfolio System in terms of functions such as recording, feedback, and assessment.

Methods

Research Material

The EPAs-Based e-Portfolio System in this study used the Mahara platform as a user interface to collect learning and assessment data. There were three parts—(1) An evaluation system for clinical teachers to perform assessment and feedback; (2) A system for residents to write about their learning experience, reflections, and discussions; and (3) A system for recording the clinical experience. These data were stored in a cloud-based knowledge management platform and integrated into a graphical reporting model based on the knowledge, skills, attitudes, and experience defined in EPAs, allowing users to instantly grasp the capabilities in each EPA (Fig. 1).

The EPAs-Based e-Portfolio System enabled the assessment data to be classified automatically into correspondent EPAs and the presentation thereof in graphical statistical reports simultaneously (Fig. 2); the residents could access the assessment result, feedback content, and the number of cases they took care of. They could also record their individual learning experience and reflection. Overall, the EPAs-Based e-Portfolio System provided a visual dashboard for the development of clinical competencies. The integration of quantitative and qualitative assessment results enabled the residents to understand their learning trajectory clearly.[4]

Research Subjects

The participants in this study were residents and faculties enrolled in emergency medicine training hospitals, which are currently promoting and implementing the EPAs-Based e-Portfolio System. In all, 11 emergency department residents and nine clinical teachers (emergency medical specialists) from the north, central, and south of Taiwan were enrolled through purposeful sampling. All participants had at least three months' experience using the EPAs-Based e-Portfolio System.

Among the respondents, six were from teaching hospitals in the north, three from those in the central, and 11 from those in the south. To protect the respondents' identity, they are represented by codes, each a combination of digits and letters. The first letter stands for the area (N: north, W: central; S: south); the second and third digits represent the respondent's identity and seniority group number (clinical teachers are VB or VC, residents R1–R4); the fourth and fifth digits are the number of interviewers; and the sixth letter represents the gender. In the verbatim record of the interviews, question numbers are added to a respondent's code; for example, NVB01M-1 indicates the response to the first question of respondent No. 01, a male clinical teacher from the north.

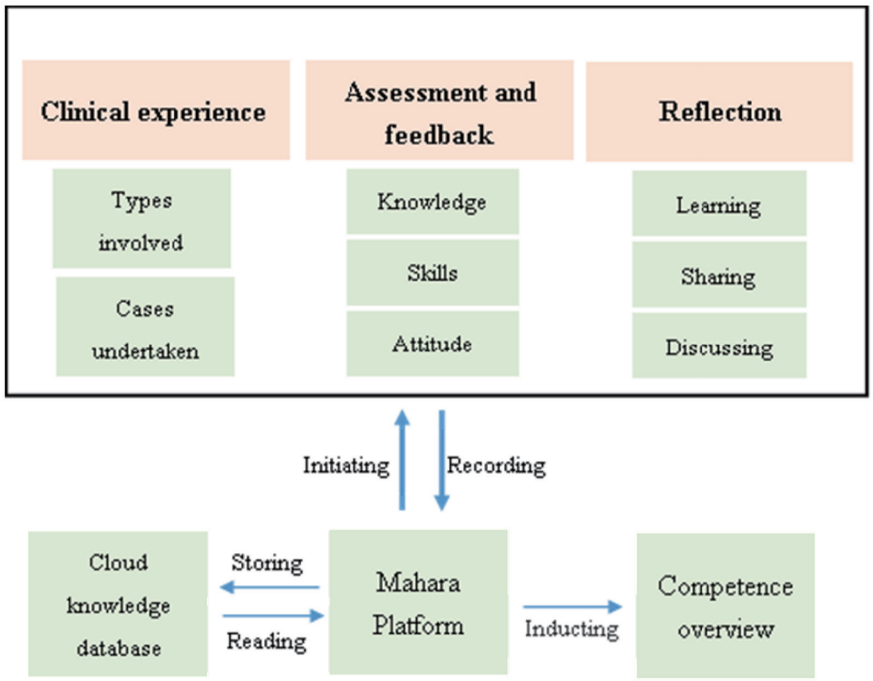

Fig. 1. Concept map of the prototype of the Entrustable Professional Activities Based e-Portfolio System (the first version).

Research Instrument

This study used the TAM to analyze the experience of clinical teachers and residents in their use of the EPAs-Based e-Portfolio System, to understand their attitudes, behaviors, intentions, and actual post-use conduct and perceptions, which will enable subsequent corrections of system functions, better tailored to user needs, and reduce the practical difficulties in the introduction and promotion of EPAs.

