Using Cognitive Science and Technology to Enhance Financial Education: The Effect of Spaced Retrieval Practice

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Financial literacy is an important life skill, yet the impact of financial education has often been found to be modest. We conducted a field experiment to assess the effectiveness of a postinstruction intervention using a smartphone app that incorporated cognitive science principles aimed at improving learning. College students who completed a required credit review workshop during their sophomore year used the smartphone app in one of three practice conditions: control (no practice), massed, or spaced retrieval practice with elaborative feedback. On a final assessment about 5 months later, students who engaged in spaced retrieval practice were superior to those in the control and massed practice conditions in terms of knowledge. Given the ubiquity of smartphones today, the results highlight the potential of harnessing easily accessible technology as learning tools to augment the retention and transfer of knowledge.

Keywords: cognitive science, financial education, retrieval practice, spaced practice

Changes in the economy over the past few decades have led to the proliferation of new and often increasingly complex financial products, including a wide range of retirement saving schemes and credit options. Also, individuals have been given greater control over the management of their finances and therefore bear increased responsibility for their own financial decisions and security. These developments have generated concern over people's financial literacy, that is, whether they possess adequate knowledge and skills necessary for effective financial decision-making and planning (Hastings et al., 2013). Indeed, large-scale surveys have revealed low levels of financial literacy in the United States and several other countries (e.g., Klapper & Lusardi, 2020; Lusardi & Mitchell, 2011; Mitchell & Lusardi, 2015), which have serious implications for individual as well as societal welfare. For instance, the growth of and subsequent high default rate for subprime mortgages in the United States helped precipitate the 2007–2008 global financial crisis.

Financial education is often regarded as an obvious solution to addressing financial knowledge deficits and suboptimal financial behaviors. Across the globe, schools, employers, non-governmental organizations, and statutory agencies have been involved in designing and delivering financial literacy interventions. Substantial resources have been expended on these efforts, but several studies have failed to find any effects of these interventions on financial literacy or behavior (e.g., Mandell & Klein, 2009), and a meta-analysis of 201 studies found the average effect size to be very modest (Fernandes et al., 2014). Weak evidence of the effectiveness of financial education has led some to argue for an overhaul of how or when the interventions are delivered. There have been suggestions that interventions should perhaps be customized to an individual's needs

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and given "just in time" (Collins & O'Rourke, 2010), with even a few calling for the abandonment of financial education in favor of alternative policies that constrain behavior, such as restricting consumer choice to prevent bad financial decisions (Willis, 2008, 2011).

The aforementioned meta-analysis revealed that the size of the effects of financial education interventions is positively associated with the intensity or duration of the instruction and negatively associated with the retention interval (Fernandes et al., 2014). In other words, longer interventions tend to yield greater impact, and the impact diminishes over time. This pattern of results is perhaps unsurprising—but nonetheless noteworthy—as it is congruent with general principles of human learning and memory (e.g., the forgetting curve; Ebbinghaus et al., 1913). Generally, the more time spent on instruction or training the better the learning outcomes, and the longer you wait after learning the poorer the retention, all other things being equal. Financial education appears to be no exception, but it is not always feasible or desirable to increase the instructional dosage, as it would increase costs and onerous time requirements may dissuade potential learners/consumers. Also, it is not always possible to time the instruction so that it aligns well with when important financial decisions are made. "Just in time" interventions assume that individuals are aware of their knowledge deficits and carefully plan ahead to address them at an appropriate time. Clearly, the status quo is unsatisfactory, and new strategies are needed. This article explored the use of cognitive learning principles and technology to raise the impact of financial education.

Literature Review

Cognitive Science of Learning

There has been a growing realization in recent years of the importance of using scientific evidence to inform educational practice and policy. For example, the Institute of Education Sciences, a U.S. government agency, was established in 2002 to promote rigorous education research. The science of learning is a systematic, interdisciplinary, and empirical approach to understanding how we learn, with great potential for application in instruction (Benassi et al., 2014; Horvath et al., 2017; Kang, 2021; Mayer, 2010). Indeed, there have been several attempts to implement learning principles from cognitive science in instruction across a variety of learning domains —including science (e.g., McDaniel et al., 2013; Nosofsky & McDaniel, 2019; Schunn et al., 2018), mathematics (e.g., Lyle et al., 2020; Rohrer et al., 2015, 2020), languages (e.g., Kim & Webb, 2022; Lindsey et al., 2014), statistics (Lyle & Crawford, 2011), medicine (e.g., Larsen et al., 2009, 2015; Versteeg et al., 2020), and multimedia materials (e.g., Mayer, 2008, 2019)—often with promising results.

