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HOW DO STUDENTS REALLY INTERACT? AN INVESTIGATION OF LITHUANIAN STUDENTS' INTERACTIONS VIA SMARTPHONE APPS

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ABSTRACT

Purpose: This mixed-method study investigated the ways smartphone applications (apps) promote students' interaction, collaboration and learning performance.

Method: A total of 160 respondents from a Lithuanian university were identified using convenience sampling. A survey was conducted to explore the frequent activities involving interaction, collaboration and learning performance. Focus group interviews were also conducted to determine the apps used in their interactions.

Findings: The quantitative results suggest that smartphone apps promote students' interaction, collaboration and improved learning performance.

Qualitative results indicate three types of apps that are commonly used for interactions by the undergraduates in Lithuania, namely the educational, communication, and entertainment apps.

Significance: The findings suggest that the instructions can play a constructive role in mediating the learners' interaction on smartphone apps. As such, the study creates space for instructors to further craft pedagogical practices to better account for learners' access to these apps. It is hoped that this study will provide a path for educational solutions for instructors and practitioners.

Keywords: Smartphone, apps, higher institutions, interaction, collaboration.

INTRODUCTION

The integration of mobile phones to aid different aspects of teaching and learning activities have met with varying degrees of success. A number of studies have demonstrated on how smartphones are appreciated for communication capacity (Aoki & Downes, 2003; Leung & Wei, 2000; Walsh & Young, 2008), alleviate stress (Toda et al., 2006), and engagement and collaboration (Chen & Lan, 2013; Oigara & Keenwe, 2013; Gikas & Grant, 2013). Studies have also suggested that students use mobile phones to maintain social connection and to overcome boredom (Aagaard, 2015; Emanuel, 2013; McCoy, 2016 & Olifadi, 2015). Herrington et al. (2009) acknowledged that mobile learning has the potential to enhance learners' engagement across "collaborative, contextual, constructionist and constructivist learning environments" (p.2). As a result, many higher learning institutions are considering smartphones as a learning aid since the digital natives are attached to smartphones (Anshari et al., 2017).

Yet as valuable as they are, mobile phones seem to be a major distraction for learners (Rosen et al., 2013). Literature shows that issues related to the adoption of smartphone apps still exist. For example, Cooper (2015) in his study with secondary and high school students, found that those who spent more than five hours on mobile phones tend to take more than an hour to fall asleep. The author also highlighted that most of the students are accessing smartphones during school hours. For Williams and Pence (2011), smartphones are a distraction rather than a learning tool. A study conducted by Chen et al. (2016) found that young Chinese adults who are addicted to mobile phones seem to have more negative emotions compared to non-addicts. The addiction also prevents student-student connection and the establishment of a collaborative learning environment (Soomro, Zai, Nasrullah & Hina, 2019). Other studies reported on psychological distress (Thomee et al., 2011) and

depression (Lemola et al., 2015). The mixed results have led researchers to call for more studies related to the usage of mobile phones (Merchant, 2019). To unravel these contradictory research findings and to achieve a better understanding of how smartphone apps work, an elaborated understanding of the interactions and the use of various apps is needed. Besides, schools tend to purchase mobile apps without being accompanied by clear and valid objectives on how it can be integrated into pedagogical practices (Lawless & Pellegrino, 2007). Educators are challenged with various complex and conflicting demands in the use of the mobile device in their pedagogical repertoire (Burnett & Merchant, 2019). Similarly, Merchant (2019) argued that educators are caught in a dilemma where they are positioned between the discourse of risk, exploitation and those of unfettered digital optimism on the other. He further urged researchers to consider empirical research rather than popular belief. Therefore, this study is not focused on the strengths and weaknesses of the smartphone app but rather to understand the interactions and the types of apps that are used in their learning activities.

The study has been conducted in a single institution in Lithuania with social science undergraduate students. Although there are existing studies on the use of smartphones in Lithuania (Vilmante, 2017; Andrasen, 2013), none of these studies focused on interaction via smartphone apps. The absence of qualitative studies on interactions hinders researchers from fully understanding the students' use of smartphone apps. Given the importance of high-quality learning in higher institutions, it is pertinent to capture the experiences of the undergraduate students to understand the possible rules of apps on learning in the wider educational context. A more fine-grained analysis is needed to gain a better understanding of the emerging smartphone apps practices. What digital natives 'do', 'say' and 'relate' will possibly describe the role of smartphone apps in the education landscape.

