

# Digital, Self-Regulated Vocabulary Learning and Device Control In Out-Of-Class, Higher Education Settings

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**Abstract:** Self-regulation of learning behaviour is particularly important when it comes to vocabulary learning for academic purposes in a second language because it often needs to be done on a regular and consistent basis and mostly in out-of-class, self-directed settings to be successful. Self-regulation is also vital when this learning takes place using digital activities on smartphones because these are now ubiquitous devices and deeply embedded in both daily life and higher education settings. Features such as notifications from social media applications can end up distracting students from their academic tasks unless they have the capacity to manage and control their behaviour. This naturalistic, mixed methods study conducted with students on an academic English foundation course in a higher education context aimed to measure their capacity for self-regulated vocabulary learning through technology before and after 10 weeks of intentional digital vocabulary learning in out-of-class settings and to see if there was any difference between learning on a laptop and a smartphone. The purpose of this study was to find out if device control was a relevant dimension of self-regulation, which is an under-researched area. The study collected quantitative data through a recently developed self-report survey tool, and differences in scores were measured using Wilcoxon signed-rank tests. Qualitative data was also collected from students through paired-depth interviews, and this was analysed using typological analysis. The results revealed that the students' self-reported capacity for self-regulated vocabulary learning through laptops was significantly higher than their capacity for self-regulated vocabulary learning through smartphones. In addition, commitment regulation when using a smartphone decreased significantly over the 10-week period primarily due to distractions from social media notifications. At the same time, students were aware of when to use each device for different types of learning activities and under different temporal and spatial conditions. Overall, this study showed that device control should be considered an additional dimension of a model of digital, self-regulated vocabulary learning and should also be incorporated into future research in the field of e-learning. In addition, students in higher education need to be given more guidance about the benefits and drawbacks of different devices and how to develop their capacity and strategies for greater device self-regulation.

**Keywords:** Digital vocabulary learning, Self-regulated e-Learning, Digital devices, Laptops, Smartphones

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## 1. Introduction

Obtaining sufficient receptive knowledge of English vocabulary is often seen as a vital prerequisite for achieving academic success in higher education courses conducted through the medium of English (EMI) mainly because academic reading is a key component of most undergraduate degree courses (Nation, 2013; Schmitt, 2010). Knowledge of the 8-9,000 most frequent word families in English should enable readers to recognise 98% of the words in most written academic texts and result in nearly 70% comprehension of these texts (Schmitt, Jiang, and Grabe, 2011, p.34). However, reaching this size of vocabulary is a particular challenge for students whose first language is not English (Schmitt, 2014).

One of the main challenges for students is that vocabulary learning in a second language (L2) is a lengthy and demanding task (Nation, 2013; Schmitt, 2010) that involves learning the form and meaning of new words to increase vocabulary size (breadth), as well as different aspects of the same word (depth) through repeated encounters and retrievals in different contexts (Schmitt, 2014). Due to the 'word gap' between the number of words students know and need to know, and the limited number of contact hours in many English foundation courses that are taken before a degree course, students often need to take on the main responsibility for this learning in out-of-class settings (Nation, 2013). Those with lower levels of L2 proficiency should devote a large percentage of their vocabulary learning time to deliberate, form-focused learning (Nation, 2013, p.2) and therefore need to be able to manage and control their vocabulary learning through self-regulation (Tseng, Dörnyei and Schmitt, 2006). Indeed, self-regulation is now seen as a key component in L2 learning (Oxford, 2017), and the cyclical process of L2 vocabulary learning (Tseng and Schmitt, 2008).

At the same time, digital vocabulary learning applications and websites, which can be accessed on various devices such as smartphones, tablets, and laptops, have provided students with a greater variety of learning activities and more efficient ways to manage and track their vocabulary learning. Indeed, numerous studies have found that mobile-assisted vocabulary learning is more effective than using traditional, paper-based methods (Lin and Lin, 2019; Yu and Trainin, 2022). However, the use of digital devices, particularly smartphones, can also lead to digital distraction (Dontre, 2021). Some of the features of smartphones, such as notifications from social

media applications, have often been designed to attract users' attention (Pedro, Barbosa and Santos, 2018), and can end up distracting students from their academic tasks (Pérez-Juárez, González-Ortega and Aguiar-Pérez, 2023), and encourage them to multitask (Hanin, 2021). The capacity and ability of students to develop self-regulation is therefore even more important when learning L2 vocabulary on digital devices, but we do not currently know much about this. Several studies have measured the effects of digital device usage on academic performance in higher education, but these have mostly been conducted in on-campus settings, such as lecture halls (Limniou, 2021) and few have focused on the domain of digital vocabulary learning.