This study used a semi-structured interview outline as a research tool. The preparation of the interview outline was based on the research purpose and conceptual framework of the literature discussion. The interview topics included three questions—(1) What was your experience of using the EPAs-Based e-Portfolio System functions, such as recording, feedback, and assessment? (2) What benefits can you offer when using the EPAs-Based e-Portfolio System? (3) What functions do you expect to be optimized for the use of the EPAs-Based e-Portfolio System?

Data Collection Procedure

This study used qualitative interviews to collect data. To make the interview process more flexible, it used semi-structured interviews.[5] There was no direct supervisor-subordinate association between the interviewers and interviewees. Before the formal interview, the researchers made telephone calls to inform each interviewee of the research purpose, how the interview would be conducted, the presentation of research results, and the interviewee's right to terminate the interview.

Data Collation and Analysis

After the interview data had been collected, the interview recordings were immediately transcribed as a verbatim draft and analyzed through the constant comparative method.[6] According to the principle of this method, the interview researchers parsed the verbatim draft of each respondent word by word, marking important words or phrases, and simultaneously converted them into "codes." Subsequently, codes with similar meanings were summarized into "meaning units," and those units with analogous or related meanings were grouped into "sub-genus," and a subsequent "genus" structure completed, according to this principle. Finally, the logic and relevance of the interview analysis structure were examined. An example of the architecture of the interview data analysis is shown in Table 1.

Fig. 2. Entrustable Professional Activities (EPAs), milestones, type of clinical cases undertaken, and learning reflections in graphical statistical reports.

EM: emergency medicine.

Table 1. An example of the architecture of the interview data analysis

Genus	Sub-genus	Meaning units	Codes
Capability of independent practice	Learning track	Recordings	Learning file
			Review and extended readings
			Teacher feedback
			Reflection and correction

Validity and Reliability

This study applies strategies like members check, peer review, and reflection for the research to ensure the reliability of the data interpreted from the semi-structured interview. Member checking is the process that handles the verbatim to the interviewee for the verification of research material. Experts and scholars in qualitative research were invited to inspect the appropriateness of the result from the semi-structured interview, including the structure of the research, the result of interpretation, and description of the qualitative analysis. To avoid misleading by the subjectivity and bias from researchers, continuous reflection and discussion with team members were mandatory to achieved authenticity and reliability of the interpreted data.

Results

Provide a Complete Learning Track Record Through Cloudization and Ease of Use

Responding to the learning record function of the EPAs-Based e-Portfolio System, 11 residents' express 24 times of positive perception without any negative argument, this indicates that the function is highly accepted among the residents.

Residents show a high level of recognition for the EPAs-Based e-Portfolio System's recording functions and agree that it provides a convenient, fast, and complete record of learning tracks. Clinical records of medical inspections, clinical teacher assessments and recommendations, and study discussions written by residents are presented in real-time and converted into data and diagrams easy for users to read and understand.

> *EPAs use e-Portfolio to make records, so that there is intuitive data to indicate that the resident has made progress, which will translate into direct encouragement for him/her.* (SR401M-3)

> *Previously, milestones were used, but all records were on paper. Now, everyone is starting to use EPAs, and feedback is recorded through the Information Assistance System. With a continued discussion now possible even after work, it is more convenient to study.* (NR301M-5)

> *I think the Information Assistance System is easy to use. It is easy to review past patients, data can be copied and posted to the study diary, and you can see the records directly when reviewing.* (WR301M-5)

Responding to the learning record function of the EPAs-Based e-Portfolio System, 13 positive perceptions were collected among 9 clinical teachers, which indicated the high level of recognition of the system.

Clinical teachers note that the system is paperless, cloud-based, and easy to use, and can provide an objective and detailed analysis of residents' learning track and progress in clinical care capabilities, while also meeting the requirements of residents' specialist exams after residency.

> *I find the software great, but it would be better if the system was more friendly. Mainly, the bit-by-bit recording of the growth trajectory is of great value, as it turns paper records into electronic files; also, residents' need to take specialist tests is taken into account.* (NVC01F-5)

> *Sometimes, I feel the need to key in is an additional loading; but with the records, residents will be able to review a case when they have forgotten the details.* (SVC01M-3)

Assist Users to Perform Feedback, Case Review, and Reflection

From the perspective of the function to assist users with feedback, case review, and reflection, there were 20 positive perceptions and two negative perceptions among 11 residents. This result indicated highly identification of the system.

Although residents consider verbal feedback to be the most effective, this system could help understand the detailed evaluation, feedback, and opinions of clinical teachers, and carry out case review, extended readings, and reflection over the opinions and comments given, which can be of great use and help one's cognitive thinking, processing flow, and complete learning experience in clinical practice.