The research aims are to:

1. examine students' interaction via smartphone apps
2. examine students' collaboration via smartphone apps
3. examine students' learning performance via smartphone, and
4. identify the smartphone apps that students use in their learning activities

LITERATURE REVIEW

Social Constructivist Theory

This study is guided by the Social Constructivist Theory suggested by Vygotsky (1978), who asserts that learning takes place in an interactive and collaborative

nature. Vygotsky argues that knowledge is the internationalisation of social activity. He also discovered that the use of activity mediators provides a way in which individuals can interact with nature. Mediation is also viewed as the use of certain tools or behaviours of another individual during social interactions (Donato & McCormick, 1994). According to Vygotsky, learning occurs in different forms of mediation. The use of new tools for mediation changes the nature of the human activity, while the goal of this activity may remain the same (Warschauer, 2005). The theory also emphasised on “more knowledgeable other” (MKO), which refers to anyone who has a better understanding or a particular skill, concept, task, or process. The MKO usually refers to an educator, an older adult, or even computers (Jones & Araje, 2002).

Another significant contribution of Vygotsky is the Zone of Proximal Development (ZPD). ZPD is “the distance between the actual developmental level as determined by independent problem-solving and the level of potential developments determined through problem-solving under adult guidance or in collaboration with more capable peers.” (p.86). In the ZPD, the educator and learner work together on a task that a learner was not able to solve independently. It emphasises the idea that a more knowledgeable individual can solve the problem with the learner who knows less. In this study, the mediation will be the mediation tool, and it is hoped that interaction, MKO, and ZPD will allow learning to occur.

The Use of Mobile Apps for Education: Previous Research

Research has documented the use of smartphone apps in various educational contexts. Hao et al. (2019) examined the changes in learning outcomes with the help of the app designed within the framework of cognitive apprenticeship with junior high school low achiever students. Data were collected from a survey, interviews and examinations. The study reported that apps help them to enhance their English vocabulary learning, bolstered their confidence and subsequently promoted a positive attitude towards EFL learning. Howard et al. (2018) explored how the Australian dataset of apps contributes to primary school children’s learning. The data mining method of clustering and association rules were employed to identify the app use patterns. The findings showed five distinct patterns of app use: educational focused app use, paid education app use, personalisation app use, and gendered app use.

Wu (2015) developed a smartphone app named Word Learning-CET6 and intended to investigate the effectiveness of the innovatively designed tool that contained 1,274 English words. To test the effectiveness of the app, a test group and a control group were set up. The researcher discovered that

the learners using the Word Learning-CET6 performed significantly better than those from the control group in learning the vocabularies. The positive outcome allowed the researcher to establish a pedagogical paradigm that can be emulated by teachers. The author asserts the need to design digital didactical materials for students. A quantitative study was conducted by Appiah (2016) to examine the influence of WhatsApp with 200 undergraduate students in Ghana. The study reported that the students were utilising WhatsApp for group discussion, network sharing content, and to overcome boredom. The study also importantly highlighted specific issues related to health such as back pain, headache and eye irritation.

Klimova (2018) conducted a literature review search in Science Direct, Scopus and Web of Science databases to discover the use of smartphone apps for foreign language learning. The findings indicated that smartphone apps are effective in learning English, particularly in enhancing vocabulary learning and increasing learners' motivation to study. In the same year, Annamalai (2018) investigated the teaching approach integrated with the use of WhatsApp with 12 pre-service teachers in Malaysia. The study found that WhatsApp allowed seamless learning and bite-size learning to take place. The author concluded that WhatsApp can be a platform to support learning in higher institutions. Further, Aljaloudet et al. (2019) demonstrated that smartphone clicker apps encouraged teacher-student and student-student interactions leading to collaborative learning and eventually improved learning performance. The study reported that although clicker apps enriched students' learning experience, the overall students' engagement was not at a satisfactory level.

