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# Designing Pre-test Questions as Phone Notifications: Studying the Effects of a Mobile Learning Intervention.

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**Abstract:** Mobile devices are increasingly becoming more pervasive and emerging as part of our daily life, particularly with university students. From these devices developed in tandem with face-to-face class interaction it has opened new possibilities for ubiquitous learning. We present out work on designing a smart-phone Mobile Learning application that streamlines pre-test questions into a "set it then forget it" input system where students can answer quiz items as slide-down notifications within the day prior to a scheduled lecture. Teachers using the application are afforded a web application to create pre-tests in advance and review class scores. The study was conducted to first-year Computer Science and Information Technology students of a university in the Philippines. Data collection techniques used in the study used experience questionnaires, usability tests, interviews, and tests of student learning outcomes. SUS testing showed consistent satisfactory scores across three iterations. Results from the Learning Experience questionnaire maps to the general answers from the focused group discussion presenting indicative of a positive learning experience. Evaluation of the pre and post test scores signified that using the mobile application can be an effective substitute to class administered tests.

**Keywords:** Mobile Learning, Android Notifications, Usability

## 1. Introduction

The act of teaching students requires several resources, such as manpower and especially time. (Baker, Fabrega, Galindo, & Mishook, 2004). In our educational setting, extending class time is not a new idea. Governments spend millions of out-of-school programs such as tutorial, homework assistance and modifying class schedules such as block scheduling to expand learning opportunities for students (Saliva, 2007).

Institutions recognized that the learning environment extends beyond the classroom thus, an area of interest is finding varieties of technological support options that would allow students to engage with learning outside class hours (Vogel, Kennedy, Juan, Kwock, & Lai, 2007).

As in every traditional classroom setting, pre-tests are common to schools and universities as it allows teachers to preview of what the students know and where to focus next. Given their prior knowledge with test scores, teachers are afforded to make changes to accommodate weak and strong points. Although one limiting point of classroom-based pre-tests is that pre-tests are not time sensitive which take time away from class instruction (Kelly, 2019)

We turn to Mobile Learning or m-learning as a pedagogy that addresses the need for giving more time for classroom instruction. Mobile Learning as defined by Dikker and Squaire (2012) is learning made flexible with the use of mobile devices to access educational resources and can be shared with others, both inside and outside classrooms.

To make efficient use of the limited time available to learn in a classroom-based setting, we describe our work in attempts to redesign the process of conducting class administered pre-tests into

utilizing android notifications to deliver pre-test questions day before the actual class lecture while looking into its impacts on the student learning experience.

### *1.1 Research Questions*

This study is aimed to perform qualitative and quantitative approach on designing and developing a mobile learning pre-test tool which answers the following research questions.

- Is using android notifications as a pre-test tool, usable in conducting pre-test quizzes?
- How will sending android quiz notifications impact the student learning experience in the context of class-administered pre-tests?

## 2. Related Work

Current research approaches have adopted to used mobile phones as part of the new learning tools in the curricula. According to Duggan (2015) it was reported in 2015 that among smartphone users in ages 18 to 29 used messaging apps in their daily lives as with the increased use of mobile devices this generation preferred collaborating, gaming than doing serious tasks and enjoyed the "customized, collaborative and interactive learning" (Bidin & Ziden, 2013). Common systems made using m-learning are implementations of an SMS quiz-based systems where students are sent quiz questions within a given time period (Kennedy et al., 2007). This type of systems explored the usability and acceptance of the system outside university grounds and overcome the challenges of a classroom-based setting. Results of the study showed that it is possible to extend learning opportunities even outside the classroom. Empirically, results from these studies suggests that students are more confident and enthusiastic to use mobile applications to study and review for their classes combined with face-to-face traditional learning methods (Mehrotra et al., 2016). Although these mobile applications may have some downsides in terms of user experience such as small screen size, problems with navigation, size of messages and speed of processing and connectivity limiting the user's full engagement with the use of mobile applications (Kumar & Vasimalairaja, 2019).

