

# Assessing the Realization of Smart Phones Learning Objects in Students' Adaptive Learning Paths

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**Abstract :** *Students are flooded with enormous Internet-based information on their smartphones in their daily routine. Getting precise and relevant information on smartphones that assist students in their learning process is tedious and time consuming activity. This research explores the effective of Smart Mobile Adaptive App for Erudition and Teaching (SMART) in facilitating students in adaptive learning. SMART app is based on adaptive m-learning model consisting of six stages. SMART app latent variables which includes usefulness, ease of use, adaptiveness, spare time management and learning collaboration were measured and evaluated to reveal how much they contribute in assisting students in learning process. Moreover, different learning objects in form of different types of learning contents were evaluated when providing them on smartphones for adaptive learning characteristics. Final results revealed that m-learning can be a prodigious complementary instrument to outmoded classroom learning.*

**Keywords:** Mobile-learning, adaptive learning, learning objects, learning contents, motivation, students' preferences, social learning

## 1. Introduction and Literature Review

### 2.1 Introduction

According to (Charles Arthur, 2015), 75 percent of Internet access is through smartphones and tablets. Furthermore, 90 percent of worldwide smartphones sales are driven by Apple iPhones and Google Android operating systems ever since they became engrained with Android leading in Europe and Asia.

International Data Corporation (IDC) predicts that at the end of 2017, total smartphones users worldwide would cross the figure of 2.1 billion (Gadgets, 2016). With attractive features of ultra HD (high definition) touchscreen, high mega pixel camera, GPS navigation system, media player, web browsing, Wi-Fi connection, online mobile payment, motion sensor along with 3G and 4G support, smartphones are becoming more and more ubiquitous especially in college and university campuses. Due to their always on, always there, one-to-one relation with its users, smartphones allows users to access information anytime and from anywhere. By 2017, it is also estimated that 90 percent of Internet users will access online contents through their smartphones (Gozalvez, et al. 2013).

M-learning is more flexible than e-learning in that it gives freedom to students to engage themselves in learning process without limiting themselves to one particular physical location. With efficient operating system, powerful processors,

eye-catching interface and frivolous features, smartphones now have become striking medium for teaching and learning. The improved capabilities of smartphones now allow students to perform almost the same operations as they can perform it on Personal Computers (PC) and laptops. Though the primary use of smartphone is to connect people to communicate but it can also have a great impact on students' learning and training. Their low cost as compared to desktop computers, smaller size, personal and spontaneous access to massive educational material on Internet make them extremely interesting for educators and students. However, it would be irrational to deem that smartphones will replace typical classroom environment. In controlled classroom environment, communication between instructor and students is synchronous and every student knows that the prime activity in classroom is learning. Whereas using smartphones as a learning tool, students can be distracted by many surrounding events. But it would also be imprudent to think that smartphones cannot assist students in learning process. What is important is to first understand the right pedagogical learning techniques that can be implemented and supported by smart phones applications. This research paper is about finding what characteristics, features and prospects of smartphone are best in helping instructors and students in teaching and learning process.

### 2.2 Literature Review

Most educators encourage students to use smartphones in learning process but there are also some serious concerns among instructors and educational specialist of using smartphones in promoting education. The primary concern is that smartphones commonly are used for entertainment like taking pictures, watching videos, listening to radio and playing games. Furthermore, the effects of environmental distractions like different noises, temperature, talking with colleagues, playing games, stress, fatigue, illness and weak mobile signals also have to be considered while facilitating students to use smartphones as learning tool. Nonetheless, numerous studies have been conducted to examine the effect of smartphones in learning process. Some of them are discussed briefly for reference and comparison with our research work.

(Zhao et al. 2008) presented architecture and algorithm for adaptive learning that considers learner's preferences and contextual environment. Learning material that is irrelevant to learner's preference is eliminated so that a learner can concentrate on learning contents that are best suitable of him/her. Adaptive contents are forwarded to a learner based on mobile device capabilities, contextual data, content's item and learner's

preferences. Their imperial study proves that context aware mobile learning system can increase learning behavior and effectiveness.

(Nieder, et al. 2004) has introduced an approach which support cross-system personalization. This approach is based on ontology-based unified user context model which extract information based on user travel through information space. Tailored information is presented to user based on user visit to the same system with similar requirements.

