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CHANGING MULTITASKING INTENTION WITH COURSE-BASED UNDERGRADUATE RESEARCH EXPERIENCES (CUREs)

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ABSTRACT

Aim/Purpose	This article aimed to design and evaluate a pedagogical technique for altering students' classroom digital multitasking behaviors. The technique we designed and evaluated is called course-based undergraduate research experience (CURE). With this technique, the students wrote a research article based on a multitasking experiment that the instructor conducted with the students. The students conducted a literature review, developed their own research questions, they analyzed experiment data, and presented results. This study evaluated the how the CURE contributed to student multitasking behavior change.
Background	Multitasking is defined as doing more than one thing at a time. Multitasking is really the engagement in individual and discrete tasks that are performed in succession. Research showed that students multitasked very often during courses. Researchers indicated that this was a problem especially for online teaching, because when students went online, they tended to multitask. Extant research indicated that digital multitasking in class harmed student performance. Multiple studies suggested that students who multitasked spent more time finishing their tasks and made more mistakes. Regardless of students' gender or GPA, students who multitasked in class performed worse and got a lower grade than those who did not. However, little is known about how to change students' digital multitasking behaviors. In this study, we used the transtheoretical model of behavior change to investigate how our pedagogical technique (CURE) changed students' digital multitasking behaviors.

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Methodology	Using a course-based undergraduate research experience design, a new classroom intervention was designed and evaluated through a content analysis of pre- and post-intervention student reflections. As part of the course-based undergraduate research experience design, the students conducted a literature review, developed their own research questions, they analyzed experiment data, and presented results. This study evaluated the how teaching using a course-based undergraduate research experience contributed to student multitasking behavior change. Transtheoretical model of behavior change was used to investigate how our pedagogical technique changed students' digital multitasking behaviors.
Contribution	The paper described how teaching using a course-based undergraduate research experience can be used in practice. Further, it demonstrated the utility of this technique in changing student digital multitasking behaviors. This study contributed to constructivist approaches in education. Other unwanted student attitudes and behaviors can be changed using this approach to learning.
Findings	As a result of CURE teaching, a majority of students observed the negative aspects of multitasking and intended to change their digital multitasking behaviors. Sixty-one percent of the participants experienced attitude changes, namely increased negative attitude towards multitasking in class. This is important because research found that while both students and instructors believed off-task technology use hinders learning, their views differed significantly, with more instructors than students feeling strongly that students' use of technology in class is a problem. Moreover, our study showed that with teaching using CURE, it is possible to move the students on the ladder of change as quickly as within one semester (13 weeks). Seventy-one percent of the students reported moving to a higher stage of change post-intervention.
Recommendations for Practitioners	Faculty wishing to curb student digital multitasking behaviors may conduct in-class experimentation with multitasking and have their students write a research report on their findings. Course-based undergraduate research experiences may make the effects of digital multitasking more apparent to the students. The students may become more aware of their own multitasking behaviors rather than doing them habitually. This technique is also recommended for those instructors who would like to introduce academic careers as a potential career option to their students.
Recommendations for Researchers	Researchers should explore changing other unwanted undergraduate student behaviors with course-based undergraduate experiences. Researchers may use the transtheoretical model of change to evaluate the effectiveness of techniques used to change behaviors.
Impact on Society	The negative outcomes of digital multitasking are not confined to the classroom. Digital multitasking impacts productivity in many domains. If techniques such as those used in this article become more common, changes in multitasking intentions could show broad improvements in productivity across many fields.
Future Research	This paper constitutes a pilot study due to the small convenience sample that is used for the study. Future research should replicate this study with larger and randomized samples. Further investigation of the CURE technique can improve its effectiveness or reduce the instructor input while attaining the same behavioral changes.

Keywords digital multitasking, research-based learning, experiential learning, content analysis, behavioral change

INTRODUCTION

College students often multitask with information technologies during classes. Two-thirds of the students report using electronic media while in class, doing homework, or studying (Jacobsen & Forste, 2010, p. 279). Often, students use their mobile phones for texting and accessing social networking sites (Ellis et al., 2010, p. 4). Students multitask in both online and face-to-face courses (Lepp et al., 2019). Similarly, when using the Internet, college students commonly engage in multiple online activities simultaneously (Moreno et al., 2012). This means that if a college student needs to use the Internet for an online course, they tend to multitask (Lepp et al., 2019). Younger adults are more likely to multitask than older adults (Brasel & Gips, 2011; Carrier et al., 2009) both in electronic and nonelectronic multitasking (Zwarun & Hall, 2014) making students especially prone to multitasking.

While multitasking is defined as doing more than one thing at a time, it is really "the engagement in individual and discrete tasks that are performed in succession," (Dzubak, 2008, p. 1). While it may be possible to do two things at once, such as running and listening to the music, the mind often switches back and forth between tasks that are seemingly done in parallel. Researchers introduced a variety of terms around multitasking such as task switching, which is defined as switching attention from one task to another while receiving information about how to respond to these tasks (Brake et al., 2017).

Students have various motivations for multitasking. These motivations include satisfying information needs (Wang & Tchernev, 2012), satisfying hedonic needs by creating a pleasant feeling (Kononova & Yuan, 2017), or satisfying the need to feel more efficient, and satisfying the need to have a greater sense of control over tasks (Robinson, 2017). Indeed, Bardhi et al. (2010) found that multitasking gives the impression of control, enjoyment, connection and efficiency to individuals who do it. In their study of multitasking college students, Lin (2019, p. 1674) found four motivations for multitasking: (a) greater control over their media consumption experiences; (b) processing related content more efficiently; (c) greater hedonic experiences through multiple media stimuli; and (d) connecting with friends and family. Lastly, students may have an addiction to the Internet due to the ubiquity of Internet-connected smartphones and smart devices (Carrier et al., 2015).