> *Verbal feedback is more useful as an immediate response, and online assessment is more valuable as it helps further understand a case in retrospect. With a record on file, the impression will be deeper when efforts are being made to collect data or toward renewed reflection.* (SR102F-3)

> *Firstly, it is easy for residents to forget verbal feedback. Secondly, the clinical teacher's thread of thinking is clearer when typed out; if there is more to be added afterward, additional feedback may be written. Lastly, sometimes, it can be difficult to speak one's mind face to face, or it might sound harsh at the moment; hence online comments. Judging from these three aspects, [online feedback] can be helpful.* (SR302M-3)

Regarding the function of the system to assist users with feedback, case review, and reflection, there were 10 positive perceptions and 16 negative perceptions among nine clinical teachers. The result points out that the responsibility of evaluation and giving feedback highly relied on clinical teachers. The implement of evaluation and giving feedback consumes times and mental efforts to complete the documentation. Thus, sometimes unable to complete on time and result in negative feedback to the system. Otherwise, both clinical teachers and residents agree with the benefit created by feedback.

Clinical teachers also confirm that verbal feedback is immediate and effective, but the online system can retain more comments in their entirety, and assessment content and feedback comments are recorded for the residents to review, extrapolate, and reflect; however, some respondents indicate that it can be difficult to give specific and in-depth feedback to more competent senior residents or about administrative process-related issues.

> *I would prefer to give feedback on the spot, as it is immediate; otherwise, I will forget what to say. I also write it down when I have time. As we are required to give systematic feedback, we are brief and write down only the gist, which makes it more like a recording.* (SVC02M-3)

> *It took lots of mental effort to complete the documentation, sometimes laziness seems an obstacle to me.* (SVC01M)

> *It is more difficult to put into words issues concerning administrative processes or their handling. In addition, when talking to senior residents, I need to think harder for a more in-depth response, and it is necessary to give quality feedback by identifying problems in the way residents deal with a case, which makes it more difficult to come up with a comment.* (SVC03M-4)

Display Assessment Information, Learning Progress, and Competence Performance

From the perspective of the system to provide the inquiry function of user assessment result and learning trajectory, 23 positive perceptions and one negative perception were interviews among 11 residents. This shows that this function is recognized by the learners.

Residents think that the advice and feedback from clinical teachers are helpful in learning, but assessment grades of individual cases do not fully reflect the current level of competency. Instead, residents believe that the level of supervision in the clinical context has an overall assessment significance; however, long-term and sustained accumulation of assessment data would be representative of an individual's clinical competency.

Most salient are teacher's comments in the lower section of the system interface. The ticked items in the upper section are alright too but for reference only. As far as trust is concerned, one can tell by looking at clinical practice alone. (SR202M-4)

Feedback is given on the spot, and I don't much care about the scores, but I do read the written comments in the system. However, there aren't as many rounds of feedback sessions now, and I'm not sure how representative they may be. With sufficient data collected over the long term, the feedback should reflect the progress made. (SR301M-5)

From the perspective of the system to provide the inquiry function of user assessment result and learning trajectory, 17 positive perceptions and one negative perception were interviews among nine clinical teachers. This shows that this function is recognized by the teachers.

Clinical teachers believe cross-referencing of EPAs with milestones makes the assessment more specific and closer to the clinical situation, providing a reference for residents' objective learning process. The long-term accumulation of different clinical teachers' assessment information can also reflect the growth of residents' practical competency from different perspectives.

Current tools such as EPAs and milestones can, of course, be applied, but words are still needed for expressing more detailed stuff; it is better to have more people give assessments, as each physician may see a different facet of a case. (SVC01M-3)

Sometimes, I may deliberately hold something back and, instead, directly observe the way residents check a patient and their medical practice. I feel that, this way, I will get closer to their real mode of operation. There is also a checklist that reminds me of which points to pay special attention to; also, when I give feedback, if I find that some parts are not up to the mark, I will specifically bring them up in my discussions with the residents. (SVB01M-2)

Through EPAs and milestones, residents will get to know the extent to which they should study, what is progress, and what is the process of learning. (NVC02M-2)

Increase Usage Rate via Additional Functions: Shortcut Keys, Initiation of Assessment Sheets by Learner, Feedback to Teacher's Comment, and Voice/Picture Input

Residents note that the system operates smoothly and is easy to use although some functions need to be enhanced—for example, the addition of shortcut keys, instant notice labels, and a temporary note-taking window to the page; an "initiation of assessment sheets by learner" function, set up by the residents themselves, allowing them to raise questions and have discussions with clinical teachers; and a feedback function, through which they can engage in follow-up communication and have further discussions on the evaluation and feedback of clinical teachers, can also be added.

