Flextensions: Exploring the Impact of Flexible Extensions

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Flextensions: Exploring the Impact of Flexible Extensions

by Fuzail Shakir

Research Project

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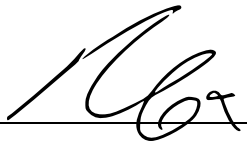

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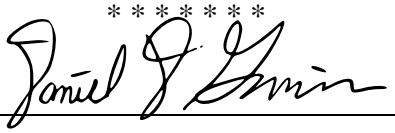

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Table of Contents

Abstract 3

I. Overview and Motivation 3

A. What are Flexible Extensions? 5

B. Research Questions and Hypotheses 6

C. Goals of a Solution 7

III. Background and Related Work 8

A. Mental Health and Academic Success 8

B. Equitable Learning 12

C. Summary 14

IV. The Flextensions System 14

A. Overview of Flextensions 15

B. Operationalizing the Research Questions 16

C. Student-Facing System 17

D. Instructor-Facing System 17

E. Who is using it? 19

V. Data Collection and Analysis 20

A. Data Collected 20

B. Quantitative Data Analysis 21

C. Case Study: Computer Security (CS161) 23

D. System Abuse 25

VI. User Response and Feedback 25

VII. Limitations 26

VIII. Future Work 28

IX. Conclusion 29

References 30

Abstract

Hard deadlines in formative assessments have been the traditional approach to managing coursework and ensuring timely completion of assignments, but recent research has highlighted several downsides to this one-size-fits-all approach, which may have negative implications for student learning outcomes, well-being, and overall academic success. This study seeks to explore the role of flexible extensions in formative assessments, examining both the potential benefits and challenges of implementing a more accommodating assessment model. By examining the impact of flexible extensions on student self-efficacy, well-being, and academic success, as well as how the introduction of such a system would impact staff time and resources, this research aims to contribute to the ongoing discourse on effective and inclusive assessment practices in higher education. We introduce the *Flextension* system for automating large portions of managing flexible extension policies through automation. Analysis of data from a case study in CS161 found an average improvement of 150% in homework assignments and 183% on project assignments when an extension was requested. Through all this, the importance of flexible extensions in its effectiveness on alleviating stress, increasing students' understanding and learning, and ensuring that a student's grade reflects their learning rather than external factors is punctuated.

I. Overview and Motivation

The landscape of education has seen a rapid transformation due to advancements in technology and pedagogical methods. One crucial aspect of the learning process is the evaluation of student progress through formative assessments. Traditional formative assessments often involve hard deadlines for assignments and projects, which may not always cater to the diverse learning needs of students nor do they provide leeway in ensuring that students have the space to take personal time and not suffer academic consequences. As

education becomes increasingly personalized and adaptive, it is essential to explore alternative assessment models that can accommodate the unique challenges faced by different learners.

Hard deadlines in formative assessments have been the traditional approach to managing coursework and ensuring timely completion of assignments, but research has highlighted several downsides to this one-size-fits-all approach. Hard deadlines can create a high-pressure environment that may undermine student self-efficacy, an individual's belief in their ability to succeed in a given task, and motivation to learn, both of which are key factors in determining an individual's ability to succeed in various tasks (Bandura 1977). According to the cognitive load theory (Sweller, 1988), students' working memory capacity can be overwhelmed by the demands of managing multiple assignments with strict deadlines. This cognitive overload may result in superficial learning, as students may be more focused on meeting deadlines rather than deeply engaging with the material (Kirschner et al., 2006). Amabile et al. (2002) found that time pressure can impede creativity, as individuals are less likely to explore novel ideas and take risks when faced with strict deadlines, therefore suggesting that the rigidity of hard deadlines in formative assessments may constrain students' ability to develop creative solutions to complex problems and hinder their capacity for innovation. The inflexibility of hard deadlines can also exacerbate stress and anxiety among students, particularly those who are struggling to keep up with the pace of their coursework (Beiter et al., 2015; Regehr et al., 2013). In some cases, the anxiety associated with meeting strict deadlines may even lead to procrastination and poor time management, further exacerbating students' difficulties in completing assignments on time (Tice & Baumeister, 1997). As such, rigid deadlines create an inequitable learning environment for students, especially those with diverse needs and circumstances who require additional support due to learning disabilities, mental health issues, or other personal challenges (Lazarus et al., 2011).

More flexible assessment models, such as those that incorporate extensions or allow for personalized pacing, may be more effective in promoting student success and fostering an inclusive learning environment (Lazarus et al., 2011; Tice & Baumeister, 1997). As educators continue to explore new approaches to assessment, it is crucial to consider the potential drawbacks of traditional hard deadlines and prioritize the development of more equitable, personalized, and effective assessment strategies.

This study seeks to explore the role of flexible extensions in formative assessments, examining both the potential benefits and challenges of implementing a more accommodating assessment model through use of a custom-built Flextensions system. By examining the impact of flexible extensions on students' learning outcomes, self-efficacy, and overall academic success, this research aims to contribute to the ongoing discourse on effective and inclusive assessment practices in higher education.

A. What are Flexible Extensions?

Flexible extension policies are defined as approaches that allow students flexibility in when to submit assignments rather than being strictly held to hard deadlines. These policies should strike a balance between maintaining structure to support learning and granting students the freedom to be self-regulated learners. They need to take into account academic schedules and teaching staff workload while moving away from rigid policies that prioritize control over learning. In doing so, these policies transfer some decision-making authority from instructors to students, acknowledging the diverse backgrounds and circumstances they bring to the learning process. Flexible deadline policies do not eliminate deadlines or consequences for subpar work; instead, they ensure that a student's grade reflects their learning rather than external factors.

B. Research Questions and Hypotheses

The goal of this research is to rigorously explore the challenges and benefits associated with flexible extension policies. Understanding the impact of these policies on learning outcomes will provide valuable insights to educators, administrators, and policymakers who seek to create more inclusive and effective learning environments that achieve a better balance between the self-efficacy and motivation of students with the administrative impact on staff. The research questions include:

1. Compared to students in courses with fixed deadline policies, do students in courses with flexible extension policies…
    a. learn more effectively by putting in more effort?
    b. gain a higher depth and breadth of course material?
    c. achieve better grades?
2. How do flexible extension policies impact student satisfaction and well-being?

