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Smartphone Usage and Studying: Investigating Relationships between Type of Use and Self-Regulatory Skills

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Abstract: The purpose of this study is to investigate the relationships between self-regulated learning skills and smartphone usage in relation to studying. It is unclear whether poor learning habits related to smartphone usage are unique traits or a reflection of existing self-regulated learning skills. The self-regulatory skills (a) regulation, (b) knowledge, and (c) management of cognition were measured and compared to the smartphone practices (a) multitasking, (b) avoiding distractions, and (c) mindful use. First-year undergraduates (n = 227) completed an online survey of self-regulatory skills and common phone practices. The results support the predictions that self-regulatory skills are negatively correlated with multitasking while studying and are positively correlated with distraction avoidance and mindful use of the phone. The management of cognition factor, which includes effort, time, and planning, was strongly correlated with multitasking (r = −0.20) and avoiding distractions (r = 0.45). Regulation of cognition was strongly correlated with mindful use (r = 0.33). These results support the need to consider the relationship between self-regulation and smartphone use as it relates to learning.

Keywords: smartphone; m-learning; self-regulated learning

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1. Introduction

The implications of smartphones and the enhanced connectivity they provide are substantial for education. Ninety-six percent of U.S. adults aged 18–29 have a smartphone [1]. While the smartphone may lag behind the laptop as the primary studying tool, the smartphone is prominent none the less. Chilean students report using the computer more frequently to access course materials but also simultaneously use the smartphone [2]. Unfortunately, increased smartphone usage is negatively correlated with college GPA [3,4], and other achievement measures such as test scores [5]. There is broad consensus that distractions from smartphones and the propensity for multitasking hinder studying and, thus, learning [6–9]. However, many students are convinced that the smartphone supports their learning [10]. Smartphones are perceived as extensions of the body and they induce a strong emotional attachment [11], so it is difficult for learners to distance themselves. While there are good examples of advantageous uses of mobile technologies when guided by instruction [12–14], a better understanding of how smartphones are being used by the independent learner while studying is needed [15].

It is important to distinguish between personal smartphone usage while learning and what is commonly referred to in the literature as mobile-learning or m-learning. Mobile learning refers to the capacity to be untethered and may include the use of smartphones, tablets, and personal digital assistants (PDAs). A good portion of the research on mobile learning focuses on classroom devices that are provided to the learner [16,17]. These investigations are generally positive toward the use of mobile learning. While that work is relevant in the sense that it provides evidence that some uses can support learning, it does

not address the questions regarding the role of the individual's personal smartphone use while studying [18]. In any learning environment, the student has choices regarding how they will or will not use the mobile device. The usage options offered by the classroom iPad differ greatly from those of the personal smartphone.

This research will focus on the personal smartphone and its use while studying. Decisions regarding how the smartphone will be used are guided by how well the student understands and balances the benefits and costs associated with smartphone use. This understanding, combined with the willingness to regulate use, has important implications for student learning. Self-regulated learning (SRL) research has grappled with similar issues for decades and will guide the current study [19]. Research supports the positive impact of SRL skills on learning [20,21]. As noted above, there is evidence that the smartphone has a negative impact on learning [9]. The literature gap that this study addresses is the relationship between SRL and smartphone use while studying. It is unclear whether poor learning habits related to smartphone use are unique traits or a reflection of existing self-regulated learning skills. The purpose of this study is to determine how students' self-regulatory skills are related to the use or avoidance of the smartphone in support of learning.

2. Self-Regulated Learning and Smartphone Use

The intersection of technology and learning can be broadly conceptualized as issues of media selection, instructional strategies, and learner characteristics. Educational research has investigated these issues with each new wave of innovation. These innovations begin as somewhat obscure novelties and reach ubiquity in an increasingly rapid manner [22]. The most recent examples include the personal computer, the Internet, and now the smartphone. Beginning with the introduction of the iPhone in 2007, the cell phone transitioned into the now ubiquitous smartphone (a phone that can access the web and run sophisticated software applications). While each new innovation introduced novel considerations, the corresponding cognitive concerns remained the same—namely issues of attention, working memory, multimedia processing, and learner characteristics.