In addition to students' motivations for multitasking, the instructors may be inadvertently contributing to the multitasking behaviors. The instructors may cause students to multitask due to how they design their courses. Content and the learning tasks that the instructors choose may influence students' multitasking behaviors. Aagaard (2015) observed that the difficulty of the content and structure of the lessons were crucial determinants of students' multitasking behaviors. When instructors build in tasks that do not require behavioral response from students, this increases the odds that the students multitask (Wang et al., 2015).

There are two key challenges with student multitasking. First, students are often ineffective while multitasking. Second, students usually do not make the choice of multitasking consciously. While the students satisfy many needs by multitasking, they are really hurting their class performance. Unbeknownst to many students, student multitasking is usually ineffective. Multiple studies suggest that students who multitask spend more time finishing their tasks and make more mistakes (Bowman et al., 2010; Ellis et al., 2010; Fox et al., 2009; Fried, 2008; Hembrooke & Gay, 2003; Kraushaar & Novak, 2010). Regardless of students' gender or GPA, students who multitask in class perform worse and get a lower grade than those who do not (Ellis et al., 2010).

Students' low performance while multitasking is especially problematic because students may believe that they are effective when multitasking. Moreover, a majority of multitasking students (59.5%) believe they are able to manage their multitasking behaviors fairly easily (Rogers, 2018). Students think that they can refrain from the multitasking behaviors when they feel it is appropriate to do so (Rogers, 2018, p. 45). This is contrary to the findings of Wang and Tchernev (2012), who suggest that individuals multitask with media as a habit rather than as a conscious choice. While the literature is clear on the problems with digital multitasking, few studies propose how to fix this problem. Literature does not show how to make students consciously understand the choices they make when digital multitasking, and how to enable students to reflect on and change their multitasking behaviors.

To change students' multitasking behaviors, we adopt an intervention as recommended by the psychotherapy field (Prochaska & Velicer, 1997). With an intervention, we expect to raise consciousness about the multitasking behavior. We also hope to bring to light problems with the multitasking behavior, resulting in motivation to change the behavior. Coupled with pedagogical theory, we choose to use an intervention that uses discovery learning techniques to change behavior. Through discovery learning, we engage students in inquiry about whether multitasking has advantages or disadvantages. We hope that the students discover for themselves the negative aspects of multitasking behaviors using the discovery learning. In particular, students need to be made aware of how their multitasking behaviors impact their learning performance for the learning to be meaningful (Novak, 2002). In order to evaluate the intervention to change their multitasking behaviors, we pose the following research question:

> RQ: Does course-based undergraduate research experience (CURE) technique change students' classroom digital multitasking behaviors?

In this paper, we present the impact of course-based undergraduate research experience method on digital multitasking during classes. Multitasking is relevant to all classes since it happens in all classes. Moreover, specifically teaching students to multitask successfully with information technologies and to help them reduce ineffective and inefficient multitasking behaviors should be key to success in many courses.

LITERATURE REVIEW

THE TRANSTHEORETICAL MODEL OF BEHAVIOR CHANGE

We adopt the transtheoretical model of behavior change (Prochaska & Velicer, 1997). We chose this model because it integrates processes and principles of change from different intervention and change theories. The integrated theories come specifically from psychotherapy and behavior change fields. Only in psychotherapy, there are more than 300 theories (Prochaska, 1984).

According to the transtheoretical model, change is a temporal phenomenon, and when individuals change their behaviors, they go through six stages of change. These are called precontemplation, contemplation, preparation, action, maintenance and termination. ***Precontemplation*** is the first stage, and this is the stage where people are not intending to take action in the foreseeable future, at least not in the next six months. The individuals who are in the precontemplation stage, as the name suggests, are not even contemplating any change. They avoid getting information about, discussing or reading about the subject that requires change. They may not be sufficiently informed about the consequences of their behaviors.

The second stage is called ***contemplation***. The individuals who are in this stage intend to change their behaviors within the upcoming six months. While they may not be at the moment ready to take direct action, they are acutely aware of the cons of their behavior, which causes them to intend to change in the foreseeable future (Prochaska, 1984).

The third stage is the ***preparation*** stage, which indicates people's intentions to immediately take action. The immediate term refers to within the next month. Individuals in this stage typically have a plan of action, and they are ready to follow action-oriented interventions(Prochaska, 1984).

Action is the fourth stage, which indicates that the people have changed their behaviors in an observable way within the last six months. It is important that the action helps attain a criterion that scientists and professionals agree is sufficient to reduce the risks of the situation/disease (Prochaska, 1997, p. 39).

The stage that follows action is called ***maintenance.*** In this stage, individuals may not put forth as systematic effort as they do in the action stage to eliminate/change behavior. They may be less tempted to continue their old behaviors although some temptation may still be there. This stage refers to the stage where individuals are working to prevent relapse, and it may last between 6 months to 5 years. Relapse in this stage may indicate a return to a previous stage of change (Prochaska, 1984).

The final stage of change is called ***termination.*** This is the stage where individuals have zero temptation and they have total self-efficacy over their behavior. A study of former smokers and alcoholics found that only 20% of the people reached this termination stage (Snow et al., 1994).

TEACHING RELATED EXPERIMENTS ABOUT MULTITASKING

Students multitask heavily in classes (Fried, 2008). When they are told by their instructors not to use technology, this frustrates the students (Downs et al., 2015). Perhaps, motivated by this worrying trend, much research has been conducted on student multitasking. Most of these studies found negative outcomes of multitasking based on experimental designs. A brief overview of these articles is provided below.