It is important to acknowledge that various factors contribute to the computation of both homework grades and final grades, which may influence the outcomes of this study. Moreover, homework grades often display *ceiling effects*, wherein a large proportion of students achieve top scores, potentially limiting the sensitivity of the measure to detect differences between the two groups. Consequently, a comprehensive evaluation of learning outcomes must consider additional measures and factors that may affect the relationship between flexible extension policies and student performance.

By making it easy for students to have flexible deadlines, flexible extensions can potentially address individual needs and foster an inclusive learning environment. We hypothesize that:

1. Students who have access to flexible extensions will demonstrate higher self-efficacy, leading to improved engagement and performance in formative assessments.
2. The implementation of flexible extensions will lead to a decrease in the number of students who "leave points on the table" due to self-imposed ceilings or optimization strategies.
3. Flexible extensions will result in higher levels of course satisfaction and better learning outcomes, as students are better able to manage their workload and learning pace.
4. The implementation of flexible extensions using the Flextensions system will decrease the work needed to implement extensions and will not drastically increase the amount of time needed to maintain such a system when compared to a no-extension model.

To test these hypotheses, this study employed a mixed-methods approach, including quantitative data analysis of student performance and extension requests, as well as qualitative research methods such as surveys and interviews to gather insights into student experiences and perceptions of flexible extensions. By analyzing the collected data, we aim to provide evidence-based recommendations for the implementation of flexible extensions in formative assessments within computer science education and potentially other disciplines.

C. Goals of a Solution

One key aspect of implementing flexible extension policies in formative assessments is minimizing the administrative burden on educators and staff. A majority of systems devised with the explicit aim of enhancing learning outcomes and ensuring fairness and equity require substantial resources required for deployment and maintenance, and would likely overshadow those allocated for current traditional methods. The sheer scale of resources needed could be so vast that it might lead to the abandonment of the system altogether. Furthermore, the traditional flow of extension requests is an arduous process on behalf of students and staff alike,

as courses need to categorize extension requests based on Disabled Student Program (DSP) status, review the student's previous extension request record, update the requested extension on a spreadsheet or directly on the course's Learning Management System (LMS), before finally sending the updated deadline to the student. Therefore, a range of issues, from the increased chances of human error and communication problems to slower processing times and high hurdles when asking for an extension, all combine to prevent students from having the time they need to fully grasp the course material. The simple fact is that a system like this, given current time and resource constraints, is not easily scalable or manageable in a large class setting.

We postulate that, in many learning contexts, software and automation techniques can be leveraged to streamline the management of a flexible extension policy such that it takes the same or fewer resources than policies that do not handle extension requests. Therefore, it is critical that approaches to implementing flexible extension policies are predicated on minimizing staff time through automation. In other words, by developing an automated system for managing extension requests, we can streamline the process, thereby reducing the need for manual intervention and maintaining a record of granted extension requests and their outcomes, while simultaneously improving quality-of-life for students.

III. Background and Related Work

A. Mental Health and Academic Success

Self-regulated learning, defined as the process by which students actively manage their own learning strategies and motivation (Zimmerman, 2002), is closely related to academic success. Personalized and flexible assessment approaches can foster self-regulated learning and improve learning outcomes by providing students with opportunities to take responsibility for their own learning process and adapt their approach based on their needs (Winstone et al.,

2017). Self-efficacy is another significant factor in academic performance as flexible assessment models can enhance student self-efficacy and positively influence their motivation and achievement (Schunk & Zimmerman, 2007).

Flexible assessment models have emerged as a potential solution to address the diverse needs of learners, including those with learning disabilities or mental health issues (Lazarus et al., 2011; Rose & Meyer, 2002). Withington and Schroeder (2017) explored the impact of "rolling deadlines"—student-selected deadlines from a range of available dates—on pass rates in first-year English courses at a US community college, with around 400 participants. Their research revealed a 12–22% increase in class pass rates when greater deadline flexibility was provided. Similarly, Nickels and Uddin (2003) allowed engineering students (141 participants) to use a two-day late bank for course assignments without justification, with a 10% penalty per day afterward. Their findings showed broad acceptance of these policies, reduced stress, minimal reduction in initial learning, and increased overall attention to homework. Schroeder, Makarenko, and Warren (2019) studied 78 graduate students across five courses in an online Canadian graduate program, where students could use a late bank of up to five days on one of two assignments without self-disclosure or penalty. The authors found that students considered the late bank highly useful: 45% of students believed the extra time improved their assignment quality, 62% viewed the instructor more positively as a result, and both groups self-reported reduced stress due to the late bank (97% and 89%, respectively).

Patton (2000) investigated the records of 400 post-secondary students in an open learning program at Curtin University of Technology in Australia, identifying three grading types: inflexible (fixed-deadlines), semi-flexible (2 day flexibility in deadlines), and flexible graders. He discovered that flexible grading led to higher course completion rates, with 60–90% of students completing missed coursework shortly after the term's end when given the chance. Wang (2011) examined the effects of three deadline conditions on 173 undergraduate students across three

courses, finding no significant differences in perceived learning and course satisfaction among the groups, but noted that the flexible-instructor-set deadline group had the best academic performance. Miller, Asarta, and Schmidt (2019) compared students with rigid deadlines to those with flexibility up until exam dates. The flexible deadline group performed better on assignments and exams, but the authors could not determine whether flexible deadlines were responsible for these differences. However, a small but statistically significant decrease in class participation was observed in the rigid deadline group.

Kumar and Wideman (2014) studied 35 students in a health sciences course at a Canadian university, applying Universal Design for Learning (UDL) principles, including a flexible deadline for course presentations. They found that 88% of students felt that choosing their presentation date positively impacted their learning, and the increased flexibility improved both stress perceptions and overall student success. Similarly, Peterson and Digman (2018) compared students with rigid deadlines to those in a semi self-paced (SSP) course where assignments could be submitted any time before fixed exam dates, in order to encourage self-regulation. Although students in the SSP section preferred flexible deadlines, those in the rigid deadline section did not express a strong preference for flexibility. The authors found no consensus among students on whether flexible deadlines led to procrastination; however, learning management system (LMS) data indicated that the SSP group did not keep pace with course materials as much as their rigid deadline counterparts and had twice as many missing assignments. Peterson and Digman concluded that students did not have a preference for either deadline type but preferred the format they were exposed to.

