Lost in multitasking: An exploration of Chinese university students' in-class smartphone multitasking patterns using multiple approaches

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Smartphone multitasking is prevalent in university classrooms, yet the nature and characteristics of this behaviour have not been sufficiently understood. This empirical study explored in-class smartphone multitasking behaviours based on the perspectives of the multitasking cycle and multitasking time continuum. Diverse data collection methods are employed to achieve a more authentic and holistic understanding. First, semi-structured interviews were conducted to investigate the prevalence of in-class smartphone use, the types of smartphone tasks that students engaged in and the modes of smartphone multitasking. Experience-sampling method was used to capture the frequency and duration of smartphone use. Subsequently, a questionnaire was administered with a wider population to validate the data collected in the former stage. The results provide a detailed and comprehensive account of in-class smartphone multitasking behaviours, including the prevalence of such behaviour, different types of tasks performed while multitasking, as well as modes, frequency and duration of smartphone multitasking behaviours during class sessions. By revealing a fine-grained pattern of students' multitasking behaviours, these findings contribute to the understanding of how university students multitask inside the classroom. Furthermore, the findings also highlight the need for educational researchers and practitioners to consider this behaviour from multiple perspectives and with a holistic approach.

Implications for practice or policy:

- Meaningful guidelines can be created based on the study to help students strike a balance between minimising distraction and maximising the educational use of smartphones in the classroom.
- Course instructors may need to reflect on their teaching methods to provide more engaging learning experiences, reducing the need for students to engage in excessive smartphone activities.

Keywords: in-class smartphone multitasking, real-time classroom, university classroom, multiple methods, experience sampling method

Introduction

As smartphones become omnipresent, the share of younger adults who own smartphones has risen substantially (Felisoni & Godoi, 2018). Consequently, the utilisation of smartphones extends beyond leisure time to infiltrate schools and universities (Luo et al., 2018; Ravizza et al., 2017). In-class smartphone multitasking has long been considered harmful for students because it could incur negative consequences, such as poor academic performance and attentional and attitudinal problems (Carrier et al. 2015; Jamet et al., 2020; Shi et al., 2022). However, recent evidence suggests there might be positive implications as well, as some studies have indicated a positive connection between multitasking, emotion regulation and learning (Hikmat & Mulyono, 2018; Peifer & Zipp, 2019; Wood et al., 2018). These mixed results suggest that the effects of smartphone multitasking might vary depending on the nature of phone

activities that students engaged in (Jamet et al., 2020; Wood et al., 2018) or conditional factors such as frequency, duration and phone use habits (Chen et al., 2021). In order to fully comprehend the nature and effects of this increasingly rampant behaviour, there exists a research imperative to have a complete and in-depth understanding of how students engage in smartphones during real-time contexts.

According to the literature, although a handful of studies have identified several categories of in-class multitasking behaviours among students (e.g., Hikmat & Mulyono, 2018; Kononova & Yuan, 2017; Judd, 2014, 2015), a holistic understanding of this issue has yet to be established. Furthermore, most studies focusing on multitasking behaviour in educational settings relied on a single research method (e.g., Leysens et al., 2016; McCoy, 2020) or intrusive techniques (e.g., Kim et al., 2019), which to some extent influences the reliability of the research works. Given that in-class smartphone multitasking is a complex and fluid behaviour, a comprehensive understanding can be obtained by utilising multiple research methods to examine different facets of this behaviour. As such, this study aimed to capture the patterns of university students' in-class smartphone multitasking using multiple approaches to answer the research question: How do university students multitask with their smartphones in the real-time classroom context?

The study consisted of two phases. In the first phase, semi-structured interviews and experience sampling method (ESM) were used to explore and capture the various aspects of in-class smartphone multitasking. The second phase involved a validation process to enhance the reliability of the research results with a larger sample. The study may contribute to more profound insights into the nature and extent of multitasking behaviour among students and make an unbiased judgement of the behaviour, which can inform the development of effective interventions to manage and regulate this behaviour in educational settings.

Literature review

Conceptualisation of in-class smartphone multitasking

Although scholars have been exploring the concept of multitasking since the 19th century, a universally accepted definition has yet to be formulated. According to Salvucci et al. (2009), multitasking is a two-stage continuum involving the interruption stage of switching from a primary task to a secondary task and the resumption stage of switching back from the secondary task to the primary one. These two stages of interruption and resumption jointly constitute a dynamic cycle of multitasking (see Figure 1). In line with this conceptualisation, Judd (2013) reported that "if a user switches between a series of tasks without returning to a previous task, then, no matter how frequently those switches occur, only task switching and not multitasking has occurred" (p. 359).

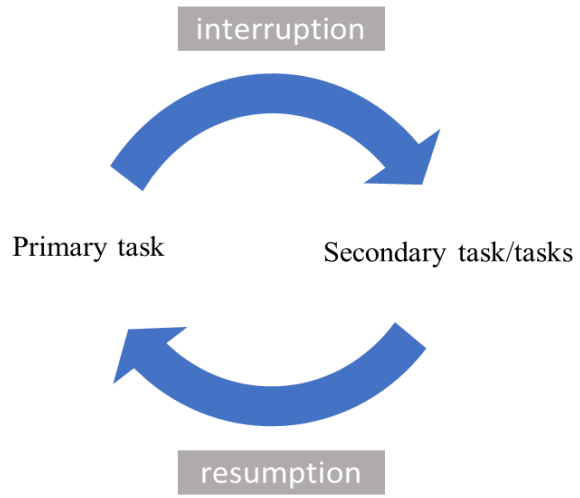

Figure 1. Cycle of multitasking

Multitasking can be categorised as concurrent and sequential based on the temporal dimension. Concurrent multitasking involves performing more than one task at a time (Monsell, 2003; Salvucci & Taatgen, 2008), while sequential multitasking involves switching from one task to another (Dzubak, 2008; Lau, 2017). In a similar vein, Salvucci et al. used the multitasking time continuum to illustrate the two forms of multitasking further (as shown in Figure 2). On the far left of the continuum, concurrent multitasking is characterised by rapid switching between tasks, often with switches occurring within seconds. For instance, listening to lectures while taking notes can be considered concurrent multitasking. On the far right, sequential multitasking (e.g., listening to lectures while completing assignments) typically involves a relatively long time between task switching. As such, we define in-class smartphone multitasking as a dynamic cycle involving interruption and resumption stages in which learners' attention switches back and forth between the ongoing class and smartphone-related activities.

