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A Survey of PDA Use in PBL-Medical Curricula

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Abstract—Objective: This study was undertaken to determine the personal digital assistant (PDA) functionalities for a problem-based learning (PBL) medical curriculum in general, the influence factors of incorporating PDAs, and the attitudes of medical educators, medical professions and educational technology specialists regarding the use of PDAs in such PBL-based medical curricula. **Methods:** web-based survey was designed and conducted with medical faculty, medical professions and medical education technology specialists. **Results:** Four major PDA functionalities were identified, these being: clinical-log, reference, communication, and personal information management (PIM). Two major aspects to incorporating PDAs into PBL-medical curricula were determined from survey. **Conclusion:** There is a potential for PDAs to be incorporated into PBL-medical curricula. However, a clear strategy needs to be defined as how best to incorporate PDAs into PBL-medical curricula with minimal impact on students, as well as financial and resource implications for the university and medical school.

Keywords—PDA, personal digital assistant, PBL, problem-based learning, medical education

I. INTRODUCTION

A systematic review of the use of PDAs in medical education has identified the general characteristics of PDAs, PDA platforms, the use of PDAs in the healthcare professions, and how PDAs can be deployed in medical education [1]. Generally speaking, the use of PDA devices has gradually increased in the healthcare professions. To effectively use PDAs in the healthcare sector, they need to be compulsorily incorporated into healthcare organization systems via network connections for data and resource sharing [1]. Advantages of using PDAs in the healthcare professions include assisting in the delivery of clinical information between doctors and staff, in assisting doctors' ordering of medical tests, and in taking notes. Therefore PDAs are essentially used in the healthcare professions for two major purposes: administrative tasks and direct clinical work. Doctors mostly use PDAs as the point-of-care for clinical decision support, prescribing medication, viewing lab results and accessing reference information, for example, drug information and drug interactions. Moreover, doctors also use PDAs for recording patient information and patient logs. In addition, four major PDA functionalities for healthcare professions were identified: these being general, referencing, organization, communication and other special

functions. These PDAs functionalities are being deployed into medical education and residency programs in order to provide alternative ways for studying medicine, taking notes, looking up references and recording clinical encounters into clinical-logs [1].

However, there are several drawbacks to using PDAs in medical education in term of technical aspects, for instance, loss of data, improper backup, technology compatibility, etc. There are a number of software applications that can be used in assisting medical study [1], for example, reference applications for drug information, classroom assessment systems, teaching evaluation, etc. Little is known about what PDA functionalities are suitable and applicable for PBL medical curricula [1, 2]. Therefore a survey of PDA use in PBL-medical curricula was set out within the international medical education experts from the US, UK, Canada and Asia Pacific.

To identify how feasible it is to incorporate PDAs into PBL medical curricula, following questions were explored (i) what are the key PDA functionalities applicable for medical education [2]?; and (ii) what are the factors, which may influence the incorporation of PDAs into PBL-medical curricula [2]? To answer these questions, web-based survey was conducted with the medical educators, clinical academics and medical education technology specialists. The primary purpose of survey is to gather their preferences towards the use of PDAs in PBL-based medical curricula. The survey process provided attitudes and experiences into the relevant issues. SPSS software package version 15.0 was used for data analysis.

II. METHOD AND STUDY DESIGN

The 31 web-based survey questions were developed and constructed based on Delphi techniques. The survey questions were derived from the literature reviews and scoping study and later reviewed and validated by the experts in four major areas, including medical education, medical education technology, medical informatics and information technology. The survey questions were organised into 5-parts, including the PDAs functionalities, IT aspects, practical aspects, attitudes towards PDA use in PBL-medical curricula and demographics. The 5-Likert scale was applied to the questions in all major aspects. In addition, the open-ended questions were included in each section, which allows the researchers to seek for additional comments and

facilitates the respondents to answers in their own wordings in each individual aspect.