These cognitive concerns have been studied extensively under the guise of self-regulated learning (SRL) [21]. Similar applications of SRL frameworks include a review of online learning outcomes that indicated a positive relationship between these skills and academic achievement [23]. This theoretical framework postulates that learning can be understood as a combination of the learner's understanding of learning (knowledge of cognition), capacity or willingness to regulate learning (regulation of cognition), and the management of cognitive resources and environment (management of cognition) [20,24]. Knowledge of cognition can be found when students understand the benefits of silencing the smartphone while studying. Regulation of cognition is exemplified by the student following through with action by silencing the smartphone. Resource management is demonstrated through effortful attention toward learning and away from distraction.

A student's SRL skills can be viewed as foundational understandings that are reflected in corresponding student beliefs and behaviors related to the use of the smartphone. Prior research has investigated the connections between the constructs of general, not learning specific, smartphone use and SRL [25,26]. This study extends this work by identifying parallels between smartphone use as it relates to learning and SRL.

2.1. Smartphone Use and Misuse as It Relates to Learning

Students who are better able to self-regulate their learning tend to earn higher grades [27,28]. This finding was established well before the introduction of the smartphone. Distractions and opportunities to multitask are not recent innovations. However, smartphone technology and the associated commercial interests have introduced functionality that encourages constant distraction and multitasking. This is not to say that the smartphone cannot be used in support of learning. There are numerous examples of specific educational uses of smartphones that

can have a positive impact on learning [29,30]. However, the focus of this work is to better understand how overall smartphone use might influence achievement.

2.1.1. Measuring Overall Smartphone Use and Academic Achievement

High smartphone use is associated with lower academic achievement. However, how smartphone use is defined varies. A recent meta-analysis of 40 studies comparing smartphone use and academic achievement found a significant negative correlation ($r = -0.016$, $p < 0.001$) [5]. Of the 40 studies evaluated, 21 measured smartphone use as overall total time spent or frequency of use. Seven of the studies used some type of phone addiction scale (more on these later). The final 12 studies were experimental interventions. Similarly, in a systematic review of studies investigating the relationship between smartphone use and achievement, the measurement of smartphone use across 23 studies was either total use or problematic use [4].

In an example of an overall use study, undergraduates' college grades were negatively correlated with cell phone use ($r = -23$, $p < 0.001$) [3]. Phone use in this study was a self-reported estimate of total time using the phone. Estimates of phone usage in this and related research do not specify the nature of the usage, so it is unclear whether the use is directly related to learning. For example, Lepp and colleagues (2015) asked participants:

> *As accurately as possible, please estimate the total amount of time you spend using your mobile phone. Please consider all uses except listening to music. For example: consider calling, texting, sending photos, gaming, surfing the Internet, watching videos, Facebook, email, and all other uses driven by apps and software.*
>
> (p. 4)

The Media and Technology Usage and Attitudes Scale (MTUAS) is another common measure for smartphone use [26]. The MTUAS smartphone subscale asks students how frequently they engage in activities such as *Read email on a mobile phone* and *Browse the web on a mobile phone*. Users can respond on a ten-point scale ranging from *never* to *all the time*. While this scale provides a finer-grained image of the usage, it does not distinguish between productive and non-productive usage as it relates to learning.

Direct measures of smartphone use have also been used to investigate the relationship between use and academic achievement. In a study of 43 undergraduate business students, smartphone use was compared to academic performance by collecting application use data directly from the participant's smartphone [31]. Again, increased overall smartphone use was related to poorer academic performance.

Smartphone use has also been viewed from a behavioral perspective under the guise of "problematic smartphone use." Related descriptions include NoMoPhobia (fear of not having one's smartphone), FOMO (fear of missing out), and smartphone addiction. Research in this area has generally measured smartphone use through questionnaires that explore "excessive" or "problematic" use. One example is the Smartphone Addiction Scale [32], which asks respondents about the impacts of use on daily life activities. Studies using this and similar scales have found a negative relationship between problematic use and academic achievement [32,33]. This approach to measurement is distinct from those described earlier in this section in that there is an effort to identify problematic as opposed to general smartphone use.