A very effective multidimensional approach based on profiling information and hierarchical aggregation is presented in (Adomavicius, et al. 2005), where apart from typical and common information, user is provided with recommendations founded in additional contextual information.

The methodologies introduced by (Economides, et al. 2006), (Bhaskar, et al. 2008) and (Patten, et al. 2006) is based on learning infrastructure which combines learner's learning state, learner's education activity and networks performance to identify learner's interest and preferences. Subsequently, based on learner's interest and preference, adaptive contents are provided to learners in ubiquitous environment.

Our previous study focused on finding relationship between students' personality types and their study behavior. Survey revealed that there does exist strong associated between students' personality types and their study behavior. Therefore, different study behaviors options were recommended to students through smartphone Android App based on their personality types. Different motivational and persuasive techniques were also applied through smartphone app on different students to assist them in learning process (Adnan, et al. 2012).

Two popular studies conducted at European universities focused exclusively on how mobile phone messages i.e. SMS can leverage students' study behavior. In the first study, researchers try to find students' interest in discussion topics (Bollen, et al. 2004). Students can send SMS anytime on various discussion topics on discussion forum which then was aggregated and analyzed by instructor to find how much students' curiosity was displayed in different study topics.

The second study focused on finding mobile phone SMS strength to help students in participating in conversational topics (Stone, et al. 2002). The success of SMS drive was measured by the quality and quantity of SMS, quickness of students' response, quality of information collected through SMS and total numbers of messages collected. It was observed that students actively participated in SMS drive with high response rate and better message quality. It was also observed that response time of SMS was also less than that of email responses.

Smartphones with ample power, strength, features, capabilities and their popularity in students can greatly influence students' learning environment (Raento, et al. 2009). It is important to know what features of smartphones are best in assisting students in learning and what features commonly are not enjoyed by students. Furthermore, it is also important to know how smartphones assist instructors in managing courses, preparing quizzes, preparing assignment and directing students. This

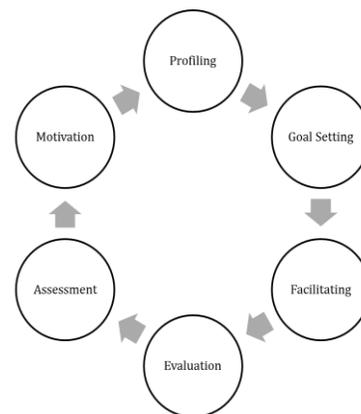
research work strives to find the acceptance of smartphone multidimensional learning contents among students and which multidimensional learning content have positive effect on them. In this regard, Smart Mobile App for Erudition and Teaching (SMART) with support of web technologies was developed and tested on undergraduate students with intention to divulge what students like most in using smartphones during their learning process.

The rest of the article is organized as follows. In Section 3.1, we provide an overview of proposed learning model and its stages. In Section 3.2, we present integration of SMART App with Web Component, their architecture and working. Section 4 details the evaluation and testing of SMART App by undergraduate students. Section 5 is about conclusion and future work.

## 2. Learning Model

### 2.1 Learning Model

Our Android smartphone app called SMART integrated with Learning Management System is based on learning model shown in Figure 1, which consists of six stages namely profiling, goal setting, facilitating, evaluation, assessment and motivation. In the following section, we briefly explain these terms in context of web, LMS and smartphones usage.



**Figure 1 M-Learning Model Stages for SMART App**

#### 3.1.1 Profiling

Students' information related to courses taken, grades, class, quizzes, assignment, attendance, examination and basic demographic is entered in Learning Management System during profiling state. The nature of this information is dynamic as student progresses in his/her course work. The academic state or the performance state of every student is also stored in his/her profile. Students can have different states like weak academic state, average academic state and good academic state. Based on students' academic states, multidimensional course contents are disseminated to them on their smartphones.

#### 3.1.2 Goal Setting

This activity is performed by instructor and web component. Goal setting is directly interrelated with students' profile information. Based on different students' performance information, stored in

students' profile, different goals are established for them. Students having different goals are provided with different learning contents. For example, a student who is not able to clear his first quiz taken on smartphone is encouraged to first clear that quiz. Learning material related to that first quiz, in the form of video tutorial, Portable Document Format (pdf), PowerPoint presentation and web links, are forwarded to student on his/her smartphone, that might help him/her in clearing that quiz. Upon clearing the first quiz, next academic goal is established for the student and related learning contents are disseminated to him/her accordingly on his/her smartphone. By setting different goals for different students based on their academic performance, every student would be clearly aware of his/her goal and what is exactly expected from him/her.

