RESEARCH ARTICLE

Undergraduate Student Adaptation to Unplanned and Unexpected Online Learning in Post-Secondary Education

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ABSTRACT

The Corona Virus Disease- 2019 (COVID-19) outbreak that occurred during the spring 2020 academic semester forced colleges and universities worldwide to suddenly switch their teaching and learning processes to remotely delivered and online environments. This unexpected and unplanned transition to online course delivery, known as emergency remote teaching (ERT), disrupted normal modes of instruction and learning for students as well as teachers and faculty. Using an inductive qualitative research approach, this study investigated how undergraduate postsecondary students adapted to ERT. Specifically, this study examined the breadth of strategies that students used to adapt to ERT and identified the adaptive strategies students perceived as being effective by helping them to successfully complete their courses. Researchers analyzed qualitative data generated by twelve hundred and thirty-seven (1237) undergraduate student participants studying twenty-seven (27) different undergraduate courses across seven different U.S. institutions of higher education. Data were generated using a self-report, face-validated survey with open-ended questions. Findings revealed that participants exercised their self-regulation in action by focusing more heavily on external induced adjustments than internal induced adjustments. Participants perceived the most effective strategies to be behavioral engagements, followed closely by cognitive and, to a lesser extent, affective engagements.

Keywords: COVID-19, ERT, online learning, adaptive learning strategies

Introduction

Due to the COVID-19 outbreak in March 2020, universities and colleges across the globe rapidly transitioned to online learning environments. Known as an emergency transition to remote teaching (ERT), this unexpected transition to remote, online delivery undoubtedly caught many instructors and students unprepared for online teaching and learning (Lawanto, et al., 2022).[1] Many students involuntarily moved home and most continued their educational experience, utilizing Internet technologies such as Learning Management Systems (LMS) and virtual Internet-based communication platforms (e.g., Zoom and Cisco WebEx). The changes needed to continue teaching and learning evolved almost instantly for both students and instructors who often had limited, if any, support from instructional designers. Resultant to these changes, students were required to adapt and adjust to their new learning environments. In prior work, poor internet performance, online exams, and remotely administered group projects were the top three features that students identified as negatively affecting their learning during the ERT.[1]

Unlike what is customarily found in traditional in-person learning interactions, online learning demands that students possess a high degree of self-autonomy and consistently exercise their self-regulation skills and habits to ensure their learning success.[2] The level of self-regulation practice required for online learning is often something that students opt out of during traditional in-person learning in favor of more structured and guided learning approaches.[3] Thus, as universities worldwide were placed into lockdowns, state curfews, and social distancing restrictions, many students needed to exercise self-autonomy and self-regulation at substantially greater levels than they were used to doing. Moreover, while traditional online learning is deliberate and "well-planned," ERT is unexpected and unplanned.[4] During the urgent transition imposed by Covid-19, students were expected not only to exercise their existing self-regulation skills, but also to be adaptive and develop and practice their essential self-regulation skills, such as planning, monitoring, and managing strategies, to ensure successful remote learning performance.

This study examined how students self-regulated or adapted to the required shift to online learning, focusing on the specific strategies that students employed to aid in this adaptation. Although classrooms are now beginning to return to in-person learning, the knowledge gained from this study will enhance our understanding about how undergraduate students adapted their learning approaches in a forced online learning situation. While we have not seen an emergency of this magnitude in recent years, the chances of humanity facing another similarly impactful emergency do exist and are very likely. Moreover, since learning in virtual environments has gained significant popularity due to this recent pandemic, it is critical to understand how students adapted to an unexpected change in learning environment, as well as their perceptions about which strategies were most effective for engaging in online learning. This published work continues a research thrust that sought to inform the broader educational community of how such a large dislocating event can influence student perceptions of learning and their strategies to adapt to a different learning modality. [1,5]

In this study, self-regulated learning (SRL) is defined as the intentional, deliberate control of thoughts, feelings, and actions to achieve valued goals.[6-7] Historically, the focus on self-regulation is rooted in developmental psychology and behavioral interventions. Initially, psychologists sought to teach the techniques used to *self-regulate* or modify negative behaviors to enable people to achieve more positive life experiences. Today, in the context of formal schooling, use of SRL practices is expected to foster a safe and supportive learning environment with opportunities for choice, support, and control over challenges.[8] Models of self-regulated *learning* have been developed over the past thirty years to understand how to support greater academic success.