Previous studies undoubtedly have given us several valuable insights into the practices of apps. However, a substantial body of studies has tended to examine one or two aspects of smartphone apps and how they can support learning. In fact, very few studies have conducted in-depth investigation of the interaction aspects and apps in certain domains. For example, there is a strong potential for social science courses to use apps and virtual environments as they do not require graphic visualisation or lab work to achieve the learning outcomes. None of the studies were focused on students-teacher interactions via apps and how they can be integrated positively in teaching and learning activities. Although Abulaziz et al. (2019)s' study was about interactions, the study, however, limits itself to quantitative study without further investigation of students' experiences on the use of smartphone apps. In fact, Elanayake and Wishart (2015) highlighted that only a few studies had examined students' experiences, needs, preferences and learning outcomes and the individual differences in the use of smartphones. In this study, a mixed-method approach will allow quantitative data to be followed by qualitative interviews. The purpose of the interviews was to obtain further insights into the quantitative findings.

METHODOLOGY

Research Design

To gain an in-depth understanding of the smartphone apps' pedagogical potentials, the researchers adopted a mixed-method case study design. The mixed-method study design allows a complete view by seeking convergence and corroboration across the methods used in a study (Yin, 2008).

Sampling Data

The participants were 160 social science undergraduate students from Lithuania university. The study used convenience sampling and was based on the voluntary participation of undergraduate students without age, gender, country of origin and course restrictions. Purposive sampling was used to identify 16 respondents for the focus group interviews. There were 72 percent Lithuanian students and 18 percent international students. The undergraduate students were briefed on the nature of this study by the authors of this study. Participation is voluntary and all completions were anonymous. The collected data will not be linked to any individual.

Data Collection Procedure

A questionnaire which comprised three sections was adapted from Aljaloud, Gromik, Kwan & Billingsley (2019). A pilot study was not conducted for the quantitative part of the study. However, face and content validity were conducted by three independent researchers who are experts in the area. Section 1 collected demographic information. Section 2 consists of questions related to interaction with students, interaction with instructors, engagement and learning outcomes. The interactions were evaluated using a five-point Likert scale response. Of the 220 questionnaires distributed, 160 completed the survey, yielding a response rate of 72 percent. Quantitative data obtained were analysed using the descriptive statistics, frequency (f) and percentage (%) to indicate the participants' interactions, collaboration and learning performance. Descriptive analysis was carried out using the IBM SPSS Statistics for Windows, Version 24.0.

The interview was conducted in English and a classroom was arranged by the English course co-ordinator for the interviews. The interview took approximately 30-40 minutes for each group, and it was recorded and transcribed for analysis. There were four focus group interviews and each group consists of four participants. The goal of the interview was to understand

participants' experience, the perspective of their interaction, collaboration and learning performance via smartphone apps.

Sixteen participants indicated their willingness to be involved in the interviews, and they were invited to participate in a semi-structured interview. The goal of the interview was to present in-depth experience, the perspective of their interaction, collaboration and learning performance in utilising the smartphone apps. A pseudonym was given to all the participants. Prior to the commencement of the interview, all participants were given the information sheet outlining the nature of the study. The interview questions were about their general feelings and their interactions in formal and informal learning. The interview took approximately 30-45 minutes for each participant, and it was recorded and transcribed for analysis.

Data Analysis

The qualitative study was guided by Braun and Clarke (2006) characterisation and process of a qualitative study, where the transcripts were read a number of times to identify the themes and sub-themes. This qualitative approach allowed the representation of reality through the eyes of the individuals to hear their voices and share the ideas, views and experiences. The five stages of Braun and Clarke's (2006) thematic analysis were considered where the entire data will go through a detailed analysis. The five steps of Braun and Clarke's (2006) are:

- i. becoming familiar with the data: reading all data for overall comprehension.
- ii. generating initial codes: initial codes were identified by keywords or/ and phrases and sentences that directly indicated ideas, views, concepts and notions of professional development.
- iii. searching for themes: similar codes that formed a single theme were put together based on all the initial codes.
- iv. reviewing themes: the themes were reviewed. Irrelevant themes were either moved, collapsed, segregated or renamed.
- v. defining and naming themes.

Two experts were trained to code the interview transcripts. Miles and Huberman's (1994) percentage and Cohen kappa inter-rater reliability were considered. The percentage was 80 for Miles and Huberman while the kappa value was 0.8. Although thick descriptions were reported in the findings, Cuba and Lincoln's strategies were used to ensure trustworthiness and rigour within the study. Member checks were conducted by confirming the interview transcripts with the participants and requesting edits and additions. Peer

debriefing was managed with the coders during the analysis where the themes and sub-themes were questioned, justified and verified. An audit trail was used to record the data collection, coding and identification of themes.

The demographic characteristic of respondents is illustrated in Table 1.