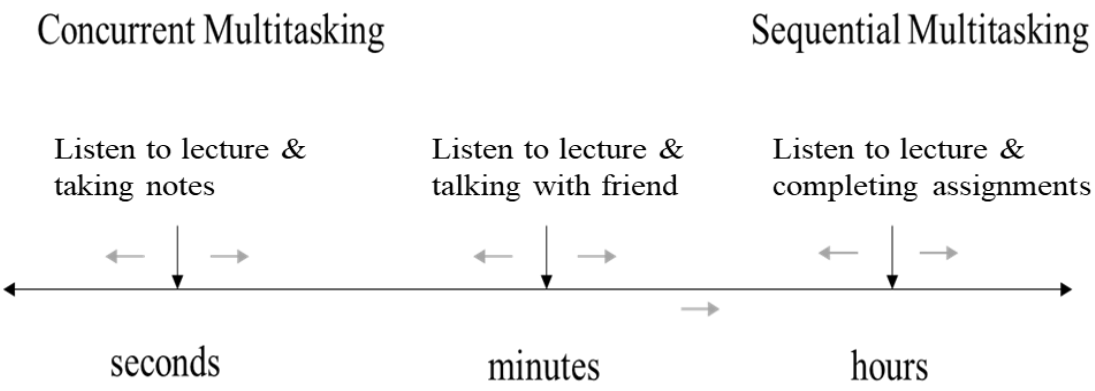

Figure 2. Multitasking time continuum in the learning context (adapted from Salvucci et al., 2009, p. 1820)

The impact of in-class multitasking

Multitasking in the classroom has become increasingly pervasive, capturing the attention of scholars who are concerned about its impact on learning. Most studies that have examined the effects of multitasking focus on learners' academic performance, cognitive ability and attitudes towards multitasking. A wealth of research suggests that multitasking is often negatively associated with learning performance (e.g., Gaudreau et al., 2014; Karpinski et al., 2013; Wammes et al., 2019). However, the relationship between multitasking and cognitive ability has been controversial. Although some studies have identified a negative correlation between cognitive abilities and multitasking, others have not (e.g., Dindar & Akbulut, 2016; Fayyoumi, 2014; Lee et al., 2012).

Furthermore, multitasking in a learning environment can have emotional consequences for learners. For instance, Fayyoumi (2014) reported a negative relationship between in-class off-task multitasking and learners' life satisfaction. Similarly, Gaudreau et al. (2014) confirmed that non-academic-related laptop multitasking was associated with lower levels of self-reported satisfaction among students. These findings suggest multitasking might be connected with students' academic performance, cognitive abilities and emotional well-being.

Multitasking under educational contexts

Research on multitasking behaviour has often focuses on three aspects: the types of multitasking, frequency and duration. In terms of the types of multitasking activities, multitasking can be classified into on-task and off-task, depending on the goal and nature of the secondary task (Burak, 2012; Downs et al., 2015; Fried, 2008; Hassoun, 2015; Rosen et al., 2013; Wood et al., 2018). Off-task multitasking is observed when the secondary task is not related to the primary learning task. For instance, sending instant messaging and browsing social network sites are the most common off-task multitasking activities (Junco

& Cotton, 2012). Smartphones and laptops were found to be the two primary sources of distraction during class sessions, and students often use them for activities such as playing games and watching YouTube videos in learning contexts (Puente, 2017). On-task multitasking occurs when the goal of the secondary task is aligned with that of the primary task. An example of on-task multitasking can be searching online for the definition of a term mentioned by an instructor or viewing an online video demonstration (Wood et al., 2018). Other common on-task multitasking activities identified by researchers are reading e-books, recording lectures and translating texts (e.g., Hikmat & Mulyuno, 2018; Wood et al., 2018). However, on-task multitasking involving digital technologies for learning is less known (Wood & Zivcakova 2015). Recently, Deng et al. (2022) revealed another type of phone activity that was learning-related yet off-task. That is, students used digital devices for other learning tasks unrelated to the ongoing class (e.g., working on assignments for another course). However, this phone activity type received the least attention.

The other lines of scholarly work centre on the frequency of multitasking behaviours. Researchers have classified multitasking into three frequency levels – high, moderate and low – based on different standards. It has been reported that using a short message service and making smartphone calls were high-frequency activities, while instant messaging (e.g., WhatsApp) was a low-frequency activity (Junco, 2012; Junco & Cotten, 2012; Kraushaar & Novak, 2010). Hikmat and Mulyuno (2018) found that students multitasked on off-task activities such as texting and searching the Internet much more frequently than on-task activities such as reading e-textbooks during lectures. Research has also revealed that students often underestimate the extension of multitasking during learning. Calderwood et al. (2014) found that students multitasked with high frequency during a 3-hour learning session. Kraushaar and Novak (2010) also measured students' in-class multitasking frequency by observing the total number of new active windows opened by the students on their laptops. They reported that, on average, students generated 65.8 active windows per lecture.

In addition to the frequency, other studies examined the multitasking duration, that is, the time individuals spend multitasking. By monitoring students' engagement in-class sessions, Calderwood et al. (2014) revealed that students spent 25 minutes on unrelated tasks within a 45-minute class time. Kay and Lauricella (2011) focused on multitasking inside the classroom and found that most students spent half of their class time multitasking. Studies also compared the duration individuals spend on different activities. Taking Kraushaar and Novak (2010) as an example, students were found to allocate more time to off-task multitasking than on-task multitasking.

