Toward More Motivating Classrooms: A Study of the Relationship Between Autonomy-Supportive Course Design Features and Autonomous Learner Motivation

by

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ABSTRACT

This dissertation is an exploratory study of the impact on motivation of using autonomy-supportive course design features across a broad range of social science courses at the University of Michigan. The primary goal of this dissertation is to explore how variation in the employment of autonomy-supportive course design features affects the degree to which students internalize their motivation to do well in that course. Broadly, autonomy-supportive course design features are ways that instructors can design a course to give students more ownership over their learning, reduce the cost of failure, provide constructive feedback, and in general allow students' perspectives to guide the way they interact with the course. The results from this study will ideally inform the way that autonomy-supportive course design is used in gameful courses, but will also be useful for course design in general. By studying autonomy-supportive course design outside of gameful courses I attempt to isolate the effects of autonomy-supportive course design from other features of gameful courses as well as student reactions to the novelty of gameful grading systems. In addition, I consider individual differences as potential moderators of the relationship between autonomy-supportive course design and student autonomous motivation.

While there were no main effects of autonomy-supportive course design features on student autonomous motivation, there are significant interactions suggesting that different students react differently to certain autonomy-supportive course design features. Students may not perceive choice in the same way and these perceptions are influenced by student individual differences. Results indicate that higher achieving students were more adept at managing the

additional responsibility of choice and thus approached the use of autonomy-supportive course design from a more autonomous perspective than lower achieving students. Students who perceived a low cost of engaging with a course, relative to students who perceived a high cost, tended to also approach autonomy-supportive course design from a more autonomous perspective since they had more time to manage that increased responsibility. One implication of these results for courses that utilize autonomy-supportive course design, including gameful courses, is that instructors should consider providing additional scaffolding to help students adapt to the novel course design elements.

The goal of gameful pedagogy is to use the design elements of video games (not the games themselves) to re-design the grading system in a course in order to boost intrinsic motivation. Autonomy-supportive course design is one facet of gameful pedagogy alongside safe failure, and holistic backwards design (Holman, 2018). Self-Determination Theory researchers have found that well-designed video games are intrinsically motivating for players because they satisfy players' needs for autonomy, competence, and relatedness (Ryan, Rigby, and Przybylski, 2006; Przybylski, Rigby, & Ryan, 2010; Przybylski, Weinstein, Ryan, & Rigby, 2009). The intrinsically motivating nature of well-designed video games is the driver behind the study of the use of game design elements in other contexts, such as education. Limitations of the current study and potential future directions for research are discussed in the final chapter. This exploratory study of autonomy-supportive course design reveals much about the way that different students perceived autonomy-supportive course design features and raises important implications for the use of autonomy-supportive course design in gameful courses.

Chapter 1: Introduction

Background and Study Goals

The primary goal of this dissertation is to explore how variation in the employment of autonomy-supportive course design features affects the degree to which students internalize their motivation to do well in a course. Autonomy-supportive course design, a construct rooted in Self-Determination Theory, is one of many key components of gameful pedagogy. Gameful pedagogy is a relatively novel notion and stems partially from the 36 learning principles described by James Gee (2003) in his seminal work *What Video Games have to Teach us about Learning and Literacy*. Educational settings are traditionally laden with extrinsic incentives, which are rewards that are external from an activity or challenge. The aim of gameful pedagogy is to use the design elements of video games (not the games themselves) to re-design the grading system in a course in order to boost intrinsic motivation — the desire to engage in a difficult challenge for the enjoyment of that challenge. By studying the relationship between autonomy-supportive course design and autonomous learner motivation, this study can inform and improve the way that autonomy-supportive course design is utilized in gameful courses.

There is much evidence that a student who is motivated to learn for the sake of learning rather than for the sake of a grade is more likely to persist at difficult tasks, be more engaged with content, and even perform better on assessments of learning (Lonsdale et al., 2009; Pelletier et al., 2001; Black & Deci, 2000; Lavigne et al., 2007; Filak & Sheldon, 2008; Furrer & Skinner, 2003; Jang et al., 2009; Jang et al., 2012). Autonomy-supportive course design, which in theory promotes the internalization of motivation (Reeve, 2009), can be seen as a remedy to the controlled nature of the typical educational context.

Using Game Features to Inform Course Design

The root of gameful pedagogy is the notion of gamification, defined as, “the use of game design elements in non-game contexts” (Deterding et al., 2011, p. 2). Game design elements may include things like graphics, game mechanics (e.g. character movement, combat), other elements like player choice, safe failure, achievements, and more. Gameful design is powerful because it has the potential to fulfill students’ desires for autonomy and mastery, thus promoting learning for the sake of learning. Of course, gameful pedagogy is often situated within a larger controlling context (e.g. students still receive grades and an eventual letter grade for their transcripts) so in this sense students may never be truly intrinsically motivated. Despite the overarching extrinsic context, gameful pedagogy has the potential to promote a more autonomous orientation toward learning (Deci & Ryan, 2000) in part by employing autonomy-supportive course design.

Autonomy support is just one component of gameful course design and a course that employs autonomy-supportive course design practices is not necessarily a gameful course. Gameful courses often fundamentally change the way that students engage with course content, for instance, by utilizing an additive grading system where a student’s final grade is a sum of all of their points (rather than an average), or by rewarding and encouraging mastery of key competencies rather than performance on particular assignments. Gamification and gameful design can come in many different forms. Becker & Nicholson (2016) make the distinction between rewards-based and meaningful gamification to differentiate between “using rewards to modify behavior” (p. 62) and “using elements from games to help participants find a personal and meaningful connection within a specific context” (p. 62). This distinction is revisited and discussed in more detail in Chapter 2. The goal of this study is to examine how autonomy-supportive course design impacts student autonomous motivation across a variety of courses in order to inform the use of autonomy-supportive practices in gameful course design. The construct of autonomy support in motivation is derived from Self-Determination Theory, which is the reason why Self-Determination Theory was chosen as the primary theoretical framework for examining course design in this study.

Extrinsic and Intrinsic Motivation in Education

Self-Determination Theory (SDT; Deci & Ryan, 2000), an organismic macro-theory of motivation, defines three basic psychological needs: the need for autonomy, competence, and relatedness. When these three needs are satisfied, one is more likely to be intrinsically motivated, but when these basic needs are undermined, one is more likely to require extrinsic motivation to stay engaged. Deci and Ryan (2000) define intrinsic motivation as engaging in an activity due to interest and enjoyment of the activity and a willingness to do so in the absence of separable rewards. Multiple studies indicate that when students feel intrinsically motivated in school, they exhibit greater engagement in class and greater academic achievement (Black & Deci, 2000; Lavigne et al., 2007; Filak & Sheldon, 2008; Furrer & Skinner, 2003; Jang et al., 2009; Jang et al., 2012).

Broadly, extrinsic motivation is when one’s engagement in an activity is regulated by external incentives (Deci & Ryan, 2000). Common external incentives include money and fame, but one is also extrinsically motivated if the activity they are engaging in is a means to some other end. For instance, if a pre-med student completes work in their biology class in order to satisfy their pre-med requirements, that is an example of extrinsic motivation because they are not completing their biology work because of their love for the subject matter. Indeed, the distinction between extrinsic and intrinsic motivation is not a binary one. Extrinsic motivation can be conceptualized as a continuum ranging from highly controlled motivation to highly autonomous motivation (Deci & Ryan, 2000).

In this study I define *intrinsic motivation* in a similar way to Deci & Ryan (2000) in that intrinsic motivation is engaging in an activity out of interest and enjoyment rather than for an extrinsic reward. In education, this extrinsic reward can be something outside the self like a grade, or something internal, like a taking a course because you know you need the knowledge to succeed in your field of interest. In this study, most if not all students are *extrinsically motivated* (behavior is regulated by an extrinsic constraint or reward, Deci & Ryan, 2000). Since they are receiving grades and working toward degrees, their behavior is being regulated by an extrinsic constraint. Extrinsic motivation is not a unitary construct, but rather a continuum that ranges from autonomous to controlled motivation. Autonomous extrinsic motivation is when a person's behavior is regulated "on the basis of interests and self-endorsed values," (e.g. importance to the self, importance to future plans), whereas controlled extrinsic motivation is when a person's behavior is regulated by "controls" or "directives" like grades (Deci & Ryan, 2000, p. 241).In this way, an individual's *autonomy* is not just about their ability to make choices. In this study, autonomy reflects whether or not those choices are internally endorsed (e.g. I am making this choice because it is important to me) or are constrained and shaped by external constraints (e.g. I am making this choice because I am afraid of getting a bad grade if I do not).