Table 1

Demographic Characteristic of Respondents

<i>Characteristics</i>	<i>n (%)</i>
<i>Gender</i>	
<i>Male</i>	25.1
<i>Female</i>	74.9
<i>Age</i>	
<i>Less than 20</i>	55.6
<i>21-26</i>	39.6
<i>27-30</i>	4.7
<i>Residence</i>	
<i>Rural</i>	9.4
<i>Semi-rural</i>	13.2
<i>Urban</i>	77.3
<i>State of Origin</i>	
<i>Lithuania</i>	77.2
<i>Other states</i>	22.8

RESULTS AND DISCUSSION

Table 2 shows the results of the survey which can be grouped into three main constructs. The first construct focuses on interactivity with users. It can be noted that a majority (73.6%) of the respondents agreed (combination of strongly agree and agree) that smartphone apps facilitate more interactions with other students. Nearly half (48.2%) felt that the use of smartphone apps in the class gave them the opportunity to discuss with the instructors.

As for the active collaborative learning construct, it is clearly noted that two-thirds (63.2%) of the students strongly agreed and agreed that smartphone apps usage allows them to actively collaborate within their learning experience. However, only (29.3%) thinks that the use of smartphone apps spur interactions with faculty members, which made them feel valued.

The last item was focused on learning performance. More than half (61%) of the respondents at least agreed that the use of smartphone apps enhances their learning experience although approximately one in four (29.2%) of the respondents chose to be neutral in this aspect. It is worth noting that a very small number (8.5% disagree and 9% strongly disagree) of the participants believed that smartphone apps did not benefit their learning experience in their courses.

Table 2

Percentage of Students' Response for each item by Construct

Construct	Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
User's Interactivity	B1. The use of smartphone apps facilitates interaction with other students.	27.36	46.23	21.70	1.89	2.83
	B2. The use of smartphone apps in this class provides me with the opportunity to engage in discussion with my peers.	17.92	35.85	35.85	6.60	2.83
	B3. The use of smartphone apps facilitates interactions with the instructors.	31.13	44.34	17.92	4.72	1.89
	B4. The use of smartphone apps in this class gives me the opportunity to discuss with the instructors	16.04	32.08	31.13	15.09	5.66

(continued)

Construct	Items	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Active collaborative learning	C1. The use of smartphone apps allows me to actively collaborate within my learning experience	19.81	43.40	31.13	3.77	1.89
	C2. The use of smartphone apps allows me to collaborate with others to enhance my learning experience	17.92	44.34	30.19	5.66	1.89
	C3. The use of smartphone allows me to participate freely in my learning experience	16.98	42.45	33.02	4.72	2.83
	C4. The use of smartphone apps has spurred interactions with faculty and peers that made me feel valued	10.38	18.87	52.83	10.38	7.55
Learning Performance	D1. The use of smartphone apps helps to improve my ability to comprehend the ideas and concepts taught	16.04	43.40	27.36	11.32	1.89
	D2. The use of smartphone apps enhances my learning experience in my course	15.09	46.23	29.25	8.49	0.94

Data in Table 2 showed that students are positive about the use of smartphone apps for interaction and collaboration, and admitted that smartphone apps help them in their learning performance. Further, the interviews were transcribed and categorised into three emerging themes: communication, education and entertainment apps.

Communication Apps

Participants in this study acknowledged that smartphone apps allowed them to interact with peers and other students on matters related to learning activities. There were repeated testimonies that they were engaged in during the interaction in the WhatsApp group. The communication app helps to ensure that students are up to date with current events related to their courses such as course, venue and assignment details. It seems that the class members have created a chat group to share important dates and information related to their courses. Several participants mentioned: *“we share information related to assignments and materials”* and *“share info while in lecturers...”* Another student stressed the importance of chat group *“...it is easy to say anything on the chat...face to face they might get angry...Further, if you are lazy easy to open the phone and interact. Not going to the library to find the books.”* They highlighted that they were able to allocate the group members’ task via WhatsApp. One student expressed that *“I talk to my classmates share our course exams and assignments via WhatsApp.”* Most of the participants indicated that their interaction with the instructor was often with the Moodle app. One of the participants said *“looking into Moodle Apps for information that has been put up by the lecturer.”* The apps act as conduits for students’ interaction related to their courses.