Hembrooke and Gay (2003) conducted an experiment called the Laptop and the Lecture with 44 college students, where only half of the group could use their laptops during the lecture as they wished. They found that the students who used laptops performed worse on the test after the lecture than the control group. They also found that even leaving tabs opened on their screen caused students to "perform significantly poorer on immediate measures of memory for the lecture material" (Hembrooke and Gay, 2003, p. 51). Ellis et al. (2010) conducted an experiment with 62 undergraduate business students. They allowed half of the participants to text during the lecture, whereas the other half was not allowed. They found a significant reduction in the exam grades of the students who were allowed to multitask by texting. Thus, they concluded that the learning performance of multitaskers were less than those who did not multitask. In a similar study, Froese et al. (2012) found that students performed 30% on a quiz when texting. Bowman et al. (2010) conducted a reading-based experiment where the multitasking condition was instant messaging. They found that the students who did instant messaging while reading a typical academic psychology text online read much more slowly and performed significantly less in a comprehension test.

The only unique finding where multitasking did not always reduce learning performance was in the experiment of Pashler et al. (2013) involving 82 undergraduate students. They found that when materials were presented in a spoken form and played without waiting for the learner, multitasking resulted in substantial reduction in information acquired. On the other hand, when the learner read the materials at their pace, the information acquired was not affected significantly, even when the interruptions occurred at moments not chosen by the student. Similarly, listening to the materials and pausing to do the concurrent task was also relatively harmless.

Rosen et al. (2011) conducted a multitasking experiment with mobile phones during a course lecture. Researchers sent students text messages and asked them to respond. Students in the high text messaging group performed worse on the test grade by 10.6%. Participants who received and sent more words in their texts received the lowest grades on the test moderated by time between receiving and sending a text. Those students who waited longer between receiving and sending a text had better

performance than those who waited less. Other studies comparing student performance under the conditions of texting and non-texting found that the non-texting group outperformed regardless of gender and GPA (Ellis et al., 2010). McDonald (2013) found a negative correlation between in-class texting and final grade score, regardless of texting condition. This negative correlation remained after controlling for GPA, ACT score, and attendance. In another experimental study, Kuznekoff et al. (2013) divided participants in three groups (non-multitasking, low-distraction, and high-distraction) and had them watch a video lecture while taking notes. To evaluate the learning performance, they were asked to complete assessments. Those in the control group recalled better, provided 62% more information, and their assessments were higher than the other groups.

May and Elder (2018) suggested that the purpose of multitasking, rather than multitasking itself, creates the negative learning outcomes. Wood et al. (2012) compared note taking on a piece of paper versus Microsoft Word together with multitasking. Multitasking conditions included texting, emailing, Instant Messaging (IM), and Facebook. Student learning performance was measured with a quiz. Results indicated that participants who did not use any technologies outperformed multitasking students. This happened regardless of medium. Downs et al. (2015) had 204 students watch a 25-minute video. They controlled students' multitasking behaviors by randomly assigning them to one of the six groups: (1) Facebook distracted; (2) paper note-taking; (3) no media use control group; (4) mixed distraction; (5) laptop note-taking; and (6) distracted combination. Participants who participated in non-class related multitasking (groups 1, 4, & 6) performed worse on the learning performance test than other groups. Brooks (2015) conducted a survey regarding multitasking in a natural classroom setting. Students completed a pre-task survey before watching a 15-minute video lecture. Following the video, students completed a quiz. Students also completed a survey regarding social media use, attentional control, multitasking computer self-efficacy, technostress, and happiness. The quiz findings indicated that social media usage negatively affected student performance. Attentional control and multitasking computer self-efficacy did not have a significant effect on this relationship. The authors concluded that the students were not as skilled at multitasking as they thought they were. Conard and Marsh (2014) examined the effect of interruptions via instant messaging and situational interest on learning during multitasking. Participants viewed a 16-minute video presentation. Participants simultaneously responded to instant messages sent at specific times by research assistants. Following the video, participants' learning was assessed using a test. The researchers found that multitasking interruptions reduced learning; but interest did not moderate the effect of interruptions. In a slightly different experiment, participants watched Netflix while they read a text, where the control group read without watching anything. The results showed that the group that that multitasked by watching a video scored lower in the reading comprehension than the control group (Lauer, 2017).

Lastly, multitasking not only affects the learning of the individuals who are doing it, but also those who are nearby as well. Sana et al. (2013) conducted an experiment with 40 undergraduate students in which students viewed a 45-min PowerPoint lecture in multitasking or non-multitasking conditions. Participants who multitasked on a laptop during the lecture scored lower on the test than non-multitaskers. Moreover, participants in direct view of a multitasking peer scored 17% lower than those who were not.

Overall, this body of research shows that multitasking with non-relevant tasks hinder learning. These negative effects on academics were demonstrated with varied outcomes – test performance, grades, comprehension, recall, and note-taking. Students habitually using laptops in class report low satisfaction with their education, are more likely to multitask in class, and are more distracted (Wurst et al., 2008). Laptop use negatively related to multiple learning outcomes including course grade, focus on lectures, reported clarity of lectures, exam performance, and comprehension (Fried, 2008; Kraushaar & Novak, 2010; Wood et al., 2012). Interestingly, laptop multitasking not only harms the multitaskers, but also distracts the nearby peers, affecting their learning negatively (Fried, 2008; Sana et al., 2013). Moreover, students do not have the correct knowledge of how much time they spend on multitasking (Tanner et al., 2008). Students spend 1.5 times more time on social media than they think

they do, and they estimate twice the time they actually spend on learning (Tanner et al., 2008). Furthermore, students overestimate their abilities to effectively and efficiently multitask (Downs, 2015).