Three learning principles, in particular, stand out as being very robust (i.e., strong evidence of their efficacy) and complementary (i.e., work well together). The first is that testing can enhance learning. People usually think of tests as just tools for measuring learning, but there is a wealth of research demonstrating that retrieving information from memory (when answering a test question) improves retention of the information (Agarwal et al., 2021; Roediger & Karpicke, 2006; see Rowland, 2014 for a meta-analysis) as well as its transfer or application to novel contexts, relative to rereading (Butler, 2010; Carpenter, 2012; Eglington & Kang, 2018; see Pan & Rickard, 2018, for a meta-analysis). In other words, tests (or other activities that encourage the learner to practice retrieving from memory, often referred to as "retrieval practice") are also useful for promoting learning. The second principle is the provision of feedback to facilitate the correction of erroneous responses (Kulhavy, 1977; for meta-analyses of the effectiveness of feedback, see Bangert-Drowns et al., 1991; Hattie & Timperley, 2007). Importantly, feedback that contains the correct answer is more effective for verbal learning than just telling the learner s/he is right or wrong (Pashler et al., 2005), and explanatory feedback that elaborates on why an answer is correct boosts the transfer of learning to new situations (Butler et al., 2013; Corral & Carpenter, 2020). The third principle is that spacing out the review of the information over time (instead of massing or cramming it all at once soon after learning) benefits learning. Like the previous two principles, the advantage of spaced (or distributed) over massed review or practice is well supported by the research literature (for reviews, see Cepeda et al., 2006; Kang, 2016).

The three learning principles complement each other and can be implemented simultaneously in a practicable manner in the form of spaced retrieval practice with elaborative feedback. Retrieval practice (or testing) is an effective way to review or practice one's learning

(as previously mentioned), and it can be spaced out or distributed over time for greater impact (e.g., Hopkins et al., 2016; Kang et al., 2014; Latimier et al., 2021). Also, corrective feedback augments the benefit of testing especially when the performance on the practice tests is not high (Kang et al., 2007).

Digital Technologies in Education

Technology and education have been intertwined since the early days of human civilization. Agriculture was transformed during the Bronze and Iron Ages with the invention of tools that increased productivity and enabled the division of labor; as society became more complex, the need for record keeping led to the development of writing systems and schools to train scribes (Schmandt-Besserat, 1975, 1996). More relevant to the current context is the proliferation of computers and other digital devices over the past few decades, which has altered the educational landscape. Educational technology (EdTech) is a rapidly expanding industry, with estimates of global market size exceeding US$89 billion in 2020 and a projected compound annual growth rate of about 20% from 2021 to 2028 (Grand View Research, 2021). One advantage of using digital technologies in education is the potential to transcend the boundaries of the traditional classroom: Learning and/or instruction can occur at more flexible times and locations, thus providing greater educational access and opportunities to students.

A recent Pew Research survey found smartphone ownership among adults to be very high and on an upward trajectory in advanced economies. In the United States, for instance, 81% of adults own smartphones, and the proportion is even higher among young adults aged 18–34 at 95% (Pew Research Center, 2019). Also, 95% of teenagers aged 13–17 report owning or having access to smartphones (Pew Research Center, 2018). In other words, the vast majority of adults and almost all teenagers and young adults have with them the equivalent of a portable mini-computer and are able to run various application programs (apps) on their mobile devices whenever they want.

The ubiquity of mobile devices nowadays means that there is a tool with a wide reach that can be harnessed for educational purposes, and this potential has contributed to an upsurge in educational apps, leading to concerns about whether the apps are effective (in promoting learning) or designed in accordance with principles from the science of learning (Hirsh-Pasek et al., 2015). Another consideration when using mobile devices or apps for educational purposes is whether students have reliable Internet access, which may not be given in rural areas. Also, if Internet access is not free or the student does not subscribe to an unlimited data plan, then the data usage by the educational app becomes another potential barrier.

Present Study and Hypothesis

Given that the impact of financial education interventions has tended to be underwhelming, it is important to find ways to improve their effectiveness. The goal of the present study was to assess in a field experiment (Collins, 2017) whether incorporating theory-based cognitive science learning strategies in a smartphone app could positively affect learners' financial knowledge, metacognition (confidence about their learning/abilities), and behaviors. Specifically, we designed an app that participants would use after completing a financial education workshop. Users in the target intervention condition engaged in spaced retrieval practice (with elaborative feedback) of financial concepts acquired during the workshop, and they were compared against users in two other conditions—a massed retrieval practice condition, in which all the practice questions were attempted in a single session soon after the workshop, and a control condition, in which no practice was provided. A final assessment was administered 20 weeks after the last practice (or exposure to the content, for the control condition) to evaluate the efficacy of the intervention. The hypothesis was that spaced retrieval practice would be advantageous, at least for knowledge retention.

It is worth noting that the study was conducted at Champlain College, where financial education is already implemented using strategies that have been shown to increase effectiveness, including peer-to-peer education and coaching; "just in time" education by introducing topics aligned with the development and needs of students as they progress through their college life; and relevant hands-on activities with custom and personalized action plans (e.g., Loke et al., 2015).