Through a system review of the growing number of studies on multitasking in an educational context, Zhou and Deng (2022) noted a notable lack of attention to multitasking behaviour, with most research focusing on the impact of multitasking. The literature on the theme has examined various aspects of multitasking behaviours, such as the types of smartphone tasks, frequency and duration of in-class smartphone multitasking. Based on our previous work (Zhou & Deng, 2022), the current study sought to provide a more nuanced understanding of in-class smartphone behaviour through a more comprehensive approach and rigorous measures.

Measures of in-class multitasking

Following the synthesis of the relevant studies on multitasking behaviours, we further examined the types of measurement our previous work used. Table 1 highlights some recent empirical studies on in-class multitasking behaviour. Within this limited body of studies, scholars have primarily depended on subjective and singular methods, such as surveys, interviews or observations, to measure in-class multitasking behaviour (e.g., Hikmat & Mulyuno, 2018; Lepp et al., 2019; Leysens et al., 2016; McCoy, 2020; Wood et al., 2018). For example, Deng et al. (2022) examined the types of multitasking among college students using semi-structured interviews. Leysens et al. and McCoy measured the frequency and duration of students' multitasking with surveys. Moreover, some studies used objective measures for data collection. For example, Wammes et al. (2019) emphasised experimentally manipulating multitasking behaviours, and Kim et al. (2019) adopted observation and tracking technologies to delve into this matter. Although researchers have used diversified methods to collect data (e.g., Hikmat & Mulyuno, 2018; Wood et al., 2018), the resulting data have typically been geared towards measuring or repeatedly measuring

the same research question. However, attention given to determining whether the research method is appropriate is insufficient. Furthermore, objective data regarding students' multitasking behaviour were often obtained through intrusive techniques such as video cameras and monitoring equipment, which may lead to a reactivity effect on the part of participants. Thus, the reliability of the studies was potentially affected. These limitations highlight a strong need for researchers to design their studies more scientifically and scrutinise multitasking behaviour more comprehensively in real-life contexts.

Table 1
Empirical studies on in-class multitasking behaviours

Source	Focus	Technique
Leysens et al., 2016	Multitasking frequency	Survey
Hikmat & Mulyono, 2018	Type and frequency of multitasking	Observation, survey
Wood et al., 2018	Type and duration of multitasking	Survey, observation
Lepp et al., 2019	Multitasking behaviour in online versus offline courses	Survey
Kim et al., 2019	Frequency and duration of multitasking	Usage logging, mobility tracking, class evaluation and class attendance detection
Wammes et al., 2019	Multitasking frequency	Simulated classroom experiment
McCoy, 2020	Frequency and duration of multitasking	Survey
Deng et al., 2022	Multitasking type	Interview

In summary, the review of the research on multitasking in educational settings revealed two apparent limitations: an inadequate examination of the multitasking behaviour itself and the lack of robust means to measure the behaviours in question. To address these limitations, the current study employed diverse and differentiated approaches to measure five main aspects of in-class smartphone multitasking behaviour, including levels of prevalence, smartphone multitasking modes, task type, duration and frequency. We aim to provide a more comprehensive and reliable understanding of students' in-class behaviour through these approaches.

Methods

The current study adopted a mixed-method research design with data collection in two stages. In the first stage, we conducted semi-structured interviews to obtain a detailed account of smartphone use, types of tasks performed on smartphones and mode of multitasking. Furthermore, we utilised ESM to investigate two relatively hard-to-recall aspects of smartphone multitasking, which are the duration and frequency of smartphone use during class time. We purposefully selected 15 undergraduate students from a first-tier university located in East China. We first identified the students who self-reported their smartphone multitasking behaviours during class time. Then, we used a set of criteria to recruit a diverse group of participants, considering factors such as year levels, majors and academic performance (i.e., grade point average). In the second stage, we designed a questionnaire based on the interview data to validate the findings with a larger sample to enhance the reliability of the research. The respondents of the second stage were undergraduates from different Chinese universities recruited through the advertisement posted on online social platforms. The data collection process is shown in Figure 3.