In this work, we are to set-up a similar environment of mobile learning where students answer pre-test questions directly using a slide-down notification feature that allows less throughput and decrease interaction time as to reduce distractions by opening unnecessary applications thus an increase of engagement. We hypothesize that this simpler interaction would elicit sustained engagement among students. In the next subsections, we will discuss each feature on by one.

### *2.1 How do users engage with notifications?*

Mobile notifications are extremely beneficial to the users: however, at the same time, they are a cause of potential disruptions, since it often requires users' attention at inopportune moments (Mehrotra et al., 2016). Thus, there are several ways a user can engage with a notification. In this section we discuss on how we can understand the use of notifications for designing a better and effective notification feature in our mobile learning application.

There are five ways a user may interaction with notifications (Pradhan, Qiu, Parate, & Kim, 2017). First is read, this is when the user spends time reading the notification but does not take any actions. Second, it can be sometimes it can be partnered with Read and Dismiss where the user spends some time reading the notification the but does not take an action. Third is Take action is another interaction wherein notifications provide users with embedded set of buttons to take quick actions. Fourth is Launch an app, as in this form is the highest level of engagement where a user launches the app corresponding to the notification and lastly, Ignore or dismiss is when the user may ignore the notifications.

In summary, although there are numerous ways of how a user may interact with a notification, we take into consideration into using the five types of engagement in creating our application.

### *2.2 Mobile Learning Applications with Time Adaptability*

Mobile learning systems that adapt to the learners learning time schedule is one of the many ways that a a learning application can retain the user's motivation to learn and use the application. A study by Li et al (2010) implemented an SMS quiz system feature that sends quiz items for the user to answer with initial test results showed that learners tend to lose interaction and feel burdened with too much information when learning systems spam quiz items by sending multiple SMS messages at random hours of the day. Improvements had been made to adapt to the students learning schedules resulting to an increase of motivation and participation by synchronizing the users time schedule using time adaptation that studies habitual interaction between user and application through setting frequency checks (Li et al., 2010).

In our study we see this as one important aspect in our application to adapt and synchronize the sending of quiz items and made our own adaptation algorithm discussed in section 3.2.

## 3. Methodology

### *3.1 Scope and limitations*

We implemented our system in a university where 18 students are taking up an Introductory Programming Course aging from 18 to 20 years old owning Android phones and run operating systems 6.0 Marshmallow and above as the custom notification features cannot be catered to lower Android operating systems.

### *3.2 Time Adaptation Algorithm*

The application implements a time adaptation algorithm that computes a simple frequency check every time the students answers an item on a specific time of the day. For every user, an array of Preferred Time (PT) is assigned to record and receive quiz notifications. Each PT corresponds to the item during the day. Quiz items are arbitrarily appointed each time. However, an item might not be answered within the PT. In this note, we developed range periods.

Range periods are a set of interval block which varies per preferred time. The idea is to adapt to the student's habitual time to answer quizzes. As aforementioned, range periods vary in relation to PT and the Quiz deadline which is at midnight. These sets of time will also be a cue to notify or re-notify students about dismissed items.

### *3.3 Implementation of Web and Mobile Applications*

The quiz system is packaged into a downloadable mobile application and a web application deployed on the server. Test group A upon testing did not have the time adaptation algorithm and solely relied in the static preferred time stated in the demographic's questionnaire. Test group B had already been using the mobile application with the Time Adaptation Algorithm.

Test groups had been exposed to pen and paper and notification pre-tests. The intervention of the class instructor remained the same throughout the study as it can be seen in Figure 1.

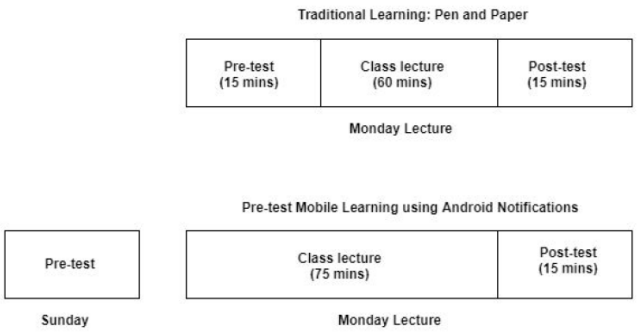


*Figure 1.* Classroom Design Set-up for Traditional and Mobile Learning.