Methods

Participants

Participants were recruited from Champlain College undergraduates who attended a workshop targeted at

sophomores on the topic of credit in Fall 2018. The workshops were led by trained peer coaches, conducted in groups of 25–30 students, about 1.5 hours in duration, and covered concepts such as the different kinds of credits, interest, balance-to-limit ratio, credit risks and uses, and credit score and report. Attendance at the workshop was compulsory for all sophomores as part of the graduation requirements of the college, and only those with valid reasons (e.g., illness and leave of absence) were excused. Of the 457 who attended, 275 accepted an invitation to participate in the study by downloading our smartphone app and creating a user account, for which they were paid a $10 Amazon gift certificate. Participants who completed all subsequent study-related activities within appointed time periods (including the final assessment) were paid an additional $40 in Amazon gift certificates. The study was conducted in compliance with the regulations of Dartmouth College's Committee for the Protection of Human Subjects.

Upon creating an account on the app, participants were randomly assigned to one of three conditions: spaced practice, massed practice, or control. Of the 275 who enrolled in the study, 182 completed all the sessions/tasks (61, 53, and 68 in the spaced, massed, and control conditions, respectively), and their data were included in the analysis. The dropout rate was independent of the condition, $\chi^2(2) = 4.14$, $p = .126$. A sample size of 60 per group provides sufficient power to detect an effect size greater than $d = .51$ (between-participants design, two-tailed, alpha = .05, and power = .8). The demographic profile of the participants reflects the demographics of the college (more males than females; predominantly White), and those who dropped out of the study had a very similar profile, with the exception of a higher percentage of males (see Table 1).

Materials

Three sets of 10 multiple-choice questions each were developed around the content of the workshop. The questions in each set tapped the same concepts related to the topic of credit, but there was no exact repetition of questions within a set or across sets. Two sets were used for the practice quizzes (retrieval practice), and most of the questions in the practice quizzes allowed for the selection of multiple options (i.e., more than one correct answer). Also, each question was accompanied by an explanation of the answers. The remaining set was used in the final assessment to measure knowledge. The questions in the final set had only one correct answer each. The items used are available from the first author upon request. The final assessment also contained two questions related to participants' metacognition about credit (How confident are you today about your knowledge/understanding of credit? How confident are you today in your ability to manage your credit? 0–10 scale) and four questions related to participants' financial behaviors since the workshop (Have you provided advice to family/friends about how they could manage their credit? Have you checked your credit score? Have you checked your credit report? Have you intentionally taken steps to try to improve your credit score?), and a final question asking whether participants made a sincere attempt to answer the previous questions based on their own knowledge (e.g., did not consult the Internet or answer randomly). To encourage an honest response, participants were assured payment regardless of how they responded to this question. Also, two news articles unrelated to financial topics were selected for use in the control condition as a filler activity in lieu of the practice quizzes. The articles were approximately 1,700 words in length; one was on smart cities, and the other was on Jeff Bezos. Each article was accompanied by three multiple-choice comprehension questions.

A smartphone app (Android and iOS versions) was developed to administer the practice activities and final assessment to participants. The app notified participants when it was time to do an activity (and provided multiple reminders), allowed participants to do study-related activities during appointed time windows, and recorded participants' responses during the activities. A back-up website (on Qualtrics) was also developed in case participants encountered technical problems using the app midway through the study. The website was accessible on a smartphone or on a computer and allowed participants to perform the same activities as on the app. Ten participants ended up using the back-up website for at least one of the study activities, and the inclusion of their data did not change the pattern of results.

Design and Procedure

The study was a field experiment with practice conditions manipulated between participants. Participants were randomly assigned to either a spaced practice, massed practice, or control group.

TABLE 1. Demographic Profile of Participants

	Participants who completed the study	Participants who started but did not complete the study
Gender		
Female	37.4%	21.5%
Male	58.2%	77.4%
Other	4.4%	1.1%
Race/ethnicity		
White	81.3%	81.7%
Hispanic/Latino	6.0%	5.4%
Asian/Pacific Islander	4.4%	1.1%
African American	2.2%	6.5%
Native American	1.1%	--
Other	2.7%	4.3%
No response	2.2%	1.1%
Age (median)	19	19

Attendees at a financial education workshop on credit were informed that they were eligible to participate in a study on financial education, and if they wanted to participate they had to download an app onto their smartphones and register an account on the app within 24 hours. During the account registration, participants completed a demographic questionnaire and were randomly assigned to one of three practice conditions. In the spaced practice condition, 1 week and 4 weeks after account registration, participants were notified on their smartphones that it was time to do the first and second study activities, respectively, and they had a 1-week window to complete each activity (reminders were provided after the third and sixth days if the activity had not yet been completed). Each activity was a practice quiz on the topic of credit consisting of 10 questions. The quiz was self-paced, and elaborative feedback explaining the answers was provided after each question. In the massed practice condition, participants had to complete the same two practice quizzes within 24 hours of account registration, and reminders were given after 6 and 12 hours. In the control condition, participants were notified to do a study activity 1 week and 4 weeks after account registration, just as in the spaced practice condition, except that instead of a practice quiz, they were asked to read a news article and answer a few questions on it (self-paced). Each practice quiz or activity took about 10 minutes or less.