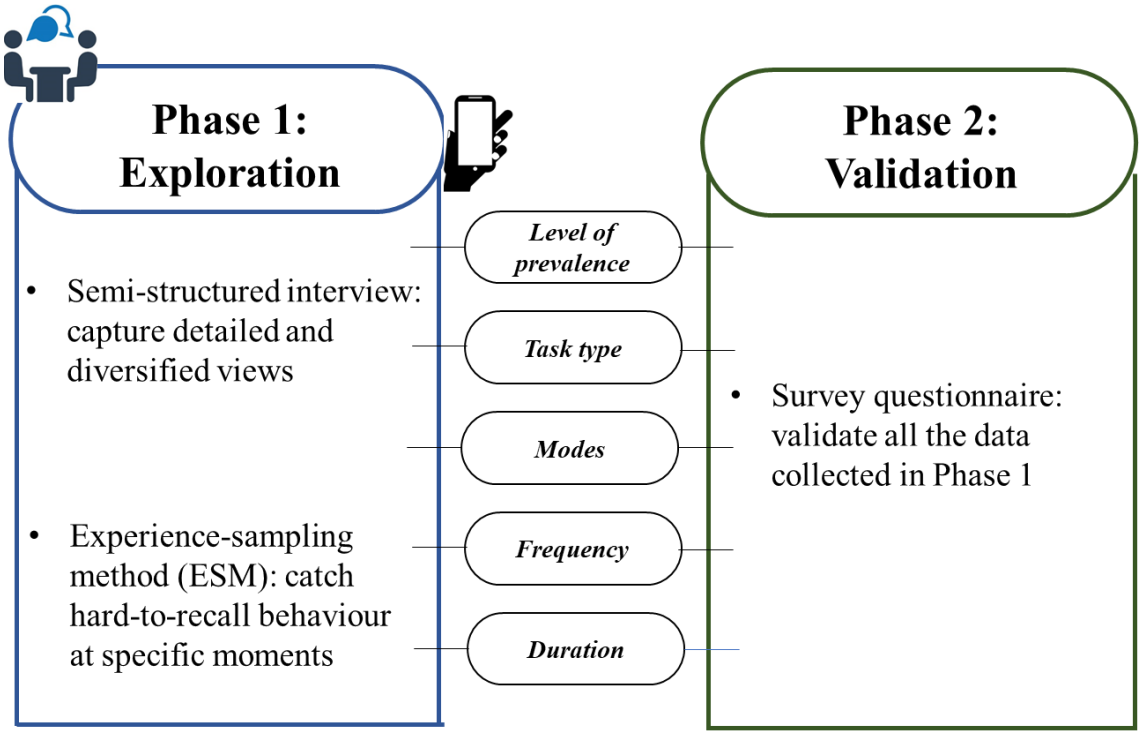

Figure 3. Process of data collection

Data collection

Semi-structured interviews

In the qualitative data collection stage, we conducted one-to-one semi-structured interviews with 15 students through Zoom, an online conference software. We designed four open-ended interview questions with a set of follow-up questions based on related multitasking literature. The interview protocol was reviewed by an expert in multitasking to ensure its feasibility. For example, we designed the question "Do you use your smartphone while having classes?" to determine the participants' multitasking activities. We interviewed all 15 participants according to the finalised interview protocol, and each interview lasted for around half an hour.

ESM

To capture the duration and frequency of students' in-class smartphone multitasking, 15 participants were also invited to attend the ESM stage. As shown in Figure 4, ESM involves the use of electronic devices (i.e., smartphones) to explore individuals' thoughts and behaviours at that moment (Larson & Csikszentmihalyi, 1983). ESM is thought to possess great sensitivity in reflecting and analysing individuals' behaviours within a specific context compared to other traditional self-report approaches that rely solely on retrospective recall (i.e., data gathered after the occurrence of the events) (Xie et al., 2019). Considering that multitasking behaviours are context-specific (Deng et al., 2022), ESM will help provide a more accurate picture. We designed a mini-questionnaire with a set of closed-ended questions in accordance with the standard format recommended by Larson and Csikszentmihalyi (1983) to probe the frequency and duration of phone use during lectures.

The ESM data collection procedure consisted of three stages: introductory, preparation and experience sampling. First, the participants were invited to a WeChat group for an introductory session where the concept and implementation of the ESM session were clearly introduced. During the preparation stage, the participants were requested to provide their class timetables for the ongoing semester and randomly select one mandatory and one optional course for ESM data collection. This approach is based on the assumption that students' smartphone behaviour might differ in courses of different importance levels. According to the timetable students provided, a fixed schedule comprising 12 ESM occasions spread over

3 consecutive weeks was set. This meant that participants were required to complete the mini-questionnaire 12 times within those 3 weeks. The selected sampling time and period adhered to the guidelines for ESM recommended by Christensen et al. (2003). A timetable was prepared in advance, with all the scheduled time slots for sending prompts determined based on the information collected. The ESM stage started less than 1 week after the introductory session. During the ESM data collection periods, the participants were required to have the WeChat app installed on their smartphones. This allowed them to receive alerts at 20-minute intervals during their chosen classes, prompting them to answer the mini-question. If the alerts were ignored, the participants would not receive further reminders for the next 20 minutes. Moreover, it was essential for all questions to be completed within 1 minute; otherwise, they would be considered ignored.

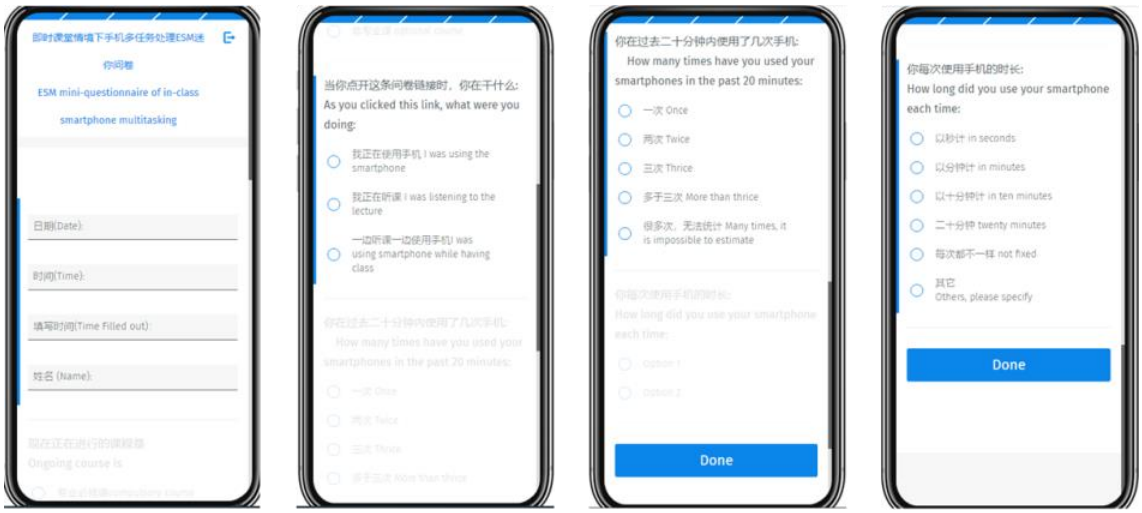

Figure 4. Diagram of experience-sampling method

Survey

Following the semi-structured interviews and ESM sessions, we designed a questionnaire to validate the findings from the interviews and ESM data regarding students' smartphone multitasking behaviour during class sessions. The questionnaire consisted of two sections. The first section gathered demographic information, including gender, year level and grade point average (questions 1 to 5). The second section focused on collecting data pertaining to the five aspects of students' in-class smartphone multitasking behaviour. The multiple or single-choice questions, along with the options, were designed based on the findings of the interview and ESM. For example, the interview revealed that smartphones had become a necessity for students. Then, this finding was further transferred into a single-choice question: "Do you usually bring your smartphone to class?". Drawing on the relevant data from the ESM mini-questionnaire, we designed the questions pertaining to the duration and frequency of in-class smartphone multitasking, such as "How long do you use your smartphone each time for course-unrelated/course-related/course-unrelated but learning-related activities?" and "How often do you get distracted by your smartphone during classes?". Finally, we created a questionnaire containing 10 questions, which could be completed in 5 minutes. Its link was generated through Qualtrics, an online survey platform. Two filter questions were posed at the beginning of the questionnaire to ensure the participants met the selective criteria: (a) "Are you currently an undergraduate student at a university or college in mainland China?"; (b) "Have you used your smartphone during class time?".

