



HAL
open science

How Do They Use Their Smartphones: A Study on Smartphone Usage by Indian Students

Subrata Tikadar, Samit Bhattacharya

► **To cite this version:**

Subrata Tikadar, Samit Bhattacharya. How Do They Use Their Smartphones: A Study on Smartphone Usage by Indian Students. 17th IFIP Conference on Human-Computer Interaction (INTERACT), Sep 2019, Paphos, Cyprus. pp.132-151, 10.1007/978-3-030-29387-1_8 . hal-02553919

HAL Id: hal-02553919

<https://inria.hal.science/hal-02553919>

Submitted on 24 Apr 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

How Do They Use Their Smartphones: A Study on Smartphone Usage by Indian Students

Subrata Tikadar and Samit Bhattacharya

Indian Institute of Technology Guwahati, Guwahati, India
subratatikadar@gmail.com, samit3k@gmail.com

Abstract. It is very important to know users' behavior to design and build effective interactive systems, tools, or applications. The behavioral study not only helps to assure the success of any design or product but also helps other researchers from various related areas. In this study, we have systematically collected and analyzed the behavioral data for smartphone usage by 1711 students of 188 academic institutions throughout India. We have observed students' behavior on smartphone usages both inside and outside the classroom. We conducted the study focusing on two aspects: to find the behavioral differences on the smartphone usage based on the gender, and academic level; and to identify the most frequently performed smartphone activities by the students inside and outside the classroom. Although there are few similarities with the existing related studies, we have found many dissimilarities as well. It is expected that the findings of the study will help many researchers from various fields including HCI, Mobile HCI, Behavioral Science, Psychology, and Education.

Keywords: Academic Class, Classroom activities, Indian students, Smartphone usage, Students' behavior.

1 Introduction

With the increasing adoption of new technologies and gradual decreasing cost of Internet connectivity, smartphone ownership among students has become very common in developed as well as in developing countries. Today we rarely find a college student who does not have a smartphone. Nowadays, many school students also use smartphones beyond the school hours, and sometimes in the classroom without the knowledge of teacher and administration. Present day smartphones are so advanced that we cannot but term them as 'pocket-computer.' Students use their smartphones for various academic and non-academic purposes. Academic purposes include taking class-note, participating in real-time online poll, accessing online course material, surfing educational sites and so on. Non-academic purposes include playing games, accessing instant messaging services and social networking websites, listening to music, watching movies, monitoring health, booking tickets (air, railway, bus, movie etc.) and hotels, online shopping, performing financial transactions, and other daily-life activities (booking cab, using location access service and so on) [1, 20, 28, 29].

Many researchers and academicians have tried and are trying to identify the effect (and probable reason of it) of using smartphones inside and outside the classroom. For instance, it has been observed that using digital devices in the classroom may cause distraction and exhaustion, especially when those are used for non-academic purposes [12]. These distractions and exhaustions are in addition to the common classroom distractions and fatigues [11, 21]. Common distractions include conversation among students, and other noises in and outside the classroom. Ragan et al [26] found that students have a tendency to use digital devices largely for non-academic purposes, even when they are in the classroom. When the students are addicted to some non-academic applications, their academic performances hampers [14]. Classroom learning can be affected due to multitasking activities, even if the tasks are classroom related [29]. Other harms of smartphone overuse among students are insomnia, lack of attention, social anxiety, impulsive behavior, depression and stress [19, 33]. These may affect the classroom learning and performance of the students, directly and/or indirectly.

These are the instances of possible downsides of using smartphones by students, particularly when they are in the classroom. However, there are many evidences where researchers have clearly reported that there is no negative impact of using smartphones by students, even when they are in the classroom [10, 15]. In fact, there are many direct and indirect advantages of using smartphone in and outside the classroom [5]. Sometimes the advantages are more than disadvantages [16]. For instance, findings of Wang et al [34] depicts that interactions through smartphone while learning helps students to learn better and score higher grades. Cacho [5] also mentioned that smartphones are useful tools for education. Roberts and Rees [28] also reported that mobile devices help university students a lot to learn things in a better way. Now a days, learning through mobile devices like smartphone is so popular and beneficial that a new term called 'm-learning' has been fostered [7, 9, 13]. Recently, a new kind of learning environment called 'blended learning environment' has also been popularized. In this kind of learning environment, Information and Communication Technology (ICT) is blended into traditional face-to-face classrooms to achieve the benefits of both [2, 8, 25, 32]. For instance, Tikadar et al [32] have shown that teaching-learning through mobile devices like smartphones in traditional face-to-face classrooms is more beneficial and effective.

Although there are both advantages and disadvantages of using smartphones by students, it is clear that proper monitoring and restriction in the use of non-academic applications are very important [1, 12, 19]. For instance, Lee et al [19], in their study observed that one group of students scored higher grades than other group because of different frequency and duration of academic and non-academic 'apps' (smartphone applications) usages. This was in spite of the fact that every student of the two groups used same number and similar types of apps over the period of the study.

A survey about smartphone usage behavior of students, therefore, is required on regular basis. This helps us not only to be aware of the habits and preferences of the students for using smartphone but also to know the probable reasons of such preferences. For example, most of the time students use non-academic apps in the classroom when they are bored by uninteresting lectures [21]. The survey also helps the

academicians and policymakers to allow and/or restrict particular applications to specific groups of students. Groups may depend on age, gender, level of education, ethnicity, socio-economic status, and so on. Academicians as well as app developers can also decide to build appropriate tools and apps for specific groups.

Although the existing studies regarding smartphone usage (e.g., [4, 19 – 21, 23]) are rich and informative, they are either not up-to-date or not done on the Indian students. This is in spite of the fact that India has the largest student population (as per Census 2011, India has 315 million students, which is the largest number of students) in the world¹. Moreover, the behavior may change based on the ethnicity of the students (details are described in related work section). It might not be a right decision to be taken for Indian students, if required, based on the behavior of some non-Indian students. In this article, we, therefore, present an up-to-date survey on smartphone usage by Indian students.

The explicit research questions we wanted to address by the behavioral study are: (i) Which smartphone activities are generally performed by the Indian students? (ii) Which of the activities are performed most frequently and least frequently both inside and outside the classroom for academic and non-academic purposes? and (iii) Is there any difference in behavior on performing smartphone activities based on gender and academic level (school, UG and PG) of the students?

Here, the ‘behavior’ indicates habits and preferences for performing smartphone activities. The ‘smartphone’ refers to a mobile phone that performs many of the functions of a computer, typically having a touchscreen interface, Internet access, and an operating system capable of running downloaded apps. The term ‘Indian students’ represents all the students who are born and studying in India. Note that in India, generally ‘school students’ refers to students of (I-XII) standards; whereas ‘college students’ indicates undergraduate (UG), and ‘university students’ means postgraduate (PG) which includes research scholars (doctoral students) as well.