While students' self-regulation in vocabulary learning has been measured in several different higher education contexts (Mizumoto and Takeuchi, 2012; Sentürk, 2016; Soleimani, 2018; Tasnimi and Ravari, 2016), until recently there has been a scarcity of studies conducted on self-regulated L2 vocabulary learning through technology. In a meta-analysis of mobile-assisted vocabulary learning, none of the 33 studies focused specifically on self-regulation (Lin and Lin, 2019). Recent studies have often focused on one particular type of vocabulary learning activity, such as using digital flashcards (Boroughani, Behshad and Xodabande, 2023) and few have analysed different dimensions of self-regulated learning (SRL) nor used qualitative methods.

The purpose of this study is to address some of these gaps by measuring students' capacity for self-regulated vocabulary learning through technology and to see if there is any difference when learning through a laptop and a smartphone. It also explores students' perceptions about the reasons for any differences, which can be used to inform the types of interventions that may enhance and develop students' SRL. The study used the five dimensions of SRL identified by Şahin Kızıl and Savran (2018) as the conceptual framework to address the following research questions:

*RQ1: What is students' capacity for self-regulated vocabulary learning through technology at the beginning and end of a period of digital vocabulary learning?*

*RQ2: What differences are there in students' capacity for self-regulated vocabulary learning through different digital devices?*

*RQ3: What factors influence students' capacity for self-regulated vocabulary learning through different digital devices?*

## **2. Literature Review**

### **2.1 Self-Regulated Second Language Vocabulary Learning**

According to Zimmerman (2008, p.166), "self-regulated learning refers to the self-directive processes and self-beliefs that enable learners to transform their mental abilities, such as verbal aptitude, into academic performance skill". This is particularly important when it comes to informal learning outside the classroom where learners do not have the direct support and guidance of a teacher, such as when trying to develop their vocabulary knowledge. In the field of L2 vocabulary learning, Tseng, Dörnyei and Schmitt (2006) developed the Self-regulating Capacity in Vocabulary Learning Scale (SRCvoc), which focuses on students' underlying cognitive and behavioural actions and consists of five dimensions of SRL (see Table 1).

**Table 1: Dimensions of self-regulated vocabulary learning (Tseng, Dörnyei and Schmitt, 2006)**

1.	Commitment Control
2.	Metacognitive Control
3.	Satiation Control
4.	Emotion Control
5.	Environment Control

This capacity for self-regulated vocabulary learning has been identified as a vital component in the systematic and cyclical process of L2 vocabulary learning. Tseng and Schmitt (2008), found that SRCvoc had a close relationship with both Strategic Vocabulary Learning Involvement (SVLI) and Mastery of Vocabulary Learning Tactics (MVLТ), which then influenced vocabulary knowledge. The SRCvoc was operationalised as a survey instrument and has subsequently been used in other studies (Mizumoto and Takeuchi, 2012; Sentürk, 2016; Soleimani, 2018). These have generally shown low levels of SRL. For example, Sentürk (2016) found a moderate level of SRL among Turkish university students with a mean score of 3.76 out of a maximum score of 6. In all these studies, though, the effects of a period of vocabulary learning, especially through the use of a digital, vocabulary learning tool and different digital devices, were not measured.

More recently, there has been a greater focus on SRL within technology-based contexts. The Self-regulated Vocabulary Learning through Information and Communication Technologies (SRLvocICT) model developed by Şahin Kızıl & Savran (2018) also consists of five dimensions of SRL (see Table 2) and was operationalised as a reliable and valid survey tool (Şahin Kızıl and Savran, 2018).

**Table 2: Five dimensions of self-regulated vocabulary learning through ICTs (Şahin Kızıl & Savran, 2018, p.605)**

Dimension	Description
1. <b>Commitment regulation</b>	Concerns the preservation or increase of learners' original goal commitment.
2. <b>Metacognitive regulation</b>	Involves the SRL skills for managing concentration, procrastination, monitoring and controlling learning.
3. <b>Affective regulation</b>	Involves SRL skills for coping with impediment feelings (e.g., boredom, stress, etc.) and replacing them with facilitating emotions (e.g., maintaining interest).
4. <b>Resource regulation</b>	Relates to seeking, managing and expanding learning resources to increase learning opportunities.
5. <b>Social regulation</b>	Involves building constructive environments by seeking social support.

Several studies have focused on SRL within a technology-based context and these show that the use of technology for vocabulary learning generally has a beneficial effect on students' capacity for self-regulation (Tasnimi and Ravari, 2016, Broughani, Behshad and Xodabande, 2023). For example, Broughani, Behshad and Xodabande (2023) found that students using digital flashcards for vocabulary learning had significantly higher levels of self-regulation than a control group of students who used paper-based flashcards at the end of four months of vocabulary learning. However, none of these studies analysed the results in terms of the five different dimensions of self-regulation.