Self-Regulation in Action (SRA) lies at the heart of SRL. SRA is comprised of iterative and recursive cycles of interpreting requirements, planning (e.g., resources, time, strategies), implementing cognitive processes (i.e., enacting strategies where the work begins on the task itself), monitoring progress, evaluating progress against internal and external standards, and continually refining approaches to better achieve goals.[9,10] This iterative and recursive SRA cycle organizes students' affective and cognitive processes that they use to attain their learning goals[11]; SRA is recognized as an important contributor to learning success in both traditional and online learning settings.[12] Marzano et al. discuss how planning, monitoring, and evaluating are important aspects of metacognition as it relates to process and term this type of metacognition as executive control of behavior.[13] Biwer et al. investigated self-regulation among university students during ERT with specific focus on resource-management strategies. In this study, student participants reported that they experienced more difficulties in managing their time and regulating

their attention and efforts, and were less motivated than before the shift to remote learning.[14]

Along with the heightened need for use of SRA skills and habits, online teaching and learning experiences are often characterized by a sense of isolation for students as well as their instructors. This isolation is further intensified during ERT situations such as COVID-19. In these instances, student engagement becomes essential to reduce student's feeling of isolation and to maintain their desire to learn, learning satisfaction, and academic achievement.[15] Borup et al. discuss three different types of engagement: *behavioral*, *cognitive*, and *affective*.[16] While *behavioral engagement* emphasizes the students' executive control processes (e.g., organizing, managing, monitoring, and encouraging progress), *cognitive engagement* focuses on collaboration and instruction in the learning environment (i.e., the enacting strategies students and instructors deploy during learning). Lastly, *affective engagement* stresses the need to facilitate communication, develop relationships, and foster excitement for learning. These factors present a lens through which to investigate students' positive and negative reactions to learning during the outbreak of the COVID-19 pandemic.[5]

In sum, self-regulation in academic settings refers to the ways students manage their time and structure their learning environments. When students are both self-aware of their learning and self-motivated, they are more likely to evaluate their approach to learning. These timely and recursive evaluations can lead them to create a better environment for their learning success. As described, existing literature further shows that, along with self-regulation skills, engagement is essential to succeed in ERT. Indeed, students' ability to engage in learning depends on their personal characteristics, learning environment, and the course environment.[16] In this study, we take a deeper look into the ways undergraduate students adapted to the forced change to remote learning that occurred during the COVID-19 pandemic. Specifically, we focus on the strategies that students perceived as effective and implemented to adapt to this change.

Materials and Methods

PURPOSE AND RESEARCH QUESTIONS
The purpose of this study was to examine how undergraduate students enrolled in four-year colleges and universities across the United States adapted to the unexpected transition from traditional in-person teaching formats to online learning environments during the outbreak of the COVID-19 pandemic. Being strategically adaptive allows students to quickly respond to changes in the learning environment. Specifically, the study seeks to identify and examine the *adaptive strategies* that students deemed effective during their online learning experiences. Insight from this work will not only support improvements in online learning generally, but also will also equip online educators and curriculum developers to prepare for future emergencies that could impact or disrupt traditional learning models.

Two research questions were constructed to guide the study:

> RQ #1: How did undergraduate students adapt to their online learning environment during the Covid-19 ERT event?
>
> RQ #2: Which adaptive strategies did undergraduate students deem to be most effective for their online learning during the Covid-19 ERT event?

CONTEXT AND PARTICIPANTS
In the spring 2020 semester, all the courses started in a traditional face-to-face classroom centered learning environment. Around mid-March 2020, there was a sudden mandatory call for an immediate transition to online teaching and learning due to a severe outbreak of the COVID- 19. This sudden transition led to unexpected and unplanned modifications to teaching and learning formats in a relatively short duration of time (i.e., one to a few weeks). Due to the emergent nature of the study that limited the time to access and communicate to a wider university community, the study used convenience sampling to identify undergraduate courses from which to recruit participants to provide response to an online survey.[17] Each course in which participant were recruited was taught using an online learning environment (OLE) format characterized by numerous online learning features, including video-lectures, live synchronous chat/lecture, virtual labs, and many other features (see also, Lawanto et al.[1]).