2 Related Survey Works

Just few years back (until 2013-2014); laptops were the most used digital device in the classroom. Students used laptops for various academic and non-academic purposes. Therefore, researchers and academicians used to observe the students’ behavior on using such devices and the effect of the same [1, 11, 12, 26, 29].

Recently, Smartphones have replaced laptops [5, 19, 28]. Reasons of the replacement include high computing power and huge memory support to run every types of apps and software in spite of the smaller size of the devices; inclusion of many important functionalities (e.g., ‘qwerty’ keyboard, camera, audio recorder, high-resolution display) and sensors to support gesture based inputs; millions² of free or low-cost apps in app-stores to support almost every necessities (e.g., programming, office productivity, media production, web browsing, location based interactions,

¹ <https://timesofindia.indiatimes.com/india/At-315-million-India-has-the-most-students-in-world/articleshow/37669667.cms>

² <https://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores/>

social media, communication and entertainment); and most importantly the affordability of the devices [15, 35]. The low-cost high-speed Internet connectivity acts as a positive catalyst to its widespread popularity. The portability and ubiquitous nature of the devices is another reasons for them being popular.

Researchers' interests now, therefore, have shifted to observe the students' behavior on smartphone usages instead of laptops. For instance, Bowen and Pistilli [4] conducted a survey to know the students' preference for using mobile apps. In September – October 2011, they asked 1566 students of Purdue University about their device, activities, duration and purpose of use, and preferences for 'native mobile app' and 'mobile web browser' for executing the activities. They found that majority of the students had preferred mobile native apps rather than mobile web browsers, both for academic and non-academic activities. Today, we can realize the importance of their preference – there are now more than seven millions apps¹ in app-stores. McCoy conducted a survey in 2013 and again in 2015 to know the smartphone usage behavior and perception of American students [20, 21]. He wanted to observe the frequency and duration of smartphone usage by the students for non-academic purpose in the classroom. In 2014, Lee et al [19] conducted a survey on smartphone overuse among the undergraduate students of a Korean university. They observed that duration of app usage is more crucial than the type of app the students use. In the same year, Robert and Rees [28] conducted a survey on using mobile devices in the classroom. They wanted to know students' preference for using two different devices (smartphone and laptop) for various activities, and the duration of individual activities. In the survey at Bond University (on 99 students), they noticed that students use their mobile phones mainly for non-academic purposes whereas laptops for academic purposes. Park [23], again in 2014, conducted a survey to know the smartphone addiction among Korean students and the effect of the same. They found that females are more addictive towards apps related to social bonding. In 2015, Müller et al [22] conducted a survey on 176 US students to observe and compare the use of smartphones and tablets for various activities. They observed that smartphones are used more than tablets. Their survey results also depict that the students use both their smartphones and tablets mainly for non-academic purposes. In 2016, Rahman and Shahibi [27] noticed that students prefer to use smartphones rather than laptops, even for the academic activities. In the same year, Cacho [5] also observed that students are very much positive to use their smartphone for academic purposes, particularly for 'm-learning'.

All these works have found various important facts about smartphone usage and its effect among the student community. At the same time, these works hint us to conduct an up-to-date survey. This is because of the changes of students' behavior regarding the smartphone usages with time. There are several reasons for such changes. Technological progress is one of the major reasons for such type of behavioral changes. For instance, consider the usage of SMS (Short Message Service) over time. In 2005, the average number of SMS usage in UK and Denmark was 21-36 per day [3]. In 2011, students used to send 15 SMS per day on average (the number is 39, in case of a girl) [31]. However, in 2014 only 41% of UK students used to send more than

five³ SMS per day. Now-a-days we use SMS only for official purposes, to get OTPs, and in case of emergency. Various stakeholders use SMS for advertisement and promotions, but those are non-personal use. This is probably because people are now habituated with other advanced texting services like IMS (Instant Messaging Services). Other reasons of changes on students' preferences and behavior include their age group, gender, class of study, financial status, and ethnicity. For instance, study of Park and Lee [23, 24] has shown that students' behavior on smartphone usage may change based on their gender. Study of Schroeder et al [30] has shown that students' behavior changes based on age group and class of study. As per their study, frequency of texting by college students is more than that of school students. However, interestingly, this frequency gradually decreases with the time, as the students get older.

Bowen and Pistilli [4] reported that 40% of the students used iPhone in US in 2012, whereas iPhone share in India is only 2-3% to date⁴ (in 2018). This is the proof how statistics differ based on ethnicity as well as financial background of the students. Therefore, an up-to-date survey of smartphone usage, particularly on Indian students is important. This is because the related existing surveys are either old or based on a particular group of students (e.g., students of a particular class of a particular institute of a particular geographical location [19, 23, 30]). Most importantly, we did not find any recent survey where Indian students' behavior on smartphone usage were observed. We, therefore, decided to conduct a contemporary survey throughout India (covering all the states and union territories), among each level of students of every discipline. The survey methodology and findings are reported in the subsequent sections.

3 Methodology

We performed a descriptive type quantitative survey with semi ordered categorical close ended questions [6, 18]. The questions in the survey form are 'semi ordered categorical' because the options are in between nominal and ordinal. We followed the guideline from [18] to conduct the survey. The details are as follows.

3.1 Preparation of survey questionnaire

In this survey, we wanted to know students' habits and frequency of using smartphones both for academic and non-academic purposes. Our special focus was to know the types of activities performed on smartphone by Indian students when they are in the classroom. For preparing the survey questionnaire, we had to know all the possible activities generally performed by the students, both inside and outside the classroom. We conducted an initial pilot study for this. Total 121 UG and PG students, of a national academic institute, participated in the pilot study. We chose the

³ <https://www.statista.com/statistics/466675/frequency-of-using-main-mobile-phone-for-sms-texting-uk/>

⁴ <https://9to5mac.com/2018/07/24/apple-marketshare-in-india-falls/>

particular institute to conduct the pilot study because there is always a high probability of having students from almost every regions of the country in such an institute of national repute (the same has been affirmed by our study).

In the pilot study, we asked the students to anonymously report all the activities done by them with their smartphone. From their reports, we found that they perform 29 possible activities (Fig. 8) with their smartphone.

We prepared the survey questionnaire based on this study. The link of the survey form has been given in the footnote⁵. In the survey, we asked each student about the frequency of doing the 29 activities. We kept seven options for the participants (they had to choose one out of those options). In the second part of each question, we asked them whether they perform that when they are in the classroom. Figure 1 shows an example question used in the questionnaire. We kept a 30th question to know whether the students perform any other activities, except the specified 29 activities.