Despite the overwhelming research on the benefits of intrinsic motivation, schools continue to favor approaches that emphasize extrinsic motivators like grades and standardized test scores. While the use of extrinsic incentives as reinforcement certainly can increase engagement, that engagement does not last. Deci (1971), in a landmark experiment with college students, showed that while extrinsic incentives increase engagement with a task while they are being given, once a person stops receiving an incentive for an activity their engagement will decline to below what it was at the outset. Lepper and colleagues (1973) replicated this finding in pre-school children. In other words, if one is intrinsically motivated to engage in an activity, such as learning, the receipt of incentives undermines that intrinsic motivation. Receiving incentives initially increases engagement but at the same time erodes one's intrinsic motivation. Longitudinal studies (Harter et al., 1981; Lepper, Sethi, Dialdin, & Drake, 1997; Lepper & Hederlong, 2000) have confirmed the effects of these lab studies (Deci 1971; Lepper et al., 1973) in naturalistic contexts. These studies found that students are more intrinsically motivated to learn in the early years of their education and that this motivation declines as they grow older. This decrease may be due to the increased emphasis on grades, test scores, and performance that accompanies the transition to middle and high school. Gillet et al., (2012) found that these changes in student intrinsic motivation were mediated by a students' feelings toward their instructors. Students who felt that their instructors were supportive of their need for autonomy had an attenuated decline in intrinsic motivation compared to students who did not feel that their instructor supported their autonomy. In other words, the decline in intrinsic motivation over time is not monotonic and it is partially linked to instructor behavior and classroom environments.

Reeve (2009) defines instructor autonomy support as "interpersonal sentiment and behavior teachers provide during instruction to identify, nurture, and develop students' inner motivational resources" (Reeve, 2009, p. 160). Students who feel autonomy support from their instructors show greater persistence (Lonsdale et al., 2009; Pelletier et al., 2001), experience greater basic need satisfaction, and show greater engagement (Black & Deci, 2000; Lavigne et al., 2007; Filak & Sheldon, 2008; Furrer & Skinner, 2003; Jang et al., 2009; Jang et al., 2012).

Autonomy support is not a defined set of instructor behaviors that promote students' basic need satisfaction. Instructor autonomy support can take many forms: from course design decisions to the way that an instructor frames their feedback to students. Autonomy-supportive education allows students to explore their own views and preferences and allows those views to guide how students engage with a course. Examples of autonomy-supportive behavior include providing choice accompanied by appropriate structure, encouraging active participation, and adapting to what students prefer in a course (Kusurkar, Croiset, & Cate, 2011).

Overview of Study Design and Research Questions

This dissertation is an exploratory study of how variation in the employment of autonomy-supportive course design features affect the degree to which students internalize their motivation to do well in that course. While there are many potential ways to support student autonomy, I am focusing on one particular group of course design features: assignment choice and flexible opportunities to receive additional feedback and recover from low grades. In gameful course design, these practices are employed alongside a host of other features as well as an overall shift in perspective on the part of the instructor. One reason that it is difficult to study autonomy support within gameful courses is that it is difficult to distinguish whether changes (or lack thereof) in student motivation are due to course design features or are due to the novelty of the pedagogy. This is why I have chosen to study autonomy-supportive course design in courses that are not necessarily gameful (although gameful courses were not excluded from the sample if they fit the inclusion criteria). The study explores a wide variety of courses in order to investigate the relationship between autonomy-supportive course design features and student autonomous motivation. This information will in turn inform the way that these features may be designed or implemented in gameful courses. It is important to remember that this study focuses on a small set of autonomy-supportive course design features and does not speak to other facets of autonomy support, nor does it speak to the overall effect(s) of gameful course design.

I begin the study with a list of 10 autonomy-supportive course design dimensions identified through a historical analysis of past gameful courses and from there identify a subset of those dimensions that are related to student autonomous motivation. I do not make claims about how the use of these features relates to the *amount* of student motivation, only how they relate to the *quality* of student motivation (autonomous versus controlled motivation).

To date there have been no studies that look at autonomy-supportive course design across a large set of courses in relation to student motivation. Understanding how different features impact student motivation and if there are certain individual differences that affect this relationship could influence course design decisions and how instructors think about scaffolding students' experience within gameful course design. For instance, if certain students experience optional assignments in an autonomous way whereas other students approach those choices from a controlled perspective, what might instructors do to help those students perceive assignment choices from a more autonomous perspective? On the other hand, if an instructor knows the benefits of assignment choice relative to other autonomy-supportive course design features they can make decisions about which features to include based on the way they benefit different students in the class. It may be that for a given a population of students, assignment choice may not be the best fit.

Although the notion of autonomy support is rooted in SDT, the study also employs measures from two additional theoretical frameworks: Expectancy Value Theory (Wigfield & Eccles, 2000), and Achievement Goal Theory (Ames, 1992) to further explore the relationship between autonomy-supportive course design and student autonomous motivation and the way that student individual differences affect that relationship. Autonomy-supportive course design changes the structure of a grading system by affording additional choices between and within assignments as well as opportunities to recover from a setback (e.g. dropping the lowest quiz grade, choosing how to weight assignments). While these affordances may increase student autonomous motivation by satisfying their need for autonomy, increased choice may also come at an additional cost or change the value of those assignments in terms of a student's future education or career. In addition, a student's expectancy to do well on an assignment may change due to the degree of control over it. Lastly, depending on the structure of assignments and opportunities for recovery, students' perception of the classroom goal structure (mastery versus performance) may be affected. Studies of autonomy-supportive course design do not often take this multipronged theoretical approach. Approaching this study using three theoretical frameworks of motivation will allow me to glean a more complete and nuanced picture of the way that autonomy-supportive course design affects student motivation and the way they perceive and approach work in their courses.

This exploratory study is guided by the following research questions:

- RQ1: How is the employment of autonomy-supportive course design dimensions related to student autonomous motivation?
- RQ2: How do student individual differences relate to student autonomous motivation?
- RQ3: How do student individual differences affect the relationship between autonomy-supportive course design dimensions and student autonomous motivation?

Dissertation Overview

This dissertation is divided into six chapters: Two literature review chapters, methods, analyses, discussion, and conclusion. Following this chapter, I provide a detailed overview of the key theoretical tenets of SDT, and review literature pertaining to how SDT has been used to study student motivation in the educational context (Chapter 2). Next, I review the idea of gameful pedagogy, its origins, and explain the components that define it. I review research on gameful design that focuses on autonomy-supportive features as autonomy-supportive course design is the focus of this study (Chapter 3). Following this chapter I explain my dissertation procedure, measures (see Appendix A for the full survey), sample selection, and the way I identified and coded courses on their employment of autonomy-supportive course design features (Chapter 4). After explaining study methods I review all significant findings organized by research question (Chapter 5). Next, I discuss the implications of my findings both in terms of autonomy support as well as the way that autonomy support can be employed in gameful courses (Chapter 6). The dissertation concludes with study limitations, future directions, and an overarching conclusion that incorporates findings associated with all research questions (Chapter 7).

Chapter 2: Overview of Self-Determination Theory

In this chapter I introduce Self-Determination Theory (SDT) to explain how different types of motivation affect engagement and well-being and to underscore the dangers of extrinsic motivation for learning and education. In describing the ways that SDT has been applied to education, I highlight the notion of instructor autonomy support which encompasses various actions an instructor can take to promote student need satisfaction. Instructor autonomy support factors into an important mediation model (Jang et al., 2009) that underlies many studies of SDT in educational contexts including this dissertation research. Finally, I explicate the way that autonomy support has been traditionally studied through instructor behavior and how the current study differs, as an investigation of autonomy support through course design. In the following chapter I introduce the notion of gameful design, its history at the University of Michigan, and how SDT has informed the study and conceptualization of gameful design.