## 2.2 Device use in Vocabulary Learning Through Technology

Numerous studies have found that learning through the use of smartphones and other mobile or portable devices has had positive effects on vocabulary learning (Hao, Wang, and Ardasheva, 2021; Lin and Lin, 2019; Yu and Trainin, 2022). One of the main reasons for this is that "the portability and interconnectivity of mobile devices enhance the integration of formal and informal learning, which can promote learners' interest and thus foster comprehension and retention" (Hao, Wang and Ardasheva, 2021, p.662). This has often been enabled by the high rates of smartphone ownership among university students (Andrew *et al.*, 2018).

Studies that have investigated the use of different devices for vocabulary learning have highlighted a student preference for using laptop computers. For example, Lai and Zheng (2018) found that more students preferred using a laptop (50%) than a smartphone (40%). When asked in interviews about their reasoning, most students said that they associated laptops with serious study and were better for academic multi-tasking. Similarly, Stockwell and Liu (2015) found that 83% of Japanese and Taiwanese university students using online activities only accessed these activities from a personal computer (laptop or desktop), while just 17% used their mobile or smartphone. In semi-structured interviews, students said that the small screen size and the corresponding small font size on their smartphones impeded completing the activities properly. There was also general resistance and "psychological barriers" to seeing their smartphone as a device for learning purposes (p.316). At the same time, many university and high school students mainly use their smartphones for non-academic purposes, rather than for learning. Cojocnean (2016,) found that the vast majority of students (72%) "showed neutral attitudes towards the use of mobile-assisted learning tools in their vocabulary learning" (p.31) and perceived their smartphones as "sources of entertainment" (p.36) and opportunities for socialising, rather than as learning devices.

On the other hand, there is some evidence that students use their smartphones for casual learning and for tasks that are quick and light (Jurkovič, 2019; Lai and Zheng, 2018). Lai and Zheng (2018, p.310) found that 73% of students primarily used smartphones to consult dictionaries or translation tools for vocabulary learning, as opposed to only 22% who preferred laptops. More students also preferred using a smartphone when it came to using digital flashcards for learning vocabulary.

In addition to these studies focused on L2 vocabulary learning, educational psychology has identified some negative aspects of smartphones which can impact learning. Many mobile applications on smartphones have

been deliberately designed to compete for the user's attention through "prolonged immersion, frequent distraction and consumption of divisive content" (Hanin, 2021). This is further enabled through the use of push notifications and pop-ups (Pedro, Barbosa and Santos, 2018, p.7), which encourage "dopamine escapes" (Means, 2020, p.269) from academic tasks and challenging learning activities. This often leads to "habitual distraction" (Aagaard, 2018, p.6), increased multitasking amongst undergraduate students (Judd, 2015), and in some cases, nomophobia or fear of being without a mobile telephone and even smartphone addiction (Chiu, 2014). In terms of the effects on students in higher education, digital distractions negatively impact academic achievement (Aaron and Lipton, 2018) and academic performance (Lepp, Barkley and Karpinski, 2015). Aaron and Lipton (2018), for example, showed that non-academic use of digital devices contributed to poorer retention of classroom material. Since students often lack the necessary capacity for self-regulation to overcome these distractions (Mahapatra, 2019), this seems to be a vital issue to investigate further.

### **3. Method**

#### **3.1 Participants**

The participants in this study were Gulf Arab students enrolled on an English foundation course at a university in the Middle East. This 16-week, one-semester course was designed for students who had just graduated from high school, but whose level of English language proficiency was not sufficient to start their EMI undergraduate degree course. After reading a written information sheet about the research, those who agreed to take part in the study signed a consent form. Two hundred and sixty-seven participants were initially recruited for this study across 26 separate sections of the same course. Due to course withdrawals, the total number of participants fell to 246 by the end of the study. This constituted 49% of the total student population who completed the 16-week course. The vast majority of the participants (230 or 94%) were female with a small group of male students (16 or 6%) and were all aged between 17 and 20 years old.

#### **3.2 Vocabulary Learning**

One of the learning outcomes of this English foundation course was for students to have a receptive knowledge of 500 additional academic English words to help them comprehend the academic texts in their degree courses. To learn to recognise the meaning and form of each word, students were provided with free access to digital activities hosted on Quizlet, which is said to be "the largest user-generated consumer learning platform in the United States", with 50 million active users in 130 countries (Stevens, 2019, p.1). Quizlet features a web-based interface that can be accessed on laptop computers, as well as a mobile application for smartphones and tablets.