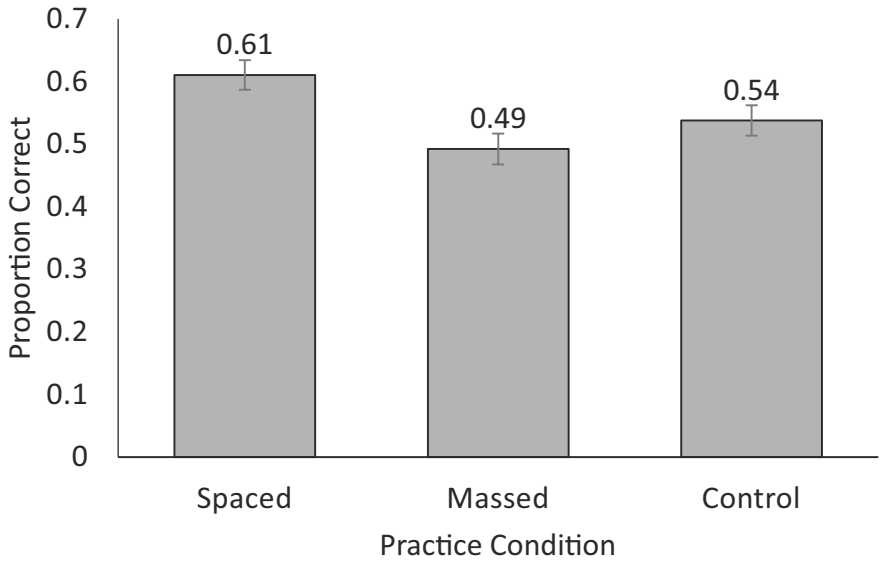
Twenty weeks after the last exposure to the target content (workshop or practice quiz)— i.e., 20 weeks after the workshop for participants in the massed practice and control conditions, and 24 weeks after the workshop for those in the spaced practice condition—all participants were notified to complete a final assessment using the app. The final assessment was self-paced and contained questions to assess credit-related metacognition, knowledge, and behavior (in that order). No feedback was provided, and participants had up to 1 week to complete it. Reminders were given after the third and sixth day if the task was not completed by then. The final assessment took about 10 minutes or less. Upon completing the study, participants were thanked and paid for their time.

The actual interval between the financial education workshop and the final assessment turned out to be 170, 142, and 142 days, on average, for the spaced practice, massed practice, and control conditions, respectively. The interval between the second practice quiz and the final assessment was 141 and 142 days, on average, for the spaced and massed practice conditions, respectively. In other words, the mean retention interval between the last practice or exposure to the content and the final assessment was very similar across the conditions (141 or 142 days).

Results

Of those who completed the study, seven participants indicated that they had not answered the final assessment questions sincerely (e.g., consulted the Internet or responded randomly). They were excluded from the analysis, leaving a total of 175 participants in the dataset. The α-level for all statistical analyses was set at .05 (unless stated otherwise).

Figure 1. Mean proportion correct on the final assessment knowledge questions as a function of practice conditions. Error bars indicate the standard error of the mean.



Financial Knowledge

First and foremost, we examined whether the different practice conditions produced different levels of knowledge retention (see Figure 1 for performance on the final assessment knowledge questions). An ANOVA of performance on the knowledge questions on the final assessment revealed a significant effect of practice condition, $F(2, 172) = 5.654$, $p = .004$, and partial $\eta^2 = .062$. Pairwise comparisons revealed that spaced practice yielded better performance than massed practice ($t[107] = 3.453$, $p = .001$, and $d = .66$) and the control group ($t[121] = 2.124$, $p = .036$, and $d = .39$), while the massed practice and control groups did not differ significantly from each other ($t[116] = 1.299$ and $p = .197$).

Metacognition

Participants' level of subjective confidence in their own knowledge/understanding of credit did not vary significantly across the spaced practice ($M = 6.0$), massed practice ($M = 6.2$), and control ($M = 6.5$) groups ($F[2, 172] = 1.046$, $p = .354$). Similarly, participants' subjective confidence in their ability to manage their credit was very similar across the spaced practice ($M = 6.4$), massed practice ($M = 6.3$), and control ($M = 6.5$) groups ($F[2, 172] < 1$).

Behavior

There was also no reliable evidence that practice conditions influenced financial behaviors (χ^2 tests of independence did not reveal any significant associations between practice conditions and the behaviors assessed, $p > .05$). Participants' reported behaviors are listed in Table 2.

Relationship Among Dependent Variables

To explore possible relationships among the various outcome variables, Pearson bivariate correlational analyses were run (see Table 3 for the matrix of correlation coefficients). In general, participants' subjective metacognitive confidence in their own knowledge and ability regarding credit was positively correlated with good financial behaviors and advice giving. Although the performance on the knowledge questions in the final assessment also correlated positively with confidence in one's knowledge, it did not significantly correlate with behavior.