Self-Determination Theory Overview

In the current study, I use vocabulary and concepts from SDT to frame my conceptualization of autonomy-supportive course design and to explain its relevance to gameful pedagogy. An understanding of the basic tenets of SDT is crucial in order to fully understand the implications of this study for gameful course design. SDT posits that humans have an innate tendency to seek out intrinsically motivating activities and environments (Deci & Ryan, 2000). Deci and Ryan (2000) define intrinsic motivation as engaging in an activity due to interest and enjoyment of the activity and a willingness to do so in the absence of separable rewards. When people find that they are not intrinsically motivated by an activity, they look for something else to engage in. However, one would not expect a person to be intrinsically motivated for activities that are not interesting and pleasant to begin with (Niemiec & Ryan, 2009). SDT posits that humans have three basic needs: the need for autonomy, the need for competence, and the need for relatedness (Deci & Ryan, 2000). The need for autonomy is the need to feel like your choices and actions originate internally and that those choices have a demonstrable impact on your surroundings. In this sense, autonomy is not just about the ability to make choices, but also whether those choices are internally endorsed or are constrained and shaped by external constraints (e.g. a concern over a grade, perceived ability level). The need for competence is the need to experience and master difficult challenges. This need also encompasses the need to understand the impact of one's actions through some sort of feedback mechanism and the need for clear goals, expectations, and parameters. The need for relatedness is the need to feel a sense of connection to those around you; the need to have positive social interactions with one's peers. The satisfaction of these three needs promotes intrinsic motivation, which is the motivation to engage in an activity because it is interesting and enjoyable (Deci & Ryan, 2000). On the other hand, the undermining of these needs (for example, through constraining choice, providing excessive negative feedback, or from bad peer interactions), promotes extrinsic motivation or in extreme cases amotivation (lack of motivation). Extrinsic motivation is when one is motivated to engage in an activity for the sake of some external reward. This reward does not have anything to do with the activity, but is something that is added in order to increase engagement.

SDT defines the process of internalization and externalization of motivation: "Internalization represents the active assimilation of behavioral regulations that are originally alien or external to the self" (Ryan, 1995, p. 405) and externalization is the opposite of this process. Internalization is a dynamic process. One's motivation for an activity or goal pursuit changes based on personal and environmental dynamics. There are four levels of internalization for extrinsic motivation (Deci & Ryan, 2000): *external regulation, introjected regulation, identified regulation,* and *integrated regulation* from the most controlled or external to the most autonomous or internal. *External regulation* and *introjected regulation* are considered controlled forms of extrinsic motivation whereas *identified* and *integrated* regulation are considered autonomous forms of extrinsic motivation. *External regulation* is when one's behavior is entirely regulated by the environment. *Introjected regulation* is when one internalizes external contingencies. With external regulation, external contingencies are reinforced by factors or people in the environment (e.g., if I don't complete this assignment my boss will yell at me) whereas with introjected regulation, the individual enforces the contingency themselves (e.g., if I don't complete this task I won't consider myself a good employee). *Identified regulation* is when an individual has internalized the value of a behavior. The individual knows that the behavior is valuable and important, but it is not a part of their identity or sense of self. An example of this would be a student that tries hard at math not because anybody is telling them to or because they enjoy it, but because they know that it will be instrumental to their future career. *Integrated regulation* is similar to identified regulation, but the motive or activity is integrated into one's sense of self and becomes part of an individual's identity. To go back to the math example, that individual could not only be completing math for the utility that it offers them, but also because they see themselves as a "math person." On the other hand, intrinsic motivation is when one is motivated to engage in an activity for the sheer joy of doing so. Intrinsic motivation represents the more autonomous form of motivation that one can possess. The reward is the activity itself. SDT research shows that being intrinsically motivated in an educational setting is beneficial in terms of performance, engagement, and persistence. Thus it is in an instructor's best interest to find ways to promote intrinsic motivation in their students. In some research studies (e.g. Black & Deci, 2000; Hardre et al., 2003; Cox & Williams, 2008; Sheldon, Ryan, & Reis, 1996), researchers measure these regulatory styles as different degrees of autonomous versus controlled motivation rather than breaking it down into four different styles. A person is autonomously motivated when their behavior is regulated "on the basis of interests and self-endorsed values," (identified or integrated regulation) and a person experiences controlled motivation when their behavior is regulated by "controls" or "directives" (external or introjected regulation, Deci & Ryan, 2000 p. 241). Basic need satisfaction promotes the internalization of motivation and undermining basic needs promotes externalization. Autonomous motivation and intrinsic motivation are associated with less boredom (Ntoumanis, 2001) and increased external and introjected regulation for scholastic activities are associated with greater anxiety in students (Ryan & Connell, 1989). One of the goals of gameful pedagogy (explored more fully in the next chapter) is to utilize autonomy-supportive course design features, alongside other types of features, to promote autonomous motivation in students in an effort to increase engagement with a course.

SDT has six mini-theories (Deci & Ryan, 2000): Basic Psychological Needs Theory, Causality Orientations Theory, Goal Contents Theory, Organismic Integration Theory, Cognitive Evaluation Theory, and most recently Relationships Motivation Theory (Deci & Ryan, 2014). Each of these mini-theories is relevant for different types of studies on motivation and there is substantial overlap between theories in the way that they are employed. The current work is situated most strongly in Cognitive Evaluation Theory and I therefore review that mini-theory in more depth.

Cognitive Evaluation Theory deals with what aspects of the environment support or undermine intrinsic motivation. Based on this theory, individuals are intrinsically motivated to engage in interesting activities by default. Various environmental factors, like external incentives, influence that motivation. One of the principles of cognitive evaluation theory is the undermining effect. The undermining effect is the way that extrinsic incentives, like money, reduce intrinsic motivation to a level that is below what it was before the incentives were introduced. In Deci's (1971) experiment, undergraduates came into a lab and completed intrinsically engaging puzzles during a baseline period (no incentive). Afterwards, participants were told that they would or would not receive a $1 incentive for each puzzle that they successfully completed during the experimental phase. After completing puzzles during the experimental phase the experimenter told participants that he needed to leave to get some final paperwork and they had to remain in the lab. Participants were free to do what they wanted—engage in other leisure activities or continue to complete puzzles for no incentive. This was called the free choice period and time spent working on puzzles without receiving an incentive was the measure of intrinsic motivation. He found that during the free choice period participants in the incentive condition worked on the puzzles for significantly less time than their counterparts in the control condition. Furthermore, participants in the experimental condition spent less time on puzzles during the free choice period than they did during the baseline period. This iconic procedure became known as the free choice paradigm. Deci (1972) extended this work to other types of incentives. Using the same procedure he found that in addition to task-contingent extrinsic rewards (e.g. $1 for each puzzle solved), threats of punishment and negative feedback undermined intrinsic motivation whereas task non-contingent rewards (e.g. Earn $5 regardless of how many puzzles you complete), unexpected rewards, and genuine positive feedback supported intrinsic motivation (Deci, 1972). This effect was also replicated in preschool children using an intrinsically motivating drawing task (Lepper, Greene, & Nisbett, 1973). Cognitive Evaluation Theory is useful in educational contexts since the goal of many teachers is to promote interest and enjoyment in learning. To do this one needs to be cognizant of the incentive structures in the classroom and how one's behavior satisfies or undermines students' basic needs.

Self-Determination Theory in Education

The US educational system is an inherently controlling context. So much of a student's future depends not on their interest in a topic or how much they enjoy it but how well they can perform on a series of high-stakes tests. Often this added pressure of performing well on tests does increase student engagement while they are in school or while they are in a particular class. However, in order for a student's engagement to persist, the student needs to develop an intrinsic interest in the subject or at least internalize the value of pursuing that subject. Once a high stakes test has passed it is as if the experimenter has removed the monetary incentive in Deci's 1971 experiment.