The 500 words were divided into 50 daily blocks of ten words, and short definitions and simple gap-fill sentences for each word were uploaded to Quizlet. The site then generated seven different activities for each block. The participants were asked to complete at least five different digital vocabulary activities each day for one block of ten words (250 activities in total) over 50 days (five days a week for ten weeks). Students were not told which activities or which digital device to use. The intervention could be described as an assigned task with other regulation at the macro level (Winne, 2018), with students needing to self-regulate at the micro level in terms of when, where and how they used Quizlet. To check the completion of the digital activities, the number of Quizlet activities that each student completed was recorded by their class teacher on a Microsoft Excel spreadsheet. At the end of the ten weeks of vocabulary learning, the mean number of completed Quizlet activities was just under 210 or 84% of the target number.

#### **3.3 Research Design**

A mixed methods research design (Yin, 2006) was used because it helps to capture a more complete picture of the phenomenon being studied (Denscombe, 2014). Two main data collection methods were used (see Table 3).

**Table 3: Research methods**

<b>Method</b>	<b>Purpose</b>
1. Self-regulated vocabulary learning through technology surveys (Quantitative)	To measure students' capacity for SRL in L2 vocabulary learning through smartphones and laptops.
2. Paired-depth interviews (Qualitative)	To explore students' experiences and perceptions in relation to SRL and use of different devices.

There were two stages to the data collection. The first stage took place at the beginning of the semester when self-regulation surveys (pre-surveys) were administered. The second stage took place one week after the ten-

week vocabulary learning period had ended when the same surveys (post-surveys) were administered again and paired-depth interviews were conducted.

### 3.4 Data Collection

The SRLvocICT survey tool (Şahin Kızıl and Savran, 2018) was used as a self-report instrument to measure SRL. The scale contains 23 statements that relate to the five different dimensions of self-regulated vocabulary learning described earlier. With a mean scale coefficient of 0.85 (Şahin Kızıl and Savran, 2018, p. 610), the survey instrument is an extremely reliable tool.

In this present study, the original statements were adapted slightly by replacing the word 'ICTs' with 'smartphone' and 'smartphone applications' in Survey 1 and 'laptop' and 'the Internet' in Survey 2. This was undertaken to try and draw out any possible differences between how the participants perceived the two devices. For each statement, participants were required to indicate the degree to which they agreed on a 6-point Likert scale (see Table 4). A numeric value was assigned to each response to enable quantitative data analysis, with a possible maximum score of 138. The surveys were distributed electronically via Qualtrics, an online survey tool.

**Table 4: Survey response options**

Response	Numeric Value
Strongly Disagree	1
Disagree	2
Slightly Disagree	3
Partly Agree	4
Agree	5
Strongly Agree	6

Paired-depth interviews involved the interlocutor interviewing two participants at the same time, which enabled the participants to interact with each other (Wilson, Onwuegbuzie and Manning, 2016). Initial interview questions and an interview protocol were developed to ensure consistency in how the interviews were conducted. As an example, the initial questions used to explore the students' perceptions of their metacognitive regulation were as follows:

1. How did the choice of device (smartphone or laptop computer) affect your concentration?
2. Which device helped you to concentrate the most / least? How? Why?

Interviewees were purposefully selected from the existing participants and as many different classes as possible. Overall, a total of 28 students were recruited from 20 of the 26 sections and were divided into 14 pairs. The interviews were conducted in English and lasted between 30 and 40 minutes. Each participant was given a pseudonym to use during the interview to protect their identity and this same pseudonym was used to attribute quotes in the results section of this paper.

### 3.5 Data Analysis

Quantitative results from the SRL surveys were imported into SPSS Version 25.0 to generate descriptive statistics. The study variables were assessed for normality using the Shapiro-Wilk test, histograms and normal probability plots, and these revealed that the scores were not normally distributed. As a result, Wilcoxon signed-rank tests were used to measure the differences between the survey scores. A *p*-value of 0.05 was used to determine the statistical significance of all tests. Cronbach alphas were also calculated to assess the reliability and internal consistency of the SRL surveys. The average mean scale coefficient was 0.83 for the pre-surveys and 0.91 for the post-surveys, demonstrating high reliability and internal consistency.

For the paired-depth interviews, typological analysis and constant comparison (LeCompte and Preissle, 1993) were used to analyse the data. Firstly, a sequence of steps was drawn up to code the responses from the 28 interview transcripts. Then through an iterative process of reading and re-reading, responses within each interview transcript were categorised according to one of the five dimensions of SRL and whether the responses were positive or negative.

## 4. Results

### 4.1 RQ1: Students' Capacity for SRL Through Technology

When comparing the pre- and post-survey scores for each device, there was little change in the overall self-reported capacity for self-regulation. In terms of SRL through smartphones, there was a very small decline in the overall average scores between the pre-and post-surveys from 102.93 to 101.73 (see Table 5), while the average score per survey item fell from 4.48 to 4.42. This difference was not statistically significant ( $Z = -0.204, p = 0.838$ ).