### 3.1.3 Facilitating (Learning Material Dissemination)

As discussed earlier, one of the objectives of this research is to ascertain which type of smartphone multidimensional learning material is best and most liked by students. After setting different goals for students based on their academic performance, learning material in the form of video tutorials, screencasts, animations, PDF files, MS PPT files, MS Word files and web links are sent to students' smartphones by Learning Management System on recommendation of instructors. For the ease of Instructors, they can, from their smartphones, upload different learning material on LMS. Subsequently, for the simplicity of students, they can also, from their smartphones SMART App, access different learning material from LMS.

### 3.1.4 Evaluation (Taking quizzes and assignments)

Contrary to desktop computers where students are restricted to specific location, students with SMART app can give quizzes and submit assignments from anywhere. Furthermore, there are also no restrictions on students to give quiz or submit assignment at some specific time. With smartphone in hand, students can give quiz or submit assignment at their preferred time. Upon receiving notification about quiz or assignment, students can with the help of SMART app, set a specific time for it using timer and can delay it to time where they feel most comfortable in doing it. Thus restrictions of time and locations are detached from students and they can give quizzes or submit assignment at any time and from anywhere. In busy semester schedule, students can utilize their spare time e.g. waiting for bus, train, airplane or travelling in bus, train and airplane in completing assignments or giving online quizzes or reading study material.

### 3.1.5 Assessment

In assessment stage, students' performance in quizzes and assignments are evaluated. This activity is same as monitoring students for what they are doing. Unlike other online mobile learning applications, where only learning material are provided to students, our SMART app summarizes the academic performances of every student and send the result on instructor smartphone. This way instructor has full picture of every student on his/her smartphone regardless of place or time restrictions. Instructors can analyze result of students and make recommendation to students accordingly.

### 3.1.6 Motivation

After students' evaluation and assessment, different motivational SMS messages, notifications and recommendations are sent to students on their smartphones by web components. As little as possible efforts are put on instructors to give different recommendations, instructions and advices to students through their smartphones. Automated system generated notifications and alerts are also sent on students' smartphones to keep them up to date about academic activities. Performance based SMS are sent to students for personalized motivation. Similarly, for recognition and social motivation, performance of good students' is shared with other students through SMS. This way weak student also get motivated to work hard and get recognition from instructors and other students. Few examples of instructors recommendations sent on weak students' smartphones are:

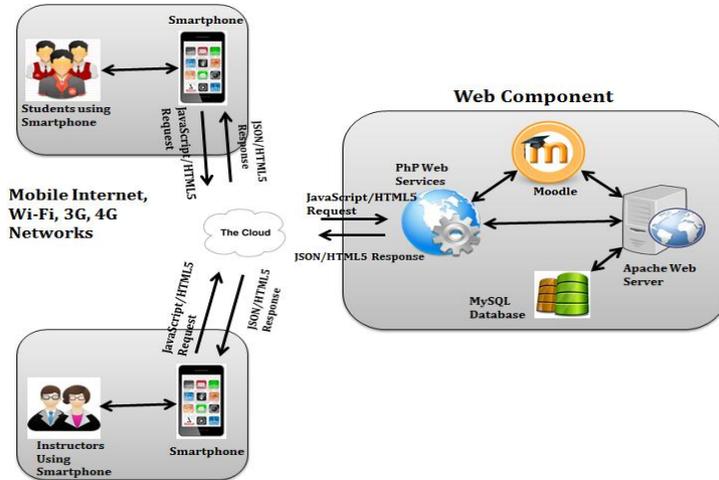
- Your strength is revision. Try to rehearse your learning contents to improve your performance.
- Please feel free to post your questions on discussion board if you have problem in understanding any topic.
- Try to study in group. This will help you in learning new study skill and increasing your knowledge.

Similarly, following are some examples of performance based smartphones messages sent by web component:

- You are very good right from the start of semester. We hope that you will retain your performance throughout the semester (for good consistent students).
- Your previous quiz result shows that your performance is improving. Try to study more to getting top position in class (for improving students).
- You may get relegated if you show the same poor performance. Try to study day and night right from now. (Warning for weak students).