2.1.2. Technology Use and SRL

Concerns about the potential negative impacts of smartphones are similar to those raised regarding other technologies. This often resulted in investigations of the potential relationship between self-regulatory skills and technology use. The expectation is that highly self-regulated learners commit effort toward staying focused on a task and would be less susceptible to the adverse impact of technology. However, the plethora and intensity of technology distractions now available to students can make this difficult for even the most judicious student [7,34]. One study that observed middle school students studying in

their home environment found that they averaged only 6 minutes of study before engaging in technology-supported off-task behaviors [35].

Terry and colleagues compared students' metacognition and time management measured via the Motivational Strategies for Learning Questionnaire (MSLQ) to students' responses to the MTUAS [25]. They found a significant negative correlation between the MTUAS task switching subscale and the MSLQ time and study subscale. They also found a negative but not statistically significant correlation between the metacognitive subscale and task switching.

In the same [3] study noted above, which demonstrated the negative correlation with college GPA, student self-efficacy for SRL exhibited a strong positive association with college GPA. However, given the nature of the smartphone use measurement, it is difficult to determine how these associations are related. In other words, how does a high self-efficacy for SRL change the nature of smartphone use in a manner that influences overall achievement?

Some have speculated that this technology-induced distraction is distinct from conventional distractions [36]. Xu explored student self-reported activities while completing homework. Activities were classified as tech-related (e.g., stop homework to play video games) or conventional (e.g., daydream). The results of a multilevel analysis indicated that the technology-induced distractions were empirically distinct from the conventional. However, the high correlations between the two factors and the subtle distinctions between the survey items leave open the possibility that a common learner propensity underlies the participant responses.

In sum, the current literature has identified a negative correlation between general smartphone use and academic achievement. In addition, preliminary indications point to a relationship between general smartphone use and SRL skills. A better understanding of the challenges presented by smartphone use can be gained through a clearer description of the types of learning-related use and the relationship with specific SRL skills.

2.2. SRL and the Smartphone

The research related to SRL and academic achievement can inform the study of smartphones and learning. An extensive research review of psychological constructs and the impact on academic performance identified 50 important variables for researchers and educators to consider [37]. Many of the factors that have been demonstrated to have a substantial impact, as measured by effect size and consistency, are readily measured. In addition, many of the cognitive factors are highly correlated (e.g., conscientiousness and grit) [38]. Cognitive factors associated with higher academic achievement include goal orientation, academic self-efficacy, and conscientiousness (persistence and effort regulation). These factors are frequently aggregated under the concept of self-regulated learning (SRL). SRL research has an extensive and nuanced history with conceptual roots in the 1960s [19] and integrated models appearing in the 1980s [39]. While the demarcations and specific encapsulated constructs are still debated, SRL has proven to be a useful and robust conceptual model. For the purposes of this study, SRL will be reduced to three related constructs, knowledge of cognition, regulation of cognition [24], and resource management [20]. As described below, these three constructs share both the demonstrated relationship to academic achievement and corresponding linkages with common smartphone activities.

The understanding the learner has about their own thinking and learning is referred to as their knowledge of cognition. This understanding includes the toolbox of strategies that can be deployed in a variety of learning situations [24]. Reading strategies, such as self-questioning, are commonly taught and somewhat less commonly used. Rereading confusing passages is another example. Rereading as a strategy interacts with the regulation of cognition and is discussed further below. Knowledge of cognition can also refer to skills such as recognizing important information and the ability to control one's own learning. In the context of smartphone use, knowledge of cognition might be exhibited as the awareness of relevant apps that support particular learning strategies.

Regulation of cognition is identified as a mediator between knowledge of cognition and other learning beliefs and the relevant actions [24]. For example, the recognition of the importance of rereading confusing passages (knowledge of cognition) is of little value if the strategy is not implemented (regulation). Similarly, a belief in effortful learning matters little if it is not translated into more-focused attention (regulation) on the relevant academic task. Maintaining focused attention is acutely relevant to the smartphone-using learner.

Efficient learners recognize the limitations of cognitive capacity, mental energy, and time. They recognize the need for a learning environment that is conducive to focus [40]. They recognize the effortful nature of learning and report working hard to learn. Efficient learners will make study plans and stick to those plans. Resource management is also dependent upon habit and routine [20]. In some ways, it serves as a proxy for lives that are more stable. The college student with a variety of obligations beyond academics (e.g., employment, family, and health) may recognize the need for planning but find it difficult. While promoters of smartphone use might point out the attributes of the device that can support management activities such as planning, it is more likely a hindrance to efficient resource management.