Additionally, in the beginning of the survey form, there was a portion to collect demographic data. The data include participants' 'gender', 'age', 'academic-class', 'name of the institute', 'native place', and 'annual family income'.

Smartphone-Usage by Indian Students

*Required

Your Smartphone Usage

Please inform us how, when and for what do you use your smartphone. Please be honest while answering the question below (we assure you that the info will NOT be shared with anyone).

You use your smartphone for "SMS" *

All the time

Several times in a day

Once / twice a day

Once a week

Once a month

Less than once a month

Never

Do you use your smartphone for "SMS" even when you are in "Classroom"? *

Yes

No

Never submit passwords through Google Forms.

Fig. 1. Example question used in online survey questionnaire

⁵https://docs.google.com/forms/d/e/1FAIpQLSdL9jS3dy3QOFjgZeHAhFYMA7JRcsntMUp6T5nxLQAjimZzGA/viewform?usp=sf_link

All the questions in the survey form were mandatory, except the question regarding annual family income. The survey was anonymous; nowhere had we asked the name of the students. We did the survey anonymously to get more number of responses as well as to get honest responses from the participants. Some students might hesitate to provide correct information if the form was not anonymous. The questions were written in simple English (and explained wherever required) to make it understandable by every student, keeping the fact in mind that students from India are from diverse backgrounds in the context of medium of instruction. Note that logging the usage detail instead of self-report throughout India may be cumbersome and unethical as the students may have a lot of privacy sensitive data. We took special care while preparing the survey questionnaire to get the accuracy in data and to minimize the latent issues as we targeted a large number of heterogeneous participants [18].

We prepared another version of the survey form (to collect data from school students) with exactly the same questionnaire with two minor modifications. First modification was done in the second part of each of the questions (whether they do a specific activity in the classroom). The statement was modified as ‘do you want to use your smartphone for <name of the specific activity> even when you are in the classroom?’ instead of ‘do you use your smartphone for <name of the specific activity> even when you are in the classroom?’. This is because smartphones are not allowed in many of the schools in India. However, we wanted to know their willingness and preferences for the various smartphone activities in the classroom, if they were allowed (as they are habituated to perform those outside the school-hours, and sometimes in the classroom without the knowledge of the teacher). This may help us to decide whether the devices should be allowed in the schools. Second modification was done for asking the ‘academic-class’. Instead of giving multiple-choice options, we simply provided a space to write their ‘Class’ (VII, VIII, IX, and so on).

3.2 Approach

The survey was conducted both online and offline. We conducted online survey to collect data from college students (‘Google Form’ was used) whereas offline survey was done to collect the data from school students. We used printed copies of the other version of the form (prepared with ‘Microsoft Office Word’) for this.

We requested UG & PG students to participate in the survey by writing a formal mail mentioning the purpose of the survey and providing the link of the survey form, wherever the email addresses were available. We also collected the e-mail addresses of the HODs, Principals, Deans, Directors and other administrators of various institutions all over India and requested them to circulate the online survey form among their students. We also requested them to ask their students to participate in the survey. For this, we targeted all IITs (Indian Institute of Technology), all NITs (National Institute of Technology), all IIITs (Indian Institute of Information Technology), other reputed AICTE (All India Council for Technical Education) approved government and private engineering colleges, almost all reputed general degree colleges and universities of central and state government, and all reputed medical colleges. We got positive response and appreciation for conducting the survey from everywhere we approached.

Table 1 presents the number of institutions we approached with their categories as well as number of institutes from where students have participated in the survey. Figure 2 represents the location distribution of the Institutes.

Table 1. Description of academic institutions we approached and students participated from

Type of Institution	Specification	Approached	Participated
Engineering and Technology	IIT	23	14
	NIT	31	17
	IIIT	23	19
	Others	56	46
General	General Degree (Science, Arts, Commerce) Colleges and Universities	88	74
Medical	AIIMS and Others	29	12
School	Secondary and Higher Secondary Schools	06	06

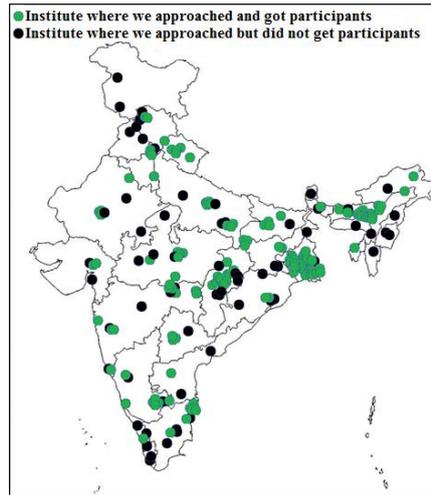


Fig. 2. Distribution of institutions we approached and collected data throughout India

We also approached six schools through the Principals of the schools (sometimes called ‘Headmaster/Headmistress’) to collect data from school students. All of them helped us to conduct the survey in their schools. Among these six schools, two were KVs (‘Kendriya Vidyalaya’ Sanskrit phrase meaning central school), three were state government’s schools and one was a private school running central government’s curriculum. Two schools were situated in Guwahati (Assam) and four were in Kolkata (West Bengal). Medium of instructions for all these schools is English. We distributed the printed copy of the offline version of the form among the school students and collected the filled-up form with the help of the class teachers. Although the data collection procedure was completely anonymous, we assured them of not sharing their responses with anyone, not even with their teachers or guardians.

3.3 Participants

We have reported 1711 students' behavioral data on smartphone usages from 188 academic institutions throughout India. Among those, 1469 students (belonging to 182 institutes) responded to the online survey. Remaining 242 students' data were collected offline from the six schools. The data were collected in the period from December 2017 to July 2018. Figure 3 – 7 represent the demographic information of the participants. Distribution of the age-frequency of the participants is presented in Fig. 3. Figure 4 represents participants' category based on their discipline of studies and institutes. Academic classes of the participants are depicted in Fig. 5. Distribution of the native places of the participants is presented in Fig. 6 ('Others' here mean they did not mention the name of the states or UT properly, e.g., they reported the native place as 'India', 'states', 'Union Territory' and so on). Figure 7 shows the financial backgrounds of the participants. Overall distribution of the gender of the participants were 76% male and 24% female (for the college students, it was 79% male and 21% female whereas for the school students, it was 52% male and 48% female). The statistics of the demographic data show that our study contains students of almost all ages from each location of India, covering all the academic classes, disciplines, and financial backgrounds. The statistics and the number of participants in the study show that we have a good representation of Indian students for the study.