Data analysis

We recorded the interviews and transcribed all the audio files into text. Then, we and the participants thoroughly reviewed the transcribed data to prevent any errors and misinterpretations.

The text files were then imported to NVivo version 12 for data analysis. The pertinent data were coded according to each interview question. For instance, the question "Which smartphone activities do you

usually perform during class?" was considered a theme, and the corresponding statements were coded under this theme. During the subsequent round of coding, the themes were further consolidated into more abstract categories.

A total of 144 valid responses (i.e., 144 instances) were returned during the ESM data collection, yielding an 80% response rate. The descriptive statistics analysis was conducted using IBM SPSS Statistics version 23 software to analyse the collected data systematically. Measures such as mean, media, and frequency distribution were examined to gain an understanding of the central tendency, variability and distribution of the data concerning students' frequency and duration of in-class smartphone multitasking.

Moreover, based on the system record of Qualtrics, 543 valid questionnaire responses were received and analysed with IBM SPSS Statistics version 23 software, which yielded descriptive results. Among the 543 participants, 55.2% (*n* = 300) were female, while 44.8% (*n* = 243) were male, indicating a balanced gender distribution. Furthermore, they represented various year levels, with sophomores comprising the largest proportion (50.6% or *n* = 275), followed by freshmen, juniors and seniors, accounting for 31.7% (*n* = 172), 10.3% (*n* = 56), and 7.4% (*n* = 40) of the sample, respectively.

Findings

In the subsequent sections, we present the qualitative findings, accompanied by quotes selected from the participants' interview responses. Each quote is labelled with a unique code that combines the participant's pseudonym and identification number, along with the corresponding line number from the transcript.

Level of prevalence

The interview data indicated a prevalent occurrence of smartphone multitasking during class. This is evident through various indicators, such as the presence and accessibility of smartphones in class, as well as the visibility of smartphone use. First, the interviewees acknowledged that smartphones had become a necessity in their daily lives, as one student expressed: "I take my smartphone wherever I go because it has a lot of functions that I need such as contacting friends, receiving information, or online shopping" (ZMY006:2). Additionally, the participants reported that they often observe the use of smartphones during class. For instance, a student who often sat at the back of the classroom mentioned observing behaviours of other classmates, such as "hand sliding or bending over their desks" (ZQM011:16), which signalled engagement in phone activities. Additionally, the easy accessibility of smartphones during class contributed to their widespread use. The participants mentioned that it was usual practice to place their phones within reach, either on their desks with the screen facing up or down (e.g., ZZJ009:4, HZY007:4-6, ZQM011:4-6, DHY013:5-9).

In line with the interview data, the survey results from the 543 participants revealed that almost all the participants (99.4%) reported the habit of bringing phones to class, and 98% also reported observing smartphone multitasking from their peers. As to the phone locations, close to 65% of the respondents claimed that they usually placed their phones directly on the desktop, with only 30% putting their phones in a hidden place (e.g., pockets, bags or desk drawers). Overall, the interview and survey data demonstrated that smartphone use during class was quite pervasive.

Task type

The students disclosed three types of smartphone activities they frequently multitask with: on-task; off-task; and off-task yet learning-related. Regarding class-related (on-task) smartphone activities, most participants mentioned using their phones primarily for tasks such as taking photos of slides, searching for course-related materials, recording lectures or taking notes. Under the off-task category, eight activities were frequently reported: sending or replying to instant messages, navigating social networks, online shopping, reading news, watching videos, reading novels, browsing photos and playing mobile

games. For the class-unrelated yet learning-related tasks, the majority of the participants indicated using their smartphones to complete assignments or search for materials related to other courses. A few others mentioned utilising their smartphones in class to study the content of another course.

The questionnaire consisted of these three types of smartphone tasks with the aim of identifying the most commonly performed activity during class. Among the course-unrelated phone activities listed, instant messaging emerged as the most frequently reported task, with 64.5% of the participants admitting to engaging in it during real-time lectures. Social networking was identified as the second-most popular phone activity (40.1%, *n* = 218), followed by less frequent activities such as online shopping (17.9%, *n* = 97), novel reading (14.2%, *n* = 77), and video watching (11.6%, *n* = 63). In terms of course-related smartphone activities, the respondents reported using their phones frequently to take photos of course materials, such as slides (71.6%, *n* = 389), and to take notes (59.7%, *n* = 324). Moreover, over half of the participants (52.7%, *n* = 286) utilised their smartphones to search for course materials. Regarding the course-unrelated yet learning-related phone activities, only 16% (*n* = 87) selected this option, indicating such a secondary task is not common among the respondents. In summary, the findings revealed that students engaged in a variety of smartphone-related activities during class that were predominately unrelated to the ongoing coursework. In short, our data indicated that smartphones were extensively used for non-academic purposes.

Modes of smartphone multitasking

During the interview, the students were prompted to provide a detailed description of how they managed multiple tasks simultaneously during real-time lectures and the cognitive states and behaviours involved. As a result, three modes of in-class smartphone multitasking were identified: frequent switching, concurrent multitasking and immersive multitasking.

Mode 1: Sequential switching

Sequential switching refers to switching between the primary learning task and a secondary phone-related task. In some cases, the participants described this mode as "just a temporary distraction and then promptly returned to the class" (HZY007:58). Normally, they spend only a short period on phone tasks with both interruption and resumption as conscious decisions. For instance, HZY007 recalled that he frequently switched from the ongoing lecture to his smartphone upon receiving external triggers such as alerts or the lighting up of the smartphone's screen. In other cases, the participants would dedicate a relatively longer period to the secondary task and would switch back to the primary one only after its completion. For example, HHF008 shared "I would put my smartphone down and switch my attention back to the class once I finished taking photos of all PowerPoint slides".