**Table 5: Overall self-regulated learning through smartphones survey scores**

	N	Max.	Min.	Range	Mean	Median	SD
Pre-Survey	246	138	23	115	102.93	104	18.46
Post-Survey	246	138	23	115	101.73	105	24.55

For SRL through laptops, there was a small increase in the overall average score of 2.11 points between the pre- and post-surveys, while the average score per item increased from 4.67 to 4.76 (see Table 6). Again, this difference was not statistically significant ( $Z = -1.656, p = 0.098$ ).

**Table 6: Overall self-regulated vocabulary learning through laptops survey scores**

	N	Max.	Min.	Range	Mean	Median	SD
Pre-Survey	246	138	28	110	107.30	111	18.49
Post-Survey	246	138	23	115	109.41	114	21.51

Thus, the period of vocabulary learning does not appear to have had any effect on students' overall capacity for self-regulated vocabulary learning through laptops or smartphones.

By examining each dimension of SRL, some more significant differences were identified. In terms of SRL through smartphones, the mean survey score for three of the five dimensions (commitment, affective and resource) decreased after the period of vocabulary learning (see Table 7). Commitment regulation decreased by nearly 5% and the post-survey score was statistically significantly lower than the pre-survey score ( $Z = -2.286, p = 0.022$ ).

**Table 7: Mean scores for five dimensions of self-regulation in smartphone surveys**

	Commitment	Meta-cognitive	Affective	Resource	Social
Pre-survey	4.59	4.47	4.48	4.59	4.17
Post-survey	4.30	4.50	4.41	4.54	4.30

For SRL through laptops, the mean scores for all five dimensions increased slightly between the pre-survey scores and post-survey scores (see Table 8), but none of these increases were statistically significant.

**Table 8: Mean scores for five dimensions of self-regulation in laptop surveys.**

	Commitment	Meta-cognitive	Affective	Resource	Social
Pre-survey	4.86	4.69	4.66	4.73	4.43
Post-survey	4.89	4.77	4.72	4.81	4.54

### 4.2 RQ2: Differences in Capacity for SRL by Digital Device

A comparison of the survey scores between the two devices shows some significant differences (see Table 9). In both the pre-survey and the post-survey, students' capacity for self-regulated vocabulary learning through laptops was statistically significantly higher than that through smartphones and the differential increased. However, the increase in the differential before and after vocabulary learning was not statistically significant ( $Z = 1.073, p = 0.283$ ).



**Table 9: Comparison of self-regulation through smartphones and laptops**

	Pre-survey	Post-survey
<b>Laptop</b>	107.30	109.41
<b>Smartphone</b>	102.93	101.73
<b>Difference</b>	4.37	7.68
<b>Z</b>	-4.572	-5.916
<b>Sig (2-tailed)</b>	.000	.000

A comparison of the scores for the five dimensions in the two pre-surveys indicates that the mean scores for all five dimensions in the laptop pre-survey were statistically significantly higher than those in the smartphone pre-survey (see Table 10). The largest difference and the most statistically significant was in commitment regulation ( $Z = -4.133, p < 0.001$ ).

**Table 10: Pre-survey mean dimension scores**

	Commitment	Metacognitive	Affective	Resource	Social
<b>Smartphone</b>	4.59	4.47	4.48	4.59	4.17
<b>Laptop</b>	4.86	4.69	4.66	4.73	4.43
<b>Difference</b>	0.27	0.22	0.18	0.14	0.26
<b>Z</b>	-4.133	-3.174	-2.907	-2.107	-3.229
<b>Sig (2-tailed)</b>	.000	.002	.004	.035	.001

In the two post-surveys, the mean scores in the laptop post-survey for all five dimensions were also statistically significantly higher than those in the post-smartphone survey (see Table 11). The difference for commitment regulation was again statistically significantly higher ( $Z = -6.677, p < 0.001$ ) than the other dimensions.

**Table 11: Post-survey mean dimension scores**

	Commitment	Metacognitive	Affective	Resource	Social
<b>Smartphone</b>	4.30	4.50	4.41	4.54	4.30
<b>Laptop</b>	4.89	4.77	4.72	4.81	4.54
<b>Difference</b>	0.59	0.27	0.31	0.27	0.24
<b>% Difference</b>	13.72	6.00	7.03	5.95	5.58
<b>Z</b>	-6.677	-3.624	-4.409	-4.419	-3.613
<b>Sig (2-tailed)</b>	.000	.000	.000	.000	.000

As the results in Tables 10 and 11 show, the differential between the scores in the two pre-surveys and between the scores in the two post-surveys for four of the five dimensions increased over the period of vocabulary learning. The largest increase was in commitment regulation and this increase in the differential was statistically significant ( $Z = -2.868, p = 0.004$ ). These results suggest that when learning vocabulary through a smartphone the learners' commitment regulation was negatively affected during the vocabulary learning period.