On logging in, you need to click many buttons to access the final project page, which, I feel, makes it difficult to view my evaluation. If there was a shortcut key that allowed access with a simple click, people could be more willing to use the function. (SR201M-5)

A medical record number is required for the learning track or the completion of the evaluation sheet. A memo function should be created to allow temporary note-taking. (SR102F-5)

The initiation of assessment sheets by learner [function] is presently accessible only to teachers. If access is granted to us students, it would be more like us asking a question by creating an assessment sheet. (SR102F-5)

There should be another column for feedback. Feedback means there is some thinking involved. A response to a teacher's comment is equivalent to another level of communication by going backward to what was happening at that time. (SR202M-5)

There should be a push notice or an email reminder when a new message pops up, so that you can access the assessment page by clicking on the link provided. (SR202M-5)

Clinical teachers believe that residents' responses and interaction with the assessment and feedback can enhance the professional communication and teaching effect between teachers and students. Therefore, the addition of functions such as instant notice and discussion over feedback would be a crucial improvement. On the other hand, because it is the responsibility of clinical teachers to give assessment and feedback on the EPAs-Based e-Portfolio System, apart from the emphasis on the effects of assessments and feedback on residents' learning, special attention would also be paid to the ease of publishing an assessment and feedback; accordingly, voice input, image attachments, assisted text feedback, etc. have been proposed. It is also recommended that a self-assessment be filled out by residents themselves before they go and ask clinical teachers for changes and modifications.

It would be nice if it could work like that app of Yating Transcriber, converting voice directly into words; this way, it would be more efficient, allowing for assessment of a resident every three or four hours in a day. It could increase the sampling rate. (SVC02M-6)

It would be better if one was able to tag and involve an attending physician for comments, feedback, and discussion, as it is more appealing if the interaction is a continuous process. It is also important to have immediate response and notice, as after two to three days, the moment is gone. (SVC01M-6)

Residents can do immediate self-assessment for the feedback given on the spot; a message sent to the mailbox will necessarily require a response. It might be simpler if we, as teachers, help revise and correct residents' self-assessments. (SVC03M-6)

There are many blank spaces [in feedback], which makes it open-ended, a bit like creative writing; it would be better with a note-taking approach, where you key in some words and attach a picture afterward. (SVC02M-5)

The feedback I am talking about refers to that of residents and for the entire team, and includes both mental health advice and remunerative rewards; this may help give an impetus to the continued running of assessment work. (SVB01M-6)

Discussion

The TAM is based on the actual use of technological products, determined by the user's "intention to use," which is influenced by the user's opinion of a system, such as considering it as "useful" and "easy to use." When users realize that the system can improve their work performance and is easy to use, it will generate a positive feeling, i.e., a system's "usefulness" and "ease of use" will directly affect the user's "attitude" toward using technological products; the more positive users feel, the more willing they will be to use a product. The user's "behavioral willingness" will extend further to affect the "actual user behavior."[7] In other words, the stronger the behavioral willingness to use a product, the more intensive and frequent the actual use of technological products.

The study reveals that residents highly agree that the functions of assisting users with feedback, case review, and reflection in the system are useful and ease for use. The positive attitude actually drives their willingness and action toward using the system. In addition, they have provided specific and actionable suggestions to further revise and optimize the system. Clinical teachers express a high degree of acceptance and affirmation of the records and assessment functions provided by the system. However, they express negative emotions toward the feedback function of the system as it consumes time and mental efforts to complete the documentation. Thus, they provide more suggestions for further improvement of the feedback function. The discrepancy between "attitude," "willingness" and "action" toward using the feedback function was found in some clinical teachers. They agree that real-time clinical feedback is useful and "feeling useful" toward the feedback documentation function in the system, but sometimes just couldn't

give effective feedback accordingly. Thus, a negative perception toward the feedback function was developed. Implementation of CBME and EPAs highly relied on the engagement of clinical teachers. Therefore, faculty development aiming at the assessment and feedback skills is mandatory. Meanwhile, to optimize user interface and the feedback function of the system also plays an important role to increase the clinical teachers' willingness and action toward giving feedback and make documentation in the system.

EPAs-Based e-Portfolio System Provides Convenient, Fast, and Complete Digital Learning Track

CBME stresses on a learner-friendly training environment that provides a high degree of flexibility, and these elements have led to perceptible progress on all levels of learning.[8] The EPAs-Based e-Portfolio System extends beyond temporal and spatial limitations, providing convenient, fast, and complete digital learning track records; it uses information technology to help users convert all kinds of learning records and assessment results into data and charts easily readable and understandable by users. Residents with different levels of competencies and clinical experience can thus understand their learning progress, adjust learning objectives, and regulate their learning pace.