Experiential Learning and Change Using Course-Based Undergraduate Experiences (CUREs)

Research and inquiry engages undergraduates meaningfully in their education. Research enables the undergraduates to learn how to inquire and to critically evaluate knowledge, which is crucial for today's complex work setting (Brew & Jewell, 2012). Many undergraduate research programs are in place across the USA and are growing in other countries (Healey et al., 2010).

We define course-based undergraduate experience as *an inquiry, investigation or a research-based activity, conducted by undergraduate students under the guidance of an instructor as part of a course design, that makes an original intellectual or creative contribution to the discipline and/or to understanding.* This definition is an extended version of the research based-learning definition of Brew and Jewell (2012).

Course-based undergraduate research experiences enhance the students' knowledge and understanding of their subject by their active engagement in their learning (Lambert, 2009). Further, it enriches the students' investment in education by their participation in the research culture of their intellectual disciplines (Lambert, 2009). A body of literature has documented the advantages to students of engaging with research (De Haan, 2009; Elsen et al., 2009; Garde-Hansen & Calvert, 2007; Healey, 2005a, 2005b; Jenkins et al., 2007; McGuinness & Simm, 2003; Seymour et al., 2004) and of doing so early (Walkington et al., 2011). In this article, we focus on the aspect of CUREs, not only on inquiry and learning, but also on personal change.

Course-based undergraduate research experiences (CUREs) have at their core the idea of experiential learning and the resulting change. Changing student behaviors requires students first to observe their own behaviors (Johnson & White, 1971). The fact that students don't have the correct knowledge of how much they multitask is a problem. Furthermore, students who have positive attitudes toward multitasking do not perform better than the rest of the students (Eseryel et al., 2021). Secondly, changing behavior requires the understanding of the negative outcomes of behavior and getting a feeling that the negative outcomes outweigh positive behaviors. This suggests that the students should not only be conscious about their own multitasking behaviors, but they should learn and internalize the outcomes of such multitasking. Conceptual change must occur prior to behavioral change. The theory of experiential learning (Kolb & Kolb, 2005) suggests that learning is "the process whereby knowledge is created through the transformation of experience" and "knowledge results from the combination of grasping and transforming experience" (Kolb & Kolb, 2005, p. 194). Principles of situated cognition and experiential learning suggest that if students were to arrive at that conclusion on their own, it would be a more potent learning experience than if they were simply told what they can and cannot do with their technology (Downs et al., 2015). Across many fields, college faculty teach through lecturing, while research indicates that other methods are more effective in motivating students to learn (Huba & Freed, 2000).

Experiential learning theory draws from scholars of human learning and development, such as John Dewey, Kurt Lewin, Jean Piaget, William James, Carl Jung, Paolo Freire, Carl Rogers, and others. The theory is built on six propositions that are shared by these scholars (Kolb & Kolb, 2005, p. 194):

(1) Learning is a process that includes feedback on student learning effectiveness.

(2) All learning is relearning. Namely, learning is a process that draws out the students' thoughts, ideas, and beliefs so that these can be tested and new ideas can be incorporated into existing knowledge.

(3) Learning requires resolution of conflicts between dialectically opposed models of adaptation to the world. Learning is the process of moving back and forth between opposing

thoughts and feelings. These opposing ideas are then resolved when one moves to incorporate a new idea and make it their own.

(4) Learning is a holistic process of adaptation to the world, meaning learning is not only about cognition of facts. It includes thinking about new knowledge, feeling, perceiving, and behaving according to new knowledge.

(5) Learning results from synergetic transactions between the person and the environment. Learning happens through the dialectical processes of integrating new experiences into concepts that exist in one's mind.

(6) Learning is the process of creating new knowledge. Learning is a process where social knowledge is created and recreated. Thus, learning is not the process of instructors transmitting ideas to students.

The instructor's role in experiential learning is threefold (Wurdinger & Carlson, 2009). First, instructors should guide the students to learn by making mistakes and learning from their mistakes. Second, the instructors should provide freedom to the students to experiment in order to discover the solutions to the problems they encounter. Finally, the instructors should provide the students with resources and information when they get stuck, so that the students can continue to make progress and learn.

Wurdinger and Carlson (2009) identify five different types of experiential learning: active learning, problem-based learning, inquiry-based learning, project-based learning, and service-learning. The course-based undergraduate research experience, detailed below, is an experiential learning approach that incorporates problem-based learning and active learning. Our study incorporates a problem-based educational approach by organizing instruction around a carefully crafted "ill-structured" problem of deciding whether multitasking is something that is good for them or not. Guided by their instructor as a coach, they design two experiments, conduct a literature review on multitasking, formulate hypotheses, analyze their data, and determine the solution to their question (Wurdinger & Carlson, 2009). In doing all these, they develop critical thinking, problem solving, and collaborative skills (Wurdinger & Carlson, 2009) in addition to gaining hands-on skills in conducting a quasi-experimental academic research study. The research-based teaching approach we adopted also incorporates active learning by embedding group participation assignments where the students have to engage in research-based activities thinking about and reflecting on these activities (Bonwell & Eison, 1991).

We have chosen active learning for the students to study the extant literature on multi-tasking because active learning is often more effective than being lectured (Prince, 2004), and active learning enables students to transfer their learning to multiple problem-solving contexts (Bransford et al., 1999). Having the students actively learn about different aspects of multitasking is an effective way of consciousness raising (Prochaska & Velicer, 1997), thereby prompting the change process in students.

METHODOLOGY

To answer our research question, we followed the design science research best practices to create an intervention technique and evaluate its effectiveness (Gregor & Hevner, 2013; Hevner et al., 2004). The evaluation focused on students' change in intention to multitask. We conducted a content analysis of their thoughts during two phases: pre-intervention and post-intervention. In this section, we: (1) detail how we designed our intervention; and (2) describe how we evaluated the resulting technique.