Collectively, this research suggests that flexible deadlines may increase student pass rates (Patton 2000; Withington and Schroeder 2017), improve participation (Miller, Asarta, and Schmidt 2019), enhance student achievement (Kumar and Wideman 2014; Miller, Asarta, and Schmidt 2019; Wang 2011), reduce student stress perceptions (Kumar and Wideman 2014;

Nickels and Uddin 2003; Schroeder, Makarenko, and Warren 2019), increase student attention to work (Nickels and Uddin 2003), and improve assignment quality and student perception of the instructor (Schroeder, Makarenko, and Warren 2019). We believe these can all become a reality, as long as it can be done efficiently and without being an undue burden on staff time.

In order for flexible extensions to be effectively implemented in the educational landscape, there are two essential prerequisites that must be met: (1) the adoption of autograding systems, and (2) the integration of assignment submission and deadline management with automated systems, such as Learning Management Systems (LMS) or assessment-authoring and assessment-administration platforms like Gradescope. Firstly, the implementation of autograding systems is crucial to mitigate the challenges associated with manual grading, particularly when flexible extensions are in place. Autograding systems have gained significant attention in recent years as a means to streamline the grading process, improve consistency, and reduce the workload of instructors (Alario-Hoyos et al., 2014; Gehringer, 2018). In the context of flexible extensions, autograding plays a vital role in addressing the issue of staff being "on call" to grade assignments submitted at arbitrary times. By automating the grading process, instructors can allocate their time and effort to other essential aspects of teaching and learning, such as providing individualized feedback and support (Gehringer, 2018). Secondly, if an LMS or a platform like Gradescope is employed for assignment management, it is imperative that the flexible extensions tool is integrated with the respective system to ensure seamless implementation. This integration is essential to accommodate flexible extensions without requiring manual intervention from staff. By automating the deadline adjustment process, instructors can avoid the cumbersome task of manually managing individual extension requests, thereby saving time and ensuring consistency in the application of the policy, all while reducing the error rate (Hershkovitz & Lavie, 2020).

B. Equitable Learning

Many instructors develop classroom policies based on what they believe is suitable for a "typical" student. However, Gaudry and Lorenz (2019) argue that universities often normalize the experiences of students who are white, cisgender male, heterosexual, middle-to-upper class, without disabilities, and childless. This overlooks the fact that today's diverse student body includes individuals from various abilities, backgrounds, ethnicities, interests, learning styles, languages, and expectations (Gorham and Roberts, 2014). It is crucial to design courses considering that many students face barriers in completing coursework on time. To challenge the "myth of the normal student," we need to consider the potential benefits of flexible deadline policies and learning environments more broadly (Ramohai 2019).

Vaughn and Viera (2021) identify flexible due dates or extensions as appropriate accommodations for various disabilities. Despite 24% of first-year university students in the United States self-identifying as having a disability, this number may be inaccurate, as not all students with disabilities are diagnosed or disclose their disabilities. Newman and Madaus (2015) found that only 35% of U.S. post-secondary students who received special education services in secondary school disclosed their disability to their college, citing concerns about stigma and discrimination. As such, having a flexible extensions policy mitigates such issues, allowing all students to receive the time they need to fully succeed (Vaughn and Viera, 2021). The social model of disability argues that barriers to education stem from an exclusive learning environment rather than the student's disability (Kumar and Wideman 2014). Flexible deadlines can remove a potential learning barrier for some disabled students, and incorporating this flexibility into course structure is essential given that many disabilities are undiagnosed or undisclosed and attitudes towards deadline flexibility as an appropriate accommodation vary in higher education.

Neurodiverse students, such as those with attention deficit hyperactivity disorder (ADHD), who account for approximately 12% of college students according to a study done in 2010, may also benefit from flexible deadlines (Garnier-Dykstra et al., 2010). ADHD can lead to executive function and self-regulation challenges, making it difficult for individuals to organize, plan, and manage deadlines (Jansen et al. 2017; Fleming and McMahon 2012). Although deadlines can support time management and reduce procrastination, allowing some flexibility can prevent missed deadlines and alleviate stress related to deadline concerns (Centre for ADHD Awareness, Jansen et al. 2017).

Mental health challenges are also increasingly prevalent among post-secondary students, impacting their ability to meet deadlines (Condra et al. 2015). The American College Health Association (2019) reported that stress (41.9%), anxiety (34.6%), sleep difficulties (29.0%), and depression (24.2%) were the top health factors affecting college students' academic performance. Moreover, the COVID-19 pandemic has further exacerbated mental health and self-regulation issues among students (Rashid and DiGenova 2020). Flexible deadlines would reduce stress, support completion of classwork, and help students achieve course learning goals, even for those considered "normal" students who are experiencing mental health challenges.

Many students encounter unforeseen barriers to their academic success, including illness, trauma, poverty, caregiving responsibilities, and more. Students with competing responsibilities, such as work, childcare, and family obligations, may struggle with academic expectations (Brownson et al. 2016; Moore and Greenland 2017; Xuereb 2014). As tuition costs rise, students face increased financial hardships, putting pressure on them to work while attending school (Goldrick-Rab, Richardson, and Hernandez 2017). While most instructors often support these students by granting assignment extensions, they lack the infrastructure to do so in an

organized, scalable manner. Flexible extension policies offer equitable opportunities for students to complete work when unforeseen circumstances arise.

C. Summary

Assessments are major stressors for students, particularly during midterms and finals when multiple assignments are due (Pitt et al. 2018). Flexible learning environments can enhance student learning experiences and pass rates (Patton 2000). Hall (2010) found that when full-time students engaged in part-time work were asked how to address work-study balance issues, the most common suggestion was greater flexibility around assignment deadlines. Courses with flexible deadlines are also shown to empower students with a sense of control, leading to reduced stress (Whitman, Spendlove, and Clark 1986).

In higher education, students exhibit diverse identities and circumstances, necessitating structured flexibility. This requirement extends beyond deadlines, calling for instructors to establish flexible learning environments that include, empower, and support all students. The richness of higher education lies in the variety of experiences, skills, and ways of knowing students bring to the table. Adhering to the "myth of the normal student" undermines academia's fundamental mission and fails to serve a society that requires diversity and creativity to tackle increasingly complex challenges. Flexible deadlines represent one strategy for fostering more accessible and equitable learning opportunities for diverse students. As Boucher (2016) argues, "Strict deadlines only serve to reproduce the inequalities of access and inclusion that universities are trying so hard to correct".