The researcher, therefore, invited the web-based survey respondents via the medical education mailing list. However, the participation to the web-based survey data collection is based on the volunteer panel-based [3] from this mailing list. This approach created the volunteer respondents from the letter of invitation through the mailing list, which was embedded the survey website. The non-probability surveys with volunteer-based respondents is significantly different from the probability-based method for participants sampling and selection as the response rate can be determined based on statistical principles [3, 4]. In total, 45-participants responded. The demographics of respondents include (i) country (US = 31, 68.9%; non-US = 14%), (ii) age (45 and over = 16, 35.6%; over 45 = 29, 64.4), (iii) gender (male = 34, 75.6%; female = 11, 24.4%) and (iv) position (academics = 34, 75.6%, non-academics = 11, 24.4%).

III. RESULTS

The results are presented according to two research questions.

A. PDA functionalities

The majority of survey respondents agreed that four-functionalities should be incorporated on students' PDAs. These findings also gave the greatest support to reference, PIM, special and communication functions, respectively. The reference and PIM seem to be the important PDA functionalities for medical study. This could be because, firstly, PDAs provide portability and mobility while students are at clinical encounters in the clinical placements. Secondly, there are not many software applications that could directly support the context of PBL-medical curriculum in each medical school.

1) *Reference function*: The majority of respondents agreed (n = 40, 88.9%) that reference function should be incorporated to students' PDA (Table I). The respondents agreed with three benefits of having reference function on students PDAs. Reference function would be beneficial for students as the information can be accessible at hand as students could access the useful resources through reference software applications, for instance medical dictionary, ePocrate, e-textbook, pharmacology etc. This would facilitate students in enhancing knowledge and learning (n = 42, 93.3%). Secondly, using reference function could facilitate the interactions with relevant clinical resources (n = 35, 77.8%) especially online reference/online database, for instance Up-To-Date, etc. Finally, the benefit of reference function on PDAs is alternative ways for looking up references (n = 39, 86.7%). Having reference function on PDAs provides the information accessibility on the spot and timely access information while away from the library or offsite.

2) *PIM function*: The respondents gave a positive support to PIM function (Table I) as one of PDA functionalities for the incorporation of PDAs into PBL-

medical curricula. The majority of respondents agreed (n = 40, 88.9%) towards this aspect, as commented on this function, "...I depend on its PIM functions very heavily...."

TABLE I. PDA FUNCTIONALITIES

PDA Functions	Mean	S.D.	SD	D	N	A	SA
Reference	4.40	0.837	1	0	4	15	25
PIM	4.33	0.739	0	1	4	19	21
Special	4.02	0.892	2	0	5	26	12
Communication	3.98	0.892	1	1	9	21	13

3) *Special functions*: According to the attitudes towards special functions (e.g. clinical-log, classroom interaction, classroom resources, etc.), the respondents agreed (n = 38, 84.4%) that special functions in particular clinical-log is considered as a useful function in facilitating the medical study in PBL-medical curriculum. However, the respondents also aware of patient privacy regarding information being recorded on PDA-based clinical-log may contain personal information and involve with confidentiality concern.

The respondents agreed and strongly agreed with four benefits of using clinical-log in PBL-medical curriculum. Firstly, clinical-log function is beneficial for assessment purpose. The respondents (n = 33, 73.4%) indicated that recording all clinical encounters on clinical-log would be beneficial for both students and medical faculty in tracking students' progress. Secondly, the use of clinical-log function is beneficial in sharing information between learners and educator regardless the geographical areas. The majority of respondents agreed (n = 33, 73.4%) with this aspect. Thirdly, the respondents agreed (n = 37, 82.2%) that the use of clinical-log is beneficial for students in enhancing their life-long learning as it facilitates students in recording clinical experience, clinical notes and reflection when encountered with clinical problems. Finally, the benefit of having clinical-log function on PDAs is that it provides the convenience in obtaining data and feedback during clinical rotations without recall. The majority of respondents (n = 38, 84.5%) agreed and strongly agreed with this aspect.