Discussions, Limitations, and Implications

Discussions

The present study found that engaging in spaced retrieval practice improved retention of learning after a financial education workshop, consistent with previous research showing an advantage of spaced practice in

TABLE 2. Percentage of Participants in Each Practice Condition Reporting a Given Behavior

Behavior	Condition	Yes, multiple times	Yes, once	No
Gave advice to others on the topic of credit	Spaced	10.5%	29.8%	59.6%
	Massed	21.2%	21.2%	57.7%
	Control	13.6%	27.3%	59.1%
Checked own credit score	Spaced	8.8%	12.3%	78.9%
	Massed	13.5%	11.5%	75.0%
	Control	13.6%	18.2%	68.2%
Checked own credit report	Spaced	1.8%	17.5%	80.7%
	Massed	7.7%	11.5%	80.8%
	Control	10.6%	15.2%	74.2%
			Yes	**No**
Taken steps to improve one's credit	Spaced		33.3%	66.7%
	Massed		38.5%	61.5%
	Control		37.9%	62.1%

other domains (e.g., Donovan & Radosevich, 1999; Kerfoot et al., 2007; Latimier et al., 2021). Specifically, participants who took a brief quiz and were given explanatory feedback on the material about 1 week and 1 month after initial learning were able to retain more of the knowledge than those who were not quizzed or who were quizzed very soon (within 1 day) after initial learning. Importantly, the items on the quizzes and on the final assessment were never repeated (though they tapped a common set of concepts related to credit), and so the benefit observed was not due to improved memorization of specific answers to previously encountered questions but rather reflect deeper learning or transfer (i.e., the ability to apply learning to a different context; e.g., Carpenter, 2012). The enhanced learning produced by the spaced practice condition is noteworthy given the relatively low intensity of the intervention—just two short bouts of practice each lasting less than 10 minutes. It is likely that larger effects would have been obtained if there were more practice sessions or opportunities for retrieval (e.g., Karpicke & Roediger, 2007), but one must also consider whether making a learning intervention more time-consuming or onerous might have an unintended side effect of causing higher dropout or attrition.

Although practice conditions did influence learners' financial knowledge in the current study, they did not have any noticeable impact on learners' metacognition (e.g., subjective confidence in their understanding of the target financial topic). Also, there was no effect on financial behaviors surrounding the topic (credit). It would probably be premature to conclude that improved learning does not lead to better behaviors for a number of reasons. First, as already alluded to, the intervention was brief, and so it is certainly possible that more intensive practice would have yielded larger learning benefits that would have led to observable changes in behaviors. Second, the final assessment was administered about 5 months after initial learning, and while that is a relatively long

TABLE 3. Correlations Between the Dependent Variables

	1	2	3	4	5	6
1. Confidence in knowledge						
2. Confidence in managing credit	.53*					
3. Gave advice	.43*	.51*				
4. Checked score	.36*	.37*	.44*			
5. Checked report	.31*	.39*	.43*	.66*		
6. Tried to improve credit	.33*	.32*	.37*	.46*	.38*	
7. Performance on knowledge questions	.24*	.10	−.01	.08	−.08	.08

Note. *indicates correlation is significant at the .01 level (2-tailed).

interval for examining retention of learning, it might be too short for any differences in the frequency of particular behaviors to emerge, especially the kinds of behaviors associated with the topic of credit and for the given participant sample (college students). Third, the study was conducted at Champlain College, which provides a career-driven education that incorporates comprehensive personal finance and career positioning co-curricular education that is mandatory for all students. This focus on preparing students for the next stage in life might instill a campus culture that emphasizes the importance of financial literacy and other life skills, and so the "baseline" for financial attitudes and behaviors might already be relatively high. Finally, a recent meta-analysis that included newer studies with more rigorous designs (i.e., randomized experiments) found that financial literacy is a significant predictor of financial behaviors and that financial education does have an impact on both literacy and behaviors, albeit with a smaller effect on the latter (Kaiser & Menkhoff, 2017).

In addition, we found that participants' subjective confidence in their financial knowledge was correlated with their behaviors and objective knowledge. Although the observed correlations were generally modest, they add to the growing research on the metacognitive aspects of financial decision-making and the interplay between confidence, knowledge, and behaviors (e.g., Ameer & Khan, 2020; Białowolski et al., 2021; Zhu, 2021).

Limitations

A limitation of the present study is that the items used to assess financial knowledge were created ad hoc to tap the concepts introduced in the workshop, and formal validation of the measures used was beyond the scope of the project. Future research should extend the current work by employing instruments that have known reliability and validity.

Implications for Practitioners

The delivery of financial education can and should be improved, and there are efforts to examine new ideas and techniques (e.g., the use of visualization tools; Kothakota & Kiss, 2020; Lusardi et al., 2017). In this vein, the present findings provide useful evidence that incorporating principles from the cognitive science of learning with the use of commonly available technology can extend financial learning beyond the traditional classroom and yield dividends for learners. The long-term impact of financial literacy interventions, especially those of limited intensity/duration, is often underwhelming (Fernandes et al., 2014). Yet, to minimize costs and maximize convenience to participants, it is sometimes only feasible to offer one-time educational workshops. Our results suggest that a practical and effective way for educators to augment a single-session financial education workshop is to create opportunities for participants to think about and/or make use of the information they have learned (e.g., through answering questions), not immediately after the workshop, but several days later, and again a few weeks later. The practice that participants get retrieving the critical information from memory, spread out over time, and coupled with corrective feedback which explains and elaborates on the concepts, helps consolidate the learning and make it more durable and transferable in the long term. Also, assuming learners have mobile devices/computers and access to reliable Internet, educators could also consider how these mobile devices might be used as educational tools for providing timely reminders and encouraging spaced retrieval practice.