The implementation of EPAs needs to collect large quantities of assessment data; teachers may feel a lot of pressure if compiling of records and classification was made manual, which might make them reluctant to accept the EPAs during the promotion stage.[9] The use of the EPAs-Based e-Portfolio System can simplify the assessment workload and reduce data recording and organization; furthermore, the paperless and cloud-related records make the information easy to use and search. Functions such as complete and comprehensive data analysis and application enable clinical teachers to effectively monitor the progress of residents' clinical care ability and encourage the participation of both the teacher and learner.

EPAs-Based e-Portfolio System Provides Constructive Comments and Feedback

Shrivastava and Shrivastava pointed out that CBME is different from other traditional clinical training orientations, providing more constructive comments and feedback. Comments from clinical teachers and feedback from residents can be considered as the two pillars of CBME.[8] Although oral feedback in a clinical situation is immediate and the most effective, the information system can retain comments in their entirety, assist residents to understand nuances in the assessment and feedback, and use them in case reviews, extended readings, and reflection for making improvements in clinical practices.

The feedback function proposed to be added will allow residents to conduct follow-up communication and post-reflection discussions on the assessment and feedback. In this respect, clinical teachers also agree that response and interaction can enhance the professional communication between teachers and students, and boost teaching results; therefore, the addition of functions such as instant notice and discussion of feedback would be a major improvement.

On the other hand, as per the preference of most users for on-the-spot feedback due to the belief that on some levels it is difficult to provide specific and in-depth feedback in words, it is proposed that a structured assessment framework be established to encourage clinical teachers to improve evaluation frequency and feedback quality,[10] and further, deepen the understanding of EPAs as well as skills for and confidence of giving assessment and feedback.

EPAs-Based e-Portfolio System Provides an Objective Reference for Learning Process With Continuous Accumulation of Assessment Data

The combination of and cross-referencing between EPAs and milestones make assessments more specific and closer to clinical contexts, providing an objective point of reference for learning processes. The system aggregates the long-term and cumulative assessment data from different clinical teachers, so that assessment of residents' clinical competencies is representative.

If teachers carry out an insufficient number of assessments, or when the number of teachers available for assessments is low, it is difficult to reflect the students' true levels of competencies. Therefore, with a convenient and user-friendly system, teachers are more likely to feel encouraged to conduct assessments and record feedback, which will then form a larger pool of teachers' feedback from which students can learn and make sustained progress. As more and more users begin to adopt this system, it will get easier to spot flaws in it and suggest improvements; during this

process, an esprit de corps can develop, and a sharing model will take shape as well.[11]

Conclusions

To conclude, most residents and clinical teachers recognize the advantages of EPAs, and both can focus on the progress of learning experience and competency.[9] Being easy to learn and use, the EPAs-Based e-Portfolio system has a complementary effect—users feel that the easier it is to use the system, the more helpful it will be, and the more positive will be their attitude, which also increases their willingness to use the system and the intensity of the actual user behavior. The functions of the EPAs-Based e-Portfolio system will be used to their full potential only when the information recorded in the system complies with the assessment results and feedback given by the teachers on-site during clinical teaching.

On the other hand, from the analysis of opinions on the functional corrections through semi-structured interviews, it has been found that if we want to enhance users' positive attitude toward the EPAs-Based e-Portfolio System and promote their willingness to use it, it is necessary to make the interface more user-friendly and add functions such as reminders, initiation of assessment sheets by learner by residents, voice-to-text, chat box, and allowing learner response to teachers' feedback. To maintain user satisfaction with the system and enhance the willingness to and frequency of use after further development of the platform, users need to believe that the flexibility, convenience, and efficiency brought by the EPAs-Based e-Portfolio System are indeed helpful in meeting the teaching and learning needs of their training programs.

In addition, the understanding of EPAs by residents and clinical teachers needs to be deepened and the skills and the confidence of clinical teachers in assessment and feedback need to be strengthened. Also, some clinical teachers still have insufficient motivation toward recording assessment results and feedback online. Clinical teachers' insufficient understanding of and inadequate participation in CBME have always been a challenge. Following up, the focus will be on increasing clinical teachers' awareness of their roles, strengthening their sense of responsibility, and extending the program outreach. Going forward, improvements can be made in terms of education and training, faculty development, reward and feedback mechanisms, etc., with the expectation that with an increase in assessment quality and frequency, improvement in assessment results will reflect the study and progress of residents more truthfully, enhance their clinical expertise, and strengthen their competence of comprehensive professional care.

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