All participants in this study were undergraduate students enrolled in one of the 27 distinct courses sampled for recruitment. Courses included engineering (i.e., 19 courses), mathematics and statistics (i.e., 3 courses), technical writing (i.e., 2 courses), and social sciences (i.e., 3 courses). In total, researchers generated data with 1237 undergraduates, including 983 (79.5%) students who identified as male and 249 (20.1%) students who identified as female. Five (0.4%) participants elected not to disclose their gender. Data were generated using an anonymous online survey

administered through Qualtrics. All students who accepted the invitation to participate were included in data collection and invited to complete the survey.

DATA GENERATION AND ANALYSIS

Data were generated using an ad-hoc survey prepared and tailored to the specific context of this study. The researchers developed, face-validated and refined the survey items to meet the purpose of this study and to improve the readability. The original survey administered to the participants consisted of 13 items including 10 multiple-choice/multiple-answer and three open ended questions.

The focus of this paper is to understand how students adapted to the new online learning and teaching environment in the emergency, and the perceived effective strategies they employed during this forced transition. To address these questions, participants' responses to only two open-ended survey questions concerning these issues in combination with four demographic items have been considered in the analysis for this study. Analysis and discussion of participants' responses to other survey items is outside the scope of this paper (for other survey items see: Lawanto, et al.[1]; Minichiello et al.[5]). Table 1 provides a description of the survey items used in this study.

Table 1. Survey Items

What to assess	Description of survey items
Demographics	- Current academic status (i.e., freshman, sophomore, Junior, and senior) - Current cumulative GPA (i.e., 3.50 or above, 3.00-3.49, 2.50-2.99, 2.00-2.49, below 2.00 - Gender (i.e., male, female, prefer not to disclose) - Taken any online classes before spring 2020 (i.e., yes, no)
Survey Question 11. Ways to adapt to an unexpected change to online learning	What did you do to adapt to the online learning environment in this course?
Survey Question 12. Effective strategies employed during the unexpected online learning	What were the effective strategies that you used during your online learning experience in this course (e.g., regularly checking course calendar/announcements, etc.)?

A research protocol was approved by the Institutional Review Board (IRB) located at the authors' institution prior to conducting any portion of the study. Student participation in the survey was voluntary, and participants were allowed to opt out of further participation at any stage of the survey completion process. Participants were invited by their respective course instructors to complete the survey before the final exam at the end of the semester. Some participating instructors offered extra credit for participation.

Due to the exploratory nature of this study, an *inductive qualitative analysis* approach was used to analyze the data and answer the research questions. Inductive approaches are more relevant in cases where existing theoretical concepts are not immediately available to help comprehend the phenomenon at hand. One thousand two hundred thirty-seven (1237) textual responses corresponding to the two open-ended survey questions (Table 1) were inductively analyzed and

coded in two cycles (i.e. first cycle coding and second cycle coding) to answer the two research questions. We note that survey questions 11 and 12 (Table 1) directly align to research questions RQ #1 and RQ #2, respectively.

During the first cycle coding, the research team used descriptive coding processes to assign labels that summarized segments of the qualitative responses provided by participants. In second cycle coding, labels grouped into categories and emerging themes using pattern coding/identification.[18] First cycle (descriptive) coding was completed in two rounds. During the first round, two coders individually analyzed all collected responses to the two open-ended survey questions. Both coders were provided with the list of student responses in an excel worksheet. Each coder segmented and analyzed each student response and noted descriptive codes in the form of words and short phrases related to the research questions (e.g., goal setting and planning, staying connected with peers,

managing physical space, etc.) opposite to that segments' cell. It is noted that some of the students' responses comprised multiple segments (each segment coded differently) and hence could be labeled with more than one descriptive phrase. Data segments that did not relate to the research questions were not labeled with descriptive codes. Once completed, the two coders met with two faculty researchers from the team and discussed the analysis together to reach a consensus and refine descriptive phrases into codes to ensure analytic consistency and inter-coder reliability.