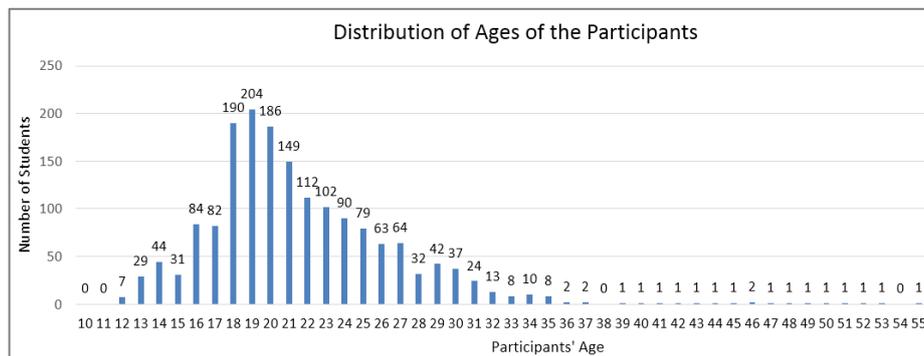


Fig. 3. Distribution of age frequencies of the participants

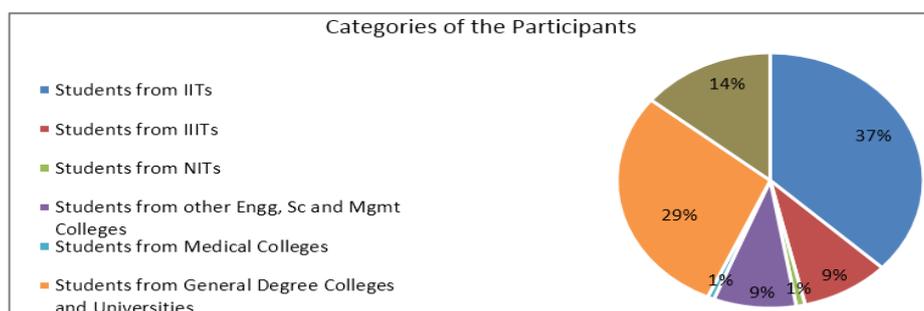


Fig. 4. Distribution of participants' categories based on their discipline of studies and institutes

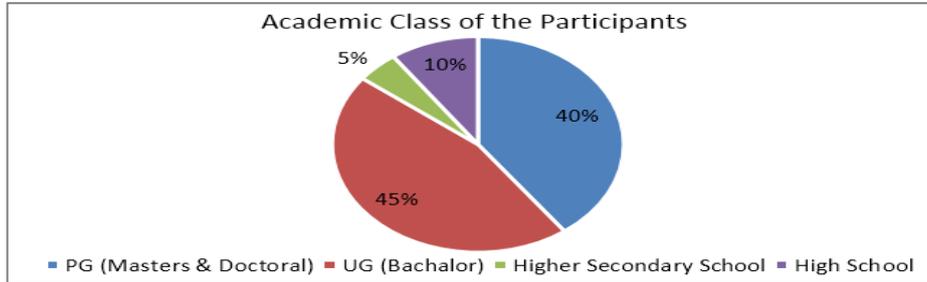


Fig. 5. Distribution of participants' academic class

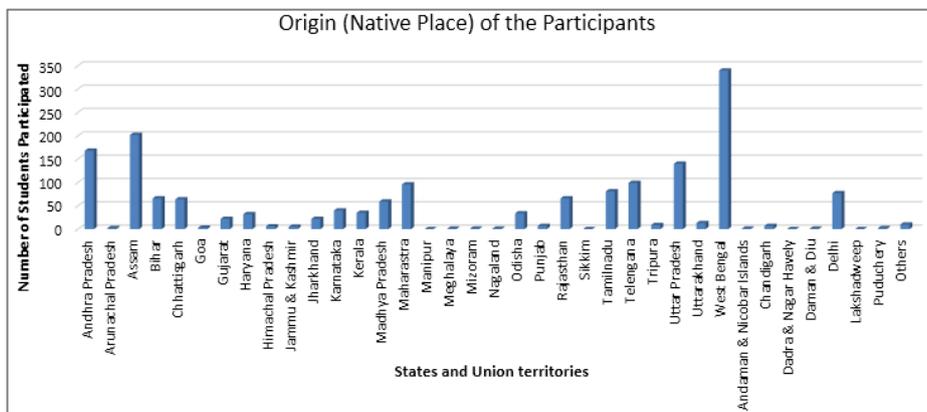


Fig. 6. Number of participants from different regions of the country



Fig. 7. Participants' financial background

Overview of Outliers. The actual number of students participated were 1784 (1522 from online and 262 from offline survey), out of which 73 (53 from online and 20 from offline survey) students were rejected as outliers. We therefore considered the rest of the participants (1711) for our analysis and discussion. For selecting outliers, we manually scrutinized the responses of all the participants. We did not consider the data of those participants who provided the same answer for every question (e.g., responded as 'never' for the first part, and as 'no' for the second part), who did not

respond for all the questions (particularly for school students), or who expressed their irritations and used bad words and slangs in 'comments' field of the survey form. This is because we assumed that these students did not participate seriously and/or honestly in the survey.