4) *Communication function*: It is the final four of basic PDA functionalities, which the survey respondents considered for the incorporation of PDAs into medical education. The majority of respondents (n = 34, 75.5%) agreed with the use of communication function in PBL-medical curricula. Further the majority of them (n = 34, 75.5%) also indicated the benefit of this function, which is the ability in providing flexibility and adaptability for information exchange and facilitating students in communicating with medical faculty and peers while offsite. Further, PDAs can provide the alternative ways for communicating wirelessly.

B. IT aspects

In this section, the attitudes, knowledge and experiences towards technical aspects for the incorporation of PDAs into PBL-medical education will be discussed. These aspects are

data security and information privacy, data transmission and network connectivity, systems maintenance and support and interoperability among different PDA platforms.

1) *Data security and information privacy*: The respondents strongly agreed ($n = 33$, 73.3%) that data security and information privacy of clinical-log is a concern. In case, the information being recorded on clinical-log contains any patient identifier then the information privacy acts would be considered in such case. However, the issue around data security and information privacy is the most concern for the incorporation of PDAs to medical education. This is because this aspect is not only involved with clinical-log function but also other PDA functionalities as well as the security of PDA device.

2) *Data transmission and network connectivity*: When asked about their attitudes towards Wi-Fi network connectivity for on-campus environment, the respondents provided a greater support ($n = 35$, 77.8%) on this type of network connectivity. This is because the signal of Wi-Fi is much stronger than Bluetooth. Further, Wi-Fi is more applicable and flexible to use anywhere on-campus under the network coverage.

On the other hand, when asked about the attitudes, knowledge and experiences of respondents regarding the appropriate type of network connectivity for on-campus environment. The respondents also agreed ($n = 20$, 44.4%) to use Bluetooth as data transmission medium (Figure 2).

In addition both Bluetooth and Wi-Fi are applicable and can be used for on-campus network connectivity. The decision on which type of connectivity is the most appropriate for medical education is dependent on the purpose of its use for data transmission. Bluetooth is suitable to use for data transmission in short-range as its limitation of the signal's range while Wi-Fi does not have limitation on the strength of signal. Therefore Bluetooth can be used in classroom environment while Wi-Fi can be use anywhere within campus network. Further, the respondents had a strong support that using *Wi-Fi* for on-campus network connectivity while Bluetooth seems to be the second preference.

The majority of respondents agreed ($n = 36$, 80.0%) that PDAs should have the capability to access remote clinical databases wirelessly especially while students are in the clinical placements. Further, the respondents had a positive support ($n = 36$, 80.0%) that students should have wireless network connectivity for *off-campus* environments including clinical environments, clinical settings and in hospitals in both urban and city areas in order to keep the information up-to-date and provide the students access to medical knowledge.

Having internet connectivity for off-campus environment is important for access relevant information while in the clinical placement. The internet connectivity is not only important for information access and retrieval but also communication with medical faculty, clinical preceptors and peers. Students, therefore, can use PDA at its optimum capacity.

3) *Systems maintenance and support*: The respondents agreed ($n = 41$, 91.1%) that the technical support team should be available upon request to provide relevant support in relation to clinical-log function and other related software applications for PDAs regardless where students are located.

The appropriate level of maintenance and support should be available for PDA use especially while offsite. The sufficient maintenance and support should be available for any important PDA functionality in particular clinical-log and reference function. A particular maintenance and support is essential for clinical-log function as this function is designed and developed for particular needs and requirements of each medical school. On the other hand, the maintenance and support on reference software applications can be provided directly via the software vendors. However, the medical school or university can provide several supports in relation to software installation, troubleshooting, etc.

4) *Interoperability*: The majority of respondents agreed ($n = 36$, 80.0%) that PDA platform directly affects PDA functionalities and the availability of software applications for medical education particularly in PBL-medical education. Even though there are a number of reference software applications, which are compatible for various PDA platforms, a selection of PDA platform still affects PDA use in medical education in particular the typical PDA functionalities, for instance, clinical-log.

Further, the majority of respondents agreed ($n = 33$, 73.3%) that the selection of PDA platform should reflect the major PDA functionalities and software applications to support PBL-medical curricula.