2.3. The Current Study

The purpose of this study is to determine how students' self-regulatory skills influence the use or avoidance of the smartphone in support of learning. The questions being addressed in this study are

1) Are self-regulated learners *less* likely to engage in counter-productive behaviors such as multitasking while studying?
2) Are self-regulated learners *more* likely to engage in positive smartphone behaviors such as avoiding distraction while studying?
3) Are self-regulated learners *more* likely to engage in mindful smartphone use?

It is anticipated that highly self-regulated learners will be less likely to engage in uses of the smartphone that are counter-productive to learning, such as multitasking while they are studying. Highly self-regulated learners will also be more likely to use the smartphone in a manner that is conducive to learning, such as monitoring or restricting usage.

3. Method

3.1. Participants

A total of 227 undergraduate students (124 females, 103 males) from a diverse, urban, research university located in the southwest United States participated in the study. The students were enrolled in a first-year seminar (e.g., student success course) that was primarily designed for new students exploring their choice of major or students working toward acceptance into their desired major. The average age of the participants was 18.7 years old, with a minimum of 18 and a maximum of 24. All of the participants reported owning a smartphone. The study was reviewed and approved by the university office of research integrity.

3.2. Measures

3.2.1. Self-Regulated Learning Survey

Items from the Metacognitive Awareness Inventory (MAI) [24] and Motivational Strategies for Learning Questionnaire (MSLQ) [41] were used to measure SRL for this study. See Table 1 for sample items. The original MAI included 52 items that measure two factors: knowledge of cognition and regulation of cognition [24]. The MAI has been used in numerous studies, in a variety of contexts, and with frequent modification [42]. Harrison and Vallin recently completed a systematic analysis of the overall measure, independent factors, and individual items. The analysis resulted in a recommendation for an improved MAI consisting of a two-factor, 19-item subset (11 regulation items and 8 knowledge items). For the current study, three of the recommended items were excluded based upon the

mismatch between the reported factor loadings and the theoretical models (regulation 51, knowledge 27 and 35). This resulted in 10 regulation of cognition and 6 knowledge of cognition items that were used for this study. The regulation of cognition items used a 5-point fully labeled Likert response scale: (1) not at all typical of me, (2) not very typical of me, (3) somewhat typical of me, (4) fairly typical of me, (5) very typical of me. The knowledge of cognition items utilized a 5-point agreement scale: (1) strongly disagree, (2) disagree, (3) neither agree or disagree, (4) agree, (5) strongly agree. In the present study, the internal consistency (McDonald's omega [43]) was 0.642 for knowledge of cognition and 0.780 for regulation of cognition (see Table 2).

Table 1. Self-regulated learning measures.

Source	Factor	Sample Item
MAI	Regulation of cognition	I try to translate new information into my own words.
MAI	Knowledge of cognition	I know what kind of information is most important to learn.
MSLQ	Resource management	I make good use of my study time.

Table 2. Means, standard deviations, and internal consistency of SRL subscales.

	Scale				Items	
Variable	**Range**	**Mean**	**SD**	**Omega**	**Number**	**Mean**
(1) Resource management	18–50	20.55	3.85	0.740	6	3.43
(2) Regulation of cognition	14–30	33.60	6.02	0.786	10	3.36
(3) Knowledge of cognition	8–30	22.54	3.12	0.642	6	3.76

Resource management was measured with 6 items from the MSLQ Resource management scales (three from the effort regulation subscale and three from the time and study environment subscale). As with the MAI, the MSLQ is an accepted measure of self-regulated learning that has been evaluated and used extensively in the educational literature (e.g., [44,45]. These items were chosen based upon the high correlations with achievement [20]. The resource management items used the same 5-point fully labeled Likert response "typical of me" scale used for the regulation of cognition items. In the present study, the internal consistency (McDonald's omega) of the resource management scale was 0.740 (see Table 2).