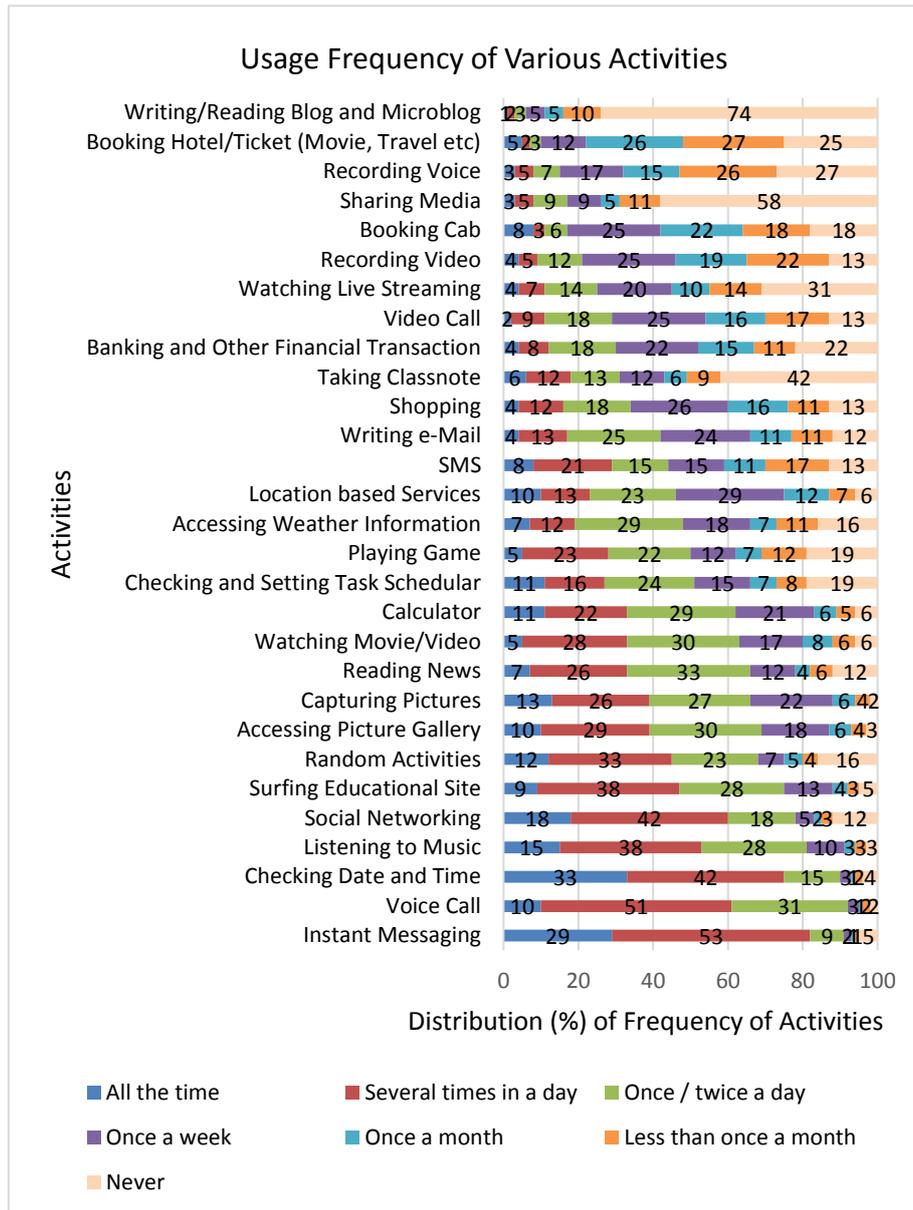


Fig. 8. Overall statistics of smartphone usages by Indian students

4 Results and Findings

Figure 8 represents the overall survey statistics. For instances, the blue colored portion (labelled 29) of the bottom most bar of the figure (bar chart) means that 29% of the students use their smartphones all the time for instant messaging; brown colored portion (labelled 53) of the same bar means that 53% of the students use their smartphones several times in a day for instant messaging; and so on.

Survey result depicts that the following activities are done by the students most frequently: Instant messaging (91% at least once/twice a day⁶, and 82% at least several times a day); voice call (92% at least once/twice a day, and 61% at least several times a day); checking date and time (90% at least once/twice a day, and 75% at least several times a day); listening to music (81% at least once/twice a day, and 53% at least several times a day); social networking (78% at least once/twice a day, and 60% at least several times a day); and surfing educational site (75% at least once/twice a day, and 47% at least several times a day).

Second most frequent activities done by the students are random activities, accessing picture gallery, capturing pictures, reading news, watching movie/video, using calculator, checking and setting task scheduler, and playing game. Accessing weather information, accessing location based services, reading and writing SMS, writing emails, shopping, taking class-note, and financial transactions are found as third most frequently done activities. Rest of the activities are rarely done by the students.

Figure 9 represents the overall statistics of the students' activities on their smartphone inside the classroom. For example, the blue colored portion of the bottommost bar (labelled 66) means that 66% students use their smartphone for checking date and time, even when they are in the classroom. The most frequently done activities inside the classroom are checking date and time (66%), running calculator app (60%), instant messaging (56%), surfing educational site (49%), and social networking (40%). The activities with next level of frequency in the classroom are random activities (34%), SMS (32%), task scheduling (31%), reading news (29%), accessing picture gallery (29%), playing games (27%), capturing pictures (25%), and writing emails (20%). Rest of the activities are rarely performed by the students inside the classroom.

We also asked the students whether they use their smartphone for any other purposes excluding the specified 29 activities. 75% students have reported that they do nothing other than the specified activities. Rest of the 25% students have mentioned various other activities. Few of the other activities are as follows. 47 (3%) students reported that they read e-books (half of them read academic e-books, others read non-academic e-books like novel and magazine). 30 (2%) students have reported that they watch porn. 26 students (1.5%) have reported that they use their smartphone as alarm clock. Four groups of students (1% each) have reported that they use their smartphone for monitoring health, editing photo and video, participating in 'Quora', and flashing

⁶ The term 'at least once/twice a day' means either they use it 'all the time' or 'several times a day' or 'once/twice a day'; similarly, 'at least several times' means either they use it 'all the time' or 'several times a day'; and so on.

torch. Few students (0.5%) have reported that they develop apps in their smartphone. Many other groups of very few students (2-5 students in each group) have reported about various other activities including writing diary, running dating app, playing digital musical instruments, checking stock market, paying bills and maintaining digital wallet, running stopwatch, searching job, and running dictionary app. However, frequency of doing these other activities are rare, as reported by the students. Moreover, none of the students has reported that these other activities are performed in the classroom.