STUDY DESIGN

Study participants came from multiple sections of an introductory Management Information Systems class taught by the first author. The students were told that participation was NOT mandatory, and that for any assignments related to the task that are graded, the students were told that they had the right to opt out at any time and receive another assignment for the same grade. None of the students chose to opt out of the study or the experiments before or during the study. A total of 34 students agreed to participate.

In the pre-intervention phase, students completed a "brain-dump." Brain dumps show the general student attitudes towards multi-tasking before and after the intervention. The brain-dump was a time-limited assignment, for which the students were prompted to use the given time (15 minutes) to write as much as possible about the topic without thinking much, and without correcting their grammar or voice. This allowed them to write the first thing that came to their mind, which often reflected their true and original thoughts about the subject matter. A series of question prompts helped guide the student brain dumps.

The instructor told the students that multitasking may have advantages and disadvantages, and that the students will conduct a research assignment to find out the best way to multitask. There were further discussions on how students tended to multitask in this and other classes. The instructor created an open, non-judgemental atmosphere that allowed the students to easily talk about how they multitasked, even when they multitasked against the wishes of the instructors.

During the intervention, the students were given three "Group Participation Assignments". Each assignment asked the students to collect research articles and then summarize the key findings. The first group participation assignment asked the students to list the advantages of multitasking. The second group participation assignment asked the students to list the disadvantages of multitasking. The final group participation assignment asked the students to identify tips for successfully multitasking. Each of these three assignments constituted a change intervention provided by the instructor, called "consciousness raising" by Prochaska and Velicer (1997). Namely, the students were educated on the benefits and disadvantages of multitasking, and how to multitask best.

After the literature search by students, two controlled experiments were conducted with the students based on a discussion in class with all students on what kind of experiments they would like to do. The first experiment included doodling with pen and paper, while at the same time listening to the lecture. The second experiment included texting back and forth with a friend, while at the same time listening to the lecture. At both times, the students were prompted repeatedly that they should be paying attention to the lecture and that 5-6 questions were going to be asked (out of 40) in the midterm exam from the chapter at hand. This was a required prompting to get them to pay attention to the lecture as best as they could to manage their intentional attention. After the lecture, the students were given a 5-question quiz based on the key learnings of the lecture and, immediately after the quiz, they were given the answers and asked to calculate how many questions they answered correctly. Lastly, they were given a general survey that included their demographic information, their grades, interest level, and their general multitasking habits. Having the students experiment with multitasking, and then having the students immediately calculate the percentage of their learnings from the given lecture was another way of consciousness raising through feedback (Prochaska & Velicer, 1997).

The last change process that was incorporated into the class was the stimulus control (Prochaska & Velicer, 1997). The instructor introduced during the first class a set of class norms, one of which included keeping the laptops, cell phones and smart devices in students' bags during lectures. The instructor justified this value by previous literature which suggested that even having the phone with screen turned down on the table during conversations distracted the speakers and distracted learners (Duke et al., 2018).

To be fair to all students and ensure that the experiments would not affect student grades, the students were told after both experiments were concluded that none of the topics taught during the experiment were included in the exam. Furthermore, other means to learn the same information (such as videos and slides of the presentation) were provided for those who missed the content due to multitasking experiments.

During the post-intervention phase, the participating students wrote a research report and gave a presentation on the topic of multitasking based on in-class experiments. The research report that the students were asked to write followed a similar outline to that of a journal article in addition to having a reflections section. The literature section of the research report included an enhanced literature study that the students conducted using the group participation assignments. Then the students were given their own experiment outcome data as well as the survey results. The students were asked to formulate research questions by finding interesting patterns in the data. Then they were asked to analyze the data to answer their own research questions. The instructor guided this process by conducting other group participation assignments where the students were asked to come up with research questions, and where they received feedback on their research questions on how to improve them and how to analyze the data.

At the end of the report, each student separately shared their personal reflections on the experiments and their own experience of multi-tasking in classes. The personal reflection provided the second piece of content to be analysed for our investigation.

EVALUATION OF THE TEACHING TECHNIQUE

The evaluation of the CURE teaching technique was performed with a content analysis (Krippendorff, 2019). Two coders with postgraduate training were used to analyse the pre-intervention (brain dump) and post-intervention (personal reflection). To limit potential bias in the coders, neither coder was involved with the experiment nor the class setting. The coders were trained on the coding scheme and independently coded 4 students' documents over 7 categories for a total of 28 coded items. The coders agreed on 27/28 coded items resulting in a 96.4% interrater reliability. The coders discussed the one disagreement and came to a consensus on the coding strategy to employ. Because of the high level of agreement, all remaining coding was conducted by just one of the coders.

In both pre-intervention and post-intervention, the stage of behaviour change was captured. The change stage was based on the six stages in the transtheoretical model (Prochaska & Velicer, 1997). The appendix provides the coding schema that was used for this study.

For the pre-intervention, three additional items were coded in addition to the stages provided by Prochaska & Velicer (1997), developed using a grounded theory approach. These three were perception of skills, attitude toward multitasking, and frequency of multitasking. Perception of skills was defined at three levels: novice, medium-experienced, and highly skilled. Attitude toward multitasking ranged from mostly positive, neutral, and mostly negative. Frequency of multitasking was coded as high, medium, or low.

For the post-intervention, two items were coded, change in attitude and change in intention. Change in attitude was defined as increased negative, no change, and increased positive. Change in intention was classified as reduce, no change, and increase.

To analyze the data, raw counts and percentages were calculated for each category. Cross-tabulation between pre- and post-intervention category recorded associations to describe how the intervention impacted students. These findings are expressed below, supported by quotes from the students.