References

Agarwal, P. K., Nunes, L. D., & Blunt, J. R. (2021). Retrieval practice consistently benefits student learning: A systematic review of applied research in schools and classrooms. *Educational Psychology Review*, *33*(4), 1409–1453. https://doi.org/10.1007/s10648-021-09595-9

Ameer, R., & Khan, R. (2020). Financial socialization, financial literacy, and financial behavior of adults in New Zealand. *Journal of Financial Counseling and Planning*, *31*(2), 313–329. https://doi.org/10.1891/JFCP-18-00042

Bangert-Drowns, R. L., Kulik, C. L. C., Kulik, J. A., & Morgan, M. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research*, *61*(2), 213–238. https://doi.org/10.3102/00346543061002213

Benassi, V. A., Overson, C. E., & Hakala, C. M. (2014). *Applying science of learning in education: Infusing psychological science into the curriculum*. Society for the Teaching of Psychology. http://teachpsych.org/ebooks/asle2014/index.php

Białowolski, P., Cwynar, A., & Cwynar, W. (2021). Decomposition of the financial capability construct: A structural model of debt knowledge, skills, confidence, attitudes, and behavior. *Journal of Financial Counseling and Planning*, *32*(1), 5–20. https://doi.org/10.1891/JFCP-19-00056

Butler, A. C. (2010). Repeated testing produces superior transfer of learning relative to repeated studying. *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *36*(5), 1118–1133. https://doi.org/10.1037/a0019902

Butler, A. C., Godbole, N., & Marsh, E. J. (2013). Explanation feedback is better than correct answer feedback for promoting transfer of learning. *Journal of Educational Psychology*, *105*(2), 290–298. https://doi.org/10.1037/a0031026

Carpenter, S. K. (2012). Testing enhances the transfer of learning. *Current Directions in Psychological Science*, *21*(5), 279–283. https://doi.org/10.1177/0963721412452728

Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin*, *132*(3), 354–380. https://doi.org/10.1037/0033-2909.132.3.354

Collins, J. M. (2017). Using field experiments to evaluate the impact of financial planning andcounseling interventions. *Journal of Financial Counseling and Planning*, *28*(2), 247–252. https://doi.org/10.1891/1052-3073.28.2.247

Collins, J. M., & O'Rourke, C. M. (2010). Financial education and counseling—still holding promise. *Journal of Consumer Affairs*, *44*(3), 483–498. https://doi.org/10.1111/j.1745-6606.2010.01179.x

Corral, D., & Carpenter, S. K. (2020). Facilitating transfer through incorrect examples and explanatory feedback. *Quarterly Journal of Experimental Psychology*, *73*(9), 1340–1359. https://doi.org/10.1177/1747021820909454

Donovan, J. J., & Radosevich, D. J. (1999). A meta-analytic review of the distribution of practice effect: Now you see it, now you don't. *Journal of Applied Psychology*, *84*(5), 795–805. https://doi.org/10.1037/0021-9010.84.5.795

Ebbinghaus, H., Ruger, H. A., & Bussenius, C. E. (1913). *Memory: A contribution to experimental psychology*. (H. A. Ruger & C. E. Bussenius, Trans.). Teachers College, Columbia University. (Original work published 1885). https://doi.org/10.1037/10011-000

Eglington, L. G., & Kang, S. H. K. (2018). Retrieval practice benefits deductive inference. *Educational Psychology Review*, *30*(1), 215–228. https://doi.org/10.1007/s10648-016-9386-y

Fernandes, D., Lynch, J. G., & Netemeyer, R. G. (2014). Financial literacy, financial education, and downstream financial behaviors. *Management Science*, *60*(8), 1861–1883. https://doi.org/10.1287/mnsc.2013.1849

Grand View Research. (2021). *Education technology market size, share & trends analysis report (2021–2028)*. www.grandviewresearch.com/industry-analysis/education-technology-market

Hastings, J. S., Madrian, B. C., & Skimmyhorn, W. L. (2013). Financial literacy, financial education, and economic outcomes. *Annual Review of Economics*, *5*(1), 347–373. https://doi.org/10.1146/annurev-economics-082312-125807

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Hirsh-Pasek, K., Zosh, J. M., Golinkoff, R. M., Gray, J. H., Robb, M. B., & Kaufman, J. (2015). Putting education in "educational" apps: Lessons from the science of learning. *Psychological Science in the Public Interest*, *16*(1), 3–34. https://doi.org/10.1177/1529100615569721

Hopkins, R. F., Lyle, K. B., Hieb, J. L., & Ralston, P. A. S. (2016). Spaced retrieval practice increases college students' short- and long-term retention of mathematics knowledge. *Educational Psychology Review*, *28*(4), 853–873. https://doi.org/10.1007/s10648-015-9349-8

Horvath, J. C., Lodge, J. M., & Hattie, J. (Eds.). (2017). *From the laboratory to the classroom: Translating science of learning for teachers*. Routledge.