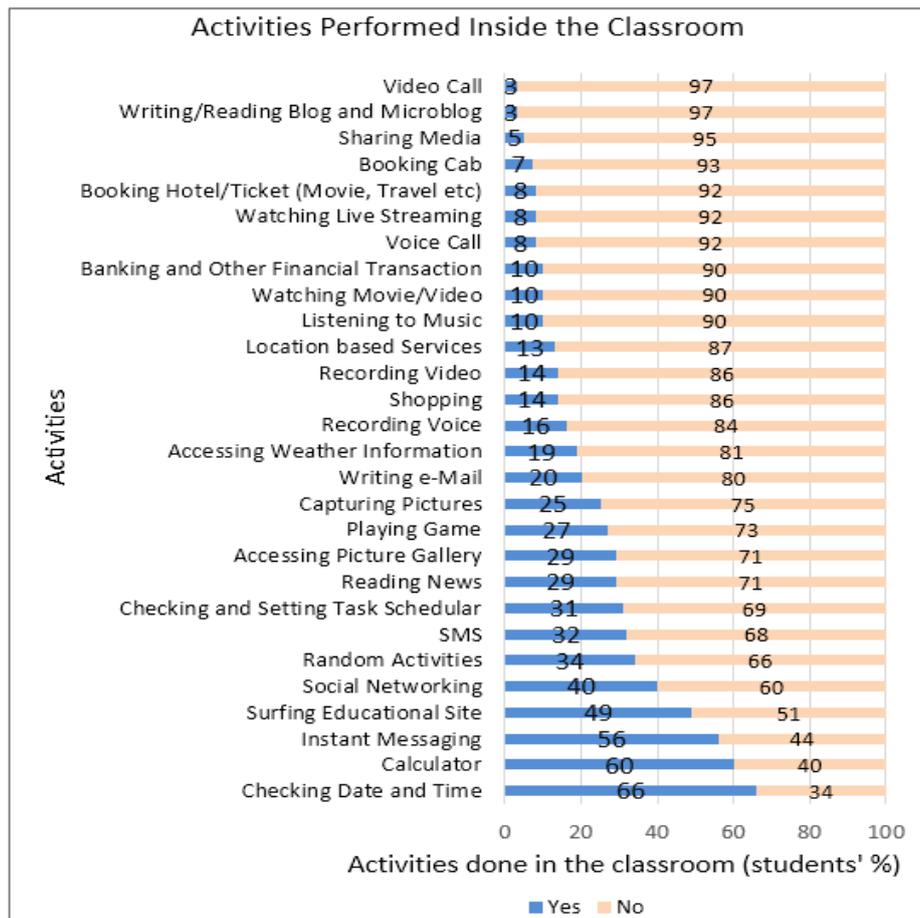


Fig. 9. Smartphone usages statistics inside the classroom

Overall survey results prove that most of the time students have a tendency to perform those activities in the classroom, which are performed most frequently by them in general (except the voice call). Other than these overall statistics of the smartphone usages, we have also observed the behavioral differences of smartphone usage based on students' gender, and academic level.

4.1 Usage Differences based on Gender

We found that the male students play games, perform social networking, write e-mails, read news, surf educational sites, perform financial transactions, check date and time, and perform random activities more than female students. On the other hand, the female students use mobile camera to take pictures, access picture galleries, and send SMSs more than the male students. While testing the significance of the differences statistically, we have found that the differences are significant only for playing games ($p=0.04$), and reading news ($p=0.02$). Note that we have used t-test for all the statistical tests mentioned in the paper. We considered $\alpha=0.05$. This means that the difference is significant with 95% confidence, if and only if the p value is found to be <0.05 .

Similar gender based differences on performing smartphone activities have been observed inside the classroom as well, except listening to music and writing e-mail (female students listen to music more than the male students, whereas male students writes more e-mails than the female students inside the classroom). However the gender based differences for these two activities inside the classroom are found insignificant. Inside the classroom, significant differences have been found for playing games ($p=0.02$), and reading news ($p=0.02$). These two activities are performed by the male students significantly more than the female students in general as well. This observation indicates that the smartphone usage differences based on gender are similar, both inside and outside the classroom.

4.2 Usage Differences Based on Academic Level

Our survey result depicts few dissimilarities in students' behavior on smartphone usage depending upon the level of academic class.

School vs College & University. We have observed that the school students perform video calls, send SMSs, play games, take pictures, watch live streaming, share multimedia data, and record videos as well as voices more frequently than the college and university students. On the other hand, the college and university students perform voice calls, perform instant messaging, do social networking, surf educational sites, read news, access picture galleries, perform financial transactions, check date and time, check and set task scheduler, and perform random activities more frequently than the school students. However, among these, significant differences have been found for SMS ($p=0.002$), watching live streaming ($p=0.04$), sharing media ($p=0.03$), social networking ($p=0.04$), and random activities ($p=0.03$).

Inside the classroom, majorly following activities are done more frequently by the UG and PG students compared to the school students (for school students, we asked their willingness to do the various activities in the classroom as sometimes they are not allowed to use smartphones in the classroom): Playing game, instant messaging, social networking, surfing educational site, writing e-mail, reading news, accessing picture gallery, checking date and time, scheduling tasks, calculator, and different random activities. When we performed statistical test, it has been found that the differences are significant for performing all these activities ($p\leq 0.04$). Possible reasons

may include underage, and the restriction of using such device in the school (although the school students have reported their willingness of using those activities inside the classroom, that may not be exactly the same when they will be allowed to use).

UG vs PG. We also have observed the differences of the usage behavior among the UG and PG students. It has been observed that the UG students play games, listen to music, watch live streaming, record videos and voices, use calculator, and take class notes more frequently compared to the PG students. On the other hand, the PG students perform instant messaging, surf educational sites, write e-mails, read news, do shopping, and perform banking and other financial transactions more frequently than the UG students. In this case, we found significant differences for watching live streaming ($p=0.03$), recording voice ($p=0.03$), writing e-mail ($p=0.03$), and shopping ($p=0.01$).

Inside the classroom, the UG students play games, listen to music, watch movies and videos, do social networking, surf educational sites, read news, capture pictures, access picture galleries, watch live streaming, record videos and voices, and perform random activities more frequently compared to the PG students. Nevertheless, these differences were found insignificant while tested statistically. We have not found any activity, which is performed by the PG students more frequently than the UG students inside the classroom.

We summarize the findings of the study in Table 2.

Table 2. Summary of the findings

SN	Observational Aspect	Findings and/or lesson learned
1	Number of activities generally performed by the students	29 (see figure 8 and 9 to for the name of the activities).
2	Five most frequently performed activities (in general)	Instant messaging, voice calls, checking date and time, listening to music, and accessing social networking sites (presented in descending order).
3	Five least frequently performed activities (in general)	Writing/reading blogs, booking hotels/tickets, recording voices, sharing media, and booking cabs (presented in ascending order).
4	Five most frequently performed activities (inside the classroom)	Checking date and time, calculator, instant messaging, surfing educational sites, and social networking (presented in descending order).
5	Five least frequently performed activities (inside the classroom)	Video calls, writing/reading blogs/microblogs, sharing media, boking cabs, and booking tickets and hotels (presented in ascending order).
6	General Observation	In the classroom, students have a tendency to perform all the activities frequently which are performed most frequently by them in general (except the 'voice call').
7	Behavioral differences based on gender	Male students read news and play games more than female students both inside and outside the classrooms
8	Behavioral difference based on academic level	(i) school students watch live streaming and share media significantly more than college students, (ii) college students perform social networking, and random activities significantly more than school

		students, (iii) UG students watch live streaming, and record voice significantly more than the PG students, (iv) PG students write e-mails and do shopping significantly more than the UG students.
--	--	---

5 Discussions

The research questions that we wanted to address by the behavioral study were: (i) which smartphone activities are generally performed by the Indian students? Our answer to that question is that there are 29 activities including instant messaging, voice call, listening to music and so on; (ii) which of the activities are performed most frequently and least frequently both inside and outside the classroom for academic and non-academic purposes? We have observed that the activities like instant messaging, voice call are performed most frequently and the activities like writing/reading blogs, booking hotels/tickets are performed least frequently in general (none of these are related to academic); inside the classroom, activities like checking date and time, calculator are performed most frequently (majority of those are non-academic) and the activities like video calls, writing/reading blogs/microblogs are performed least frequently; (iii) Is there any difference in behavior on performing smartphone activities based on gender and academic level (school, UG and PG) of the students? The answer is yes. We have found significant differences on performing smartphone activities based on the gender and academic level (e.g., PG students write e-mails and do shopping significantly more than the UG students, male students read news and play games more than female students and so on).