Clinical-log function can be either developed to run on a certain PDA platform or any platform. This is dependent on PDA functionalities being required by the medical school requirements, design, development and implementation of PDA functions. As a result PDA platform still affects PDA use and its functionalities.

In addition, using standard PDA platform is beneficial for medical schools in providing maintenance and support on software applications, development and implementation of PDA system as it provides the ease of selecting software applications, future development and implementation PDA function for one particular PDA platform. On the other hand, the advantage of using open-standard PDA platform is that it provides the flexibility for users particular students in choosing PDA device for their needs. Moreover using open-standard PDA platform may provide the ease of maintenance and support PDA and its functions. This is because there are a number of programming languages which can be used for developing and implementing particular PDA functionalities to run on any platform.

In summary, even though the respondents may have different perceptions in certain aspect, the majority of respondents agreed that all technical aspects should be considered before incorporating PDAs into medical education, these being, data security and information privacy, data transmission and network connectivity, systems

maintenance and support and interoperability among different PDA platforms.

C. Practical aspects

The web-based survey findings on practical aspects, which are education and training, technology comfort and electromagnetic interference (EI), are reported and discussed in the following sections.

1) *Education and training*: The purpose of providing education and training are threefold. Firstly, to ensure that there is no resistance in using PDAs as an educational tool in medical education. The majority of respondents agreed (n = 30, 66.7%) towards this aspect.

Secondly, the objective of providing education and training is to maximize familiarity with the technology. The majority of respondents agreed (n = 38, 84.4%) with this aspect.

Finally, another objective of providing education and training regarding PDA use in medical education is to ensure that students can use PDAs in an effective and efficient way during their medical education. Most of respondents agreed (n = 44, 97.8%) with this aspect.

2) *Technology comfort*: Technology comfort of both students and medical faculty is important for the adoption of PDA use in medical education. Therefore, it is essential to determine what their perceptions regarding the comfortability of using technology are.

a) *Technology comfort of students*: The respondents agreed (n = 11, 24.4%), neutral (n = 11, 24.4%) or disagree (n = 12, 26.7%) that students will have no problem using PDAs in the PBL-medical education. The finding indicated that there is no significant difference among the respondents' attitudes on this aspect. In addition one respondent commented on this aspect regarding PDA use in medical education,

"... Also, there is a fairly steep learning curve which is why I disagree students will have 'no problem.' However, once they learn to use them, they love them (according to our students here, US and Canada...)" (Web#11)

It is possible that students from other medical schools may have various level of technology comfort. However, this different learning curve can be balanced by providing sufficient education and technology use during their medical study.

b) *Technology comfort of medical faculty*: There are a large number of the respondents neither agreed nor disagreed (n=18, 40%) that the medical faculty members will feel comfortable with IT use in PBL-medical education. Surprisingly the respondents agreed (n = 11, 24.4%) towards this aspect. On the other hand, there are a large number of the respondents, who disagreed (n = 16, 35.6%) on this aspect. The majority of them had a negative perception about the technology comfort of medical faculty. It is possible that not all medical faculty are competent with technology use in medical education. Further the respondent from North America also commented on this aspect regarding IT use in medical education.

"Faculty are somewhat behind the curve in learning to use PDA technology..." (Web #11)

"...Need to train the faculty first. If they do not use the technology, neither will the students." (Web #26)

In term of practical aspects, the technology comfort of PDA users play an important role for the incorporation of PDAs into PBL-medical curricula. The technology comfort is more likely an indicator to estimate the readiness of the medical school in incorporating PDA devices and relevant technology into the medical education in PBL-approach. Even though the findings in this study indicated that the comfortability in using technology of both learners (students) and educators (the medical faculty and honorary clinical academics) are very high and competent in using technology. However, the sufficient education and training regarding PDA use is still essential. This is because medical education is the art and science, which has its own culture in learning and doing [5]. Therefore having incorporated the additional device, it is essential to ensure that PDAs can really facilitate the medical study without any technology barrier.