Kaiser, T., & Menkhoff, L. (2017). Does financial education impact financial literacy and financial behavior, and if so, when? *The World Bank Economic*

Review, *31*(3), 611–630. https://doi.org/10.1093/wber/lhx018

Kang, S. H. K. (2016). Spaced repetition promotes efficient and effective learning: Policy implications for instruction. *Policy Insights from the Behavioral and Brain Sciences*, *3*(1), 12–19. https://doi.org/10.1177/2372732215624708

Kang, S. H. K. (2021). Charting new waters in the science of learning: Reflections on the emergence of the science of learning in Australia and its place on the international landscape by an outside insider. In A. Carroll, R. Cunnington, & A. Nugent (Eds.), *Learning under the lens: Applying findings from the science of learning to the classroom* (pp. 220–229). Routledge.

Kang, S. H. K., Lindsey, R. V., Mozer, M. C., & Pashler, H. (2014). Retrieval practice over the long term: Should spacing be expanding or equal-interval? *Psychonomic Bulletin & Review*, *21*(6), 1544–1550. https://doi.org/10.3758/s13423-014-0636-z

Kang, S. H. K., McDermott, K. B., & Roediger, H. L. (2007). Test format and corrective feedback modify the effect of testing on long-term retention. *European Journal of Cognitive Psychology*, *19*(4–5), 528–558. https://doi.org/10.1080/09541440601056620

Karpicke, J., & Roediger, H. L., III. (2007). Repeated retrieval during learning is the key to long-term retention. *Journal of Memory and Language*, *57*(2), 151–162. https://doi.org/10.1016/j.jml.2006.09.004

Kerfoot, B. P., DeWolf, W. C., Masser, B. A., Church, P. A., & Federman, D. D. (2007). Spaced education improves the retention of clinical knowledge by medical students: A randomised controlled trial. *Medical Education*, *41*(1), 23–31. https://doi.org/10.1111/j.1365-2929.2006.02644.x

Kim, S. K., & Webb, S. (2022). The effects of spaced practice on second language learning: A meta‐analysis. *Language Learning*, *72*(1), 269–319. https://doi.org/10.1111/lang.12479

Klapper, L., & Lusardi, A. (2020). Financial literacy and financial resilience: Evidence from around the world. *Financial Management*, *49*(3), 589–614. https://doi.org/10.1111/fima.12283

Kothakota, M. G., & Kiss, D. E. (2020). Use of visualization tools to improve financial knowledge: Anexperimental approach. *Journal of Financial Counseling and Planning*, *31*(2), 193–208. https://doi.org/10.1891/JFCP-18-00070

Kulhavy, R. W. (1977). Feedback in written instruction. *Review of Educational Research*, *47*(2), 211–232. https://doi.org/10.3102/00346543047002211

Larsen, D. P., Butler, A. C., Aung, W. Y., Corboy, J. R., Friedman, D. I., & Sperling, M. R. (2015). The effects of test-enhanced learning on long-term retention in AAN annual meeting courses. *Neurology*, *84*(7), 748–754. https://doi.org/10.1212/WNL.0000000000001264

Larsen, D. P., Butler, A. C., & Roediger, H. L. (2009). Repeated testing improves long-term retention relative to repeated study: A randomised controlled trial. *Medical Education*, *43*(12), 1174–1181. https://doi.org/10.1111/j.1365-2923.2009.03518.x

Latimier, A., Peyre, H., & Ramus, F. (2021). A meta-analytic review of the benefit of spacing out retrieval practice episodes on retention. *Educational Psychology Review*, *33*(3), 959–987. https://doi.org/10.1007/s10648-020-09572-8

Lindsey, R. V., Shroyer, J. D., Pashler, H., & Mozer, M. C. (2014). Improving students' long-term knowledge retention through personalized review. *Psychological Science*, *25*(3), 639–647. https://doi.org/10.1177/0956797613504302

Loke, V., Choi, L., & Libby, M. (2015). Increasing youth financial capability: An evaluation of the mypath savings initiative. *Journal of Consumer Affairs*, *49*(1), 97–126. https://doi.org/10.1111/joca.12066

Lusardi, A., & Mitchell, O. S. (2011). Financial literacy around the world: An overview. *Journal of Pension Economics & Finance*, *10*(4), 497–508. https://doi.org/10.1017/S1474747211000448

Lusardi, A., Samek, A., Kapteyn, A., Glinert, L., Hung, A., & Heinberg, A. (2017). Visual tools and narratives: New ways to improve financial literacy. *Journal of Pension Economics and Finance*, *16*(3), 297–323. https://doi.org/10.1017/S1474747215000323

Lyle, K. B., Bego, C. R., Hopkins, R. F., Hieb, J. L., & Ralston, P. A. S. (2020). How the amount and spacing of retrieval practice affect the short-and long-term retention of mathematics knowledge. *Educational Psychology Review*, *32*(1), 277–295. https://doi.org/10.1007/s10648-019-09489-x

Lyle, K. B., & Crawford, N. A. (2011). Retrieving essential material at the end of lectures improves performance on statistics exams. *Teaching of Psychology*, *38*(2), 94–97. https://doi.org/10.1177/0098628311401587

Mandell, L., & Klein, L. S. (2009). The impact of financial literacy education on subsequent financial behavior. *Journal of Financial Counseling and Planning*, *20*(1), 15–24.