Significant gender differences have been found in case of playing games and reading news. Male students perform these activities more than female students. Research may be conducted to identify the probable reasons for the lack of interest of the female students in these activities, and their fascination for spending more time in some other activities like taking picture, and accessing picture gallery. For instance, one reason for playing less games by the female students may be the lack of interesting elements for many of them in most of the existing games. Game designers may rethink about this while design a game for targeting more number of players. While observing the differences of usage between college and school students, we have noticed that the school students send SMS, watch live streaming, and share media significantly more than college students. On the other hand, the college students perform social networking and random activities considerably more than the school students. Reasons for these may include less usage of the devices (parents' monitoring for restricted use of smartphones), lack of openness and less connection with the outer world for school students. The college students may habituated with using instant messaging service instead of SMS for communicating with their relatively larger number of contacts. While comparing the UG and PG students we have found that the PG students write numerous e-mail and do shopping more than the UG students. Reasons for writing more mail may include requirement for staying in touch and formal interactions with a large number of people for their job applications, teaching assis-

tantships, and research guidance as well as collaborations. Students tend to become less dependent on their parents as they grow older. Sometimes they start earning or getting fellowships while they are in PG courses. These may be the probable reasons for more shopping by PG students compared to a UG students. If we compare among the school, UG, and PG students, it is noticeable that the school students perform media related activities (e.g., sharing media, live streaming) more than the UG students whereas the UG students perform those more than the PG students. The probable reasons may include the lack of interests because of the age differences [30].

Our survey results contradict many aspects of the earlier findings. Kukulska-Hulme et al [17] reported that SMS is the most frequently performed activity among all the activities performed on the smartphone. As per their findings, three top most usages (in Australia, Hong Kong, Portugal, Sweden, and UK) were SMS, browsing website, and listening to music (in descending order). However, we have found instant messaging as most frequently performed activity and the three top most usages are instant messaging, voice call, and checking date and time (in descending order). The reasons might be the availability of advanced messaging service, lower cost for Internet connection, and ethnicity. We found dissimilarities in one of the least frequently used activities as well. As per our survey result, booking hotel/ticket (movie, travel) is the second least frequently activity which was not found in their list of 'least performed activities'. The possible reason may be the ethnicity; may be India and Indian students are still not technologically advanced in that extend. Another reasons for this may be their consideration of only mature students in their study.

Our survey results also contradict the finding of Jena [15]. He reported that the use of smartphones for academic purposes is more than that of the non-academic purposes. However, our survey results portray the opposite scenario; students use their smartphones mainly for non-academic purposes, rather than academic purposes. The reasons for such difference might be their limited and specific participants for study; they collected data from 310 postgraduate students of business management.

There is partial contradiction between our findings and the findings of Park [23]. Although his findings about gender differences on smartphone is similar in many aspects, our result mainly contradicts two such aspects. Firstly, for SMS, they found that the males are more addicted than females; whereas we have found that females are more addicted to SMS than males. However, the differences are not statistically significant ($p=0.19$). Secondly, they found that males are more addicted to listen to music than females; whereas we found that addiction of listening to music on smartphone is similar (~80% at least once/twice a day, and ~54% at least several times in a day) for both the male and female students. In fact, sometimes (e.g., in the classroom) the female students listen to music more than the male students. Ethnicity, technological growth and changes in society may be few of the probable reasons for these kind of contradictory statistics.

We expect that this updated knowledge will be useful in many ways, both for the researchers of HCI/Mobile-HCI as well of other multidisciplinary domains. For instance, in a blended learning platform, if we want to systematically identify whether a student is performing some study related activities or using the device for some unexpected activities (e.g., playing game, watching movies and so on), we first require to

know all possible activities performed by the student. Academicians and policymakers can decide whether the devices should be allowed or not in the Institute, based on the level of academic-class (e.g., for school students). Even if allowed, they can make policy for the controlled use of smartphones inside and outside the classroom for maximizing the benefits and minimizing the harms from it. Students should also restrict the use of their devices for academic purpose only especially when they are in the classroom. Based on the students' interest, academicians and researchers can build effective tools and systems having interesting features. For instance, inclusion of features of social networking apps in a blended learning classroom system may increase the rate of acceptance of the same and consequently the learning outcomes. Consideration of users' interests while designing and developing new systems and applications increases the rate of acceptance of the product. Therefore, smartphone makers as well as app developers can utilize the knowledge for designing and developing new phones and its apps. The knowledge may be useful for the researchers of behavioral science as well. They can analyze the results to explore the cognitive processes among students of different groups. Sociologists and psychologists may treat a student (of a particular group) or make effective guidelines for them keeping in mind their interests and habits. This is equally applicable for parents and teachers.

6 Conclusion

We conducted a behavioral study to find out the smartphone activities performed by the Indian students and the frequencies of those activities both inside and outside the classroom. The study is important since the literature reveals that ethnicity plays important role in the student behavior and there is no up-to-date survey on the smartphone usage behavior of the Indian students. We also studied the differences in the behavior of the students based on their gender and academic level. We have found that twenty nine activities are generally performed by the Indian students. Most of the frequently performed activities are also performed frequently inside the classroom. Majority of the frequently performed activities are non-academic, both inside and outside the classroom. We have found significant differences in the behavior based on the gender and academic level of the students. Findings including gender based difference in playing games, and academic level based difference in performing media related activities corroborate the findings of the related studies. At the same time, findings including gender based difference in listening to music, and the tendency of using the smartphone for non-academic purposes contradict the earlier findings in the related studies. We hope that the survey and its findings will help many multidisciplinary researchers.

Acknowledgements. We sincerely acknowledge the contribution of Mr. Shashank Kotyan and all the survey participants (both students and the faculty members). We also thank all the reviewers and the shepherd for their constructive suggestions to improve the quality of the manuscript.