Once the group agreed on the codes and their application, the two coders re-analyzed the data corpus using the refined codes. This second round of first cycle coding was conducted with the two coders working in isolation to avoid any coercion in deciding how to assign codes to the data. Once the second round of initial coding was complete, its results were compared. Only those descriptive codes their respective data segments that were agreed upon by both coders and were considered for categorization, emerging themes, and discussion during second cycle coding.

During second cycle coding, the identified codes and their data segments were grouped using an iterative and collaborative process. The goal of second cycle coding was to identify data categories, as well as emerging themes (patterns) that explained the phenomena concerning the two research questions. As a final step, the resultant themes and patterns in the data were reconsidered in light of the existing theory and the extant literature.

Results

DEMOGRAPHIC CHARACTERISTICS
As noted previously, a majority (79.5%) of participants identified as male and (20.1%) identified as female. The remaining 0.4% participants preferred not to disclose their gender. Demographic data related to participant race, ethnicity, and orientation were not generated.

Table 2. Students' Cumulative GPA (CGPA) (*N*=1237)

CGPA	Number of Count (%)
3.50 and above	629 (51%)
3.00-3.49	476 (38%)
2.50-2.99	110 (9.2%)
2.00-2.49	15 (1.2%)
Below 2.00	7 (0.6%)

As shown in Table 2, 89% of participants self-reported having cumulative grade-point-averages (CGPA) of 3.00 or above. In terms of academic status, forty-five percent (45%) of the respondents reported being seniors, 26% juniors, 23% sophomores, and 6% freshmen. Importantly, sixty percent (60%) of the participants reported that they have had prior online learning experience (i.e., taken at least one online course prior to spring 2020 semester).

FINDINGS RELATED TO THE RESEARCH QUESTIONS
RQ#1: How did undergraduate students adapt to their online learning environment during the Covid-19 ERT event?

To answer the first research question, a total of two thousand and ninety-two (2092) segments from 1237 student responses for survey question 11 were descriptively coded. A comparison showed that the two coders agreed (100%) on nineteen (19) unique descriptive codes for a total of 1509 response segments. Thus nineteen (19) unique descriptive codes corresponding to 1509 response segments were considered for second cycle coding (pattern identification). In order to find how students adapted to the new online learning environment, the 19 unique descriptive codes were categorized into two major categories that aligned with the internal or external focus of the adaptation. Specifically, if an adaptation was created or developed by the students themselves and was found to affect their own cognitive or affective strategies, it was considered as an *internally focused adaptation*. In contrast, an adaptation that is initiated by someone/thing other than the student themselves and impacted or modified students' resources or environment was seen as an *externally focused adaptation*.

The first category included codes that represented internal adjustments by the students. Internal adjustments focused on students' cognitive and affective processes that occur within, and are created and controlled by, the students. For example, efforts to create a learning schedule and to organize a better task list, was considered as internal adjustments developed by a student to help create a better learning process. In these cases, participants implemented internally focused adjustments.

The second category included codes that represented external adjustments by the students. External adjustments focused students' cognitive and affective processes that have direct links with or impacts on the external learning environment or its actors and focus solely on implementation. For example, when participants reported that they started reading the textbook when they had questions or reached out for help via email and/or zoom call if they were uncertain, they were designated as implementing externally focused adaptions because they were using previously available learning resources (i.e., textbook) and communication resources or tools (i.e., email and zoom communication platform). In these cases, the mechanisms for adaptation were previously provided and participants merely needed to change how they engaged with the mechanisms. In these cases, participants implemented externally focused adjustments.

Looking across findings regarding students' locus of control when faced with an ERT situation, it was seen that some participants desired to exercise personal control and develop adjustments themselves, while others more simply chose to make better use of available resources and instructor-provided strategies. In some cases, participants chose to implement both internally and externally focused adaptations by developing their own adjustments while also changing how they used existing resources.