Autonomy support in the context of education has a special meaning defined by Reeve as, "interpersonal sentiment and behavior teachers provide during instruction to identify, nurture, and develop students' inner motivational resources" (Reeve, 2009, p. 160). Examples of instructor autonomy support include promoting student choice by giving them assignment options or by giving them meaningful choices within required assignments (e.g. choice of an essay topic), genuine praise for high quality work, constructive negative feedback that does not reflect on the student as a person, and other behaviors that help the student feel accepted in the classroom for who they are (See Table 1). On the other hand, Reeve defines a controlling teaching style as, “interpersonal sentiment and behavior teachers provide during instruction to pressure students to think, feel, or behave in a specific way” (Reeve, 2009, p. 160). A teacher has a controlling style if they force students to behave or to complete work in a certain way, if they give negative feedback without any rationale or if the negative feedback reflects on the student as a person, or if the classroom is teacher-focused rather than student-centered.

Table 1
Examples of Autonomy-Supportive Behavior

1. Identify and nurture what students need and want
2. Have students’ internal states guide their behavior
3. Encourage active participation
4. Encourage students to accept more responsibility for their learning
5. Provide structured guidance
6. Provide optimal challenges
7. Give positive and constructive feedback
8. Give emotional support
9. Acknowledge students’ expressions of negative affect
10. Communicate value in uninteresting activities
11. Give choices
12. Direct with “can, may, could” instead of “must, need, should”

Note. Table is derived from Kusurkar, Croiset, & Cate (2011).

Jang, Reeve, Ryan, & Kim (2009) developed a motivation mediation model (Figure 1), in which they investigate the impact of instructor autonomy support on need satisfaction and eventually academic engagement. Notably Jang, as well as other researchers in education, deal with *perceived* instructor support rather than looking at actual teacher behavior. The notion is that a teacher’s behavior is only as autonomy-supportive as students perceive it to be. This distinction makes it clear that the emphasis is on the student rather than the teacher and is in line with promoting an autonomy-supportive, student-centered classroom. An instructor can act in a way that they think is autonomy-supportive but if a student does not perceive those actions as autonomy-supportive—for instance if they do not perceive positive feedback as genuine (Deci,

1972) or if there is too much assignment choice in the classroom such that it becomes confusing and overwhelming—then the instructor is not supporting a student's basic psychological needs.

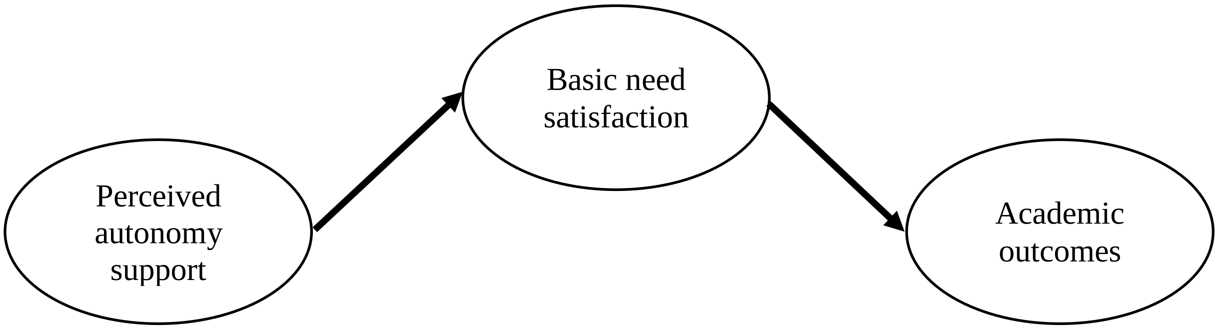

Figure 1. Motivation Mediation Model adapted from Jang et al., 2009.

Jang and colleagues (2012) verified this model in a longitudinal study. This study was a three-wave longitudinal study of Korean 8th grade students that lasted for an entire semester. Students completed surveys at each of the three time points that contained measures of need satisfaction, perceived instructor autonomy support, as well as self-reported measures of classroom engagement. In addition, the researchers obtained actual school grades from academic records to use as a measure of academic performance. Using structural equation modeling, they found support for their motivation mediation model. Early-semester (time 1) instructor autonomy support predicted time 2 (mid semester) autonomy need satisfaction. Mid-semester autonomy need satisfaction predicted end-of-semester engagement (time 3) which in turn predicted achievement (grades).

On the other hand when teachers adopt a controlling style, they end up reducing student persistence and increasing negative affect (Lonsdale et al., 2009; Pelletier et al., 2001; Cox & Williams, 2008; De Meyer et al., 2014; Ntoumanis, 2001; Ntoumanis, 2005), the opposite effects from autonomy-supportive behavior. It is truly in a teacher's best interests to support student autonomy. However, simply giving increased choices may not be enough. Clear expectations and guidelines are key. Increased choice, while empowering, can also be confusing in the absence of clear goals and expectations. Vansteenkiste et al. (2012) conducted a study in which they clustered students based on their ratings of their instructor's autonomy support and the clarity of their instructor's expectations. They found that students in the high autonomy support-high expectations cluster had the greatest autonomous motivation compared to students in the other three clusters. This demonstrates that an instructor cannot increase choice without any boundary, but instead the instructor should offer some amount of guidance as the amount of choice increases (Plummer, Holman, & Fishman, 2016). The idea of choice within constraints or choice bounded by clear expectations and guidelines is important when considering how autonomy-supportive course design is employed in gameful contexts, especially given that gameful courses introduce new rules and constraints that are likely foreign to students. In addition, because students' perception of autonomy is crucial to how designs are received, it is important to consider individual personality factors when assessing the impact of instructor autonomy support on student motivation.

The quality of student motivation (autonomous or controlled) is just as important if not more so than the quantity of their motivation. Since the quality of student motivation as an outcome variable is the focus of this study, I chose SDT as a theoretical lens due to the importance it places on the type of motivation and how it applies to educational contexts. Instructor autonomy support has traditionally been studied as student reactions to instructor behavior rather than reactions to course design features. In other words, most studies ask students to rate how autonomy-supportive their instructor was during class (Jang et al., 2009; Jang et al., 2012; How et al., 2013; Lonsdale et al., 2009; Pelletier et al., 2001; Cox & Williams, 2008; De Meyer et al., 2014; Ntoumanis, 2001; Ntoumanis, 2005) or study the effectiveness of interventions to train instructors to be more autonomy-supportive (Cheon & Reeve, 2015; see Su

& Reeve, 2011 for a comprehensive review). A comparatively understudied area is how instructors can support student need satisfaction through course design. An instructor who employs autonomy-supportive practices within a controlling course design (e.g. emphasizes high-stakes assessments, no student agency) may not be perceived as autonomy-supportive by students, thus it is important to employ autonomy-supportive course design practices alongside autonomy-supportive practices in instructor-student interactions. In this study I investigate the use of autonomy-supportive course design features (alongside student individual differences) in order to inform the use of these practices in gameful pedagogy, a course design philosophy rooted in video game design, which I describe in the following chapter.

Chapter 3: Overview of Gameful Design

One of the motivations behind this study is a desire to explore a key aspect of an instructional design theory called *gameful design*. The question that concerns educators is whether or not the underlying design elements of video games will serve the same motivational function when they are removed from the traditional game context. In this chapter I provide an overview the history of gameful course design at the University of Michigan as well as its theoretical origins. I also discuss the difference between rewards-based and meaningful gamification, the merits of this distinction, and how it relates to the scope of the current study. I review findings from studies of gameful course design as they pertain to autonomy-supportive course practices in particular and review exemplar studies to emphasize the importance of autonomy-supportive course design features in gameful design. The chapter concludes with an overview of potential moderators in the current study and why it is important to consider individual differences as moderators of the relationship between course design and autonomous motivation.

Gameful Course Design at the University of Michigan

Gameful course design gained traction at the University of Michigan and beyond as a student-centered pedagogy designed to give students more control over and responsibility for their learning. At the University of Michigan, 58 unique courses have employed gameful pedagogy impacting over 10,000 student learners as of Winter, 2018 (Academic Innovation). Gameful courses at the University of Michigan are supported by a platform called GradeCraft (Holman, Aguilar, & Fishman, 2013) which enables gameful features such as visualizations of student progress, analytics that display student scores in relation to other students, a grade prediction tool to allow students to plan out their future work, as well more gamified features such as badges and leaderboards. The goal of the current study is to inform the implementation of gameful pedagogy at the University of Michigan and possibly elsewhere. In focusing the scope of this study on autonomy-supportive course design features, I draw from the way that gameful course design has been conceptualized at the University of Michigan.