IV. The *Flextensions* System

The traditional system for managing extensions and individualized deadlines is an arduous process for students and instructors alike. At every manual step, there's a chance for data entry errors that are capable of propagating downstream, and may not become apparent until the end of the semester as final grades (or final grade reports) are being generated. For classes that outsource work to course managers (i.e. department staff who are not a part of course teaching staff, but help ensure that the course logistics run smoothly), there are three parties with different views on extension data: what course managers see, what course staff see, and what students see. All communication, by default, needs to be inclusive of all three parties; if even one email is two-way instead of three-way, then information is "lost". Because of the number of manual steps required here, it can take several days for students to learn whether their requests were granted, leaving them in a state of stress and uncertainty. And finally, due to the number of steps in approving each extension, there's a tendency for instructors to write strongly-worded policies discouraging most student extension requests.

When building the flextensions system, we aimed to fix such issues by providing a streamlined process for instructors and students, building upon the work of previous GSIs like Peyrin Kao, Zephyr, and Vron Vance. Students simply fill out a form with the required fields of their requested assignments, their new deadlines, and the reason for requesting such an extension. Instructors can view the updated requests as color-filtered rows on a centralized spreadsheet before toggling the approval button which automatically sends out an email to the student with their updated deadline and updates their deadline on Gradescope accordingly (for other LMS systems like bCourses, see Section VIII), and some extensions can even be auto-approved based on threshold values that can be set within the spreadsheet (see Section IV. B).

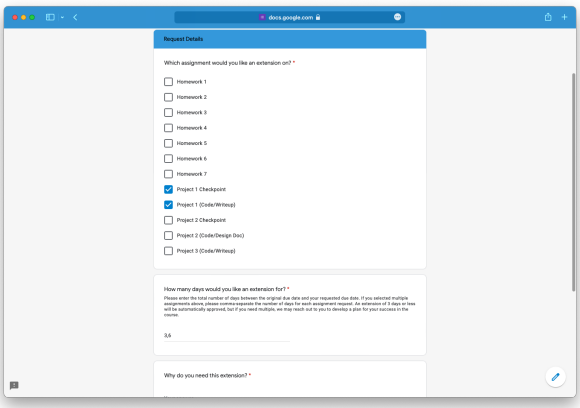
A. Overview of Flextensions

The Flextensions system has three configurable threshold values whose units are days: an auto-approval (known as `auto_approve_threshold`), approval with email check-in (known as `email_approve_threshold`), and approval after a face-to-face conversation, with default values of 3 and 7 days respectively; it also has an an `auto_approve_assignment_threshold` which ensures that students cannot gain auto-approvals for large numbers of assignments all at once. Any extensions that are requested as less than or equal to `auto_approve_threshold` get automatically approved on the spreadsheet, with an automated email being sent out to the student that details their new due date, as well as an automatic update of the student's deadline on Gradescope. Requests between `auto_approve_threshold` and 7 days create a Slack ping to the extensions manager, before sending a templated email to the student; after the email check-in, the extensions manager toggles the approval status to *approved*, and the automated email and Gradescope deadline update takes effect. Finally, extension requests beyond 7 days also create a Slack ping to the extensions manager updating them of the request before sending an automated email to the student with a Calendly link to sign-up for a zoom call – once the call is completed and the student and extensions manager have agreed upon a number of days, the extensions manager toggles the approval to *approved*, and the automated email and Gradescope deadline update takes effect. The two threshold values are completely customizable per course offering at any given time (and can be removed altogether if needed). If a class has enabled Gradescope extensions, students will see extensions reflected in Gradescope automatically after they receive the email with their updated deadlines. This works for one or multiple Gradescope assignments per in-class assignment, meaning that if there exists one assignment for code and one for a written PDF, then both assignment URLs can be placed into the Assignments tab of the central spreadsheet, and the tool will create extensions on both Gradescope assignments.

B. Operationalizing the Research Questions

When a student requests an extension, the spreadsheet records the raw form responses as well as a formatted response that creates a row for every student within which all previous assignment requests are recorded. Understanding the timeline in which students request extensions in comparison to the original deadline, looking at the grade changes before and after an extension is requested, and through an NLP analysis of the reasonings given why the extension was requested, we can begin to better understand the effectiveness of flexible extensions in their impact on learning and student satisfaction.

C. Student-Facing System



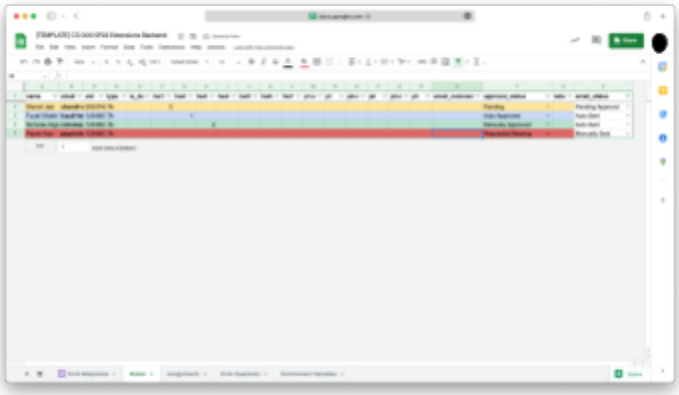
Students request an extension through a Google Form. If a student knows which assignments they want to request an extension on, then they're prompted to select from a list of assignments, and provide a number of days for each extension. They can either enter a single number, which will apply to all assignments that they select, or enter comma-separated numbers to allow them to request a different number of days for different assignments. If a student is working with one or more partners, then they are asked to enter their partners' emails and Student IDs (SIDs) – their partner(s) will be included in extensions for any assignments that they select which are marked as partner assignments by the instructor team.

If a student doesn't know what assignment they need an extension on, they can request a meeting with a TA – students who are experiencing extenuating circumstances often need to

talk through their situation with an instructor or Graduate Student Instructor (GSI) before collectively deciding upon a specific request. When a student's request has been approved (either manually or automatically), students receive a templated email with their updated assignment deadlines.

D. Instructor-Facing System

Staff view all extensions on a master spreadsheet, with two main tabs: a Form Responses tab, which contains all raw form responses from students, and a Roster tab, which contains a list of all students in the course, with a column for each assignment. When an extension request comes in, staff first receive a Slack message in a private Slack channel. If an extension request falls into an auto-approval category, the message contains a summary of the student's request, as well as a list of all of their granted extensions – when an extension is automatically approved, staff don't need to do anything, but if it requires manual approval, the message contains a reason why the request could not be auto-approved.



