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Development and Evaluation of the Application-Based Case Study Program

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Abstract

Background: Health educators have developed mobile learning activities to improve teaching and learning.

Aims: To evaluate a mobile application-based case study (ABCS) assignment and to determine the attitudes of pharmacy students.

Methods: We designed an application (APP) to explore the learning implications of ABCS in advancing therapeutic decision making skills. Students were asked to work on case studies by the APP and then surveys were conducted to determine students' attitude toward ABCS.

Results: The survey results showed that 78.5% agreed the APP was well designed, 65.6% agreed that communication with the instructor was convenient by the APP, and 86.1% agreed that ABCS was valuable to their learning.

Conclusions: The majority of students liked ABCS for convenience and promoting interaction with the instructor, some disliked it due to small screen and technical feasibility. Instructors planning to use ABCS in their course should balance its advantages with its disadvantages.

Keywords: Mobile learning; Pharmacy education; Case study; Application

Background

The rapid developments in communication and wireless technologies have made mobile devices (e.g. smartphone, iPad) widely available, more convenient, and less expensive [1]. Mobile device such as iPad/iPhone has been used in a variety of areas in health and medicines including education, data collecting, public health promotion, and other health-related information [2]. Health educators have developed mobile learning activities for medical and nursing students to improve teaching and learning [3-6]. Various studies have shown that student-centered, interactive case study learning can advance understanding and skill development [7-9]. Studies have also shown that mobile learning is an effective way to promote learning [5] and students showed favorable attitude towards it [1]. In this study, an iOS/android platform based application was used to create and evaluate an interactive tool for pharmacotherapy case studies. The research aim was to determine pharmacy students' attitude toward mobile learning by studying student's application-based case study activity and student survey. This research was approved by the Institutional Review Board for School of Pharmaceutical Sciences, Peking University.

Methods

Pharmacy students and the pharmacotherapy introduction class

A total of 121 pharmacy students in the 4th year of a 6-year continuous Masters of Science in Clinical Pharmacy program at Peking University [10] were enrolled in a course titled "Introduction to Pharmacotherapy." The 17-week course met once weekly for 3 hours. The course was designed to provide introductory pharmacotherapeutic knowledge while exploring evidence based clinical decision-making skills. Foundational pharmacologic knowledge was enhanced and critical thinking process was explored in clinical patient cases studies. Therapeutic cases included realistic patients with pain, depression, and osteoporosis disease states [11].

Development of the PKU pharmacy application

There is currently no standardized method/guideline to develop smartphone-based healthcare applications for educational use [2]. Our study utilized Motiwalla's mobile learning model [12] which has been widely used by educators to design mobile learning system. Motiwalla's mobile learning model provides a framework for designing this mobile application, [12] the model integrates mobile connectivity and e-learning: the combination of push and pull mechanism makes the content delivery more effective; personalization and collaboration makes the content delivered more useful.

Motiwalla's model consists of 4 components: pedagogical agents and mentors, communication aids, system tools and resources, simulated classrooms [12]. Three dimensions of Motiwalla's mobile learning model (pedagogical agents, mentors, communication aids) were addressed when designing our PKU pharmacy application. The simulated classrooms were omitted because we have the face-to-face classroom environment in the "Introduction to Pharmacotherapy" course.