References

1. Awwad, F., Ayesh, A., Awwad, S.: Are laptops distracting educational tools in classrooms. *Procedia-Social and Behavioral Sciences* 103(1), 154-160 (2013).
2. Bär, H., Tews, E., Rößling, G.: Improving feedback and classroom interaction using mobile phones. *Proceedings of Mobile Learning*, pp. 55-62. Qwara, Malta (2005).
3. Barkhuus, L.: Why everyone loves to text message: social management with SMS. In *Proceedings of the 2005 International ACM SIGGROUP Conference on Supporting Group work*, pp. 324-325. ACM, Sanibel Island, Florida, USA (2005).
4. Bowen, K., Pistilli, M.D.: Student preferences for mobile app usage. *Research Bulletin*(Louisville, CO: EDUCAUSE Center for Applied Research, forthcoming), (2012) available from <http://www.educause.edu/ecar>.
5. Cacho, R.M.: Student teachers' smartphone academic uses and preferences: Perspectives for mobile-aided pedagogy. In *2016 14th International Conference on ICT and Knowledge Engineering (ICT&KE)*, pp. 57-61. IEEE, Bangkok, Thailand (2016).
6. Cairns, P., Cox, A.L. eds.: *Research methods for human-computer interaction*. Cambridge University Press (2011).
7. Chen, C.M., et al.: Personalized intelligent m-learning system for supporting effective English learning. In *IEEE International Conference on Systems, Man and Cybernetics (SMC'06)*, vol. 6, pp. 4898-4903. IEEE, Taipei, Taiwan (2006).
8. Du, H., Rosson, M.B., Carroll, J.M.: Augmenting classroom participation through public digital backchannels. In *Proceedings of the 17th ACM international conference on Supporting group work*, pp. 155-164. ACM, Sanibel Island, FL, USA (2012).
9. Evans, C.: The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers & education* 50(2), 491-498 (2008).
10. Ezenenaka, E.: The usage and impact of internet enabled phones on academic concentration among students of tertiary institutions: A study of University of Ibadan, Nigeria. *International Journal of Education and Development using ICT* 9(3), 162-173 (2013).
11. Fried, C.B.: In-class laptop use and its effects on student learning. *Computers & Education* 50(3), 906-914 (2008).
12. Gaudreau, P., Miranda, D., Gareau, A.: Canadian university students in wireless classrooms: What do they do on their laptops and does it really matter?. *Computers & Education* 70(1), 245-255 (2014).
13. Georgiev, T., Georgieva, E., Smrikarov, A.: M-learning-a New Stage of E-Learning. In *International conference on computer systems and technologies (CompSysTech'2004)*, vol. 4, no. 28, pp. 1-4. Rousse, Bulgaria (2004).
14. Giunchiglia, F., et al.: Mobile social media and academic performance. In *International Conference on Social Informatics (SocInfo17)*, pp. 3-13. Springer, Cham, Oxford, UK (2017).
15. Jena, R.K.: The impact and penetration of smartphone usage in student's life. *Global Journal of Business Management* 8(1), 29-35 (2014).
16. Kay, R., Lauricella, S.: Exploring the benefits and challenges of using laptop computers in higher education classrooms: A formative analysis. *Canadian Journal of Learning and Technology/La revue canadienne de l'apprentissage et de la technologie* 37(1), 1-18 (2011).
17. Kukulska-Hulme, A., et al.: Mature students using mobile devices in life and learning. *International Journal of Mobile and Blended Learning (IJMBL)* 3(1), 18-52 (2011).
18. Lazar, J., Feng, J.H., Hochheiser, H.: *Research methods in human-computer interaction*. WILEY (2010).

19. Lee, U., et al.: Hooked on smartphones: an exploratory study on smartphone overuse among college students. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems (CHI 2014), pp. 2327-2336. ACM, Toronto, Canada (2014).
20. McCoy, B.: Digital Distractions in the Classroom: Student Classroom Use of Digital Devices for Non-Class Related Purposes. *Journal of Media Education* 4(4), 5-14. (2013).
21. McCoy, B.R.: Digital distractions in the classroom phase II: Student classroom use of digital devices for non-class related purposes. *Journal of Media Education* 4(4), 5-14 (2016).
22. Müller, H., et al.: Understanding and comparing smartphone and tablet use: Insights from a large-scale diary study. In Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction (OzCHI '15), pp. 427-436. ACM, Parkville, VIC, Australia (2015).
23. Park, N.: Gender difference in social networking on smartphones: A case study of Korean college student smartphone users. *정보통신정책연구 (International Telecommunications Policy Review Research)* 21(2), 1-18 (2014).
24. Park, N., Lee, H.: Nature of youth smartphone addiction in Korea. *언론정보연구 (Media Information Research)* 51(1), 100-132 (2014).
25. Pohl, A., Gehlen-Baum, V., Bry, F.: Introducing Backstage—a digital backchannel for large class lectures. *Interactive Technology and Smart Education* 8(3), 186-200 (2011).
26. Ragan, E.D., et al.: Unregulated use of laptops over time in large lecture classes. *Computers & Education* 78(1), 78-86 (2014).
27. Rahman, N.F.A., Shahibi, M.S.: The Growth of Smartphone Usage among Students. *Research Hub* 2(1), 64-68 (2016).
28. Roberts, N., Rees, M.: Student use of mobile devices in university lectures. *Australasian Journal of Educational Technology* 30(4), 415-426 (2014).
29. Sana, F., Weston, T., Cepeda, N.J.: Laptop multitasking hinders classroom learning for both users and nearby peers. *Computers & Education* 62(1), 24-31 (2013).
30. Schroeder, B.L., et al.: Individual differences in middle school and college students' texting. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting, vol. 60, no. 1, pp. 1215-1219. Sage CA, Los Angeles, California, US (2016).
31. Shahyad, S., et al.: A Comparison of motivation, frequency and content of SMS messages sent in boys and girls high school student. *Procedia-Social and Behavioral Sciences* 15(1), 895-898 (2011).
32. Tikadar, S., Bhattacharya, S., Tamarapalli, V.: A Blended Learning Platform to Improve Teaching-Learning Experience. In 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT) (pp. 87-89). IEEE, Mumbai, India (2018).
33. Van den Eijnden, R.J., et al.: Online communication, compulsive Internet use, and psychosocial well-being among adolescents: a longitudinal study. *Developmental psychology* 44(3), 655-665 (2008).
34. Wang, R., et al.: StudentLife: assessing mental health, academic performance and behavioral trends of college students using smartphones. In Proceedings of the 2014 ACM international joint conference on pervasive and ubiquitous computing (UbiComp '14), pp. 3-14. ACM, Seattle, WA, USA (2014).
35. Woodcock, B., Middleton, A., Nortcliffe, A.: Considering the Smartphone Learner: an investigation into student interest in the use of personal technology to enhance their learning. *Student Engagement and Experience Journal* 1(1), 1-15 (2012).