Mode 2: Concurrent smartphone multitasking

Concurrent smartphone multitasking occurs when students divide their attention between class-related and phone-related activities simultaneously. The participants commonly reported experiencing divided attention, as evidenced by the following statements: "While scrolling my smartphone, I would pay attention to teachers' words at the same time" (ZYN004:59) and "paid attention by ears" while using the smartphone (YC02:76).

Mode 3: Immersive smartphone multitasking

In the mode of immersive multitasking, the participants focused primarily on smartphone activities and only occasionally shifted their attention back to the ongoing lecture. As one participant explained, "I would only take a few glances at the PowerPoint and spend most of my class time continuously scrolling my phone" (ZHZ003:47). However, this smartphone multitasking mode was reported only by a small number of students and typically involved secondary tasks that required continuous attention such as watching videos and reading novels.

In the questionnaire, the participants were asked to indicate the mode of in-class smartphone multitasking. The results showed that sequential multitasking was the most common mode reported by 66.3% of the participants (*n* = 360). In contrast, only a small minority (4.1%, *n* = 22) reported engaging in

immersive multitasking mode during classes. Additionally, less than 30% (*n* = 161) of the respondents reported simultaneous engagement in phone activities and class-related activities.

Frequency of in-class smartphone multitasking

We collected ESM data to gain more concrete information regarding the frequency and duration of students' multitasking. In terms of the 144 ESM responses, each one denotes a sampled instance. The results showed that in most instances, the participants engaged in smartphone activities at least once during a 20-minute class time. Moreover, around a quarter of sampled instances involved students engaging in phone multitasking more than twice (25 instances, 25.5%), and 26.5% (26 instances) reported doing so three times or more. In 31 instances, the participants reported using their phones only once during the data collection periods, while seven instances (7.1%) involved persistent smartphone use.

In the questionnaire, the participants were also asked how often they were distracted by smartphones, with several response options provided. The results indicated that a majority of the participants (60.5%, *n* = 328) reported engaging in regular task switching, with intervals ranging from 5 to 25 minutes or even longer. Additionally, over 200 (37%) participants mentioned not having fixed patterns for task switching. Only a small percentage (1.5%) reported never being distracted by their smartphones, while 1.1% (*n* = 6) claimed to struggle with maintaining concentration during lectures.

Duration of in-class smartphone multitasking

Participants were asked to respond to a single-choice question designed to capture their behaviour during lecture sessions as part of the study's data collection. The ESM results reflected that the duration varied greatly, ranging from a few seconds to dozens of minutes. In most of the sampled instances (77.5%, *n* = 76), the in-class smartphone behaviours lasted about 1 to 10 minutes, while in only 15 cases, the respondents reported spending 10 to 20 minutes on their smartphones. Moreover, even though the respondents were only required to recall their phone behaviours in the preceding 20 minutes, there were seven records (7.1%) where the students found it difficult to estimate their phone usage due to inconsistent durations of their phone activities.

To validate the ESM results, the questionnaire investigated the duration of in-class smartphone multitasking from two perspectives: (a) the duration of each event of smartphone multitasking, which refers to the amount of time a student spends on a smartphone-related task and (b) the accumulative duration of smartphone multitasking within a 45-minute class time. For the duration of each event, nearly 70% of participants (69.4%, *n* = 377) reported non-academic smartphone multitasking lasting less than 10 minutes, while only 11% (10.9%, *n* = 59) reported more than 20 or 30 minutes. However, the duration of on-task smartphone activity reported by students was highly polarised: 35% (*n* = 190) reported spending less than 10 minutes on smartphone activities related to the ongoing class, whereas 141 participants (26%) mentioned spending over 30 minutes. Furthermore, the duration of course-unrelated yet learning-related smartphone multitasking for each event was similar to off-task multitasking, with over half of participants (61.1%, *n* = 332) reporting less than 10 minutes, 27.3% (*n* = 148) reporting 10 to 20 minutes and 11.6% (*n* = 63) reporting over 20 minutes.

As to the accumulated duration of in-class smartphones, over half of the participants (57.3%, *n* = 311) stated that they spent less than a quarter of their class time on off-task smartphone multitasking. Additionally, 32.8% (*n* = 178) indicated spending 10 to 20 minutes on such activities. A small proportion of participants reported spending 20 minutes (6.4%, *n* = 35) to 30 minutes (3.5%, *n* = 19) on off-task smartphone multitasking. The accumulated duration of on-task smartphone multitasking showed a different pattern. Specifically, most of the participants reported that they spent 10 to 20 minutes (38.3%, *n* = 208) on on-task multitasking during a class, followed by less than 10 minutes (22.5%, *n*=122) and more than 30 minutes (21.3%, *n* = 116). Furthermore, the accumulated duration of course-unrelated yet learning-related smartphone multitasking exhibited a similar pattern to that of off-task smartphone multitasking. About 58.7% (*n* = 319) of the participants reported spending only a few minutes on this type

of smartphone activity, 29.8% (*n* = 162) claimed to spend 10 to 20 minutes, 7.2% (*n* = 39) spent 21 to 30 minutes, and 4.3% (*n* = 23) spent 30 minutes or more.

Discussion

In this study, we examined how Chinese university students multitask with smartphones in real-time classrooms through collecting data with multiple approaches. The mixed data sources jointly confirmed that smartphones are widely considered a necessity by Chinese undergraduates and that smartphone multitasking has become ubiquitous during class. To obtain a holistic understanding of this widespread phenomenon, we scrutinised different types of multitasking behaviours in four primary aspects, including the mode of multitasking, the types of activities involved, and the frequency and duration of in-class multitasking.