Table 3. Students' adaptation to an unexpected online learning environment

Categories/ Emerging Themes	Codes	Counts (%)
Internally Focused Adjustments: Internally developed and directed cognitive and affective processes occurring and controlled consciously by students	Developing goals, tactics and strategies	459 (30.4%)
	Planning and monitoring task's schedule	48 (3.2%)
	Monitoring announcements	29 (1.9%)
	Stress Management	21 (1.4%)
	Relying on self-guidance (self-reliance)	21 (1.4%)
	Self-motivation	15 (1.0%)
	Survival attitude	10 (0.7%)
	Monitoring changes in the learning environment	5 (0.3%)
	Subtotal	**608 (40.3%)**
Externally Focused Adjustments: Externally implemented and directed cognitive processes having direct impacts on learning environment	Implementing (study) goals, tactics and strategies	459 (30.4%)
	Managing physical learning space	127 (8.4%)
	Utilizing the available learning (online and non-online) resources	112 (7.4%)
	Peer Engagement	79 (5.2%)
	Increasing the learning time/effort	37 (2.5%)
	Utilizing the available technologies and tools	36 (2.4%)
	Upgrading technology	23 (1.5%)
	Prioritizing tasks	12 (0.8%)
	Reviewing the learning resources multiple times	8 (0.5%)
	Utilizing communication resources/tools	4 (0.3%)
	Following instructor's guidance	4 (0.3%)
	Subtotal	**901 (59.7%)**

Table 3 shows the distribution of codes falling into each data category (emerging theme) and the corresponding frequency of each code appearing in participant responses. Out of the 1509 coded response segments, the most dominant category of responses was externally focused adjustments. A total of 901 (59.7%) codes were found referring to these externally focused adjustments. The most frequent externally focused adjustment activity was *"implementing (study) goals, tactics, and strategies"* identified in 459 (30.4%) coded segments, followed by *"managing physical learning space"* identified in 127 (8.4%) coded segments, and *"utilizing the available (online and non-online resources"* identified in 112 (7.4%) of coded segments. Additionally, *"engaging with peers,"* *"increasing learning effort and time,"* and *"utilizing available technologies and tools"* were also externally focused adjustments used by

comparatively more students to adapt to the new online learning environment.

The second dominant category of participants' responses was internally focused adjustments that were internally directed towards cognitive and affective processes occurring in and controlled by students' own consciousness. A total of 608 (40.3%) of coded segments described activities that were referring to these internal adjustments. The most popular of the identified internal adjustments was "developing goals, tactics, and strategies" which was reported in 459 (30.4%) segments. Additionally, "planning and monitoring task schedule," "monitoring announcements," "stress management," "self-reliance," "self-motivation," "survival attitude," and a "close monitoring of changes in the learning environment" were also the internal adjustments reported by some of the respondents and were deemed to be placed in the first category of codes.

RQ#2: Which adaptive strategies did undergraduate students deem to be most effective for their online learning during the unexpected ERT event?

To answer the second research question, 1237 participants described effective strategies they used during the online learning experience. A total of 2978 response segments were descriptively coded as referring to one or multiple effective strategies that participants used. However, 100%

inter-coder agreement was attained for a subset of 20 unique descriptive codes corresponding to 1904 coded segments. Therefore, only 20 descriptive codes corresponding to 1904 response segments were considered in second cycle coding to identify effective strategies. Analysis of the resulting data assigned to the 20 unique codes showed subcategories related to three types of learning engagement: behavioral, cognitive, or affective engagement (Borup et al., 2020).

Table 4 shows the distribution of codes into three sub-categories with corresponding frequencies and percentages. Among the three types of learning engagement, the most dominant comprised strategies related to behavioral engagement, which was identified in 1344 (70.6%) coded segments. As shown in table 4, the top four behavioral engagement strategies as reported by the students were, "planning and monitoring tasks' schedule," "monitoring announcements," "goal setting and planning," and "monitoring new course contents" found in 540 (26.36%), 392 (20.59%), 304 (15.97%), and 95 (4.99%) of coded segments, respectively. Other behavioral engagement strategies identified in the coded segments included, "monitoring own learning schedule" and "monitoring changes in the learning environment," which were found in less than 1% coded segments.