A request is not auto-approved if the student has requested an extension for a single assignment that is greater than `auto_approve_threshold` for any single assignment, a student requests extensions for a number of assignments over the auto_approve_assignment_threshold, or if the student record has a "work-in-progress", meaning that the student either has an existing, pending request or ongoing student meeting. Each of these threshold values are configurable per class, allowing for slightly different policy generation, and has the potential to hold different values between DSP and non-DSP students.

If the extension warrants manual approval, staff should set the approval status on the spreadsheet to *manually approved*, set the email status to *in queue* before using the dispatch emails menu item; this automatically send emails to all the students in the queue, removes them from the queue as the emails are sent, and sends automated updates to the Slack channel when all the emails have been processed.

If a student requests a student meeting, the slack message contains a description of the student's request. If, during a student meeting (or through some other channel), staff would like to grant a student an extension on an assignment, staff should enter the number of days to extend the deadline directly onto the student record on the Roster, and add the student record in the queue for outbound emails. This is a natural "form bypass" case, where a form submission isn't required to grant a student an extension, but these specially-granted extensions are still tracked alongside the rest of the student's extension requests.

Any requested extensions for assignments that are "partner" assignments will apply to the designated partner(s) as well as the student. Both student records will be updated on the Roster, and the logic for approval will apply to all partners (e.g. if Partner A submits the form and Partner B has a "work-in-progress" record, then the extension as a whole will be flagged for manual approval).

E. Who is using it?

The system is currently being used by a number of classes at UC Berkeley in Electrical Engineering and Computer Science (EECS) and Data Science (DS), including all 5 lower division courses and 15 upper-division courses. Each class has an estimated 300 to 700 enrolled students, and from our collected data, roughly 94% of students enrolled request at least

one extension during the semester, with the estimated number of total extensions being 3-4x the number of students per class.

Semester	Courses Using the System	Feature(s) added
Fall 2021	CS161	Original deployment
Spring 2022	CS61C, CS161, CS164, CS168, CS170, CS182	Introduction of the front-end and back-end systems as well as automated emailing
Fall 2022	CS10, CS61C, CS161, CS164, CS168, CS170, CS182, CS186, CS189, CS194-26, EECS126, EECS127, EECS151	Gradescope integration, support for groups/partners, slack integration
Spring 2023 (current semester)	Data 8, CS61A, EE16A, EE16B, CS10, CS61C, CS161, CS164, CS168, CS170, CS182, CS186, CS189, CS194, EECS126, EECS127, EECS151, EECS 152, EECS 252, Data 100	None

V. Data Collection and Analysis

A. Data Collected

When a student requests an extension, the backend spreadsheet records the raw form responses as well as a formatted response that creates a row for every student within which all previous assignment requests are recorded. Specifically, the collected data includes the student's name, email, and SID along with the assignment(s) they want an extension on, the number of days they are requesting per assignment, and the reasoning behind requesting this extension. When conducting the data analysis, all this information was anonymized by getting rid of the email and name columns and running the SIDs through a SHA-3 hash function. The collected data does not differ across semesters nor for the various courses using the system. However, for the special case of CS161 (see Section V.C), students were also required to

submit the assignment when requesting the extension, therefore giving us information on what their grade would have been had the extension not been approved. This grade data was also anonymized by running the corresponding SID through the aforementioned SHA-3.

B. Quantitative Data Analysis

Using data from course offerings (n=11) that have the same threshold values, we can see that on average, 62.5% of students request an extension that is less than 3 days long, 23% request an extension that is between 3 and 7 days long, and only a small fraction (less than 10%) request an extension that is longer than 7 days. The spike of extension requests less than 3 days is likely influenced by the default value of the auto_approve_threshold, which is 3 days. These thresholds can be configured by each class and from collected data from classes that utilize different threshold values, we see that the vast majority of students would request extensions below this limit. While just over 60% of student requests in our data set required no manual intervention, the remaining 40% required varying levels of manual adjudication. The second most common group of students (25%) requested extensions that were above the auto_approve_threshold, but were approved after a brief email exchange with the corresponding extension manager for the course.

Figure 1 shows the time delta between when an extension was requested and the original assignment deadline. Along the x-axis, zero indicates that the extension request was received on the date of the original assignment deadline; positive values represent requests before the deadline; negative values represent requests after the deadline has already passed. The

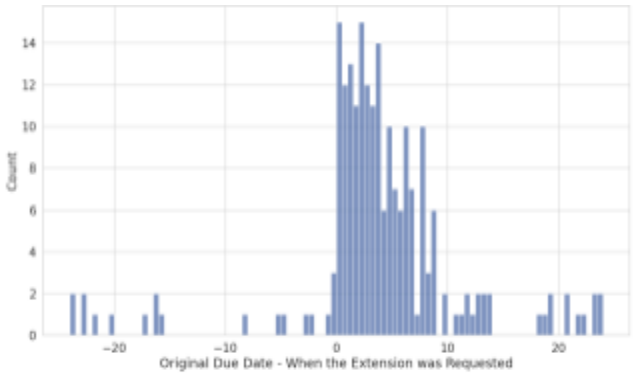


Figure 1: Histogram of when students asked for extensions relative to the deadline

distribution matches basic intuition: the amount of extension requests begins about one week (7 days) before the deadline and the most extension requests occur just before or directly on the original deadline. However, the data at the tails is more interesting to analyze. Data at the right tail depicts students who request extensions early on in the semester, sometimes even before the assignment is even released to the general students. From an analysis of the reasons provided, this can be classified into two subsets: (1) students who attempt to get as many extensions as possible up front as they realize that they need extended deadlines in order to get through the material and (2) students who "abuse" the system. One of the goals in developing such an automated system is the reduction of the second set of students as much as possible, which therefore resulted in the `auto_approve_assignment_threshold`. Students falling into the first category, though, pose an interesting question as they are able to recognize the amount of time they need, in addition to the current class schedule, to properly gain a mastery of the class material. Students requesting extensions closer to the deadline are, in some cases, worse off in comparison, as they don't actually know the amount of time they need to fully comprehend and master the material. Data at the left tail depicts students who request extensions long after the original deadline has passed. These requests are likely due to extenuating circumstances wherein some form of extension was already requested, and it simply wasn't enough time to fully complete the assignment.