3) *EI*: The respondents agreed (n = 32, 71.1%) that using PDAs in hospital settings does not affect the operation of medical devices. This particular group of respondents are medical faculty from the US and Canada. On the other hand, one respondent, who is the medical faculty from elsewhere besides Europe, US and Canada, disagreed on this aspect. In addition the respondent noted that it depends on which PDA models being used.

"Depends on the PDA" (Web #20)

In addition, the PDAs could generate the EI with various factors, including the distance between PDAs and medical devices, types of PDA (e.g. PDA, PDA with Wi-Fi or PDA phones).

The findings indicated that EI is another practical aspect, which may influence PDA use in a real clinical practice especially in the hospital and clinical placements.

However, the solution regarding PDA use in the hospital and clinical environments can be relied on the regulation and policy on the site. Further, the most important is, firstly, to ensure that the devices are not used in the restricted areas, for instance, cardiac care unit (CCU). Secondly, it is essential to ensure that incorporating and using PDAs would not interfere the professional contact between student-doctors and patients.

D. Attitudes towards the adoption of PDAs into PBL-medical education

The majority of respondents agreed (n = 32, 71.1%) that PDA use in PBL medical education should be incorporated into daily medical study and medical practice therefore their use becomes an accepted practice. This finding provides a positive support to the adoption of PDA use at the beginning year of medical study. The early use of PDAs in medical study would enhance students to be familiar with the technology use not only for learning medicine but also their medical practice as well.

Further the majority of respondents also agreed (n = 35, 77.8%) that the incorporation of PDAs into PBL-medical

curricula can play a major role in creating and distributing medical and clinical knowledge to assist students when they are providing clinical care. For instance, using PDAs in the clinical placement can facilitate students in accessing reference, clinical procedures, school schedule or relevant information, communicating with peers and recording or capturing information at the patient bedside.

In addition, the respondents provide positive support agreed (n = 33, 73.3%) that it is also feasible to incorporate PDAs into PBL-based medical curricula given the variety of software applications available to support this learning method and clinical practice. It is the fact that there are a number of software applications available for PDAs, for instance, references, clinical decision support applications, etc. It is possible for the medical schools to provide basic or relevant software applications for PBL-medical education. However, it is also essential for students to pick and choose which software applications and other learning tools are suitable for their learning needs.

E. Demographics

Three major hypotheses were set out to determine whether demographics of respondents influence their attitudes towards PDA functionalities, IT and practical aspects. The findings are reported accordingly.

1) *Hypothesis-1*: There will be a significant difference of the attitudes towards the use of PDA functionalities in PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

There was no significant difference for the follow-up scores on PDA functionalities, between respondents with different demographics regarding country, age, gender and position. The findings of the Mann-Whitney U test indicated that there was no difference at 0.05 significant level. This suggested that despite a difference of country, age, gender and position, the respondents had similar attitudes towards

the use of the four basic PDA functionalities in PBL-medical curricula. Therefore, a hypothesis that there was a significant difference of the attitudes towards the use of PDA functionalities in PBL-medical curricula was rejected.

2) *Hypothesis-2*: There will be a significant difference of the attitudes towards technical aspects regarding the incorporation of PDAs into PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

There was no significant difference for the follow-up scores on technical aspects, between respondents with different demographics regarding country, age, gender and position. The findings of the Mann-Whitney U test indicated that there was no difference at 0.05 significant level. This suggested that despite a difference of country, age, gender and position, the respondents had similar attitudes towards the technical aspects regarding the incorporation of PDAs into PBL-medical curricula. Therefore, a hypothesis that there was a significant difference of the attitudes towards the technical aspects for the incorporation of PDAs into PBL-medical curricula was rejected.

3) *Hypothesis-3*: There will be a significant difference of the attitudes towards practical aspects regarding the incorporation of PDAs into PBL-medical curricula, between respondents with different backgrounds regarding country, gender, age and position.