Pedagogical agents and mentors: A management website was designed to realize the function of pedagogical agents and mentors [12] (Figure 1). This website was designed for the instructor to manage the app-based case study project, which contains 4 sections: Grading Assignment, Assignment Library, Project Management, and User Management. The "Grading Assignment" section was designed to review and grade answers submitted by the students. After the instructor selects a specific assignment, the web will show the answers submitted by students in the order by student's ID; for each student's submission, the answer for each question will be shown next to the questions. The "Assignment Library" section was designed to build a library of assignments, the instructor can add, delete, and edit an assignment consisted of multiple case studies. For each assignment, the instructor can add a case study by filling in the box of "Content of question"; and by clicking the "More Info" button, the instructor can add or edit detailed information such as progress notes, current medications, lab results, etc. The "Project Management" section was designed to manage a project, which may contain multiple assignments. After the instructor selects a specific project, the web will show all the assignments it contains. Then the instructor can select an assignment from the library and add it to this project, or instead, delete an assignment from this project. The "User Management" section was designed for the instructor to manage user accounts, the instructor can add a new account by inputting name and student ID, delete an existing account, and review user account list. In the user account list, the student can check messages from each student account by clicking the "Message" button. The user account was shown in chronological order: the student account that sent the latest message was shown on the top of the list.
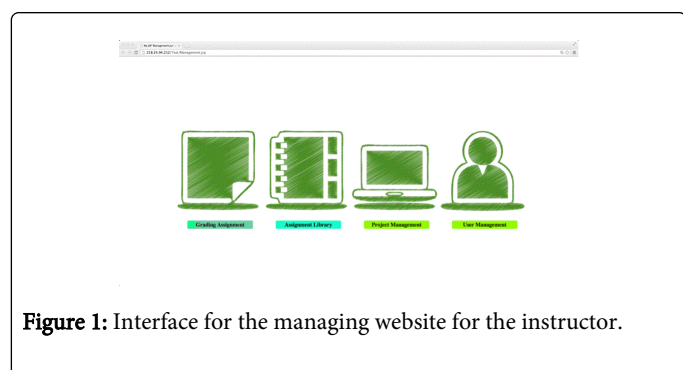

Figure 1: Interface for the managing website for the instructor.

Communication aids: A short message service (SMS) system and answer delivery system in the application was designed to promote the communication between students and the instructor (Figure 2). After logging in, by clicking the "Messages" button, students can communicate with the instructor by sending, receiving, and reading messages through the APP on their mobile devices. Messages from the instructor will be downloaded each time the student logs in the APP (Figure 2a). When clicking each message, the content will pop up (Figure 2b). By clicking the "Send" button, students can type message and send by clicking "Send" one more time (Figure 2c). Meanwhile, the instructor can receive, read, and reply messages through the "User Management" section of the management website.
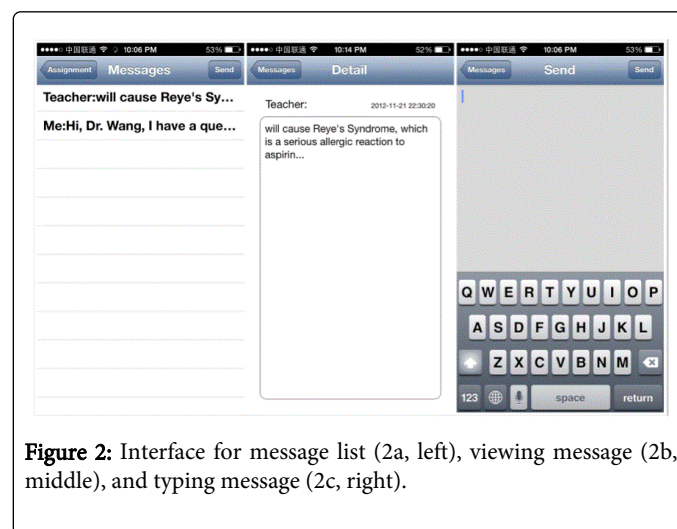

Figure 2: Interface for message list (2a, left), viewing message (2b, middle), and typing message (2c, right).

System tools and resources: A case delivery system and answer delivery system in the application were designed for the students to choose an assignment to work on it (Figure 3). After a student logs in, the cases will be downloaded from the server once an assignment was chosen. When the student clicks the "Start" button, the case studies will pop up (Figure 3a). To simulate the problem-solving tasks and scenarios as close to pharmacist's real-world situation as possible, a "More" function was designed to allow students to view a patient profile: by clicking "More" button, the students can check patients information such as chief complaint, history of present illness, family history, social history, physical exam, current medications, and lab results (Figure 3b). The APP reinforces these components of patient profile in order to train the students to use these information when providing a pharmaceutical care plan.