In addition to the quantitative analysis, a Natural Language Processing (NLP) analysis was conducted on the reasons students provided when requesting extensions to gain insights into the underlying factors that led students to request extensions and to explore the relationship between these factors and mastery learning (*n=6339*). Following some text preprocessing steps of tokenization, stopword removal, and lemmatization to reduce the data's dimensionality and improve the efficiency of the subsequent analysis, the processed text data were fed into a topic modeling algorithm, Latent Dirichlet Allocation (LDA), to identify the main themes or topics

emerging from the extension request reasons. The LDA topic modeling results revealed five main themes that contributed to students' extension requests — academic challenges, personal issues, time management difficulties, health concerns, and external obligations. This wide variety of categories suggests that flexible deadline policies should be implemented as a means to accommodate the diverse needs and circumstances of students.

Reading all the individual student responses also revealed that academic challenges encompassed reasons related to students' struggles with understanding complex concepts, difficulty in applying learned concepts to practical problems, or the need for additional time to revise and practice. This suggests that students may require more time or support to achieve mastery in certain topics, which can be addressed by incorporating flexible deadlines and providing additional resources, such as supplementary materials and personalized feedback. Moreover, some students mentioned feeling overwhelmed by the pace of the course or the volume of material covered. This result emphasizes the importance of considering the workload imposed by course materials and assignments – they should be challenging yet manageable, taking into account the aforementioned factors that can impact a students' ability to complete the work. The personal issues theme revealed anxiety, depression, and stress. Students often described the interplay between their emotional well-being and their academic performance, indicating that addressing mental health concerns could positively impact their ability to achieve mastery learning. In addition, they also mentioned the importance of having a tool like Flextensions at their disposal in alleviating stress related to deadlines.

C. Case Study: Computer Security (CS161)

For one upper-division class, students submitted the assignment they had completed so far when submitting the extension as well as a second submission at their modified due date. This allowed for an additional grade analysis to be conducted, specifically showing the change in

grades that can be seen as a direct result of the extension. The graph in Figure 2 on the right shows the average grade improvements in homework assignments before and after the extension was applied, with the average student seeing a 150% improvement in their grade on the homework as a direct result of the extension. This shows that, should an extension system that promoted flexible extensions have not existed, students would have been willing to leave an average of 50% of the material "on the table", sacrificing the points here, and as a result, only gaining a mastery of a subset of the course material. A similar analysis conducted on the projects sees a larger improvement in average student grades, with final scores before transformation into letter grades jumping by an average of 183% as a direct result of the extension. Furthermore, a calculation of final grades when conducted with students' scores without extensions versus with extensions yields an average of 39.2% grade improvement.

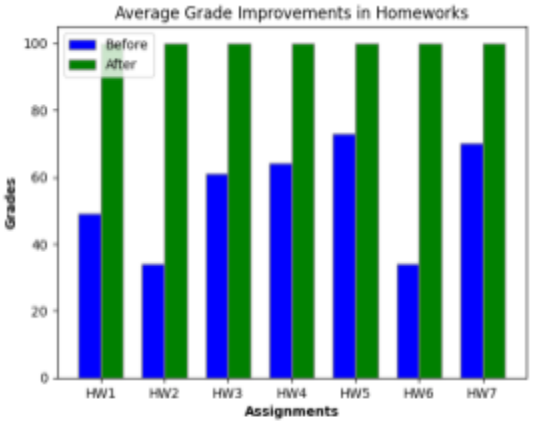


Figure 2: Double bar graph of average grade improvements in homework assignments (*n=648)*

Looking at historical data from CS 161, before the no-penalty extensions policy existed, we can see that students did not have any incentive to submit assignments after the deadline if they would get penalized, or would not get a grade bump for doing so. In other words, given a particular deadline, if a student did not receive full marks for their submission by the original deadline, and if there was no such extension policy, students did not have any incentive of completing the assignment after the deadline passed. The historical data supports the argument that once the deadline of an assignment has passed, all learning stopped, because students did not bother doing the assignment if it would be late and worth no points. This provides partial evidence that in order for students to not leave "topics on the table", if the true goal was to

ensure that students gained a complete mastery of the material, it is imperative to provide students with an additional incentive to actually complete the assignments that would help them on the way to mastery. One way to do this is through the introduction of flexible extensions, as it suggests a correlation between putting in additional time and effort (on behalf of the student) and gaining additional "learning", measured here through a grade change. However it is important to note that *if* there were hard deadlines, students would have a greater incentive to complete the assignment to begin with compared with if they know the existence of having flexible deadlines.

D. System Abuse

One potential limitation of flexible extensions is the potential for misuse by students. While the primary goal of flexible extensions is to accommodate students' diverse needs and circumstances, there may be instances, as seen in the data collected, where students take advantage of the system to procrastinate or avoid their responsibilities. This misuse could lead to a decline in students' time management skills, ultimately impacting and hindering their mastery learning progress. Striking a balance between providing flexibility and maintaining course “pace” is a fine line to walk, and it is up to the instructors to establish clear boundaries and expectations over the use of the extensions policy system. While it does have the capability to enhance students' grades for the best reasons as we ensure that everyone has the time and space needed to fully comprehend and master the material at hand, it equally has the capability of too much leeway – monitoring extension patterns and intervening when necessary is crucial to the maintenance of such a system.

The incorporation of an auto_approve_assignment_threshold in our flexible extensions system is a strategic measure to counteract potential system misuse by students who may be inclined to request multiple extensions simultaneously. This threshold essentially creates an automated

boundary that, when surpassed, necessitates human intervention, thereby adding an additional layer of scrutiny. By introducing this element of manual oversight for extension requests exceeding the auto_approve_assignment_threshold, the system not only maintains a balance between flexibility and academic rigor but also ensures that each request is evaluated contextually. This methodology allows for the discernment of genuine need from potential misuse, adding an element of fairness and accountability to the system. Moreover, this human element enables the system to adapt dynamically to complex situations that may require personalized consideration, further enhancing the system's overall effectiveness and equity.

VI. User Response and Feedback

When presented with an anonymous informal survey (*n=319)* both at the midpoint of the semester as well as the final week, students had raving reviews for the flexible extensions policy. Respondents claimed “it relieved a lot of stress" and "it helped me actually understand the HW, which paid off during the exam." Through an NLP analysis of the anonymized responses, 83% of students reported the extension policy helped to reduce stress levels, with an additional 53% stating that the policy helped them understand the assignments and the material better, which paid off during future summative assessments. Students also reported that they were able to use Flextensions to help better structure their learnings in other, hard-deadline classes as they claimed it helped them have better time-management and reduced their overall stress in trying to get the work for all their classes out at the same time. Students were very appreciative of the transparency in policies, the easy process by which extensions were requested and granted, as well as the overall process of communication between course staff and students through this process.