Mann-Whitney U test was carried out to evaluate the difference between the different demographic groups for the follow-up score of practical aspects for the incorporation of PDAs into PBL-medical curricula. The results of Mann-Whitney U test revealed that a significant difference was found (Table II) between the US and non-US groups for the follow-up total score of EI ($p < 0.05$). However there is no significant difference between other demographic groups for the follow-up scores on other practical aspects.

TABLE II. MEAN RANKS OF DEMOGRAPHIC GROUP FOR FOLLOW-UP SCORES OF TECHNICAL ASPECTS

Mann-Whitney U Test								
<i>Demo graphics</i>	<i>Practical Aspects</i>	<i>Groups</i>	<i>N</i>	<i>Mean Rank</i>	<i>Sum of Rank</i>	<i>U</i>	<i>Z</i>	<i>p</i>
Country	Education and training	US	31	25.16	780.00	150.000	-1.709	.087
		Others	14	18.21	255.00			
	EI	US	31	25.69	796.50	133.500	-2.180	.029
Age	Education and training	Others	14	17.04	238.50			
		45 and under	16	24.34	389.50	210.500	-.530	.596
	EI	Over 45	29	22.26	645.50			
		45 and under	16	21.78	348.50	212.500	-.492	.623
		Over 45	29	23.67	686.50			
Gender	Education and training	M	34	23.78	808.50	160.500	-.728	.467
		F	11	20.59	226.50			
	EI	M	34	23.60	802.50	166.500	-.576	.564
		F	11	21.14	232.50			
Position	Education and training	Academics	34	21.84	742.50	147.500	-1.085	.278
		Others	11	26.59	292.50			
	EI	Academics	34	22.03	749.00	154.000	-.928	.353
		Others	11	26.00	286.00			

IV. DISCUSSION

Many medical schools provide extensive computer facilities and network connections for their medical students. Information and communication technology becomes a major component of medical education and has a great impact on medical education, since it provides a better opportunity for medical faculty and students to teach and learn medicine in an effective way. Moreover, quite a number of medical schools have developed their own virtual campus on both PDA and web-based interfaces in order to enhance learning and teaching for both students and teachers, for example, UCLA's PDA Patient Log [6] and KNOWMOBILE at the University of Oslo [7]. The UCLA PDA Patient Log is essentially used in year 3 and 4 of medical study in order to fulfill clerkship objectives [6]. However, the contexts of using PDAs vary with medical school. The KNOWMOBILE project team at Oslo also indicated that PDAs should be used as an information gathering tool and a gateway to social network rather than supporting PBL and evidence-based medicine in medical education [7].

The PDA functionalities and the factors, which may influence the incorporation of PDAs into PBL-medical curriculum, have been identified in this paper. Further, it is essential that clear strategies should be addressed for the incorporation of PDAs into a PBL-based medical curriculum.

In the future, PDAs could become a part of medical study as a major learning tool that students may use while away in clinical placement for recording their clinical encounters, looking up references, checking time tabling, providing the opportunity for students to have online assessment and online feedback, and communicating with peers and faculty members on campus. However, the medical school must be aware of the potential risks of using PDAs, as failure may not only occur with hardware but also with software, content, security and privacy protection, and other influencing factors that might impact negatively on their use in medical study. Although web-based technology provides global access to information, it is necessary to make optimum use of same.

In addition, there are potential dangers of using IT and mobile technology in medical education, for instance, failure of information systems, poor user interface and lack of understanding of its use. Such concerns are directly related to the attitudes of medical faculty, the educational technology team, and clinical academics regarding the use of PDAs in PBL-based medical curricula. Therefore, it is important to overcome such resistance by providing adequate education and training, maintenance and support to medical faculty, staff and also students.

V. CONCLUSIONS

There is a potential that PDAs can be incorporated into PBL-medical curricula. What has yet to be determined is the strategy for incorporating of these devices into PBL-context, what necessary information for students should be carried on their PDAs, what information would be suitable for students in evidence-based medicine, how to ensure that incorporation of PDAs provides students and medical faculty effective learning given the attendant financial and resource implications.

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