### 4.3 RQ3: Factors That Influenced Capacity for SRL

Six main factors were identified from an analysis of the pair-depth interviews.

#### 4.3.1 Social media distractions on smartphones

Many students were aware that notifications from social media applications were a significant distraction from learning vocabulary on their smartphones and made it more difficult for them to stay focused on their learning goals:

*"While I'm doing my Quizlet on my phone, maybe the notifications will disturb me, and the notifications tell me like, don't do Quizlet and do chatting" (Beth).*

In many cases, messaging from friends proved too distracting:

*“the notification pop from the app and I am doing my Quizlet, I feel like I want to reply to what my friend tells me or when they call me” (May).*

There was also evidence of FOMO (Fear of Missing Out):

*“I should check it because they’re always talking, and they’re all talking without me, so what they are saying, what they are doing” (Sam).*

#### **4.3.2 Self-regulation of smartphone use**

The ability of students to self-regulate their use of their smartphones while completing the vocabulary learning activities was mixed. Some students were quite proactive:

*“I put it on silent, so I don’t hear” (Jane),*

*“I just turn off the notifications, because I want to focus on something” (Mary).*

Some students took more drastic steps:

*“I don’t use my phone because I know that I will go to use other apps and not Quizlet” (Ann).*

At the same time, there was also evidence of an unwillingness of some students to self-regulate their use of social media on their devices:

*“We need updates, that’s why we don’t turn off notifications” (Faye).*

There was also some evidence of how the smartphone can negatively affect concentration and increase procrastination:

*“the phone makes me so lazy, every time when I look at it, I’m like, ‘Oh’. I only use it while I’m lying down like on the bed” (Jo).*

#### **4.3.3 Physical features of the laptops**

The positive aspects of laptops were often related to how the physical characteristics of the device helped students stay focused on their vocabulary learning. The larger screen size means that:

*“you can see everything” (Rachel),*

*“can concentrate better” (Nina).*

The physical keyboard on the laptop gave students the ability:

*“to write faster, with no spelling mistakes” (Beth),*

*“to choose the correct spelling on the laptop” (Mary).*

Some students also felt the physical keyboard better enabled learning to take place:

*“When we’re typing, we learn more and we can concentrate more, but when we only tap, we will not remember the words later” (Jill).*

Another relevant factor was the perception that a laptop is a serious device for studying:

*“We only like to do our work on the laptop, not play or do anything else” (Ann).*

#### **4.3.4 Portability of smartphones**

Many of the positive mentions of using a smartphone centred around its portability. Several students mentioned how their smartphones enabled them to learn in a range of different locations:

*“while I’m in the car for 25 minutes from the university” (Kim),*

*“sitting in a coffee shop or I have free time outside or in class” (Clare).*

This gives the smartphone an edge over the laptop in certain out-of-class learning settings.



#### 4.3.5 Smartphone touchscreen

Some students spoke about how they used different devices for different digital vocabulary learning activities, based on both the activity requirements and the physical characteristics of the device. For example, Quizlet activities like ‘Spell’, which require physical input via a keyboard, were usually done on a laptop because of limitations of the onscreen keypad of the smartphone:

*“If I use the phone, I will make mistakes because it’s a small device” (Kim).*

On the other hand, the touchscreen of the smartphone was seen as advantageous for some of the other Quizlet activities:

*“The activity ‘Match’ was better on the smartphone because I can just read fast and touch the word” (Mary).*

#### 4.3.6 Switching between devices

Some students used their laptops and smartphones sequentially:

*“I use my phone, but when I finish, I use my laptop to see what I finished and what I didn’t finish” (Monica).*

Several students described how they multi-tasked across both devices at the same time, using the laptop for the main digital learning activities and the smartphone to access additional learning resources:

*“I have in my smartphone an app, Google Translate app, and in the laptop Quizlet” (Jill).*

A few students also accessed social media applications on their smartphones to help them overcome a sense of boredom while doing Quizlet on their laptops:

*“Yeah, I only use the laptop, but I can take a rest and watch my phone” (Jane).*

Thus, there was evidence of the dual role of social media applications on students’ smartphones. They were both a negative distraction that took them away from vocabulary learning, but also a positive response to alleviate stress and boredom.

## 5. Discussion

### 5.1 RQ1: What is Students’ Capacity for self-Regulated Vocabulary Learning Through Technology at the Beginning and end of a Period of Digital Vocabulary Learning?