A critical group from whom we need feedback is instructors and course staff to understand the amount of time it took to incorporate Flextensions into their courses, the overhead (and staffing levels) it took (say, in hours/week per hundred students) to use it, and how it impacted the running of their course (see Section VIII).

VII. Limitations

One of the primary limitations with the system is the presumption of a majority of autograded assignments. The downside of having a flexible deadline is that graders need to be "on call" until the last student submission arrives – this means that instead of grading 500 student submissions over the course of a week, they will likely be grading it over a month instead. As the automated extension system allows for different submission times, it creates a staggered flow of assignments that need to be graded. This ongoing process can result in inefficiencies and a potential loss of momentum in providing timely feedback for students. While autograding can alleviate some of this burden, it may not be applicable to all types of assignments, such as written essays or complex projects. The increased manual grading workload may also lead to inconsistencies in grading, as instructors and teaching assistants may struggle to maintain the same level of scrutiny and attention to detail over an extended period (one solution of which is the development and use of detailed rubrics). Moreover, this burden could result in delayed feedback for students, which may hinder their mastery learning progress. Classes with a split number of autograded and manually graded assignments also have a decision on whether to state that the autograded assignments have flexible deadlines while the manually graded ones don't, or whether to offer a fully flexible system and deal with the burden of a longer timeline of grading.

In the context of an education system that adopts flexible extensions, a significant limitation presents itself in the form of 'work spillover' post-semester. This phenomenon refers to the

situation where students, exercising their right to request extensions, find themselves still grappling with coursework even after the academic term has officially concluded. Not only does this disrupt the traditionally bounded nature of a semester, but it also introduces a new set of challenges for both students and instructors. For students, this spillover can overlap with their need for downtime, reflection, or preparation for subsequent courses. For instructors, it prolongs the grading period and may impinge on their own research or teaching preparation time. Moreover, the administrative burden and logistical complexities associated with managing extensions beyond the term's end could potentially strain the institution's resources. This underscores the need for comprehensive planning and strategic resource allocation when implementing a flexible extension system in an academic context.

A study limitation is that we could not impose identical conditions for extensions among all the courses using it, therefore making it difficult to draw long-term conclusions from the data. We never posed any constraints on how the threshold numbers were set by each course, as this flexibility allowed for instructors to implement their own Flextensions policy. This variation in threshold days could lead to inconsistencies in the level of flexibility afforded to students between classes, potentially affecting their ability to manage their academic workload and achieve mastery learning. Moreover, it may also impact the comparability of the results across different courses, making it challenging to draw robust conclusions about the overall effectiveness of the flexible extensions policy. To address this limitation, institutions may need to develop clear guidelines and standardized criteria for the implementation and enforcement of flexible extensions, ensuring that all instructors and students are aware of the expectations and that the policy is applied consistently across different courses. So as not to step on instructor autonomy, a middle-ground approach might be best: there would be an institutional “best practice” default, but instructors would have the flexibility to change the default parameters if they wished. As such, we would have to have multiple course offerings of the same course with

different settings for the two threshold values to find the appropriate balance between flexibility and staggered student pace.

While flexible extension systems are designed to accommodate diverse learning needs, it's crucial to consider the potential drawbacks for certain populations, particularly those with conditions like ADHD. Individuals with ADHD often grapple with executive function challenges, including time management and self-regulation. The very flexibility that such systems offer may inadvertently lead to misuse, not out of malicious intent, but due to these inherent difficulties. An open-ended system could potentially encourage procrastination or suboptimal scheduling, inadvertently exacerbating the challenges these individuals face. The absence of structured deadlines might deprive these students of the necessary scaffolding to organize their time effectively and prioritize tasks. Consequently, while the intent behind flexible extension systems is to promote inclusivity and accommodate different learning styles, it's essential to consider how such systems can be designed or supplemented with additional supports to meet the unique needs of students with conditions like ADHD.

Finally, it is difficult to pinpoint how much flexible extensions impact mastery learning, which may be influenced by various factors, such as the individual characteristics of students, the nature of the course material, and the pedagogical approaches and policies adopted by instructors. To overcome this limitation, future research should consider employing more rigorous research designs, such as randomized controlled trials to isolate the effects of flexible extensions on mastery learning. Additionally, researchers should explore the potential moderating and mediating factors that may influence the relationship between flexible extensions and mastery learning, such as student motivation, self-regulation, and cognitive load.

VIII. Future Work

The findings from this study provide valuable initial insights into the potential benefits and limitations of flexible extensions and the automated extension system tool in promoting mastery learning in computer science and data science courses. To build upon this research and to further explore the impact of flexible extensions on student learning and well-being, it would be beneficial to explore a couple of different pathways, including a generalization of the study to focus on other STEM courses (not just EECS/DS) and a more longitudinal study that tracks students' academic performance *through* different courses and across semesters as they use Flextensions. To help support this, we are currently working to support the integration of updated deadlines to more LMS systems like Canvas.

Over the next couple of months, instructors will also be surveyed to ask about the amount of time taken to uphold such a system. For example, GSIs who were in charge of managing the extension system will be asked "how many hours per week did you spend, in any way, on the management of extensions?", which will allow us to show that instructors have to spend no more additional time managing such a system when compared to a non-flexible extension system. All the GSIs will then be surveyed to ask whether having such a flexible-extension system had an impact on the amount of time they spent grading or whether they believed it had an impact on office hour queues, etc. In doing so, we are attempting to understand if having flexible extensions increases the amount of time each GSI spends working, be it in grading, office hours, or answering other questions on EdStem or Piazza.

Finally, some additional avenues and questions worth answering in a future body of work include:

1. What factors contribute to students' decisions to request extensions and how do these factors differ across various learning contexts and demographics?
2. Identifying the "optimal" auto_approve_threshold and auto_approve_assignment_threshold
3. Are there further optimizations we could add that could make the interface more usable for students or instructors?
4. Could we train an AI chatbot to answer the first round of requests, bubbling situations that were severe to a human?