Caitlin Holman (2018), a co-founder of GradeCraft and a pioneer of gameful course design at the University of Michigan, identified three core principles of gameful learning: learner agency, integrating failure into the learning experience, and holistic backwards course design. In gameful courses students have increased responsibility and control over their own learning by being able to make choices about things like which assignments to work on, assignment difficulty, and how different assignments are weighted. Failure is a part of the learning experience in that grading in gameful courses is additive rather than an average of assignment grades. Students can make up for a poor assignment grade by completing additional work and their final point total is a sum of all of their assignment grades. In this way, failure combined with clear feedback allows students to develop competencies over the course of the semester and to incrementally improve, if they take responsibility for their learning and put in the requisite effort. The notion of holistic backwards design is that in designing gameful courses, instructors should consider how each assignments fits into and contributes to the overall course design and student learning goals rather than focusing on just the learning goals for that assignment. These core principles are enabled via clear, transparent expectations and feedback, authentic assessments that are open to some amount of customization, and the ability to recover from a setback such as a low grade or a missed assignment (Holman, 2018).

This study is not a study of gameful course design, but rather a study of one of its three core principles: learner agency. I study the principle of learner agency by examining the impact of autonomy-supportive course design practices on student autonomous motivation. I chose to focus on a single component of gameful design in order to limit the potential interference of other gameful course design features, and to limit effects that would be due to the novelty of the grading system rather than particular features of its design. Studying autonomy-supportive course design outside the context of gameful courses is an attempt to isolate the effects of autonomy-supportive course design from other gameful course design features and the mere novelty of the course design philosophy. While this particular framing of learner agency in gameful pedagogy was developed at the University of Michigan, the notion of gameful pedagogy originates from the way video games support player agency (Ryan et al., 2006) and how those design features can be applied in an educational context (Gee, 2003).

Origins of Gamification and Gameful Design

James Gee (2003) was fascinated by the way that players mastered different video games. He observed that players were able to learn intricate game systems and utilize a vast network of information to optimize their play with little to no explicit instruction from the game itself. He identified 36 learning principles to help explain how video games promoted player learning. The learning principles most relevant to the study of gamification and gameful design are: that video games employ active learning, have intrinsic rewards for achievement, and that players get to spend as much time practicing a task before they are assessed and that this practice is engaging and authentic. He also identified that many games give players multiple routes to success by allowing players to make meaningful choices that affect their character and the game world. These learning principles make video games sound like an ideal learning environment.

While Gee approached the potential benefits of video game design from a learning theory perspective, SDT researchers sought to understand player engaged from a motivational perspective. In particular, SDT researchers explored the links between different game design features and player need satisfaction, well-being, and desire for future play. The surface-level aspects of video games like the graphics, characters, narrative, or violent content are not as engaging as the underlying game mechanics that satisfy players' basic needs for autonomy, competence, and relatedness. Ryan, Rigby, and Przybylski (2006) investigated the assertion that in-game experiences were linked to basic need satisfaction which is in turn linked to positive outcomes such as well-being and intrinsic motivation. This paper contained four studies: three conducted in the lab with undergraduates and one that was conducted online in a forum for massive multiplayer online role playing game (MMORPG) players. In the lab studies, participants came in and played between one and four games (depending on the particular study) and answered an SDT survey after playing each game. Next, participants were told that they had some spare time and that they had a choice to play one of the games that they had played during the study or to browse social media. This is called the free choice paradigm (Deci, 1971). The idea behind this measure is that if a participant was intrinsically motivated for the activity (in this case, playing a certain video game), then they would choose to engage in that activity even after the extrinsic constraints of the experiment were removed. If they were not intrinsically motivated for the activity then they would choose to do something else when given the choice. The researchers (Ryan et al., 2006) found that in-game experiences of autonomy and competence need satisfaction predicted post-play enjoyment, positive affect, and preference for future play (free choice). The degree to which those needs were satisfied depended on how well the game was designed. Participants did not experience as much need satisfaction in games that did not afford a lot of choice or in games that had complicated controls. These lab results were replicated in the survey study of MMORPG players except that in addition to autonomy and competence, relatedness emerged as a significant predictor due to the collaborative nature of MMORPGs.

In this sense, a player's intrinsic motivation is more about how well their in-game experiences satisfied their basic psychological needs and which game design features promoted or undermined basic need satisfaction than it is about the particular game frame (Ryan, Rigby, and Przybylski, 2006; Przybylski, Rigby, & Ryan, 2010; Przybylski, Weinstein, Ryan, & Rigby, 2009). Games satisfy the need for autonomy by offering choice about how and when to attempt different challenges, allowing players to make decisions that affect the game world, and allowing players to customize the appearance and abilities of their characters. Video games satisfy the need for competence by providing timely feedback, having intuitive controls, and presenting challenges that are optimized to the player's ability level coupled with the freedom to re-attempt a challenge as many times as one wishes. Lastly, one example of how video games satisfy one's need for relatedness is by allowing players to collaborate online to complete challenges that are too difficult for a single player to complete on their own. Based on SDT, it is hypothesized that the more that a player feels that their psychological needs are supported while playing a game, the greater their desire to play that game in the future. It is these underlying game design elements (e.g. choice, feedback) that keep players coming back to a well-designed video game for hours on end more so than the more surface elements (e.g. graphics, sounds, violence). This suggests that other non-game contexts, such as a college course, could be designed using the same motivational features that are found in games in order to take advantage of these benefits without actually engaging learners in playing video games.

Education in many ways resembles a video game. Students face artificial challenges of varying difficulty and must overcome these challenges to improve their knowledge and skills and advance to the next stage of the education process (e.g. the next grade, college, graduate school). The way that video games promote intrinsic motivation by satisfying basic needs via underlying game design elements is similar to the way that instructors promote basic need satisfaction in the classroom by employing underlying autonomy-supportive practices like assignment choice, constructive feedback, and the option to resubmit assignments. This parallel between education and video games is what sparked the use of game design elements in education, which is often referred to as gamification.

Defining and Distinguishing Between Gamification and Gameful Design

Part of what makes video games engaging is the use of underlying motivational elements like choice, feedback, and collaboration, but at the same time those elements are situated within a rich graphical interface often with an engaging narrative and captivating characters. Gamification is defined as, “the use of game design elements in non-game contexts” (Deterding et al., 2011, p. 2). The way that an instructor uses gamification may in many ways parallel the way that one might use elements of Self-Determination Theory to promote student motivation. Just like how SDT makes the distinction between intrinsic and extrinsic motivation, so does the field of gamification make the distinction between fundamentally different ways to use game design elements to promote student motivation. Becker and Nicholson (2016) make the distinction between two types of gamification: rewards-based and meaningful. Rewards-based gamification is defined as “the concept of using rewards to modify behavior” (Becker & Nicholson, 2016, p. 62) and meaningful gamification is defined as “the concept of using elements from games to help participants find a personal and meaningful connection within a specific context” (Becker &

Nicholson, 2016, p. 62). Rewards-based gamification is the addition of extrinsic incentives and constraints, such as the use of leaderboards or achievement badges to reward assignment completion, or changing the names of assignments to sound more game-like. Rewards-based gamification does not actually change anything about the setting, but just involves adding in external rewards to existing activities. Rewards-based gamification is good for promoting behavioral engagement in the short term but is unlikely to promote sustained engagement with the material. On the other hand, meaningful gamification involves a more intrinsic transformation of course structure. Instead of adding rewards, meaningful gamification entails transforming the learning context and the curriculum to afford students increased choice, the ability to take risks and fail safely (within limits), and/or opportunities to receive additional constructive feedback. Meaningful gamification tends to be associated with increased motivation, interest, and sustained engagement. There are issues with the vocabulary that Becker and Nicholson (2016) use due to the fact that it implies that rewards-based gamification is less valuable than meaningful gamification when in fact, both types of gamification have implications for different outcomes and sometimes different contexts (e.g. rewards-based gamification is better suited for activities that are not intrinsically motivating to begin with, and might be difficult to redesign in a way that is intrinsically motivating; see Niemiec & Ryan, 2009). The study of autonomy-supportive course design features in the current study as well as Holman's (2018) framing of gameful design aligns with Becker's & Nicholson's (2016) notion of meaningful gamification. While there are issues with Becker's and Nicholson's (2016) terms, the distinction between features that emphasize extrinsic rewards and features that support autonomy and competence is important in distinguishing the focus of the current study. SDT is an ideal lens through which to study the impact of gameful course design on student motivation precisely because it makes a similar distinction between controlled and autonomous motivation. I have summarized the distinction between gamification and gameful design in Table 2.