The answer delivery system was designed for the students to submit answers of the case studies. By clicking the "Answer" button, students can input the answer and then submit it by clicking the "Send" button (Figure 3c). Answers can be reviewed by the instructor from the Grading Assignment section of the management website and grades were sent by emails to students.
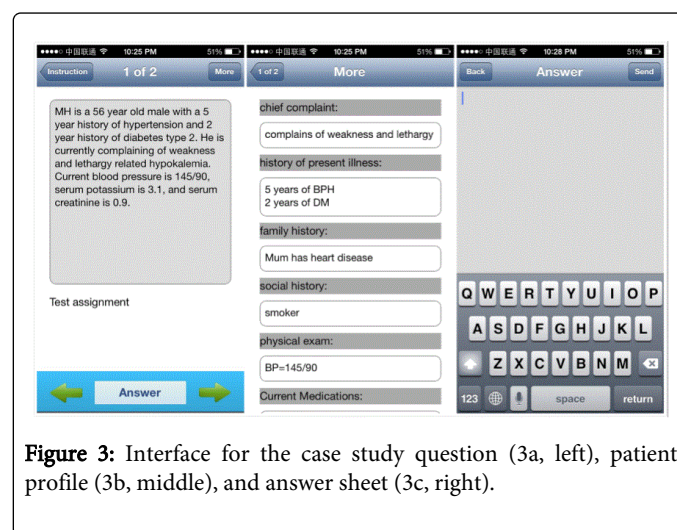

Figure 3: Interface for the case study question (3a, left), patient profile (3b, middle), and answer sheet (3c, right).

iOS/android platform based application and the management website

A web site and applications for both iOS and android platforms were developed. Apple's Xcode 4.5 software was used to develop the app for iOS platform [14], the open source software Eclipse Indigo Service Release 1 was used to develop the app for android platform and Genuite's MyEclipse 10 was used to develop the website [15].

App-based Case Study Assignment

A series of 10 different case studies was developed by the instructor in week 12 and 13; those cases closely paralleled the lectures presented in the didactic portion of the course and covered osteoporosis (case 1,2), pain management (case 3~6) and depression section (case 7~10). The 10 cases focused on key issues related to therapeutics, selection of appropriate drug, monitoring parameters for changes in therapy, and provision of patient counseling information. As the 10 cases were designed for a pharmacotherapy introduction class, the level of complexity was relatively straightforward [11] (Appendix). The 121 students were asked to do the case studies and submitted answers by the PKU pharmacy APP in week 14 after they had the 3 classes on pain management, depression and osteoporosis.

The 10 cases were required to be completed within 1 week. Once students log in the APP, they could start the assignment by click "start" button. The answer for each case could be submitted only once, and the next question would not be available until the answer for the current case was submitted. The 10 cases could be completed continuously, or students could submit answers to a few questions and restarted from where they left last time. The 121 students were encouraged to send message to the instructor by the APP as many times as they wanted as long as they remained on the cases; and they could use any mobile devices (android phone, iPhone, iPad, iPod, iPad mini) to send messages. The instructor started reading each message since the assignment was announced and replied each message from students. The flow chart of the app-based case study process is shown in Figure 4.
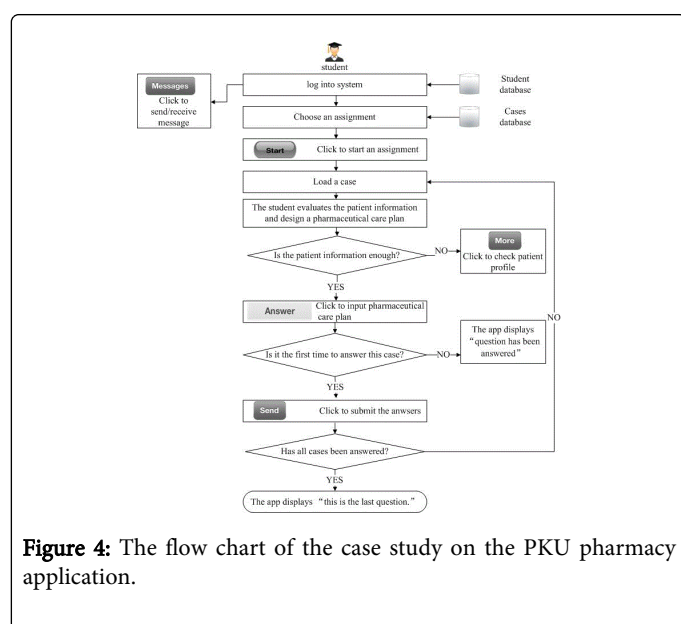