Educational Apps

Participants found that smartphone apps afforded students in their language learning. They were able to set the phase and rhythm of learning a language. The participants interviewed described a number of language apps that are used in the educational context. For example, *“6 minute English”*, *“ABA English”*, *“Voscreen”* and *“Duolingo.”* A non-local participant found a number of apps to learn English. The participants highlighted that *“English apps ...they ask you to buy but you don’t ... still the free apps are good.”* One of the participants felt that *“Even reading any information in the app requires language. Writing stuff allows one to learn language....”* Some participants acknowledged that the use of apps to memorise certain ideas and works such as *“Anki, a flashcard app for the Iphone.”* Participants felt that they can use the apps to search for information. For example, *“I use Wikipedia while in the*

lecture.” Another participant reported that “*it gives me information, I just type Quizzlet, You Tube.*” It can be inferred that most of the students treated the apps as a self-regulation tool.

Entertainment Apps

A further key feature of smartphone apps is the ability to entertain them while learning. They acknowledged that when they are bored, they often “*start watching Youtube*” and “*listen to music*”. One student explained, “*I watch TV shows, English movies help me to develop my listening skills in English*”. Almost all participants mentioned social media apps in their smartphones. Interestingly, one of the participants said: “*...conversation in social media is said to “refresh my memory and brain.”*” Another participant expressed the following view: “*I put up photos,” and share my ideas... I am far from home...*” So, students have emphasised the use of apps for social interaction while they are engaged in formal and informal learning opportunities.

DISCUSSION

Both quantitative and qualitative data confirmed that the smartphone apps firmly indicate their potential to support interaction, collaboration and learning performance. The study is consistent with the Social Constructivist Theory that emphasises interaction and collaboration to enhance learning performance. The findings have implications for instructors in a university context to tap into the smartphone apps practices of the students. This study provides additional support to (Aljaloud, Gromik, Kwan & Billingsley, 2019; Lopez, Love & Waters, 2014 & Jahnke & Kumar 2014) findings that smartphone apps enhance students’ interaction and collaborative learning. The qualitative data revealed a wide range of apps in a single study and allowed the researchers to classify the apps into communication, education and entertainment apps.

The communication apps indicated the interaction with instructors and peers on matters related to teaching and learning activities. The finding is consistent with Kukulska-Hulme (2010)’s idea that students are actively engaged in technology social support platforms to exchange information, opinions, advice, missing information with their lecturers and school mates. WhatsApp has been mentioned as a platform for interaction for matters related to learning. The finding is also consistent with the findings of Annamalai (2018) and Andujar (2016) that WhatsApp can be an extended space for students’ interaction on matters related to learning. It is also in compliance with the study by Klimova (2018) that smartphone apps seem to be a powerful tool to enhance language

learning. Social media apps such as Facebook, Twitter and Instagram were identified as entertainment needs while learning. Therefore, it seems that learners are dependent on virtual platforms for social activities while learning. This complements previous studies which showed that smartphones are used for social connection and to overcome boredom (Aagaard, 2015; Emanuel, 2013; McCoy, 2016 & Olifadi, 2015).

The qualitative findings revealed that students are involved with various apps for interaction, collaboration and engagement. This was consistent with findings proposed by Mouza and Greenly (2015) that apps were frequently used to access virtual content and reinforce content learning via personalised learning. A possible reason for mixed findings in the learning performance of smartphone apps is the inability of the students to understand the educational use of smartphone apps. Students were enthusiastic about using various apps, but the interest did not translate to learning performance. Therefore, educators need to design appropriate pedagogical practices with smartphone apps for formal learning. Probably, it is for this reason that there were mixed responses in the survey where half of the participants were neutral and disagreed on items related to learning performance.

Pedagogical Implication

This study should provide a solid starting point for future learning activities to integrate apps effectively. Instructors, with their strength in pedagogical practices, should map out how the content interaction of students can be manipulated for educational activity. The three apps drawn from the current study can be a basis for the understanding of the actual smartphone apps used in higher institutions. There must be a wise move from everyday practices to educational practices. The smartphone apps should be used as learning aids to increase the quality of face to face classroom interactions. It is not wise to isolate the used apps as good and bad; what is needed is how to place these apps to suit the learning outcomes. In other words, incorporating new literacies that have been practised by youths as digital natives. By doing so, smartphones can be a learning aid instead of using it solely for social media purposes.