### 3.2 SMART App and Web Component Architecture, Integration and Working

The functioning of SMART App is established on adaptive learning model discussed in previous section. SMART App interacts with students, instructors and web component. Web component consist of PHP language based web services, LMS and Apache Web Server connected with MySQL database. The working of SMART App depends on the role of user. The functionalities of SMART App for instructors and students are different from those of students, though instructors and students also have many things common in using SMART App. Figure 2 shows the architecture, integration and working of SMART App and Web Component. Following functions are performed by instructor while using SMART App.



**Figure 2 The architecture, integration and working of SMART App and Web Component**

- Preparing quizzes and uploading them on web server for students.
- Preparing Assignments and uploading them on web server for students.
- Creating online discussion board on web server, posting discussion topics and comments on discussion board through SMART App.
- Uploading video tutorials, screencasts, PDF files, MS Word Files, PowerPoint Files and animations on web server.
- Sharing useful and informative web links with students on web server.
- Creating general discussion boards where every class student can participate.
- Creating private and limited discussion boards where selected students can participate.
- Uploading video files, audio files, pictures, PDF files, MS Word files and PowerPoint files on discussion boards for open discussion.

On the other hand, using SMART App, students can perform the following tasks.

- Giving quizzes on their preferred time.
- Working on class assignments and submitting them online.
- Creating private discussion boards where they can share any topic and discuss it with classmates.
- Uploading video files, audio files, mobile pictures, PDF files, MS Word files and PowerPoint files on web server and discussion board.
- Accessing information about quizzes, assignment, class timetable, exams and class attendance from web server through SMART App.

### 3.2.1 Web Component

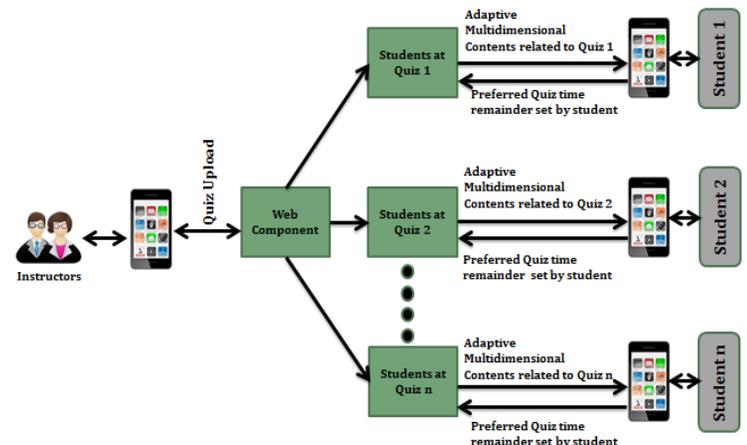
Web component consist of PHP based web services, Moodle Learning Management System (LMS), Apache Web Server and MySQL DBMS. PHP based web services that run on Apache web server extends the functionalities of LMS and provides web services to instructors and students. Data related to course work,

quizzes, assignments, attendance and exams is stored in MySQL dbms.

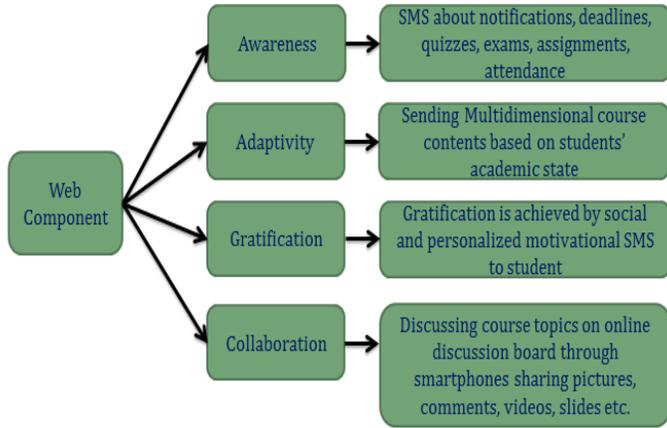
### 3.2.2 SMART App

In this section, we discuss the working of SMART App in detail. Instructors or students send their request from Android SMART App in the form of JavaScript and HTML5 request to PHP web services. After validation, processing and execution of JavaScript or HTML5 request, instructor or student gets JSON or HTML5 response. After parsing and validation of JSON or HTML5 response at SMART App side, result of request sent is shown to instructors or students on their smartphone screen. For example, JavaScript request from an instructor side could be uploading a video file related to any subject from his/her smartphone to web server for students. If the video file is successfully uploaded on web server database, the instructor gets successful upload message on his/her smartphone screen. Otherwise if the video file uploading fails, instructor gets unsuccessful upload message on his/her screen.