Figure 4: The flow chart of the case study on the PKU pharmacy application.

Student Survey

Two anonymous surveys were administered in class to all students; participation in the survey was voluntary and did not affect final student grades. The first survey collected demographic information and contained 2 open-ended questions to give students the opportunity to comment on their likes and dislikes with ABCS. The authors read each response and summarized into different categories based on responses themes. A response was categorized in multiple categories when covering more than one theme. It was administered following completion of all app-based case study assignment in week 15. The second survey was administered following completion of the final exam, which included 12 validated questions [15,16] which were designed to address the following aspects of ABCS: Technical feasibility (question 1–3), Didactic efficiency (question 4–9), and Cost effectiveness (question 10-11), User friendliness (question 12–14), and Overall satisfaction (question 15,16). All questions were reviewed for face validity by 2 pharmacy faculty members. Participants rated each item on a five-point Likert-type scale: Strongly agree = 1, Agree = 2, Neutral = 3, Disagree = 4, Strongly Disagree = 5. Frequency statistics were calculated for each question.

Results

The first survey

A total of 119 students finished the project on their mobile devices, 2 students who did not own a smartphone or could not borrow from others completed the assignments on paper. All the 119 students finished ABCS completed the first survey, 71 were male and 48 were female, the mean age was 21.9 ± 0.9 years. The students were asked about their overall familiarity with iOS/android platform and its applications, the result showed that 12.6% is poor, 10.9% is fair, 38.1% is adequate, 30.0% is good, and 8.4% is excellent. The survey indicated that 20 (16.8%) students owned an iphone, 14 (11.7%) students owned an ipad, 54 (45.4%) students owned an android phone, 9 (7.6%) students owned an android pad, 30 (25.2%) students owned other mobile devices (such as Windows phone, Blackberry, etc); and 9 (7.6%) students owned more than one kind of mobile devices.

For those 119 students who completed the assignment on mobile devices, 57 (47.9%) students spent less than 1 hour to work on assignment, 31 (26.1%) students spent 1~1.5 hours, 24 (20.2%) students spent about 1.5~2 hours, and 8 (6.7%) students spent more than 2 hours. The top 3 locations where students did the case studies are: dormitory (67%), classroom (24%), and library (4%); besides those 3 locations, 5 students also indicated vehicle (1%), cafeteria (1%), campus road (1%), coffee shop (1%), and others (unspecified) (1%), respectively. Ninety percent students did assignment at 1 location, 7.6% students did at 2 locations, and 2.5% students did at 3 different locations.

When asked how many times they log in the APP to do the assignment, 67 (56.3%) indicated once only, 33 (27.7%) stated twice, 16 (13.4%) indicated 3 times, 2 (1.7%) students indicated 4 times. When asked how many times they sent a message to the instructor, 85 (71.4%) indicated never, 24 (20.2%) stated once, 7 (5.9%) indicated twice, 3 (2.5%) students indicated 3 times. When asked how many times they received a message from the instructor, 78 (65.5%) indicated never, 34 (28.6%) stated once, 6 (5.0%) indicated twice, 1 (0.8%) student indicated more than 3 times.

Table 1 presents the categories, number of responses per category, and example responses for comments and recommendations from the open-ended questions on the survey.