3.2.2. Common Phone Practices

The existing literature on smartphone use tends to focus on overall time spent using the device [4]. Some studies have identified specific apps (e.g., Snapchat or Facebook), while others have tried to generalize the types of use (e.g., social media, media consumption, and messaging). Each of these approaches can miss the intended goal of the particular usage. Time using YouTube could be spent viewing funny cats or a previous class lecture. The expectation is that the highly self-regulated learner will commit proportionally more time to the latter during a study session.

Measurements of phone use in the context of studying should focus on the implications of the use for learning. The common phone practices survey was developed for this study to measure uses of the phone that have direct implications for learning. Items were developed in three relevant areas commonly noted in the literature and via observations. These categories include (a) avoiding distractions, (b) engaging in multitasking, and (c) mindful use of the phone (e.g., self-monitor usage). An initial pool of 15 items was circulated to researchers and instructors familiar with the topic and the target population. Two members of the target population were also asked to complete the survey and note any items in need of clarification. The result was a 9-item inventory (see Table 3) with three items in each of the three categories. Each item used a 5-point fully labeled Likert response scale: (1) not at

all typical of me, (2) not very typical of me, (3) somewhat typical of me, (4) fairly typical of me, (5) very typical of me.

Table 3. Common phone practices.

Common Practice	Impact on Learning	Items
Student prompt: *Studying: Rate how typical each of the following activities is for you while studying.*		
Multitasking while studying	Unproductive	I pay attention to what is happening on social media (e.g., Instagram, Facebook, Snapchat).
		I simultaneously watch videos.
		I respond to direct messages on my phone from friends and family.
Avoiding distractions while studying	Productive	I take steps to ensure that my phone will not interrupt my studying.
		I avoid checking my phone for notifications while studying.
		I focus completely on my studying.
Student prompt: *Rate how typical each of the following activities is for you.*		
Mindful phone use	Productive	I pay attention to how much time I spend on different phone applications.
		I set aside time where I restrict my use of the phone.
		I use apps that help me monitor my phone usage.

The reliability of the common phone use dimensions was generally strong (see Table 4). The multitasking items demonstrated moderate reliability (McDonald's Omega = 0.58) [43]. While the reliability is a concern, the level was deemed acceptable given the low number of items, the importance of the behaviors described to the research question, and the discrimination it exhibited in the subsequent factor analysis.

Table 4. Means, standard deviations, and internal consistency of common phone practices.

		Scale			Items	
Variable	**Range**	**Mean**	**SD**	**Omega**	**Number**	**Mean**
Multitasking	3–15	10.39	2.71	0.581	3	3.46
Avoiding distraction	3–15	8.10	2.61	0.750	3	2.70
Mindful phone use	3–15	7.62	3.22	0.739	3	2.54

A principal component analysis (PCA) with varimax rotation and using a minimum eigenvalue of one provided support for the three-dimensional structure (see Table 5). The Kaiser–Meyer–Olkin (KMO) measure was applied to ascertain the sampling adequacy. Using Field's guidelines, the resulting KMO of 0.72, is considered "good" [46]. Bartlett's test of sphericity X^2 (227) = 456.8, $p < 0.001$ demonstrated adequate correlations for PCA.

3.3. Procedure

The first author visited each section (14 total) of the course to introduce the survey. Participants were asked to use an Internet-connected device to complete the online survey in class. Qualtrics survey software was used to develop, deploy, and gather responses for the survey. Participants first read an overview of the study and completed an informed-consent form. Participants then completed the SRL and common phone practices survey.

Table 5. Factor analysis table for common phone practices.

Category	Items	Factor 1	Factor 2	Factor 3	Communality
1. Avoiding distraction while studying	I avoid checking my phone for notifications while studying.	0.804	−0.081	−0.269	0.726
	I take steps to ensure my phone will not interrupt my studying.	0.779	0.096	−0.211	0.661
	I focus completely on my studying.	0.730	0.168	−0.010	0.561
2. Mindful phone use	I pay attention to how much time I spend on different phone applications.	0.073	0.865	−0.041	0.755
	I use apps that help me monitor my phone usage.	−0.085	0.817	−0.023	0.675
	I set aside time where I restrict my use of the phone.	0.391	0.675	−0.016	0.610
3. Multitasking while studying	I respond to direct messages on my phone from friends and family.	−0.045	0.020	0.789	0.625
	I pay attention to what is happening on social media (e.g., Instagram, Facebook, Snapchat).	−0.200	−0.018	0.725	0.565
	I simultaneously watch videos.	−0.133	−0.072	0.656	0.453
	Eigenvalue	2.723	1.772	1.135	
	% of total variance	30.250	19.689	12.606	
	Total variance			62.545	