Using technology for vocabulary learning seems to have had a beneficial effect on students’ capacity for self-regulation, based on the SRL survey results. The average item scores of 4.42 (post-smartphone survey) and 4.76 (post-laptop survey) were significantly higher than those found in previous studies conducted in non-technology contexts. For example, Sentürk (2016), reported an average score of 3.8 with pre-intermediate and advanced learners in Turkey. This supports the findings of Tasnimi and Ravari (2016) and Boroughani, Behshad and Xodabande (2023) who found that students who used online crossword puzzles and digital flashcards had higher levels of self-regulation than students using traditional paper-based materials. One reason for this could be that the accessibility of digital learning activities, the automatic and instant feedback on answers and tracking of completed activities may enable students to shift more cognitive effort to the actual learning.

At the same time, the findings revealed that there was no statistically significant difference between the student’s overall capacity for self-regulated vocabulary learning at the beginning and end of the 10-week learning period both for laptops and smartphones. This suggests that students were already familiar with using both devices for learning purposes. However, there was one dimension of SRL that saw a statistically significant decline – that of commitment regulation when using Smartphones, which has not been identified in any previous study. The possible reasons for this decrease will be discussed below, but clearly, there was something about the Quizlet mobile application and smartphone that negatively affected students’ ability to persist and maintain their interest in achieving their learning goals.

### 5.2 RQ2: What Differences are There in Students’ Capacity for Self-Regulated Vocabulary Learning Through Different Digital Devices?

Students’ capacity for self-regulated vocabulary learning through laptops was significantly higher than through smartphones, both at the beginning and end of the 10-week period in terms of each of the five dimensions of

SRL and overall. However, because there was little change in the differences over the period, it seems that students were already aware that laptops were more suitable for sustained, out-of-class digital vocabulary learning than smartphones before the study started, which supports the findings of Lai and Zheng (2018) and Stockwell and Liu (2015).

### **5.3 RQ3: What Factors Influence Students' Capacity for Self-Regulated Vocabulary Learning Through Different Digital Devices?**

#### *5.3.1 Commitment regulation*

Based on the findings from the pair-depth interviews it would seem that both psychological and physical factors decreased the students' original goal commitment while completing the vocabulary learning activities on a smartphone. The first factor was the distraction from social media applications which are more accessible on a smartphone than a laptop, especially through visual pop-up and sound notifications. When you are trying to focus on something mentally demanding, such as vocabulary learning, it is much easier to be distracted from that task after a few minutes of concentrated effort, especially with the "ubiquitous presence of digital devices and social media in students' lives" (Pedro, Barbosa, and Santos, 2018, p.1) and the promise of 'dopamine escapes" (Means, 2020, p.269). This is a serious issue that is rarely discussed in the literature on mobile vocabulary learning and seems to be one of the main reasons for the decline in students' capacity for commitment regulation.

The second factor is that many students had a general resistance to using their smartphone as a device for learning purposes due to both the physical constraints of the small screen and virtual keyboard, and its primary role in their lives as a communication device. These findings align with those of Cojocnean (2016), Jurkovič (2019) and Lai and Zheng (2018) who identified "psychological barriers" (Lai and Zheng, p.316) that stopped students from using smartphones as learning devices. At the same time, the students in the current study also seemed to associate laptops with more focused, out-of-class learning. As Lai and Zheng (2018) found, laptops seem to better enable academic multi-tasking because students can have multiple screens open at the same time and more easily switch between them where necessary.

#### *5.3.2 Metacognitive regulation*

Perhaps the main reason for students perceiving laptops as having a more positive influence on their capacity for metacognitive self-regulation in vocabulary learning is that the physical characteristics of the device, such as the larger screen size and a physical keyboard, better enabled them to concentrate on their digital vocabulary learning than smartphones. The ability to see the whole menu of options, and clearer tracking of correct answers and overall scores perhaps also allowed students to better monitor their vocabulary learning. This mirrors the conclusions of Stockwell and Liu (2015). In addition, the ease of typing in answers for most of the Quizlet activities seems to allow the students to concentrate more and not get frustrated as some did when trying to use the virtual keyboard on their smartphones. Conversely, the use of smartphones for accessing the two game-like activities on Quizlet - Flashcards and Match - shows the value of a touch screen for certain vocabulary learning tasks and activities which do not require textual input. Tapping a smart screen with your fingers can be more efficient than having to use a mouse or a trackpad (Lai and Zheng, 2018), but there is the danger of mindless tapping with little cognitive effort.

One aspect of metacognitive regulation through using smartphones which did show a positive change at the end of the vocabulary learning period was students' ability to plan tasks and relevant materials to learn vocabulary outside of the classroom. In particular, their use of smartphones on the go underlines the portability affordance of the device (Kukulka-Hulme, 2012). Applications on smartphones can also be accessed more quickly than websites on laptops which allows students to make better use of "fragmented time" (Hu, 2013, p.147) in between classes on campus and while outside the home. At the same time, the ability to access the same digital vocabulary learning tool through both a web-based platform on their laptops and a mobile application on their smartphones perhaps gave students the confidence to switch between devices depending on the location and time, as part of a seamless mobile learning experience (Wong and Looi, 2011).