SMART App has many distinguish and powerful features that makes it attractive Android smartphone App. Within a very short time, instructor, using SMART App, can prepare quiz and upload it on the web server for students. Similarly, using SMART App, instructor can select a particular class or a group of students and give them assignments. Upon uploading of assignment on web server, students get notification about assignment and last date of submission. For the simplicity and ease of students they are not compel to give quiz or submit assignment at some fixed time. Students through their smartphone SMART App can set their preferred reminder time on web server for quiz attempt or assignment preparation. Subsequently, once students preferred time is reached, PHP web service running on web server send notifications to students about quiz or assignment. Once assignment submission time is over, instructor gets summary of students assignments. After that SMART App also give freedom to instructors to give online assignment marks to student through his/her smartphone. The



**Figure 3 Online Quiz upload activity on web server and students interaction with Quiz**



**Figure 4 Functionalities of web component**

### 3. Evaluation

The objectives of SMART App evaluation were twofold.

- To observe usefulness, ease of use and adaptiveness of SMART App. Further to determine how SMART App helps students in converting their spare (extra) time into productive time and how much students collaborate in learning while using SMART App.
- To determine which multidimensional learning material is most effective and useful in helping students in their learning process while using SMART App.

Overall, the first objective of SMART App evaluation emphasizes on students' satisfaction towards it and the second objective is related with finding students' perception about which multidimensional learning material is preeminent in learning while using smartphone.

50 undergraduate students having Android smartphones from Bachelor of Computer Science (BCS) classes were involved to test the effectiveness of SMART App. Prior to complete evaluation, students were instructed about SMART App installation and usage. It was made sure that all students have complete understandings of SMART App functionalities, its working, its connection with web component and how different tasks are performed while interacting with SMART App. Furthermore, students were also informed about different notifications and reminders that they will get on their smartphones. For increasing students' motivation towards using SMART App, they were informed that they will get participation grade if they access web component on daily basis. Web Component was programmed to logged students' access rate on daily basis and prepare students access rate summary at the end of evaluation process.

For thorough evaluation of SMART App, it was decided that students will have to use it for one full semester i.e. 4 months. At the end of evaluation process, Wang's (Ong, et al. 2004) empirically validated survey instrument developed specifically for asynchronous e-learning systems was customized for measuring students' satisfaction towards SMART App. In the first phase of the survey, questions focusing on SMART App usefulness, ease of use, adaptiveness, extra time management

and collaboration were asked from students using five points Likert scale with strongly disagree as 1, disagree as 2, neutral as 3, agree as 4 and strongly agree as 5. Students were also requested to write their comments about SMART App usage, its advantages and disadvantages. Table 1 shows the result of first survey after one semester evaluation period.

**Table 1 SMART App Features Evaluation**

Usefulness	Mean
The SMART App increases my study skills and knowledge	4.5
The SMART App provides very useful contents	4.2
The SMART App provides sufficient contents	4.1
	Mean Average = 4.26
Ease of use	
The SMART App is easy to use	3.2
The SMART App is very user-friendly	3.3
The functionalities and contents provided by SMART App are very easy to understand	3.1
	Mean Average = 3.20
Adaptiveness	
Web Component provided exactly what I wanted on SMART App	4.6
The SMART App enables you to control your learning progress.	4.7
The SMART App was enabled to successfully record your learning progress and performance.	4.6
	Mean Average = 4.63
Extra time Management	
The SMART App helped me in converting my spare time into productive time.	4.5
The SMART App helped me in managing my time more wisely.	4.7
I was able to study in my spare time while using SMART App.	4.8
	Mean Average = 4.67
Students Collaboration	
The SMART App enabled me to discuss topic questions with peers and Instructors online.	4.2
The SMART App makes it very easy to share your learning experiences with learning community.	4.1
It was very easy for me to instantly share learning contents with my classmates.	4.3
	Mean Average = 4.20