Mayer, R. E. (2008). Applying the science of learning: Evidence-based principles for the design of multimedia instruction. *The American Psychologist*, *63*(8), 760–769. https://doi.org/10.1037/0003-066X.63.8.760

Mayer, R. E. (2010). *Applying the science of learning*. Pearson.

Mayer, R. E. (2019). Thirty years of research on online learning. *Applied Cognitive Psychology*, *33*(2), 152–159. https://doi.org/10.1002/acp.3482

McDaniel, M. A., Thomas, R. C., Agarwal, P. K., McDermott, K. B., & Roediger, H. L. (2013). Quizzing in middle-school science: Successful transfer performance on classroom exams. *Applied Cognitive Psychology*, *27*(3), 360–372. https://doi.org/10.1002/acp.2914

Mitchell, O. S., & Lusardi, A. (2015). Financial literacy and economic outcomes: Evidence and policy implications. *The Journal of Retirement*, *3*(1), 107–114. https://doi.org/10.3905/jor.2015.3.1.107

Nosofsky, R. M., & McDaniel, M. A. (2019). Recommendations from cognitive psychology for enhancing the teaching of natural-science categories. *Policy Insights from the Behavioral and Brain Sciences*, *6*(1), 21–28. https://doi.org/10.1177/2372732218814861

Pan, S. C., & Rickard, T. C. (2018). Transfer of test-enhanced learning: Meta-analytic review and synthesis. *Psychological Bulletin*, *144*(7), 710–756. https://doi.org/10.1037/bul0000151

Pashler, H., Cepeda, N. J., Wixted, J. T., & Rohrer, D. (2005). When does feedback facilitate learning of words? *Journal of Experimental Psychology. Learning, Memory, and Cognition*, *31*(1), 3–8. https://doi.org/10.1037/0278-7393.31.1.3

Pew Research Center. (2018). *Teens, social media and technology 2018*. www.pewinternet.org/wp-content/uploads/sites/9/2018/05/PI_2018.05.31_TeensTech_FINAL.pdf

Pew Research Center. (2019). *Smartphone ownership is growing rapidly around the world, but not always equally*. www.pewresearch.org/global/wp-content/uploads/sites/2/2019/02/Pew-Research-Center_Global-Technology-Use-2018_2019-02-05.pdf

Roediger, H. L., & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, *17*(3), 249–255. https://doi.org/10.1111/j.1467-9280.2006.01693.x

Rohrer, D., Dedrick, R. F., Hartwig, M. K., & Cheung, C. N. (2020). A randomized controlled trial of interleaved mathematics practice. *Journal of Educational Psychology*, *112*(1), 40–52. https://doi.org/10.1037/edu0000367

Rohrer, D., Dedrick, R. F., & Stershic, S. (2015). Interleaved practice improves mathematics learning. *Journal of Educational Psychology*, *107*(3), 900–908. https://doi.org/10.1037/edu0000001

Rowland, C. A. (2014). The effect of testing versus restudy on retention: A meta-analytic review of the testing effect. *Psychological Bulletin*, *140*(6), 1432–1463. https://doi.org/10.1037/a0037559

Schmandt-Besserat, D. (1975). *First civilization: the legacy of sumer*. Blanton Museum of Art, University of Texas.

Schmandt-Besserat, D. (1996). *How writing came about*. University of Texas Press.

Schunn, C. D., Newcombe, N. S., Alfieri, L., Cromley, J. G., Massey, C., & Merlino, J. F. (2018). Using principles of cognitive science to improve science learning in middle school: What works when and for whom? *Applied Cognitive Psychology*, *32*(2), 225–240. https://doi.org/10.1002/acp.3398

Versteeg, M., Hendriks, R. A., Thomas, A., Ommering, B. W. C., & Steendijk, P. (2020). Conceptualising spaced learning in health professions education: A scoping review. *Medical Education*, *54*(3), 205–216. https://doi.org/10.1111/medu.14025

Willis, L. E. (2008). Against financial-literacy education. *Iowa Law Review*, *94*, 197–285.

Willis, L. E. (2011). The financial education fallacy. *American Economic Review*, *101*(3), 429–434. https://doi.org/10.1257/aer.101.3.429

Zhu, A. Y. F. (2021). Financial literacy types and financial behaviors among adolescents: Role of

financial education. *Journal of Financial Counseling and Planning*, *32*(2), 217–230. https://doi.org/10.1891/JFCP-19-00051

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