Table 4. Perceived effective strategies employed during the unexpected online learning

Type of Engagement (Emerging Themes)	Strategies (Codes)	Counts (%)
Behavioral Engagements (executive control of engagement)	Planning and monitoring tasks' schedule	540 (26.36%)
	Monitoring announcements	392 (20.59%)
	Goal setting and planning	304 (15.97%)
	Monitoring new course contents	95 (4.99%)
	Monitoring changes in the learning environment	10 (0.53%)
	Monitoring own learning schedule	3 (0.16%)
Subtotal		**1344 (70.6%)**
Cognitive Engagements (employed implementation strategies)	Enacting (study) tactics and strategies	304 (15.97%)
	Staying connected with peers (Peer Engagement)	81 (4.25%)
	Utilizing available learning (online and non-online) resources	68 (3.57%)
	Utilizing available technologies and tools	48 (2.52%)
	Managing physical learning space	22 (1.16%)
	Reviewing learning resources multiple times	13 (0.68%)
	Relying on self-guidance (self-reliance)	5 (0.26%)
	Prioritizing learning tasks	4 (0.21%)
	Following instructor's guidance	3 (0.16%)
	Upgrading of technology used to facilitate learning	2 (0.11%)
	Increasing the learning time	2 (0.11%)

Type of Engagement (Emerging Themes)	Strategies (Codes)	Counts (%)
Subtotal		**552 (29%)**
Affective Engagements (moods, feelings, and attitude)	Stress Management	5 (0.26%)
	Self-Motivation	2 (0.11%)
	Employing survival attitude	1 (0.05%)
	Subtotal	**8 (0.4%)**

The second most dominant category comprised *cognitive engagement strategies* found in 552 (29%) coded segments. The top five effective strategies associated with cognitive engagement included *"enacting study tactics and strategies," "staying connected with peers," "utilizing available learning resources," "utilizing available technologies and tools,"* and *"managing physical learning space,"* which were reported in 304 (15.97%), 81 (4.25%), 68 (3.57%), 48 (2.52%), and 22 (1.16%) coded segments, respectively. Similar to what was observed in the behavioral engagements category, the next six strategies in cognitive engagement category exhibited wide gaps with the top five strategies. Reported in less than 1% coded segments, these cognitive engagement strategies included *"reviewing learning resources multiple times," relying on self-guidance or self-reliance,"* and *"prioritizing learning tasks." Affective engagement strategies* were found in only 8 (0.4%) of coded segments. Three strategies associated with *affective engagement* were reported in even fewer coded segments (i.e., less than 1%). *"Stress management,"* reported in 5 (0.26%) coded segments, was the top in *affective strategies,* followed by *"self-motivation,"* and *"employing survival attitude."*

Discussion

When students were unexpectedly exposed to the many uncertainties and unfamiliar learning environments during ERT, they found that they could not attend to all of them. Resultantly, students prioritized some of these uncertainties, while ignoring others. As mentioned in the findings section,

students' coded responses revealed two dominant categorical responses. These categories reflect how participants adapted to the ERT initiated due to a pandemic situation (COVID 19).

Results show that participants exercised their SRA primarily by focusing more on externally induced adjustments than internally induced adjustments. External adjustments partially involve students' own control and consciousness and are predominantly concerned with external environmental factors. For example, enacting study tactics and strategies, managing physical learning space, utilizing available online and non-online resources, peer engagement, upgrading technologies, communication resource utilization, assessing their learning with provided formative mechanisms, and using instructor and teaching assistant guidance are adjustments that are not only related to a students' own consciousness, but are those that a student can actively alter.

Not all participants, however, had complete control to make such adjustments. In fact, these adjustments do depend upon availability of those opportunities (e.g., peers, communication resources, tools, technologies etc.). The following participant responses show how their actions to adapt to the ERT often depended upon these external factors. Responding to the question, *"what did you do to adapt to the online learning environment in this course?"* some students made statements referring to the management of physical learning space. Example data excerpts are provided in table 5 below.

Table 5. List of some excerpts

"I made a study space conducive to learning."
"I was able to make a space in my living area to work on this specifically if I didn't have that I don't believe that I would have succeeded"
Moving my desk from the living room to the 2nd bedroom - Needed to lock myself in the bedroom such that my daughter (she is 2) to not bug me during class, or HW."
"I set aside an area and time to do coursework during scheduled times."