The average score of usefulness aspect (4.26) indicated that SMART App was a successful learning companion of the students in improving their learning skills. On the other hand,

result related to ease of use factor (3.20) of SMART App indicated that students were not fully satisfied with the user interface of SMART App. Upon analyzing students' comments at the end of questionnaire, it was revealed that students did showed little frustration in using and understanding SMART App. Students clarified their interaction problems with SMART App later during interview session. Most of the students did used e-learning software application earlier in their life but all of those were web browser based applications installed on laptops and desktop computers. It was for the first time that they were using smartphones app for assisting them in their learning process. Due to small touch screen of smartphone, students find it were difficult to write long comments and post them on discussion board. Many students were of the opinion that they never thought that smartphones will assist them in their learning process. From them the prime usages of smartphones were entertainment, playing games and communication with colleagues. Nevertheless, almost all students showed great interest in using smartphones as a supporting tool to improve their study behavior in future.

Students found our SMART App as very adaptive (4.63) and they felt very comfortable in managing their extra time (4.67) as well using SMART App. The average score related to collaboration (4.20) indicated that students also showed great interest in creating and using online discussion board.

Students in interview session affirmed their full satisfaction towards adaptive factor of SMART App. Students were of the opinion that they remained focused, tailored and targeted in their learning while using SMART App. One of the student's views regarding adaptive nature of SMART App is given below:

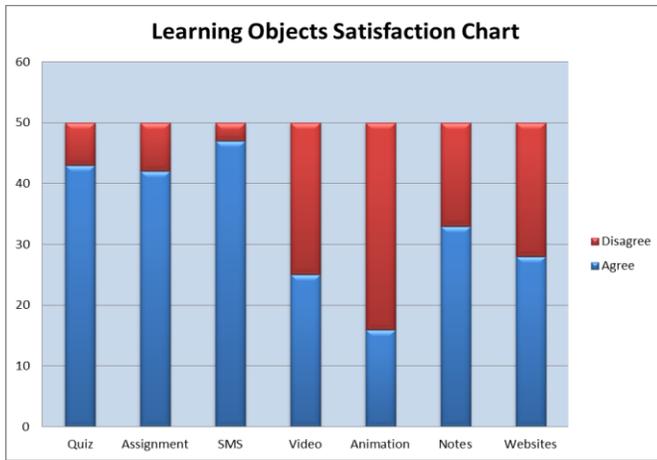
*While using SMART App, I always progressed step by step in my studies knowing what I have to do next. Knowing the good performance of other students through mobile SMS motivated me a lot in competing with them. Smart App was helping me to remember many class matters that I often forgot during my studies.*

The result of the first phase of the survey revealed that overall students were highly satisfied by our SMART App and agreed to use it as a learning tool or aid in future.

The second phase of the survey emphasized on finding the effectiveness of multidimensional learning contents and revealing students' preferred multidimensional learning content. Furthermore, the second phase also emphasized on finding students satisfaction towards performing quiz and assignment activity on SMART App. Same 50 students who participated in the first phase of survey took part in the second phase of survey. This survey consisted of 7 questions related to multidimensional contents, quizzes and assignments. In this case, students had two options of agree or disagree from which students have to select only one. At the end of survey questions every students also had to his/her comments about SMART App usefulness and lacking. Table 2 shows the survey questions and students responses. Furthermore, figure 5 shows the graphical representation of students' agreement and disagreement towards multidimensional contents, quizzes and assignments activity.

**Table 2 Students Responses towards SMART app usage**

Survey Questions	Agreed	Disagreed	Total	Agreed Percentage
SMART App allows you to easily attempt quiz -- anytime and anywhere	43	7	50	86
SMART App allows you to conveniently attempt assignment --- anytime and anywhere	42	8	50	84
SMS notifications and alerts sent on your smartphones were very helpful.	47	3	50	94
You enjoyed watching video tutorials on your smartphone.	25	25	50	50
You enjoyed watching learning HTML5 animations on your smartphone.	16	34	50	32
You enjoyed reading subject notes in the form of PowerPoint Slide, PDF files and Word files.	33	17	50	66
Websites recommendations send on your smartphones were very helpful.	28	22	50	56