Table 2

Clarifications of Vocabulary

Previous term: Rewards-based gamification Becker & Nicholson, 2016	Previous term: Meaningful gamification Becker & Nicholson, 2016
Promotes extrinsic motivation	Promotes intrinsic motivation
Example game design elements: game-themed language, leaderboards, badges to incentivize assignment completion	Example game design elements: assignment choice, safe failure, collaboration
Current vocabulary: Gamification	Current vocabulary: Gameful design/Gameful pedagogy

There are a myriad of game design elements (e.g. assignment choice, badges, leaderboards, additive points, avatars, virtual environments, increased feedback, safe failure, collaboration, assignment unlocks) which can be implemented in courses a variety of ways. The current study is unique in that it focuses on the autonomy-supportive design features exclusively and examines the employment of these features across courses that are not necessarily gameful thereby minimizing the interference of other gameful course design conventions. In the following section I review findings related to assignment choice which is the autonomy-supportive course design feature that has been most commonly utilized in gameful courses. In addition I review two studies to illustrate the importance of autonomy support and the dangers of too much extrinsic reinforcement.

Review of Studies on Assignment Choice in Gameful Courses

Similar to the way that autonomy is enacted in video games, autonomy in education can involve giving students meaningful choice over which assignments they can complete, and/or how to complete assignments. This increased choice allows students to play to their strengths (e.g. taking exams if they are a strong test taker) and allows students to take risks by trying assignment types that they would not normally complete (knowing that they can make up for a low grade). It also allows students to customize their workload to fit their schedule. If they have a particularly busy week they can skip assignments in their class that provides choice and make up for it by completing more assignments later on. However, instructors have to be sensitive to the amount of choice and that it is accompanied by the appropriate amount of structure so as not to be overwhelming to students. In addition, the studies reviewed below suggest that instructors should be aware of the potentially negative impact of extrinsic rewards has on student autonomous motivation in courses that employ assignment choice. This speaks to a larger concern of implementing autonomy-supportive course design features in largely extrinsic educational contexts such as a typical university or school setting.

Increased assignment choice is associated with increased behavioral engagement (Hew et al., 2016; Dikkers et al., 2015; Barata et al., 2013; Boskic & Hu, 2015; Nadolny & Halabi, 2016), greater motivation (Hew et al., 2016; Dikkers et al., 2015; Kingsley & Grabner-Hagen, 2015; Fabricatore & Lopez, 2014) as well as increased feelings of control and effort (Aguilar, Holman, & Fishman, 2014) and increased performance (Fabricatore & Lopez, 2014). These findings conform to the link that SDT posits between autonomy need satisfaction and intrinsic motivation and the way that intrinsic motivation relates to increased engagement and performance. However, more choice is not necessarily better. In order for increased choice to be effective, individuals have to feel like their choices have an actual impact and the amount of choice has to be manageable. In some cases, increased assignment choice has not had an impact on final grades (Barata et al., 2013; Nadoly & Halabi, 2016). In both of these studies students had the choice to stop completing assignments after earning the grade that they wanted. It could be that it was relatively easy to earn a high grade in those courses or that students felt compelled to complete every assignment until their grade reached their desired threshold at which point they decided to stop doing assignments. In this way it does not matter if students have a choice or not. Increased assignment choice has also been associated with lower performance (Szymanski, 2015), and in one case led to lower sustained engagement (Nevin et al., 2013). In the study by Szymanski (2015), students reported that they enjoyed the assignment choice but found that it was challenging to have to manage the assignment choices themselves rather than have the teacher tell them exactly what to do. This is a case where the choices between assignments was too overwhelming for students such that it interfered with their performance. In Nevin et al.'s (2013) study, assignment choice was used alongside badges and leaderboards which were employed in a more gamified way meaning that the extrinsic way that the badges and leaderboards were employed may have interfered with the benefits of assignment choice. This once again emphasizes the point that the effect of a gamification or gameful design element on student outcomes is in part determined by how it is implemented alongside other design elements.

The Difference Between Gamified and Gameful Courses

Some gamified courses eschew autonomy-supportive course design features entirely in favor of the more extrinsically motivating gamified course features such as badges, leaderboards, and game-themed language. Other gameful course designs draw almost exclusively on autonomy-supportive course design features. Below I summarize an example of each to illustrate the importance of autonomy-supportive course design features in gameful courses when the goal is to promote student autonomous motivation.

An example of a study that heavily relies on autonomy-supportive course design features is by Dikkers et al. (2015), set in a masters-level course on the applications of technology in education. The course featured 73 optional assignments and only one assignment had to be completed per week plus a required final portfolio type assignment. The course featured a voluntary leaderboard and an additive point system. This is an optimal system in that it both offers a large amount of choice but keeps students on track by requiring one submission (of any of the 73 assignments) per week. The voluntary nature of the leaderboard allowed students who did not like competition to not have their names on it. All 24 students in the class completed at least double the number of required assignments demonstrating high behavioral engagement. The authors reasoned that this increase in behavioral engagement was due to an increase in intrinsic motivation. This type of meaningful gamification is compelling and empowering for students, but the lack of rigor in measurement makes one wonder whether or not these benefits are consistent or if the benefits were due to some individual differences rather than course design. Nevertheless, studies like this are valuable because they illustrate how gameful design can be implemented and the important combination of autonomy support and clear expectations (Vansteenkiste et al., 2012).

Dominguez et al., 2013 developed a gamified module to accompany an online course environment. This module relied heavily on extrinsic incentives to motivate students to engage with the course. Undergraduate students in this study were assigned to one of two groups. One group used the gamified module when interacting with the online course environment and the second group used a traditional course website. In the gamified group students were awarded badges for completing optional assignments and ranked on a leaderboard based on the number of badges that they earned. Both of these features are examples of extrinsic incentives. Extrinsic incentives are a powerful way to increase a behavior, but may come at the cost of decreased motivation and engagement (Deci, 1971). Students in the gamified condition did score higher on the assignments for which badges were awarded, but ended up scoring lower on the final exam (not badged) than students using the traditional course website. Students in the gamified group did have higher overall final grades because the majority of the grade was based on the badged assignments throughout the course. Despite the higher grades on course assignments, students in the gamified condition also had lower class participation (number of interactions with the course website). Although students in the gamified condition scored higher on the incentivized assignments, they were less engaged overall.

These two studies represent opposite ends of the gamified – gameful course design spectrum. If one’s goal is to increase student performance on a particular assignment or in a particular course, then extrinsic incentives will suffice. However, this is not sustainable as students will continue to require rewards to maintain that performance in future courses and their careers or else risk burnout. The gamefully designed course that relies on autonomy-supportive course design is preferable as it supports students’ autonomous motivation and sets them up to maintain their internal motivation even in courses that may not feature the same level of autonomy support. Thus autonomy-supportive course design is the focus of the current study as the goal is to inform the design of gameful courses rather than gamified courses.

Studies of gameful and gamified course design, including the two before mentioned studies are typically done on a single iteration of a single class (e.g. Landers & Landers, 2015; Dominguez et al., 2013; Dikkers et al., 2015; Hew et al., 2016; Buckley & Doyle, 2016; Hanus & Fox, 2015; Nadolny & Halabi, 2016). This makes it difficult to understand if there are any trends related to the use of gameful and gamified design features or if the effects are due to something unique to the particular course. In addition, researchers rarely account for the way that students’ individual differences could affect the way that they reacted to the gameful pedagogy

(Barata et al., 2014; Codish & Ravid, 2014; Buckley & Doyle, 2017; Barata et al., in press; Fanfarelli & McDaniel, 2015). The current study addresses these shortcomings in the literature on gamification and gameful course design. By studying a broad range of different courses and controlling for between-course variance in student responses, the current study is better able to identify trends in how autonomy-supportive course design affects students and how individual differences in those students affect the way they respond to autonomy-supportive course design. Below, I review the student-level variables that were included as potential moderators in this study.