Open-ended Questions	No of Responses
What did you like BEST about the ABCS?	
Convenient to use	54
Easy to carry	7
Allow students to work anytime	25
Allow students to work anywhere	24
Facilitates discussion with instructors	53
Facilitates discussion with classmates	2
Promote student to use other drug reference APP	11
Paper less	5
It was orginal	24
It was fun	15
Make good use of fragmented time	5
What did you like LEAST about the ABCS?	
Inconvenient to use	5
It's hard to type on the small screen of a smartphone.	37
Students don't have a smartphone based on iOS/android platform could not participate.	50
The server is unstable, sometimes can't log in or load the APP.	14
The APP is unstable, sometime it crash.	26
Can't work offline, always need the campus Wi-Fi or 3G network	28
Can't see the question while typing the answer.	3
Need to check paper reference	4
Once submitted the answer, can't modify it.	6
What is your recommendation to modify the ABCS ?	
Made more versions for other platform such as Windows phone, etc.	19
Questions should be multiple-choice type question since it is not easy to type.	20
Make the case cover more sections of this pharmacotherapy class.	23
Add a new function that make students could send message to each other	9
Add a new function that promote interactions in class	1
Add a new function to notify any new message.	2
Modify the application to make it more stable	15

Table 1: Student's descriptive responses regarding the ABCS (n=119).

The second survey questionnaires

A total of 93 of students completed the 12 survey questionnaires, the results are provided in Table 2: 67.7% agreed that ABCS mimicked the realistic situation; meanwhile, 74.2% indicated that ABCS was enjoyable and interesting. And 78.5% indicated that the PKU pharmacy APP was well designed. Additionally, 65.6% indicated that

ABCS was easier to discuss with instructors. Overall, 86.1% agreed that ABCS was valuable.

Questions	Strongly agree, %	Agree, %	Neutral, %	Disagree, %	Strongly disagree, %	Mean* ± Standard deviation
Q1: The Graphic user interface is well designed (color, fonts, etc).	33.3	45.2	19.4	2.2	0	1.90 ± 0.78
Q2: Navigation through the application was easy.	40.9	44.1	15.1	0	0	1.74 ± 0.71
Q3: The application is free from technical problems (programming errors, web access, etc)	28.0	32.3	29.0	8.6	2.2	1.74 ± 0.71
Q4: The APP incorporates novel characteristics.	52.7	35.5	6.5	2.2	3.2	1.68 ± 0.93
Q5: The ABCS activity is enjoyable and interesting.	33.3	40.9	18.3	5.4	2.2	2.02 ± 0.97
Q6: The ABCS activity is clear.	36.6	46.2	15.1	2.2	0	1.83 ± 0.76
Q7: Communication with the instructor was convenient.	26.9	38.7	29.0	3.2	2.2	2.15 ± 0.93
Q8: The ABCS activity mimics realistic situations.	24.7	43.0	28.0	4.3	0	2.12 ± 0.83
Q9: I have been stimulated to do additional readings or research.	20.4	36.6	33.3	8.6	1.1	2.33 ± 0.94
Q10: The ABCS activity saves resources	58.1	32.3	7.5	2.2	0	1.54 ± 0.73
Q11: The ABCS activity is better than paper-based.	29.0	43.0	21.5	6.5	0	2.05 ± 0.88
Q12: It was easy to use the APP.	31.2	44.1	21.5	2.2	1.1	1.98 ± 0.85
Q13: The ABCS activity should be continued in this class.	38.7	44.1	12.9	2.2	2.2	1.85 ± 0.88
Q14: The ABCS activity should be used in other classes.	30.1	37.6	28.0	3.2	1.1	2.08 ± 0.90
Q15: Overall, ABCS activity was convenient (anytime/where).	28.0	47.3	21.5	2.2	1.1	2.01 ± 0.83
Q16: Overall, ABCS activity was valuable.	32.3	53.8	12.9	0	1.1	1.84 ± 0.73
*Strongly agree = 1, Agree = 2, Neutral = 3; Disagree = 4; Strongly Disagree = 5						

Table 2: Student's attitude towards App-based case studies (ABCS) (n=93)

Discussion

Mobile applications are very popular today and app-based assignment is an interesting technique for augmenting didactic teaching with the ability to learn with interactive technology outside the classroom. As with any new and innovative tool, there is always a concern as to how students will perceive it. This study clearly indicates that students had positive attitude towards the delivery of assignment on application. Students found the method enjoyable and interesting. Furthermore, many students indicated that ABCS was useful and stimulating.