Modes of in-class smartphone multitasking

Our data revealed three modes of in-class smartphone multitasking: sequential switching, concurrent multitasking and immersive multitasking. Frequently switching back and forth between the ongoing lectures and secondary phone-related tasks was the most common smartphone multitasking mode during class (see Figure 5). Each switch represents a distraction to one task and a resumption of the other. Our data also reveal two forms of sequential switching: the first involved switching between tasks without task completion, while the other was triggered by task completion. In the first form, the students exhibited what Johannes et al. (2019, p. 3) called "smartphone vigilance," continuous alertness to cues associated with phones. The students habitually placed their smartphones on top of desks for easy access and monitoring of any updates or notifications. One significant finding from our data is that when engaged in phone-related activities, the students maintained a similar level of vigilance towards cues associated with ongoing classes. This type of classroom vigilance allowed students to stay alert to the ongoing class and be prepared to shift their attention back when required, such as when their teachers prompted them with reminders or questions.

The second form of frequent switching triggered by task completion is less common in our data. Students would switch back to their lectures after completing phone activities. This tendency to switch tasks upon completion has also been reported by Payne et al. (2007) and Deng (2020). They suggested that this act can be considered a natural transition when a task at hand is completed.

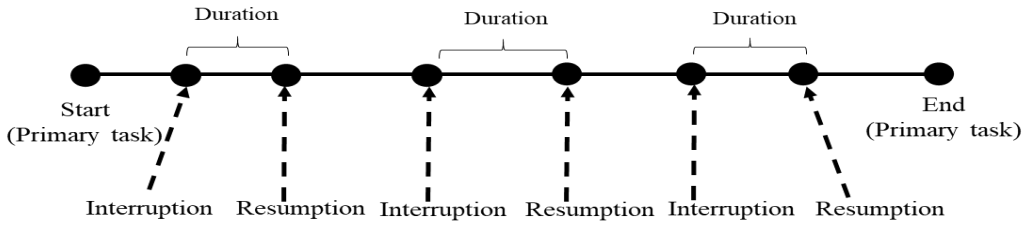

Figure 5. Frequent switching

When in the state of concurrent smartphone multitasking, students' attention becomes distributed between their primary and secondary tasks (see Figure 6). Therefore, concurrent smartphone multitasking is similar to the state of divided attention, in which students' cognitive resources are divided to process multiple tasks simultaneously (Castro et al., 2019; Junco & Cotten, 2012).

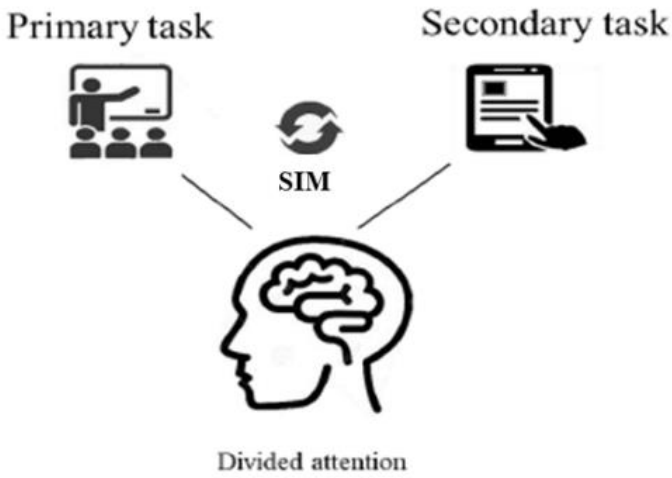

Figure 6. Concurrent smartphone multitasking

Another smartphone multitasking mode identified from our data is immersive smartphone multitasking, where students immerse themselves in phone-related secondary tasks for a relatively prolonged period compared to the other two modes (see Figure 7). This multitasking mode was often observed during optional courses that the students attached less importance. The phone activities involved usually demanded sustained attention, such as watching videos, playing games or completing assignments. This state aligns with the concept of flow (Csikszentmihalyi et al., 2005; Leung, 2020) or cognitive absorption (Goel & Schnusenberg, 2019), which describes how smartphone activities can captivate and preoccupy users, leaving minimal attention for the ongoing class.

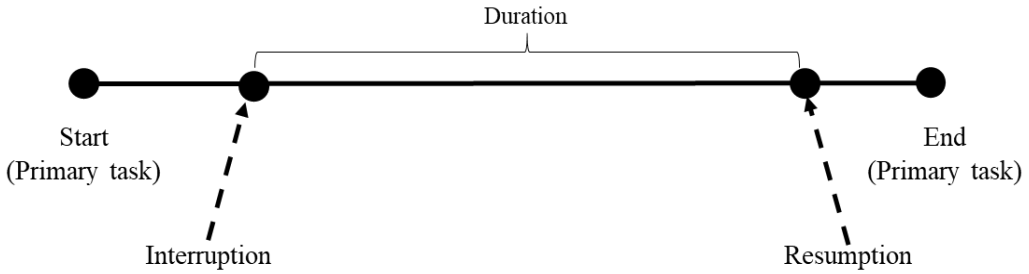

Figure 7. Immersive smartphone multitasking

Our study makes a notable contribution to the field by refining the classification of multitasking modes. While previous works have often classified the modes of multitasking as sequential and concurrent, our study provides a more refined understanding by identifying diverse modes of multitasking in a real-time classroom setting. Specifically, one can observe a decreasing trend in the switching frequency from frequent task-switching mode to concurrent multitasking mode, while the duration of tasks exhibits an increasing trend. This trend suggests students tend to handle multiple tasks in different ways depending on the demands of the situation and tasks involved.

Types of activities involved in in-class smartphone multitasking

The interview and survey data jointly revealed a complex picture of phone activities in which students engaged during class. First, students used their smartphones for a wide range of on-task and off-task activities, with off-task phone activity being the primary type. Among the off-task phone activities, the most frequent ones were sending or replying to instant messages and checking social networking websites. Other off-task activities occurred at a much lower frequency, including playing games, checking photos, online shopping and watching news and videos. This result suggests that social-oriented multitasking, such as instant messaging and social media, is dominant among Chinese university students.

These findings align with those of Burak (2012) and Yang and Christofferson (2020), who identified texting and visiting social networking sites as the most common phone activities for university students.