4. Results

The primary question was whether SRL variables (knowledge of cognition, regulation of cognition, and resource management) were related to student's unproductive (multitasking) and productive (avoiding distraction, mindful use) use of phones in the context of studying. To quantify these relationships and to identify any statistically significant relations, we first conducted a correlational analysis (see Table 6). Each variable was calculated by summing the relevant item responses. All analyses were conducted in IBM SPSS version 25.

Table 6. Correlations for all variables.

Variable	(1)	(2)	(3)	(4)	(5)
(1) Resource management	-				
(2) Regulation of cognition	0.370 **	-			
(3) Knowledge of cognition	0.396 **	0.384 **	-		
(4) Multitasking	−0.197 **	0.068	0.018	-	
(5) Avoiding distraction	0.451 **	0.205 **	0.230 **	−0.368 **	-
(6) Mindful phone use	0.245 **	0.331 **	0.210 **	−0.087	0.213 **

Note: ** $p < 0.01$ (2-tailed).

To better assess the unique variance introduced by each factor, a separate simultaneous multiple regression analysis was performed for each of the phone practice variables (multitasking, avoiding distraction, and mindful use). Scatterplots for each IV/DV were reviewed and each confirmed linearity. Predictor variable correlations were each less than 0.4. The Durbin–Watson (DW) statistic was calculated to insure the independence of the residuals. Satisfactory DW values are near 2. Values below 1 and more than 3 are problematic [46]. The DW value for the IV avoiding distraction with the DVs was 1.875. However, the DW values for multitasking (0.734) and mindful phone use (0.245) indicated a problematic lack of independence of the residual terms. The results of the regression analyses for avoiding distraction are presented in Table 7.

Table 7. Avoiding distraction regression analysis.

Variable	*B*	*SE B*	ß	95% CI for ß		R^2
				LL	UL	
Intercept	0.843	1.268				
Resource management	0.284	0.046	0.419 *	0.287	0.552	
Regulation of cognition	0.013	0.029	0.029	−0.103	0.161	
Knowledge of cognition	0.044	0.057	0.053	−0.081	0.186	
						0.207

* $p < 0.0005$.

As anticipated, students' SRL skills were positively correlated with self-reported distraction avoidance behaviors while studying ($F(3, 223) = 19.403$, $p < 0.0005$). The relationship is predominantly attributable to resource management (ß. = 0.419). Using Keith's guidelines, the magnitude of the effect is large (ß > 0.25) for educational research [47].

5. Discussion

The purpose of this study is to determine how students' self-regulatory skills influence the use or avoidance of the smartphone in support of learning. The aim was to use measures that focused on specific unproductive (e.g., multitasking) or productive (e.g., avoiding distraction and mindful use) activities rather than more generic measures of frequency of use or overall time.

The results support the predictions that SRL skills are negatively correlated with multitasking while studying (RQ1), and they are positively correlated with distraction avoidance (RQ2) and mindful use behaviors (RQ3). The SRL skills responsible for the observed relationships varied for each reported use of the phone. The resource management factor, which includes effort, time, and planning, made a statistically significant contribution to the observed variance for avoiding distraction on the smartphone while studying.

These findings are largely new observations. The negative correlation between multitasking and resource management is consistent with findings reported by Terry, Mishra et al. [25] who found a negative correlation between the MTUAS task-switching scale and the time and environment MSLQ subscale (one component of resource management). The MTUAS is designed to measure more general phone use behaviors. A key distinction from this study is the use of the common phone practices survey, which targets multitasking while studying. The positive correlation between resource management and avoiding distractions can be viewed as a corollary to the multitasking effect.