The second prominent category refers to internally focused adjustments that are comprised of cognitive and affective processes within the conscious control of the students. As described in 608 (40.3%) of

coded response segments, students further focused on goal setting, planning to achieve those set goals, continuously monitoring tasks' schedules, changes in the learning environment and adjusting their

planning accordingly, working on self-motivation and stress management, and realizing the value of self-reliance. These internally focused adjustments are associated with actions and decisions within students' own control and awareness of self. For example, a student stated,

> "I had to keep physical reminders of assignments and quizzes by marking them on a calendar, and leaving assignments open on my computer so I would remember them".

This response shows that the students' decision and SRA is related to his/her own consciousness (engagement) and behavior that he/she perceived would help in successfully adapting to the new online learning experience.
Similarly, another student stated,

> "I tried to check the Canvas page for each of my classes every day to make sure I wasn't missing assignments, announcements, or lectures that were posted. I tried to keep my schedule close to what it had been on campus, as far as what days I did homework for what class."

This student response also reflects an internal adjustment within his/her control and shows a tactic of mimicking the in-person class routine. The response reflects what the student perceived as a method that would help in adapting to the new online learning environment. This student seems to believe that in-person learning was an ideal situation. Therefore, to adapt and have control over the new online learning, he/she needs to strictly follow the same routine while also referring to reminders in locations that are observed frequently. Similarly, self-reliance, stress management, and self-motivation are also seen as students' self-controlled behaviors and that is why they have been categorized into internally focused adjustment activities.

Frequency based analysis of identified codes and emerging themes concerning the first research question, reveal that students were more focused on engaging in actions related to externally focused adjustments (e.g., enacting study tactics and strategies, managing physical learning space, peer engagement etc.) than internally focused adjustments (e.g., goal setting and planning, monitoring announcements, self-reliance, self-motivation etc.).

Similarly, an analysis of descriptive codes and identified emerging themes concerning the perceived effective strategies participants employed to adapt to the ERT (RQ #2) shows that they predominantly focused on employing behavioral engagement strategies such as "planning and monitoring tasks' schedule", "monitoring announcements", "goal setting and planning", and "monitoring new course contents" etc. The cognitive engagements are characterized by enacting strategies (e.g., peer engagement, utilizing online and on-online learning resources, and utilizing available technologies and tools.

It is interesting to note that students' actions to adapt to the new online learning environment (internal and external adjustments) are congruent with their perceived effective strategies that they employed to successfully learn in the online environment. There seems to be a connection between these two that is likely helping students in such a transition. A majority of the internally focused adjustment activities reported by students are associated closely with their perceived effective strategies that fall in the behavioral engagement (executive control of behavior) area. Similarly, emerging themes regarding externally focused adjustment activities also seem to appear in students perceived cognitive engagement strategies. Students' coded responses to the two survey questions (actions to adapt to the online learning vs perceived effective strategies employed to adapt to the online learning) seem to corroborate and support each other. In other words, the actions that students reported taking to adapt to the new online learning environment aligned with what effectively worked for them (effective adaptation strategies).

Limitations and Future Study

The active self-regulation strategies discussed in this paper were researched within an ERT context due to students change in educational venue from the health crisis imposed by the COVID-19 pandemic. Consequentially, the results presented in this paper may not represent other situations where online learning was thoughtfully designed and delivered. Moreover, the time duration of the online learning experience was investigated in this study is relatively short and does not represent a full semester course. Larger timeframes could have impacts upon results beyond what was discovered with this work. Future investigations are warranted to learn to what extent the adaptive strategies employed where pertinent in non-emergency teaching and learning conditions. Besides the discovered effective internal and external focused adjustments activities found in this research, it is also recommended that future work continue to investigate other affective and cognitive engagements, especially those that are perceived to be ineffective and may thus lead to less successful learning. Besides this work's discovered effective

internal and external focused adjustments activities, it is also recommended that future work continue to investigate other affective and cognitive engagements, especially those that are perceived to be ineffective and may thus lead to less successful learning.