We used the five concepts of a notification stated in the literature and tweaked the Ignore Notification feature into a Set Reminder when the user dismisses and ignores the quiz item. The Set Reminder feature is designed to remind the student of any unanswered items before the deadline. We opted to use these interactions to provide a byte size chunked of content as a notification for the user and set them to be personalized to their study habit with the time adaption algorithm.

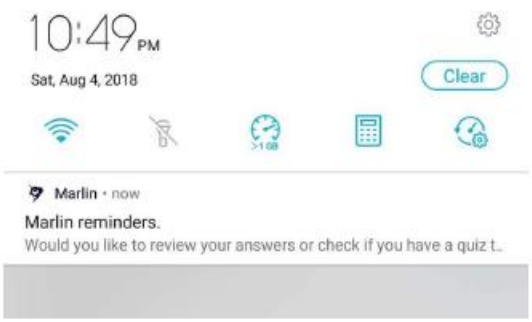


*Figure 2.* A set reminder notification for dismissed or missed quiz items.

Considering the design of the application, the main activities and functions for the application lets the users log in into the system, receive, and answer the quiz item or be dismissed through notifications and review the quiz result summary.

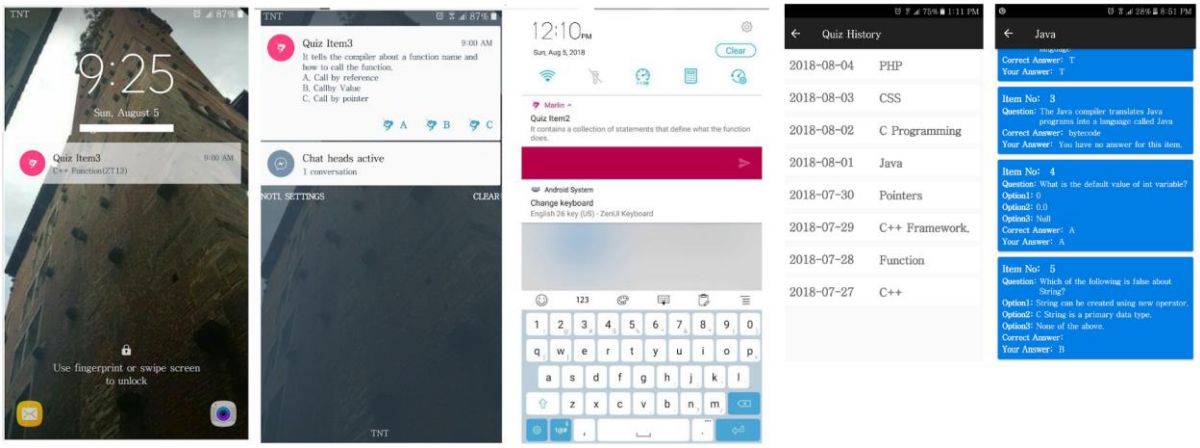


*Figure 3.* Pre-test items as Android Notifications (Left) and Quiz History Panel for reviewing pre-test items (Right).

## 4. Results and Discussion

### *4.1 System Usability Scale Results*

To measure our mobile application systems usability, we used Brooke's (1986) System Usability Scale as our evaluation matrix to measure usability.

#### *4.1.1 Beta Testing*

Preliminary testing revealed that the mobile application fell under the Acceptable-Good with a score of 73.85. Notable comments from the 13 testers were that the application lacked user feedback in terms of loading pages. Respondents were observed dragging down the screen multiple times to refresh data before giving and restarting the application. Thus, in the next iteration we implemented loading screens or splash screens to improve user experience.