Potential Moderators of the Relationship Between Autonomy-Supportive Course Design and Student Autonomous Motivation

Few studies of gamification and gameful design (Barata et al., 2014; Codish & Ravid, 2014; Buckley & Doyle, 2017; Barata et al., in press; Fanfarelli & McDaniel, 2015) take into account student individual differences alongside gameful course design features to understand the impact of gameful design on student outcomes. Students approach and think about their schoolwork in different ways and these differences in thinking could moderate the effect of gameful course design on student motivation to engage with a given course. On the other hand, the way that students approach and think about schoolwork could affect their motivation to engage in a course independent of that course's design features. In either case it is important to consider individual differences in a study of the effects of autonomy-supportive course design on motivation. I operationalized autonomy-supportive course design in this study by coding course syllabi. In other words, I defined the class-level variables using course documents. Each of the variables described below were reported by students on an end-of-term survey representing differences in the way that students perceived that they engaged with and reacted to a course. In the following sections I describe the individual differences that I examine in this study and summarize research findings associated with those individual differences.

Self-efficacy

Self-efficacy is an "individual's perception of his or her current competence at a given activity" (Wigfield & Eccles, 2000, p. 70). Greater self-efficacy in students predicts meaningful cognitive engagement (Walker et al., 2006; Neuville et al., 2007), greater intrinsic motivation (Walker et al., 2006), intention to persist in college (Baier et al., 2016), and academic achievement (Young et al., 2015; Gaylon et al., 2012; Agustiani et al., 2016). Self-efficacy can affect the way that students approach tasks and respond to feedback in a course. Students with high self-efficacy would be more likely to derive competence need satisfaction from completing tasks as they are more confident in their ability to do well on those tasks independent of course design thus affecting the degree to which they internalize their motivation for a course. In addition, students with higher self-efficacy could be better positioned to take advantage of an autonomy-supportive course design. A course that employs autonomy-supportive course design gives students varying degrees of autonomy often requiring them to make choices between assignments, try a variety of different assignment types, or work toward a long term goal by completing various scaffolds. Students with high self-efficacy may feel more confident about making choices between assignments, may be more likely to try a variety of assignment types, and may be more receptive to feedback given on long term projects. Thus it may be that students with high self-efficacy are better positioned to take advantage of a autonomy-supportive course design and in turn reap a greater boost to their autonomous motivation.

Metacognition

Metacognitive learning strategies are examples of self-regulated learning strategies which are defined as "actions and processes directed at acquisition of information or skills that involve agency, purpose, and instrumentality perceptions by learners" (Zimmerman, 1990, p. 5). In this study I focus on three metacognitive learning strategies: planning, monitoring, and regulating. Planning "refers to activities performed before actually learning the material" (Berger & Karabenick, 2016, p. 22), Monitoring is "activities performed either during or immediately after engaging in the learning process, and is generally considered an online process, because it refers to the ongoing activity" (Berger & Karabenick, 2016, p. 22), and regulation is defined as "activities contingent on monitoring process' results. Students' use of metacognitive strategies predicted academic achievement (Tuckman, 2003; Coutinho, 2007; McCabe, 2011), more use of creative problem solving strategies (Hargrove & Nietfeld, 2015), and improved student engagement (Karaali, 2015). The use of metacognitive strategies indicates that one is paying a greater attention not only to learning the material but also to understanding the learning process. Students who more frequently engage with courses at this higher level of planning, monitoring, and regulating are likely to come to care more about the subject matter thus increasing their autonomous motivation toward a course. In addition, parts of an autonomy-supportive course design may be novel for students or at least prompt students to engage in novel activities that may be outside their comfort zone. Students who have greater metacognitive awareness may be quicker to adapt to this kind of course design. This means that they would have to spend less energy trying to understand the novelties of the course design and could spend more time understanding the value of the course content thus boosting the degree of internalization.

Student responsibility

Student personal responsibility is defined as “A sense of internal obligation and commitment to produce or prevent designated outcomes, or that these outcomes should have been produced or prevented” (Lauerman & Karabenick, 2011, p. 127). Responsibility can be approach (student responsibility) or avoidance oriented (instructor responsibility). Student feelings of responsibility for their own learning can partially mediate the link between academic control and the amount of knowledge building a student engages in (Fishman, 2014) as well as the link between homework quality and academic achievement (Kitsantis & Zimmerman, 2009). Student feelings of responsibility have also been shown to directly predict academic achievement (Martel et al., 1987; Sierra, 2010), and positive affect toward a course (Sierra, 2010). How much responsibility a student takes for learning aligns with the degree to which they internalize their learning. If their motivation is very controlled or extrinsic it is as if their learning is regulated by outside factors (e.g. instructor expectations, grades) whereas if their motivation is more autonomous, the source of that regulation comes from within. It can be thought of as an internal responsibility for one’s own learning. Student responsibility could have a direct link to the degree to which they internalize their motivation for a course in that students who take more responsibility for their own learning are motivated to engage in the course for internal reasons (as opposed to extrinsic factors). Student responsibility could also affect the way that students engage with a more autonomous course design that necessitates that students make more decisions about their learning and the work they complete in the course. Students who believe that the instructor is primarily responsible for their own learning may not appreciate the increased autonomy thus reducing its motivational benefit.

Expectancy, value, and cost

The next set of constructs—expectancy, utility value, and cost—are derived from Expectancy-Value Theory (Wigfield & Eccles, 2000). Expectancies are defined as one's "beliefs about how well they will do on upcoming tasks, either in the immediate or longer term future" (Wigfield & Eccles, 2000, p. 70). Attainment value is "importance of doing well on a task", intrinsic value is "the enjoyment one gains from doing a task", and utility value is "how a task fits into an individual's future plans" (Wigfield & Eccles, 2000, p. 72). Cost is defined, overall, as "negative appraisals of what is invested, required, or given up to engage in a task" (Flake et al., 2015, p. 237). The element of cost that I am chiefly concerned with is task-effort cost defined more specifically as "negative appraisals of time, effort, or amount of work put forth for a task other than the task of interest" (Flake et al., 2015, p. 237). Greater task value predicted academic achievement and self-efficacy (Bong, 2001), task effort (Cole et al., 2008), as well as career aspirations (Singer et al., 1993). A study by Hulleman et al. (2017) demonstrated that greater student expectancies for success predict greater interest and that this relationship is mediated by the amount of connections students made between the course material and their life. Utility value most closely aligns with the Self-Determination Theory concept of internalization. The more useful a student perceives a task to be the easier they will internalize it. In addition if a student perceives a high cost to engage in schoolwork (e.g. high effort, lots of time, inability to engage in other tasks of interest) then they are likely to be focused on more external factors rather than internalizing the task itself. Students with a high level of expectancy to do well on future tasks could be more likely to derive autonomy and competence need satisfaction from assignments thus increasing the potential for internalization regardless of the type of course design. On the other hand, it may be that students who perceive class content as useful and expect that they will succeed at little cost are more willing to engage in a novel autonomy-supportive course design.

Student Perceptions of Classroom goal structure

An achievement goal "defines an integrated pattern of beliefs, attributions, and affect that produces the intentions of behavior and that is represented by different ways of approaching, engaging in, and responding to achievement activities." (Ames, 1992, p. 261). Achievement goals can be looked at as characteristics of an individual's own goals or as an individual's perception of the overall classroom climate in a course. In my dissertation I look at students' perception of the classroom goal structure. Mastery goals are when "individuals are oriented toward developing new skills, trying to understand their work, improving their level of competence, or achieving a sense of mastery based on self-referenced standards" (Ames 1992, p. 262). Performance goals are when "a perceived ability-outcome linkage guides his or her behavior so that a person's self-worth is determined by a perception of her or her ability to perform" (Ames, 1992, p. 262). Performance goals can be either approach or avoidance oriented. For performance approach goals and individual seeks to do better in comparison with their peers whereas with a performance avoidance goal an individual seeks to avoid doing worse than their peers. Archer and Scevak (1998) found that students who perceived their classroom climate as mastery-oriented made more use of learning and study strategies as well as demonstrated more enthusiasm in general. In addition, the adoption of mastery goals was associated with greater intrinsic motivation (Bieg et al., 2017; Harackiewicz et al., 1997; Harackiewicz et al., 2002), and better academic performance (Cerasoli & Ford, 2014; Dull et al., 2015). Although mastery goals are desirable for the promotion of intrinsic motivation, performance goals are not all necessarily negative. Studies find that only performance avoidance goals undermined a student's intrinsic motivation whereas performance approach goals had no impact (Rawsthorne & Elliot, 1999; Elliot & Harackiewicz, 1996). In addition, performance approach goals can predict higher academic achievement (Harackiewicz et al., 2002; Harackiewicz et al., 1997). It may be the case that autonomy-supportive course design's effect on student motivation is augmented based on the relative strength of the different types of achievement goals as perceived by students.