Conclusion

This work shows that the students in this study adapted to their online learning environment with greater focus on external adjustments that are implementation driven. It is therefore likely that additional training in areas of internally focused adjustments that directly address development may be the most fruitful area for initial interventions to help students' transition into an ERT. Additionally, areas focused on cognitive and affective engagement may also increase students' effective strategy choices that will help them deal with ERT. This paper further signifies the fact that instructional designers and instructors need to incorporate research informed practices to provide necessary behavioral, cognitive, and affective engagement opportunities to students in online learning environments. The interventions need to focus on guiding students into an effective practice of engagement strategies especially for those who do not have a prior exposure to the online learning environment and/or lack a natural aptitude to take advantage of such strategies.

Acknowledgment

References

1. Lawanto O, Iqbal A, Goodridge W, Minichiello A, Asghar M. Unexpected and Unplanned Changes resultant to a shift from Traditional Face-to-face to Online Learning: Developing an understanding about online learning features and students' feelings. *Special Edition of the International Journal of Engineering Education (IJEE)*. 2022;38(5B):1629-1642.

2. Yen C, Liu S. Learner autonomy as a predictor of course success and final grades in community college online courses. *Journal of Educational Computing Research*. 2009;41:347–367.

3. Paechter M, Maier B. Online or Face-to-Face? Students' Experiences and Preferences in E-Learning. *Internet and Higher Education*. 2010;13(4):292–297.

4. Hodges C, Moore S, Lockee B, Trust T, Bond A. *The Difference between Emergency Remote Teaching and Online Learning*. Retrieved 21 November 2021 from https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning. 2020.

5. Minichiello A, Lawanto O, Goodridge W, Iqbal A, Asghar M. Flipping the Digital Switch: Affective Responses of STEM Undergraduates to Emergency Remote Teaching during the COVID-19 Pandemic. *Project Leadership and Society*. Retrieved 29 March 2022 from https://doi.org/10.1016/j.plas.2022.100043, 2022.

6. Butler DL, Schnellert L, Perry, NE. *Developing self-regulating learners*. New Jersey: Pearson Canada Incorporated. 2017.

7. Zimmerman BJ. Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American educational research journal*. 2008;45(1):166-183.

8. Winne PH. Cognition and metacognition within self-regulated learning. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 36–48). Routledge/Taylor & Francis Group. 2018.

9. Butler DL, Winne PH. Feedback and self-regulated learning: A theoretical synthesis. *Review of educational research*. 1995;65(3):245-281.

10. Butler DL, Cartier SC. Multiple complementary methods for understanding self-regulated learning as situated in context. In *Meetings of the American Educational Research Association*. 2005;11–15.

11. Usher EL, Schunk, DH. Social cognitive theoretical perspective of self-regulation. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 19–35). Routledge/Taylor & Francis Group. 2018.

12. Dent AL, Koenka AC. The relation between self-regulated learning and academic achievement across childhood and adolescence: A meta-analysis. *Educational Psychology Review*. 2016;28(3):425-474.

13. Marzano RJ, Brandt RS, Hughes CS, Jones BF, Presseisen BZ, Rankin SC, Suhor C. Dimensions of thinking: A framework for curriculum and instruction. Alexandria, VA: Association for Supervision and Curriculum Development. 1988.

14. Biwer F, Wiradhany W, Oude Egbrink M, Hospers H, Wasenitz S, Jansen W, de Bruin A. Changes and Adaptations: How University Students Self-Regulate Their Online Learning During the COVID-19 Pandemic. *Frontiers in psychology*. 2021;12.

15. Abou-Khalil V, Helou S, Khalifé E, Chen MA, Majumdar R, Ogata H. Emergency online learning in low-resource settings: Effective student engagement strategies. *Education Sciences*, 2021;11(1):24.

16. Borup J, Jensen M, Archambault L, Short CR, & Graham CR. Supporting students during COVID-19: Developing and leveraging academic communities of engagement in a time of crisis. *Journal of Technology and Teacher Education*. 2020;28(2):161-169.

17. Creswell JW. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications. 2014.

18. Saldaña J, Omasta M. Qualitative research: Analyzing life. Sage Publications. 2016.