FINDINGS

Please note that due to missing documents or unclear participant responses, not all totals equal 34.

PRE-INTERVENTION

Prior to the intervention, the majority (71%) were in the precontemplation stage of change. These participants saw multitasking in a mostly positive way and were not inclined to change anytime soon. 22% of participants noted the potential problems with multitasking likely outweighed the benefits but had no immediate plans to change, putting them in the contemplation stage. Two of the participants stated they had already made changes to limit or stop multitasking, placing them in the maintenance stage. None of the participants made statements that would cause us to categorize them in the preparation or action stages.

Pre-intervention perceptions of attitude

Most participants reported that they multitask in class pre-intervention. This often entailed looking at their phone or computer to check email, scrolling through social media, doing homework from other classes, and texting friends. A few participants considered taking notes, marking up PowerPoint slides, completing homework assignments, and Googling confusing information to fall under multitasking.

Perhaps not surprisingly, many participants that multitasked in such a way tended to have a mostly positive attitude toward multitasking. For example, one participant stated, "I multitask during class by paying attention to the teacher and by taking notes down on my pc." And later says, "Yeah I like to multitask."

When participants had a negative attitude toward multitasking, they often felt stressed out:

> "It stresses me out because I am trying to listen while also trying to write."
>
> "It's stressful sometimes."
>
> "Multitasking stresses me out and for some reason I always feel rushed."

Although even some participants with neutral attitudes toward multitasking felt stressed sometimes, they still saw enough benefits to balance their attitude:

> "Multitasking sometimes stresses me out … but it's a way to get several things done at once."

Two participants recognized that multitasking inhibited their ability to focus, preventing them from doing their best work:

> "It makes me feel too busy, like my focus and attention is being split between two important tasks."
>
> "I feel like it hinders me from focusing."

Pre-intervention perception of skills

Of the participants, 17% perceived themselves to be highly skilled at multitasking, 38% perceived themselves to be skilled at a medium level, and 29% at novice level. Most participants (5 out of 6) that considered themselves to be highly skilled tended to have a mostly positive attitude toward multitasking. For example, one participant summarized it: "I multitask quite well. I do it in class, at work, and even at home. Multitasking makes me feel busy and the busier I am or need to be, then the more productive I am going to be." They later stated, "When I am successful, multitasking makes me feel accomplished."

Interestingly, each highly skilled multitasker also claimed their friends were good at multitasking, but their parents were not. For example, one highly skilled multitasker said:

> "My dad will not talk while he is writing an email and my mom cannot talk on the phone and write something down at the same time."

However, most participants (8 out of 10) classified as novice multitaskers claimed their parents were better at multitasking than they were. For example:

> "I honestly think my parents multitask better than me …"

Pre-intervention multitasking frequency

The frequency of multitasking was less clear in many documents with only 68% (23/34) giving some indication of frequency. Of those, 52% reported a high frequency, 17% reported medium frequency, and 30% reported a low frequency.

POST-INTERVENTION

In the post-intervention personal reflections, participants shared their changing thoughts on multitasking. Of the 34 participants, 32 completed the personal reflection.

Post-intervention, 15% of participants were at the precontemplation stage, 28% at contemplation stage, 43% at preparation stage, and 6% respectively at action and maintenance stages. (See the Appendix for examples of quotes from students at each stage.)

Post-intervention changes in attitude toward multitasking

In no cases was there an increased positive attitude toward multitasking. Of the participants, 61% explicitly expressed an increased negative attitude toward multitasking in class. Many expressed a sentiment such as:

> "When we started this project, I was anxious to see how the results would turn out. I felt like I could multitask without any drop off in my ability to do either activity. After looking at the results, I realized that there is a drop off in my learning ability when I multitask."

However, 26% of participants came away with a mixed attitude. This mixed attitude distinguished between multitasking with related tasks versus multitasking with unrelated tasks. A common observation of mixed attitude looked like this:

> "This lead [*sic*] me to realize there are two types of multi-tasking, good and bad. The good is when multitasking has to do with the assignment at hand, so taking notes on what you are listening to or working on an assignment that covers the material you are going over, anything that correlates [with] the other will be a better multitasking option. The other is just basically a distraction, anything that causes a switch in tasks or subjects like being on your phone or doing other classes [*sic*] work."

No change in attitude was shown by 13% of participants. They shared a sentiment such as:

> "My thoughts on multitasking have not changed doing this experiment or paper because I already knew what the outcome would be."

INTERVENTION EFFECTS

We next look at changes due to the CURE intervention. To do this, we looked at cross-tabulations between pre-intervention and post-intervention factors.

Ten participants did not express any movement in the stage of change. This includes the two participants who were in the maintenance stage of change pre-intervention. They stayed in that stage. The remaining participants were in precontemplation or contemplation stage pre-intervention. Of that group, 71% moved to a higher stage of change post-intervention (see Table 1).

Table 1. Cross-tabulations of pre and post intervention change stage

		Stage Post-Intervention					
		Precontemplation	Contemplation	Preparation	Action	Maintenance	Total
Stage Pre-Intervention	Precontemplation	5	6	9	2	0	28
	Contemplation	0	3	3	0	0	6
	Maintenance	0	0	0	0	2	2
Total		5	9	12	2	2	30

The intervention had a similar effect on participants, regardless of their perception of skill with multi-tasking or their attitude toward multitasking (see Tables 2 and 3). In Table 2, the distribution of novice, medium level, and expert perceptions of their multi-tasking skills showed no clear pattern across the stages of change post intervention. 88% of novices, 83% of medium level, and 80% of experts were beyond precontemplation stage of change post intervention. In table 3, the distribution of mostly negative, neutral, and mostly positive attitudes toward multitasking pre-intervention also showed no clear pattern across the stages of change post intervention. 100%, 83%, and 71% respectively of the negative, natural, and positive attitudes were marked in a stage of change of contemplation, preparation, action, or maintenance. The two participants who worried about their ability to focus pre-intervention were the only two participants that took action immediately after the intervention.