#### *5.3.3 Affective regulation*

Although the survey results showed that affective regulation when learning on smartphones was lower than on a laptop, some students relied on their smartphones to overcome boredom by checking their social media feeds, rather than using them to access digital vocabulary learning activities. This seems like a positive step to some extent, but it does not tell us how easily students were able to return to their vocabulary learning at the end of

their “social media break”. Since many students in the interviews mentioned that they had difficulty self-regulating their use of social media on their smartphones, it would probably be a challenge and may be evidence of smartphone addiction, as found by Chiu (2014).

#### 5.3.4 Resource regulation

The fact that students also used their smartphones to access mobile applications, such as the Quizlet wordlist and the Google Translate application to quickly check word information, such as definitions or Arabic translations shows that they possess the capability of accessing different learning resources to increase learning opportunities. This is similar to the findings of Lai and Zheng (2018).

### 5.4 Theorising Self-Regulated Vocabulary Learning Through Digital Devices

As a result of the findings of this study, I propose that Şahin Kızıl and Savran's model of self-regulated, vocabulary learning through technology (2018) would benefit from the addition of a sixth dimension - device regulation/control - and the inclusion of four new statements of belief (see Table 12). These statements specifically relate to learners' capacity to use different devices for vocabulary learning in terms of the digital activities, temporal and spatial factors and features of the devices. This dimension also recognises the reality of digital distractions in out-of-class, digital, self-regulated vocabulary learning.

**Table 12: Device regulation dimension**

1.	I know which device is better to use for different digital vocabulary learning tasks and activities.
2.	I believe that I can switch between using different devices depending on the time and place.
3.	I know how to use different devices simultaneously to maximise my digital vocabulary learning.
4.	I can identify digital distractions and find ways to overcome them to refocus on learning.

## 6. Conclusion

This study aimed to measure students' capacity for self-regulated vocabulary learning through technology with a particular focus on different digital devices - laptops and smartphones - using five dimensions of SRL (Şahin Kızıl and Savran, 2018) as the conceptual framework. It also aimed to explore students' perceptions about the device-related factors that may have affected their capacity for SRL. The findings make several contributions to the field of second-language digital vocabulary learning and e-learning in general. Perhaps the main contribution is that students' commitment regulation was negatively affected when learning vocabulary through a smartphone primarily because of the digital distractions caused by the ease of access to social media applications and notifications. Secondly, the findings provide evidence that a period of digital vocabulary learning in out-of-class settings has little effect on the other four dimensions of self-regulation when learning through either a smartphone or laptop. Thirdly, the findings highlight the complex interplay between digital devices, digital vocabulary learning activities and the different dimensions of students' self-regulated vocabulary learning. Finally, they support previous research findings that students' levels of SRL in a technology-based context were significantly higher than in non-technology-based contexts and that students in higher education settings have an overall preference for using laptops to access digital vocabulary learning activities.

One of the main implications of this study is that models of self-regulated vocabulary learning through technology need to include a dimension related to device control which recognises how the features, architectures and affordances of different digital devices impact SRL and the importance of digital distraction. In addition, because smartphones are ubiquitous and deeply embedded in both daily life and higher education settings, students require awareness raising about digital distractions and guidance on how to develop their use of self-regulated learning strategies (Wang *et al.*, 2022) when using different devices for academic-related tasks, such as intentional, digital vocabulary learning, in out-of-class settings.

This study has a few limitations. Firstly, self-regulation was only measured through students' perceptions, which inevitably added a subjective nature to the results. Another limitation is that only the total number of Quizlet activities completed by each participant was calculated. This did not allow for a more nuanced picture to emerge about the use of individual Quizlet activities and the relationship with the five different dimensions of self-regulation. Finally, the characteristics of the participants in this study limit the generalisability of the results to some extent. The vast majority were female, and it might be possible that they are more attached to their smartphones than male students. In addition, Gulf Arab cultures may have a stronger affinity to using their smartphones than other cultures.

The results and limitations of this study suggest some fruitful areas to focus on in follow-up research. Replication of Tseng and Schmitt's study (2008), both before and after a period of digital vocabulary learning on different devices, might help to identify any effects on strategic vocabulary learning involvement (SVLI) and mastery of vocabulary learning tactics (MVL) or specific learning strategies. This would also enable further testing of the relationships between the different components of their model of motivated vocabulary learning in technology-based contexts. Furthermore, using the extended SRLvociCT survey with the new sixth dimension of device control would allow testing of the validity and reliability of the revised tool, and also provide further insights into the ability of students to manage and control their use of different digital devices during periods of digital vocabulary learning.

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The author reports there are no competing interests to declare.

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