Additionally, smartphones serve as a tool for learning as students use them for course-related activities, such as taking photos of slides, recording lectures, searching for course-related materials and taking notes. Similarly, Wood and Zivcakova's (2015) research also indicated several common on-task smartphone activities, including summarising lessons, viewing course materials, completing online tests and assignments, searching the Internet for course-related materials, taking and sharing notes and asking questions. Interestingly, our study also found that despite the high value students placed on recording lectures, the frequency of this activity was not particularly higher than that of other on-task activities.

Echoing the findings of Deng et al. (2022), we also observed off-task yet learning-related multitasking, which usually involved completing assignments for other courses and reviewing or searching for content of other courses. Although this type of smartphone activity was comparatively rare compared to the other two types, it enriches our understanding of the diversified nature of in-class smartphone behaviour.

Frequency of in-class smartphone multitasking

The highly contextualised ESM data revealed the variability of students' smartphone multitasking frequency, as participants reported in most of the sampled instances that they engaged in smartphone activities more than once within 20 minutes. Similarly, most survey respondents reported engaging in smartphone multitasking during their lessons but found it difficult to estimate its frequency. These statements show that the results of both research methods were consistent, even though both techniques have limited capacity to capture a clear picture of the frequency of multitasking behaviour. These two data sets reflect the highly fluid and changeable characteristics of smartphone multitasking frequency, which coincide with the findings of other studies (Burak, 2012; Calderwood et al., 2014; Kraushaar & Novak, 2010).

Duration of in-class smartphone multitasking

ESM data also shed light on the duration of smartphone multitasking sessions. The results indicated that in most cases, although the duration of smartphone multitasking varied, participants spent only a few minutes in smartphone multitasking within a 20-minute time frame. The questionnaire data further revealed the duration of each multitasking session and the accumulated multitasking time in total. The pooled results revealed that even though smartphones were a source of distraction during classes, students were less likely to immerse themselves in any smartphone activity for an extended period during their class time. This outcome enriches the results of studies on the same issue. For example, Calderwood et al. (2014) claimed that students spent an average of 25 minutes on their electronic devices within a 45-minute class period, with each multitasking event lasting only 6 seconds. Similarly, Kraushaar and Novak (2010) reported that students spent around half of their class time in media multitasking.

Conclusion

This study provides a holistic picture of the smartphone multitasking behaviour of Chinese undergraduates in real-time classroom contexts by examining four aspects of in-class smartphone multitasking. The study contributes to the understanding of how Chinese students multitask inside classrooms by revealing a fine-grained pattern of students' multitasking behaviours. Today's undergraduate students are frequent multitaskers, even while attending real-time lectures (Moreno et al., 2012). Although digital devices offer potential as valuable learning tools, they can also be a source of distraction if not managed properly (Q. Chen & Yan, 2016). Our study underscores the importance of regulating off-task phone usage, such as instant messaging and social network browsing, to minimise the negative impacts of smartphone distraction. The findings also provide theoretical and practical implications.

Our study contributes to smartphone multitasking literature in several ways. First, based on studies in relation to modes of multitasking (e.g., Dzubak, 2008; Salvucci & Taatgen, 2008), our results further reveal three modes of smartphone multitasking. For instance, some students frequently switched tasks when prompted by external stimuli (i.e., frequent switching), whereas others were fully engaged in phone-related secondary tasks, which required sustained attention for extended periods (i.e., immersive smartphone multitasking). These differences may suggest that distinct modes of in-class smartphone multitasking have varying impacts on students' academic performance and learning engagement.

Additionally, as previous studies indicated, smartphone multitasking is hard to capture because of the changeable, hard-to-recall and motivational-complexity features, and thus we incorporated multiple approaches that provide a relatively comprehensive picture of in-class smartphone multitasking behaviour. As such, our work not only serves as a test for different techniques in exploring multitasking behaviours but also lays a foundation for future studies to apply various methods to examine complex human behaviour.

From a practical perspective, the findings of the study showed undergraduates engaged in a diverse range of smartphone multitasking during class. Multitasking belongs to off-task and learning-related categories, indicating that smartphones serve a dual role as a learning tool and as a source of distraction. Therefore, educational practitioners should not simply ban or blindly welcome in-class smartphone multitasking. Instead, efforts should be made to establish meaningful guidelines to minimise distraction and amplify the educational use of digital devices. For example, given that on-task smartphone multitasking is a typical in-class smartphone multitasking, educators can provide guidance on the use of smartphones during class and create more chances for utilising smartphones for teaching and learning.

In-class smartphone multitasking is undoubtedly a complex phenomenon. The results of our work show the frequency and duration of undergraduates' smartphone multitasking may vary due to external factors such as different courses and teachers. The findings suggest that improving extrinsic factors may help mitigate severe in-class smartphone multitasking among students. For instance, considering students behave differently in courses led by different teachers, course instructors should reflect on their teaching method and provide more meaningful and engaging learning experiences. The management of personal technologies in classroom settings is a critical concern (Bayless & Clipson, 2013). We urge researchers and practitioners to take our findings into account when formulating in-class technology use policies, designing digital literacy programs and implementing technical solutions to address this issue.

Although our study sought to address the research gap by utilising multiple and differentiated methods to measure students' in-class smartphone multitasking behaviour, it is contextualised to Chinese universities and may not be generalisable to the population with different cultures and geographical locations. Due to this, further studies in diverse contexts are required to explore this issue comprehensively and thoroughly. Another limitation is that although multiple methods were used for collecting data, including semi-structured interviews, ESM and questionnaires, they were all self-reported subjective data. Consequently, this methodological bias may erode the reliability of the results to some extent (Lavidas et al., 2022). Hence, we encourage future research to collect more diversified, reliable objective data to reflect and interpret this behaviour in a more balanced manner.

Author contributions

Yujie Zhou: Conceptualisation, Investigation, Data curation, Writing – original draft, Writing – review and editing**; Liping Deng**: Conceptualisation, Writing – review and editing.

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