**Figure 5 Students' learning objects satisfaction chart**

The results of the second phase survey were surprising. It was noticed that students have mixed sentiments towards video tutorials, animations, notes and websites when they used them for learning on their smartphones. This also infers that students do prefer their unique learning style influenced by the type of learning material. Table 2 shows that out of 50 students half of them enjoyed watching video tutorials on smartphones and half of others were not interested in using smartphones for watching video tutorials. Similarly, most of the students did not show interest in watching learning animations on their smartphones. The overall score on quizzes, assignments and SMS notifications indicated that students perceived them as good complimentary activities in their learning process. Regarding notes reading in the form of PowerPoint file, PDF files and Word files on smartphones, most of the students find it healthy activity. Similarly, most of the students enjoyed browsing helpful learning websites recommended by instructors. Students' comments at the end of questionnaire were worth reading and revealed that every student has unique learning styles supported by distinctive learning material. Following are some of the reasons behind the success of quizzes, assignments and SMS notification activities mentioned in students comments.

“SMART App allowed us to attempt quizzes independent of restricted physical location and at our preferred time. Unlike desktop computers and laptops, smartphones can be carried anywhere and we can attempt quizzes from anywhere and at the most suitable time. Similarly, SMART App allowed us to work on our class assignments, collaborate with friends and teachers while working on assignment from different locations. With the help of our smartphones we were able to instantly make videos, take pictures and express our ideas and upload them on web component as our assignment. SMART App helped us in moving in disciplined and step by step order making our everyday a productive day.”

SMS alerts and notifications were liked by highest numbers of students in comparison with other learning material. As mentioned earlier, these SMS alerts and notification were about class activities, exam dates, quiz and assignments dates and deadlines, class attendance and teachers advise. Following

paragraph is summary of students' comments regarding SMS alerts and notifications.

“SMART App, through smart SMS alerts and notifications was successful in making us up-to-date about different class activities. SMART App provided information to us that most often are forgotten by students due to busy semester schedule. We felt that our memory load is reduced and we were able to concentrate on most important and up-to-date tasks.”

Out of 50 students half of the students enjoyed watching educational video tutorials on smartphones and half of them were not completely satisfied by this activity. Upon thoroughly reading students' comments, many interesting students' perceptions were revealed about watching video tutorials on smartphones. Students who liked watching video tutorials on smartphones were of the view that they were able to learn more in short period of time. Additionally, whenever they were in some waiting state or traveling in vehicle, they were keen to watch those video tutorials on smartphones. Students stressed on the fact that in daily routine, there are many situation where students is in waiting state like waiting for bus, waiting for friend, waiting for teacher and time between two classes. This waiting state is always very frustrating and SMART App helped them in converting that spare time in waiting state into productive time. On the other hand students who disliked watching video tutorials on smartphones were having issues with small screen size, environmental noises and distraction, unstable state and weak smartphones audio strength.

Students complained most about HTML5 animations. Again very much similar opposing comments were given for animations as that for video tutorials by the students. It was also confessed that the quality and appeal of HTML5 animations were not of high quality.

Regarding reading PDF, MS Word and PowerPoint notes activity, most students enjoyed and appreciated it. Similarly, surfing adaptive websites was also a fruitful activity on smartphone according to students' opinion. Students were able to take better decision in fast semester phase.

#### 4. Conclusion and Future Work

In this paper we presented new smartphone based adaptive learning model consisting of six stages namely profiling, goal setting, facilitating, evaluation, assessment and motivation. Based on this adaptive learning model smartphone App called SMART was developed and tested by 50 undergraduate students for its success and usefulness. Our analysis and evaluation results shows that smartphones have very important place in improving students learning and study behavior. More important for smartphone app developers and for students is not to take smartphones to extreme usage. For example, smartphone app developed by app developers that overloads students with notifications, alerts, reminders and other learning material may result in disappointing and frustrating students. Rather than considering smartphones as facilitator, students might consider it impervious in their learning process. On the other hand, students will be wasting their valuable and usefulness resource if they do not use it in their learning process. What is important is to know

the power of smartphones, the right time to use it and the right pedagogical mobile learning techniques that result in improving students learning behavior.

## 5. Acknowledgement

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