Table 2. Cross-tabulations of perception of skill and post intervention change stage

		Stage Post Intervention					
		Precontemplation	Contemplation	Preparation	Action	Maintenance	Total
Perception of Skill	Novice	1	3	3	0	2	9
	Medium	2	4	5	1	0	12
	High	1	1	2	1	0	5
Total		4	8	10	2	2	26

Table 3. Cross-tabulations of attitude toward multitasking and post intervention change stage

		Stage Post Intervention					Total
		Precontemplation	Contemplation	Preparation	Action	Maintenance	
Attitude Pre-Intervention	Mostly negative	0	3	3	0	2	8
	Neutral	1	1	4	0	0	6
	Mostly positive	4	4	4	2	0	14
Total		5	8	11	2	2	28

DISCUSSION

The goal of this study was to design and evaluate a pedagogical technique for altering student digital multitasking behaviors. The reason for altering the student behavior about multitasking was twofold: (1) the students are often ineffective while multitasking; and (2) the students usually do not make the choice of multitasking consciously. Our research question was "Does course-based undergraduate research experience (CURE) technique change students' classroom digital multitasking behaviors?"

Research indicated that students multitask heavily in classes (Fried, 2008). Students' multitasking behaviors are strongly motivated by their various attitudes, feelings, and needs (Bardhi et al., 2010; Kononova & Yuan, 2017; Lin, 2019; Robinson, 2017; Wang & Tchernev, 2012). Therefore, when students are told by their instructors not to use technology, this frustrates the students (Downs et al., 2015). Yet, often students use technologies to multitask on unrelated tasks (Ellis et al., 2010; Jacobsen & Forste, 2010). As a result, students who multitask spend more time finishing their tasks and make more mistakes (Bowman et al., 2010; Ellis et al., 2010; Fox et al., 2009; Fried, 2008; Hembrooke & Gay, 2003; Kraushaar & Novak, 2010). Even in cases when multitasking with IT does not decrease students' class performance, it may reduce their learning satisfaction (Eseryel et al., 2021).

To change students' multitasking behaviors, we adopted an intervention as recommended by the psychotherapy field (Prochaska & Velicer, 1997). We specifically used course-based research experience as our intervention. For this method, we asked the students to write a research paper on multitasking. The students provided input on the design and implementation on the research by suggesting ways they can do the multitasking experiments in class. The students were guided on the research project by using group participation assignments, which walked them through different stages of the research. For example, as part of group participation assignments the students found research articles on the advantages of multitasking, disadvantages of multitasking, and on how to multitask successfully. With the group participant assignment, the students summarized the literature they found. After we conducted the experiments, the students used group participation assignments to analyze the data, and to come up with research questions and to get feedback from the instructor on the appropriateness of their research question. Another element of the study was getting student reflections in order to measure the effectiveness of the study. Before the study began, we used "brain dumps,"

namely 15-minute free style writing sessions, to get information on student attitudes towards and behaviors of multitasking. After the study was conducted, the students added individual student reflections to their research reports, which provided post-intervention feedback. We used the brain dumps and the post intervention reflections to evaluate the effectiveness of the research-based experiential teaching method.

Our findings showed that course-based undergraduate research experience (CURE) is effective in changing student attitudes and in moving the students further in the stages of change. We found that 61% of the participants experienced increased negative attitude towards multitasking in class. This is important because research found that while both students and instructors believed off-task technology use hinders learning, their views differed significantly, with more instructors than students feeling strongly that students' use of technology in class is a problem (Zaza & Neiterman, 2019). Moreover, our study showed that with course-based undergraduate research experience (CURE), it is possible to move the students on the ladder of change as quickly as within one semester (13 weeks). In fact, 71% of the students moved to a higher stage of change post-intervention. According to the diffusion of innovations theory (Rogers, 2003), the diffusion of new ideas takes a long time, and only 2.5% of the population are the first ones to try a new idea/innovation, followed by 13.5% of the population, who are early adopters. This is followed by the early majority (34%), who are rarely leaders, but who tend to adopt new ideas before the average person. The late majority are the following 34% of the population, who are skeptical of change and will only adopt an innovation after it has been tried by the majority. According to these percentages, making a change in 71% of the students' post-intervention is a rather successful accomplishment that we will attribute to the course-based undergraduate research experience.

Our paper adds to the constructivist teaching approach. According to constructivism, each individual constructs their own knowledge. Adopting a constructivist approach, our design goal was to create a learning environment where the students were supported in developing their own knowledge and attitudes towards multitasking and its effect on their learning performance. The design of the course-based undergraduate research experience included discovery learning principles, where we engaged students in inquiry through which, guided by the instructor and the materials, students discovered the intended content (Hammer, 1997). We added the CURE method to the toolbox of the instructors in social sciences and STEM research who prefer discovery learning methods.

Our study further helped us identify another gap in the literature: when the students were doing the group participation assignments, they easily found many articles on the disadvantages of multitasking. However, they had a very tough time finding evidence for the advantages of multitasking. Further, the researchers rarely gave tips on how to multitask successfully, although many online (popular) resources exist for tips on how to multitask successfully. Our study showed the gap in the literature on the benefits of multitasking, and on studies that highlight how students can multitask effectively.

A side-benefit of the study, which is no less important, was to show the students how to conduct research, and showing them what the research part of an academic career looks like. Such early introductions towards academic research enable those students who like such work to identify academia as a potential career option. Research found that research experience during school predicted achievement in academic careers (Brancati et al., 1992).