The positive correlation between mindful use and each of the SRL factors is also a novel contribution. Whereas the other multitasking and avoiding distraction relationships were focused on resource management, mindful use demonstrated a statistically significant relationship with each SRL factor. Of particular note is the strong relationship with regulation of cognition. Of the SRL factors measured, regulation of cognition is most strongly associated with executive functioning. Similarly, of the common phone practices measured, the mindful-use questions reflect a higher-order view of the cognitive implications of phone use. This work makes an important connection between self-regulated learning and the current studying context, which universally includes smartphones.

As indicated in the introduction, the purpose of this research is to address a gap in the literature between self-regulated learning and smartphone use while studying. Prior research indicates that the former is supportive of achievement and the latter is often detrimental. A better understanding of the link between self-regulated learning and smartphone use while studying can support improved guidance to learners. If SRL and smartphone use while studying are found to be independent, then they both should be addressed as unique concerns. Given the strong relationships between SRL and smartphone use while learning reported in studies, improving the SRL skills of learners may still be a profitable route toward improving achievement.

This leads to another key outcome of this research, the initial development of the common phone practices survey. By measuring specific behaviors that are commonly exhibited while studying, productive and non-productive learning behaviors can be more readily identified. The context in which the behavior is engaged in is important. When viewed from the larger institutional context, acknowledging and addressing these behaviors can improve the learning experience. The understanding and commitment of the educational institution to the importance of the smartphone as it relates to individual and organizational goals must begin with a broad grasp of how the phone is used [48].

5.1. Implications

As a whole, the results of this study provide valuable information for educators and researchers regarding the specific uses of the smartphone in the context of studying. The messages to students regarding the use of the smartphone must be more nuanced. Communicating a clearer message about multitasking while studying that includes a description of unproductive activities and the consequent impact on memory is warranted. This will run counter to the larger narrative in society that emphasizes the productivity gains promised by technology in general and multitasking in particular. Providing students with specific phone-related strategies to improve focus also holds promise.

The activities measured in this study provided a good starting point for engaging students in a dialogue regarding productive habits that may save time in the long run. An introduction of the concept of "mindful use" can encourage learners to consider how the phone is used not only during study sessions but also throughout the day. It is likely that many are not aware of the tools that are available either as apps or non-technical solutions (also known as the pen and paper approach) that can support a more productive role for the smartphone in learning.

Additionally, the design of educational applications and systems that utilize the smartphone should include consideration of the additional distractions that will be encumbered. Learners who lack the self-control to ignore or manage the distractions embedded in the technology may struggle.

5.2. Limitations and Future Research

The generalizability of the research is always a concern. The participants in this study were U.S. college students who were just beginning their post-secondary experience. The prevalence of the smartphone in this environment may exceed that of other countries and contexts [49]. While the socio-economic parameters may differ, the global access to the smartphone is substantial and growing.

The development and use of a new measure presents an important limitation. In particular, the modest reliability of the multitasking measure should be considered when interpreting the results. It is worth noting that, since this study was completed, this measure has undergone further development and validation with a subsequent cohort of students [50]. The results of the subsequent analysis largely support the structure initially demonstrated here. Additional scrutiny with different populations is warranted and expected. The survey will also need to identify adjustable parameters in the language used to describe specific smartphone-related behaviors. This is especially important given the ever-changing nature of technology use by students.

In consideration of these limitations, the results of this study should be framed within the needs and norms of each unique context. The variability of smartphone access, types of use, connectivity, and social value are important considerations when addressing learning implications. It is notable that the results of this study support the advice that was given to educators prior to the introduction of the smartphone. That is that the development of self-regulated learning skills can have learning benefits across disciplines and contexts [51].

Future research could address the malleability of the constructs measured by the common phone practices survey. Interventions that encourage more productive uses of the smartphone should be developed and studied [15]. It is important to better understand

not only the impact of these behaviors but also strategies to encourage or discourage use as appropriate. It is reasonable to suspect but worthy of further investigation that the relationships between the phone use and underlying SRL skills described here are reciprocal. Interventions to improve SRL skills could be expected to result in subsequent improved learning-related phone use behaviors.

Technologies will continue to evolve in ways that will impact learning. While it is prudent to investigate each new iteration of technology, it is important that this be done in the context of existing learning research. This study demonstrated the relationship between a well-established line of inquiry, self-regulated learning, and an important contemporary learning challenge. This information can help bridge the gap between what is known about self-regulated learning and the current studying environment.

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