IX. Conclusion

This report introduces the *Flextensions* system which, through automation, creates a simplified pipeline for students to request extensions and for courses to quickly and easily manage them in a manner comparable to courses without extensions. The Flextensions system has been deployed across 15 UC Berkeley EECS and DS courses with students claiming that it reduced stress and led to a better overall understanding of course material – in a case study from an upper division course, we can see a clear improvement in students' grades, which, if equated to learning, implies a strong reason for the adoption of such a system. We hope others will continue to adopt our system, to support student learning and success.

References

Alario-Hoyos, C., Pérez-Sanagustín, M., Cormier, D., & Delgado Kloos, C. (2014). Proposal for a conceptual framework for educators to describe and design MOOCs. Journal of Universal Computer Science, 20(1), 6-23.

Amabile, T. M., Hadley, C. N., & Kramer, S. J. (2002). Creativity under the gun. Harvard Business Review, 80(8), 52-61.

Ausubel, D. P. (1968). Educational psychology: A cognitive view. New York: Holt, Rinehart, and Winston.

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.

Beiter, R., Nash, R., McCrady, M., Rhoades, D., Linscomb, M., Clarahan, M., & Sammut, S. (2015). The prevalence and correlates of depression, anxiety, and stress in a sample of college students. Journal of Affective Disorders, 173, 90-96.

Boucher, M. (2016). Why Professors Should Offer Flexible Deadlines. University Affairs. Retrieved from https://www.universityaffairs.ca/opinion/in-my-opinion/why-professors-should-offer-flexible-deadlines/

Brownson, C., Drummond, J., & Smith, S. A. (2016). What Students with Children Need: A Student Parent Success Initiative. Journal of College Student Retention: Research, Theory & Practice, 18(2), 194-208.

Chichekian, T., & Bragoli-Barzan, L. (2021). First-year indigenous students' experiences of learning mathematics at a post-secondary institution. Canadian Journal of Science, Mathematics and Technology Education, 21(1), 30-45.

Condra, M., Dineen, M., Gauthier, S., Gills, H., Jack-Davies, A., & Condra, E. (2015). Academic accommodations for post-secondary students with mental health disabilities in Ontario, Canada: A review of the literature and reflections on emerging issues. Journal of Postsecondary Education and Disability, 28(3), 277-291.

Culén, A. L., & Gasaymeh, A. M. (2018). The role of a learning management system in shaping student experiences of higher education courses: A case study. In Proceedings of the 13th International Technology, Education and Development Conference (INTED2018), Valencia, Spain.

Darling-Hammond, L. (2010). The flat world and education: How America's commitment to equity will determine our future. New York: Teachers College Press.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 11(4), 227-268.

Dweck, C. S. (2006). Mindset: The new psychology of success. New York: Random House.

Gaudry, A., & Lorenz, D. (2019). Indigenization as inclusion, reconciliation, and decolonization: navigating the different visions for indigenizing the Canadian Academy. AlterNative: An International Journal of Indigenous Peoples, 15(3), 218-227.

Gehringer, E. F. (2018). Automated grading of exercises that teach notation. Journal of Computing Sciences in Colleges, 33(4), 72-81.

Gorham, J., & Roberts, A. (2014). Teaching for Inclusion: Changing Pedagogical Practice for Diverse Student Populations. Journal of the Scholarship of Teaching and Learning, 14(5), 77-89.

Hall, R. (2010). The work–study relationship: experiences of full-time university students undertaking part-time employment. Journal of Education and Work, 23(5), 439-449.

Hershkovitz, A., & Lavie, I. (2020). Assessment analytics in technology-mediated learning environments. Educational Technology & Society, 23(3), 136–150.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educational Psychologist, 41(2), 75-86.

Lazarus, R. S., DeLongis, A., Folkman, S., & Gruen, R. (1985). Stress and adaptational outcomes: The problem of confounded measures. American Psychologist, 40(7), 770-779.

McCabe, D. L., Trevino, L. K., & Butterfield, K. D. (2001). Cheating in academic institutions: A decade of research. Ethics & Behavior, 11(3), 219-232.

National Disability Institute. (2019). Financial Inclusion of People with Disabilities. Retrieved from https://www.nationaldisabilityinstitute.org/wp-content/uploads/2019/02/financial-inclusion-of-people-with-disabilities.pdf

Ottman, K. (2017). Indigenous post-secondary students navigating university life in Canada: A literature review. Interchange, 48(2), 119-134.

Patton, K. D. (2000). Flexible learning and university change. Journal of Educational Administration, 38(1), 9-19.

Pitt, A., Oprescu, F., Tapia, G., & Gray, M. (2018). An exploration of the experiences of undergraduate nursing students in an online problem-based learning course. Nurse Education in Practice, 31, 104-110.

Regehr, C., Glancy, D., & Pitts, A. (2013). Interventions to reduce stress in university students: A review and meta-analysis. Journal of Affective Disorders, 148(1), 1-11.

Richardson, M., Abraham, C., & Bond, R. (2012). Psychological correlates of university students' academic performance: A systematic review and meta-analysis. Psychological Bulletin, 138(2), 353-387.

Rodriguez, Sarah. "5 Lessons Learned from Diverse Student Panels." Inside Higher Ed, 12 Apr. 2023, https://www.insidehighered.com/opinion/views/2023/04/12/5-lessons-learned-diverse-student-panels.

Rose, D. H., & Meyer, A. (2002). Teaching every student in the digital age: Universal Design for Learning. Alexandria, VA: Association for Supervision and Curriculum Development.

Schunk, D. H., & Zimmerman, B. J. (2007). Influencing children's self-efficacy and self-regulation of reading and writing through modeling. Reading & Writing Quarterly, 23(1), 7-25.

Sweller, J. (1988). Cognitive load during problem-solving: Effects on learning. Cognitive Science, 12(2), 257-285.

Tice, D. M., & Baumeister, R. F. (1997). Longitudinal study of procrastination, performance, stress, and health: The costs and benefits of dawdling. Psychological Science, 8(6), 454-458.

Whitman, N. A., Spendlove, D. C., & Clark, C. H. (1986). Increasing students' control over their learning: Research on mastery learning and implications for nursing education. Journal of Advanced Nursing, 11(1), 9-17.

Winstone, N. E., Nash, R. A., Parker, M., & Rowntree, J. (2017). Supporting learners' agentic engagement with feedback: A systematic review and a taxonomy of recipience processes. Educational Psychologist, 52(1), 17-37.

Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. Educational Psychologist, 47(4), 302-314.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. Theory into Practice, 41(2), 64-70.