LIMITATIONS

The limitation of this study is the small convenience sample size of 34 participating students. In our analysis, some of the student documents were missing or unclear, thus the tables we created for the analysis section did not always add up to 34. Moreover, while our intervention was thorough, it was also complex. It may be possible to attain similar results with fewer components. Future studies may incorporate some of the elements presented here to test the outcomes. Lastly, this was a pilot study.

Future studies should investigate the use of course-based undergraduate research experience (CURE) across different settings, and with larger sample sizes.

CONCLUSION

We conducted a course-based undergraduate research experience to influence multitasking behavior in undergraduate students. Our study was effective in changing student behavior, by causing a change in 71% of students' multitasking behavior post intervention.

We observed that the course-based undergraduate research experience caused the students to be more aware of their own multitasking behavior, and that they could see multitasking as a choice rather than an automatic habit. The literature review component of the study caused the students to learn from the extant research on the negative aspects of multitasking. Even though some students had positive attitudes toward multitasking, not being able to find much literature on the positive aspects of multitasking was eye-opening for the students according to their comments.

The findings suggested that course-based undergraduate research experience, which combines different types of experiential learning, may be used to enable wanted changes in student attitude and behavior. This study showed that using a course-based undergraduate research experience (CURE), the instructors can change the attitudes and behaviors of their students, by making the students aware of their behaviors and the outcomes of those behaviors. This approach further enables the students to benefit from the knowledge accumulated by extant research. Students learn to value the practical benefits of research and how to use research findings for practical purposes. The course-based undergraduate research experience produced strong effects in many students. It had the most immediate effects on individuals worried about their ability to focus. Because our intervention focused on students creating and collecting their own data, the method helped students to practice cleaning, analyzing, and presenting data using Excel (or another tool), which further actively engaged the students with the data analysis concepts core to the management information systems curriculum. By personalizing the process, students became more motivated and had a similar background with the ideas, promoting more meaningful learning (Drake, 2012).

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APPENDIX: CONTENT ANALYSIS SCHEMA

Code category	Code name	Code description	Reference	Code example	Rules about the code
Change in intention to multitask	Reduce	Starting to intend a reduction in the amount of multitasking	Grounded theory coding	"I will do it less in class"	From personal reflection
	Increase	Starting to intend to increase the amount of multitasking		None found	
	No change	Stated intention is not to change the amount of multitasking		"I will continue to not multitask"	
Change in attitude toward multitasking	Increased positive	Starting to believe that multitasking is good, while originally had neutral or negative beliefs about multitasking.	Grounded theory coding	None found	Comparison between brain dump and personal reflection. Student responses are more nuanced than this. Several students found multitasking when tasks are related to be beneficial, but not so when unrelated.
	Increased negative	Starting to believe that multitasking is not good, while originally had neutral or positive beliefs about multitasking.		"I think after these experiments it shows that I'm probably not being as effective as I think I am"	
	No change	No change in attitude			
Perception of their multitasking skills	Highly skilled	Claims that they are very skilled at multitasking.	Grounded theory coding	"I can multitask very well"	From brain dump. "How well can you multitask?" and "Are you good at it?"
	Medium	Claims that are moderately good at multitasking, usually with a disclaimer such as "pretty good".		"I'm pretty good at it"	
	Novice	Claims that they are okay or bad at multitasking		"I am not good at multitasking"	

Code category	Code name	Code description	Reference	Code example	Rules about the code
Reported frequency of multitasking	High	Claims that the student multitasked very often	Grounded theory coding	"All the time"	From brain dump
	Medium	Claims that the student sometimes multitasked		"Only during class or when the rest of my day is interrupted"	
	Low	Claims that the student rarely multitasked.		"When I'm bored, which doesn't happen very often"	
Attitude to multitasking pre-intervention	Mostly positive	Statements that attribute positive reflections towards multitasking	Grounded theory coding		From brain dump questions "Do you like multitasking?" or "How does multitasking make you feel?"
	Neutral	Statements that attribute neither positive more negative reflections towards multitasking		"I could care less about it, I just do it to get work done"	
	Mostly negative	Claims that attribute negative reflections towards multitasking		"It's stressful sometimes"	
Change stages	Precontemplation	Stage in which people are not intending to take action in the foreseeable measure usually measured as the next 6 months. They may have tried to change a number of times and become demoralized about their abilities to change. Indications on avoiding reading, talking or thinking about negative multitasking behavior.	(Prochaska & Velicer, 1997)	"I will not be changing my multitasking habits"	
	Contemplation	Stage in which people are intending to change in the next 6 months. They understand s the pros of changing but the cons seem to be higher.	(Prochaska & Velicer, 1997)	"…multitasking with unrelatable task will be much more difficult and you would not be as effective on you task."	

Code category	Code name	Code description	Reference	Code example	Rules about the code
	Preparation	Stage in which people are intending to take action in the immediate future, usually measured as the next month. These individuals have a plan of action such as relying on a self-change approach, doing research, etc.	(Prochaska & Velicer, 1997)	"I think that what I learned from this experiment certainly added to my current multitasking strategy."	
	Action	The stage in which people have made specific overt modifications in their multitasking behavior within the last 6 months.	(Prochaska & Velicer, 1997)	"Since the conclusion of the experiment I have tried to stop multitasking on tasks."	
	Maintenance	Stage in which people are working to prevent relapse but they do not apply change processes as frequently as people in action.	(Prochaska & Velicer, 1997)	"In the future, I will continue to not multitask"	
	Termination	Stage in which individuals have zero temptation and 100% self-efficacy	(Prochaska & Velicer, 1997)		

AUTHORS

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