The apps (educational, entertainment and communication) can potentially be used for idea expansion, interaction, negotiation and language help (sentence formulation, grammar and vocabulary). Many tasks related to learning can be achieved with smartphone apps, such as uploading learning materials, language learning videos and to entertain oneself. These tasks can be achieved with a single device instead of owning a number of devices to complete the

tasks. The apps can be pedagogically useful in the packaging of learning objectives, skills and outcomes into smaller, more manageable learning units. Integrating apps in teaching and learning activities is an example of “bite-sized” learning. While we know that learning activities take effort, energy, dedication and commitment, many learners struggle to find those windows of concentration. It is recommended that bite-size learning will be an appropriate approach rather than a continuous lecture for an hour. According to Annamalai (2019), bite-size learning was preferred by the students when WhatsApp was used to discuss the content of their courses.

The content interactions found in the study are also related to informal learning. Such a trend should be considered by instructors to enhance the learning outcomes. For example, personalised apps such as music and videos can be integrated as part of learning activities for a number of social science courses.

For law students, videos on crime (entertainment apps) can be used as part of project-based learning or task-based learning. Further, interaction and collaboration on the task given can be conducted in the communication apps. In fact, virtual group discussions can be held in the classroom. At the end of the class, instructors can ask students to present their virtual learning exercise in the classroom. Also, for English language learning, there are a number of apps that can be utilised for task-based, problem-based learning and project-based learning. Songs, movies and videos can be part of listening, speaking, reading and writing skills. Instructors can design their teaching and learning activities by asking students to analyse and create videos. In this way, higher-order thinking skills such as analysing and creating can be easily achieved as learning outcomes via apps for most of the social science courses. A myriad of useful smartphone apps can be selected and shared with students. Kukulskahulme (2015) have pointed out that smartphones can extend learning beyond the classroom and provide learners with the opportunity to engage in formal and informal learning.

The study also found that participants showed self-regulated learning in the interaction via apps, particularly language learning. Self-regulated learning takes place when a learner starts to take responsibility for his/her academic skills (Zimmerman & Kitsantas, 1996). Previous studies have documented that mobile phones distract learners in classrooms because instructors’ pedagogies were not engaging and relevant to them (Green, 2019). In fact, their addiction and dependency on smartphones have been emphasised often (Hoffner et al., 2016). Such behaviours should be used as an opportunity to adapt their pedagogies in which they will interact effectively with the content

as well as with instructors and peers rather than forcing learners to change their relationships with mobile phones. Some portions of the informal learning can also be taken as part of an assessment to encourage students to further commit themselves to self-regulated learning.

The existing apps have plenty to say about our digital natives. For example, there are a number of free apps that can be wisely used to learn many skills, and students can be asked to bring their smartphones as suggested by the Bring Your Own Device model (Sangani, 2013). Instructors should strive to enhance teaching and learning activities and enrich education by making wise moves toward integrating smartphones in their classroom. For example, in the current study, most students are from courses related to English, Psychology, Law and Translation. The entertainment apps such as videos, YouTube, and language apps can be initiated for interesting and effective teaching and learning activities. The use of smartphones should not only be confined to accessing content. Finally, it would be easier for teachers to bring in new resources and information and focus on active learning instead of spending a lot of time inventing resources or preparing long lectures. Note-taking, discussion, presentation and discussion can all be achieved with smartphone apps.

CONCLUSION

The study extends the body of work on smartphone apps in a number of directions. The researchers argue that youth as digital natives deserve an innovative learning experience. Designing concrete pedagogical practices that account for learners' access to apps stands in contrast to the monologic traditional classroom teaching. In a way, this study urges instructors to improvise teaching methods so as to cultivate relationships with apps to arouse interest. There is still room for smartphone apps to be wisely integrated into the discourse of technology and education. According to Jenkins, Purushota, Clinton, Weigel and Robinson (2006), schools should advocate these kind of skills that will produce 21st-century skills.

There are several limitations in this study. A promising avenue for future studies is a quantitative study at a longer time scale that is deemed pertinent to identify the emerging trends. An experimental study on the use of smartphone apps will help us to understand not only the use of apps but also the effect of using such apps in their learning performance. In summary, we can conclude that smartphone apps enhance students' interaction with instructors, peers and content. The interactivity should be maximised to promote active learning

which is in line with 21st century learning. Overall, the findings provide strong support for the use of smartphone apps in higher institutions to support learning.

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