The average number of messages each student sent to the instructor was about 0.55 (a total number of 65 messages from the 119 students), this demonstrated about half of the students did have a question while doing the assignment. The ratio of total "messages received from the instructor" (40 posts) to "messages sent to the instructor" (37 posts) was 0.93, the ratio showed the amount of interaction between the instructor and students was good, considering sending messages to instructor was not a requirement.

Student survey demonstrated some particular advantages of ABCS. First, it promotes interaction between the instructor and students: Unlike previous studies measuring the interaction required a certain amounts of message sent by students [11,17], this study has no minimum requirement for number of messages. However, there are still 24 (20.2%) sent messages to the instructor with the "Message" function from the APP. It shows that ABCS has the potential of providing students with the opportunity to learn in an interactive environment. Those students probably would not contact the instructor if the assignments were paper-based. Secondly, ABCS mimics the realistic situation to enhance the traditional didactic learning. By making students check patient profile (clicking the "More" button), it provides students with the opportunity to apply therapeutic knowledge and pharmacotherapy decision making skills. Thirdly, it improved convenience of doing homework: since it made working independent of time and place: it allows them to work where there are no computers, such as cafeteria, coffee shop, etc. Fourthly, the ABCS was original and fun. Since most participants were 21 or 22 years old students who preferred learning environment with technology, app-case studies attracted pharmacy students. As more

students own smartphones and the user growth will continue at a steady pace, the study result demonstrated a potential for mobile learning to engage students outside the classroom. Lastly, it is worth to mention that ABCS has the potential to promote student to use other drug reference APP [2], such as Epocrates, Medscape, etc.

The survey suggested the ABCS had some particular disadvantages as well. First, it's hard to type on the small screen of a smartphone. Compared to mobile devices such as iPad, it is inconvenient to submit a pharmaceutical care plan on a smartphone. Thus some students recommended questions on ABCS should be multiple-choice type. Secondly, the application is based on iOS/android platform; the survey shows that nearly half of participants believed that students don't have a device for these two operating systems couldn't participate. The way to address this deficit is developing more versions for other OS such as Windows phone. Thirdly, the application is not stable: some students complained it crashed occasionally and sometimes it could not load the question. Although we didn't experience crashes when testing it, a few crashed might be possible since this is the 1.0 version of the APP and we will continue to modify it. As far as having difficulty loading the case question, this is due to the unstable campus network; a solution is turning off Wi-Fi and using 3G network. Lastly, some students complained that they could not work offline like traditional paper-based case studies. This is inevitable because network is necessary for loading questions, sending answers and messages to server.

There are some limitations in our study. The study was based on only 1 case study and with only 1 cohort of students in a single school. Besides, students were informed that a study was being conducted, thus this may have introduced the possibility of bias. Lastly, the cases used in this study were all simple cases for a pharmacotherapy introduction class, whether complicated cases (e.g. patient with multiple conditions) could be delivered by ABCS is not tested in this study.

Conclusion

Introduction of app-based case studies assignment outside the classroom setting was found to be a useful technique. The ABCS was well received by pharmacy students in the pharmacotherapy introduction class. The majority of students agreed that ABCS was a valuable tool on the aspects of convenience, promoting interaction with the instructor, and novelty. On the other hand, findings from our survey suggest that some students dislike ABCS because the small screen, technical feasibility, accessibility to free network. Instructors planning to use ABCS in their course should balance its advantages with its disadvantages.

Appendix

A case example: MJ is a 37-year-old male who is hospitalized for moderate depressive symptoms. This is his 3rd episode of major depression in the last year. He is currently being treated with Sertraline 150 mg daily. According to his wife, he often misses 3 or 4 days of his Sertraline in a row due to forgetting his medication when traveling for his job. MJ admits that on these occasions he gets very anxious and often feels nauseated.

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