### *4.1.2 Test Group A and B SUS Results*

Results from the SUS questionnaire showed that the mobile application for both test groups fell under the Acceptable-Good category with the scores 71.75 for test group A and 77.18 for test group B. We note that during the implementation the Time Adaptation Algorithm was not yet implemented in their group while test group B had their mobile learning application integrated with the Time Adaptation Algorithm.

## *4.2 Learning Experience Results (LEQ)*

### *4.2.1 LEQ Results for Test Group A*

For this group, majority or 80% of the participants strongly agreed that answering quizzes through the use of mobile notifications helped in their study habits by reminding them to review via Set Reminder Notification. Although they have been exposed to pen and paper pre-tests, 60% agreed that taking pre-tests on the same day has the same effect in their learning experience as taking quizzes with the mobile application.

### *4.2.2 LEQ Results for Test Group B*

For Test Group B, 87.5% agreed that they were able to learn more by accessing and revisiting their answered quizzes through the application. The group in general made use of the app as a preparation for their next lecture while the other 12% said that mobile application made no difference in influencing their study routine. Mixed reactions from the group were observed when asked for the difference both methods to their learning routines as it shows that the majority answered Strongly Disagree/Disagree and Neither.

## *4.3 Focused Group Discussion*

In general, both groups commented that they like how mobile pre-tests were sent to them in intervals because they felt that they were not bombarded with too much information at once. Groups A and B felt that they were more confident and prepared during class discussions because they have a sense of the lecture with the learning content sent to them is short and bite-sized content in comparison to condensed learning concepts delivered to them in a traditional classroom setting. Most of the interviewees from Test Group B strongly agreed that delivery of quiz items as slide-down notifications is "… just enough for me to not be overwhelmed of what to study", and "I like how I don't feel stressed with learning all things at once" Both groups generally preferred the dismissal feature because it made them feel in control with the pace they want to learn. One particular instance was told in the FGD that Student A from Test Group A expresses enjoyment in competing along with the group as to who gets the most answers correct while Student B from Test Group B says that "… I enjoyed the application as it makes me collaborate more with my classmates when I get answers wrong."

However, improvements on the Time Adaption Algorithm can be improved.

Overall the participants from both test groups strongly agreed that learning through the notification feature is one good way for them to learn as they were more confident for lectures having received their pre-test day before actual class lectures as their mobile phones were easily accessible to them than their laptops.

## *4.4 Test validation*

At this point of the study, our main goal was to test the effectivity of taking pre-tests day ahead of the lecture using android notifications by comparing class administered pre-test. In this evaluation the elements that were not as controlled as we should have wanted was block sections, difference in

teaching methods, and topics per lecture session this is because of the lack of teacher distribution between classes and the availability of mobile devices used.

In order to determine if the two data sets differ significantly and not by random chance for written and mobile learning pre-test in both Test Group A and B, we computed using paired t-tests. There was a significant difference in the scores for class administered test (M=2.11, SD=1.81) and mobile learning (M=3.33, SD=1.1882) conditions; t(17): -2.61, p = 0.02. These results show that the use of the mobile learning application is an effective tool for administering pre-tests.

Results from the FGD also maps that in both test groups students used the mobile application as a form of a collaborative learning tool. While the study was not explicitly designed to be for collaborative form of mobile learning, this occurrence affirms that the application can be an effective pre-test tool with a collaborative form of learning.

## 5. Conclusion and Future work

Our work primarily focused on designing and testing a mobile application wherein Android Notifications were utilized to streamline pre-test items and blast them to student's mobile devices before actual class lecture. Evaluations across three iterations show that using notifications as pre-tests can be applicable and that the inclusion of the Time Adaptation Algorithm increased the SUS score. However, it is not conclusive but only indicative of its effects. Based from the interviews and experience questionnaire, overall students report that they were more confident and prepared during class lectures as they like to take learning at their own pace delivered in bite-sized content. We can also infer that the mobile learning application does indeed enforce a positive learning experience.

For future work, we suggest to confirm whether the pre-test questions in text-mode could be another cause of motivation as learners in the "App Generation" seem to prefer the use of video and games.

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