The Current Study

SDT and literature on instructor autonomy support defines what kinds of course design features could be classified as autonomy-supportive. A review of literature on gamification and gameful pedagogy describes ways that gameful courses have utilized autonomy-supportive course design features as part of a larger gameful course design (e.g. Dikkers et al., 2015; Barata et al., 2013). While I expect that autonomy-supportive course design will support student autonomous motivation, studies caution that too much choice without accompanying guidelines and expectations could be detrimental for student autonomous motivation (Vansteenkiste et al., 2012; Plummer et al., 2016). Thus in studying the employment of autonomy-supportive course design in this study I focus on not only the presence or absence of a feature but also on the degree to which it is implemented (e.g. percent of optional assignments rather than whether or not a course has optional assignments). Other theories of motivation, such as Expectancy-Value Theory and Achievement Goal Theory advance other constructs to explain the quality of student motivation and engagement in school. These constructs, such as cost, may relate to student autonomous motivation toward a course independent of course design. My review of literature from each of these theoretical frameworks suggests that not only could individual differences affect student autonomous motivation toward a course, but that they could also moderate the relationship between autonomy-supportive course design and student motivation. This is why I have chosen to examine the potential for moderation between autonomy-supportive course design and individual differences when predicting autonomous motivation.

The primary goal of this dissertation is to explore how variation in the employment of autonomy-supportive course design features affects the degree to which students internalize their motivation to do well in a course. Support for student autonomy is a major aspect of gameful course design, but not the only one (Holman, 2018). While this study is not a study of gameful course design, the results will inform the way that gameful courses employ autonomy-supportive course design features. By studying autonomy-supportive course design outside of gameful courses I attempt to isolate the effects of autonomy-supportive course design from both other features of gameful courses as well as student reactions to the novelty of gameful grading systems, which distinguishes this study from other studies on gameful course design. The study of autonomy support via course design represents a novel application of the SDT notion of instructor autonomy support. In the next chapter I describe study methods and procedures, including how I arrived at the autonomy-supportive course design dimensions that I studied, my coding process, and data collection procedure.

Chapter 4: Methods

This dissertation is an exploratory study on the use of autonomy-supportive course design features in social science courses at a large public research university, the University of Michigan. A primary goal of this study is to understand how different course design features impact student autonomous motivation and how individual differences affect those relationships. This is accomplished through an exploration of the relationship between autonomy-supportive course design dimensions and student autonomous motivation. Data in this study were collected at a single time point at the end of the semester, thus the study is an exploration of associations between autonomy-supportive course design and student attitudes (e.g. motivation, see measures) rather than a study that seeks to make causal inferences about how autonomy-supportive course design affects student attitudes. Part of what makes this study unique is the way that autonomy-supportive course design was studied as it naturally occurred across 27 different undergraduate classes. Nothing was done to change or alter the way an instructor taught, and thus the context is naturalistic. The autonomy-supportive course design dimensions chosen as the focus for this study come both from the literature as well as from historical work on gameful pedagogy conducted by our lab at Michigan (see below for additional detail). In the following sections I review in depth: the identification of the autonomy-supportive course design dimensions, the recruitment and coding of classes, the survey measures, the data collection procedure, the student participants, and survey completion statistics.

Identifying Initial Autonomy-Supportive Course Design Dimensions

For this study I identified ten autonomy-supportive course design dimensions that serve as the initial basis for analyses in this study. These dimensions were later reduced to eight based on initial analyses that indicated that there was not enough variation along the flexible deadline dimension and that there was complete overlap between courses that employed an additive grading system and courses that used a gameful learning management system.

At the University of Michigan, there have been 58 unique gameful courses that have impacted over 10,000 student learners (Academic Innovation). Gameful courses at Michigan are comprised of three core components: student agency, the integration of failure into the learning experience, and holistic backwards course design (Holman, 2018). This study is focused on only the student agency component of gameful design. Although gameful courses are not directly examined in this study, the goal is to inform the use of autonomy-supportive course design to boost student agency in gameful pedagogy. For this reason, I focused on identifying autonomy-supportive course design dimensions that have historically been utilized in gameful courses at the University of Michigan. To identify these dimensions I reviewed syllabi, course websites, and other materials from gameful courses offered at the University of Michigan from Fall 2013 to Fall 2017 for the most commonly used autonomy-supportive course design practices. Through a review of these historical courses I identified ten autonomy-supportive gameful course design features which are summarized in Table 3.

Table 3

Initial Autonomy-Supportive Course Design Dimensions

Identifier Number	Dimension	Examples/Explanation	Possible values in this study
1	Number of assignment types	E.g., Exams, short writing assignments, research papers, group projects	Continuous numeric
2	Proportion of total points available needed to get a grade of A	In a traditional class, the proportion is 93-94%	Between 0 and 1.00
3	Percent of assignments with flexible deadlines	The greater the percent, the more flexibility students have to complete work in this class	Between 0 and 1
4	Use of a gameful LMS	Does the course employ a gameful learning management system, such as GradeCraft, designed to support the implementation of autonomy-supportive course design features.	0 or 1 dummy-code
5	Number of recovery mechanisms	The number of ways that students can recover from a low grade (e.g., dropping the lowest grade in an assignment category)	Continuous numeric
6	Additive grading system	Does the course employ an additive grading system where a student's final grade is the sum of their assignment grades rather than the average?	0 or 1 dummy code
7	Number of types of assignment scaffolds	E.g., peer review, submitting paper topic ideas	Continuous numeric
8	Percent of total assignments that are low-stakes	A low-stakes assignment is an assignment worth less than 10% of a the total points a student can earn	Between 0 and 1
9	Percent of total assignments that are optional	The more optional assignments, the more autonomy a student has in picking which assignments to complete	Between 0 and 1
10	Percent of assignments with within-assignment choices	What proportion of assignments allow students to make choices about what topics or aspects of the assignment to engage in. This DOES not include choices regarding content (e.g. the assignment tells you to write about the French Revolution or about week 4 readings) but it would include an assignment that gave you the choice about writing about the French Revolution or the Renaissance	Between 0 and 1

Recruitment and Coding Procedure

This study utilized a convenience sample of students in social science courses at the University of Michigan. I did not choose social science courses for any particular theoretical reason, but I wanted to sample courses within the same domain (social science, humanities, or natural science) to loosely control for course design or epistemological features that might vary based on academic domain. I searched for all courses in the Winter 2018 semester that satisfied the university's social science distribution requirement. I limited my searches to 200-300 level courses in order to avoid sampling introductory courses as those courses would likely contain primarily freshmen. The transition to college could create potential confounds in looking at a course's effect on student motivation or their motivation in college could be influenced by their time in high school more so than for students who had been in college longer. I also wanted to exclude advanced courses where students are more likely to be autonomously motivated because the advanced course is catered to their niche interest. I excluded "special topics" courses for this same reason.

This initial search returned a total of 173 courses. After filtering out courses that were cross-listed as another course on the list of search results I was left with 93 unique 200-300 level social science courses. I reached out to the instructors of all 93 social science courses explaining my study and asking if they would allow me to survey their students at the end of the term and requesting that they send me a copy of their course syllabus if they agree to give their students the option of participating in the study. Ten days later I sent a reminder email to those instructors that did not respond to my initial request. 49 instructors responded to either the initial or the reminder email. Of those 49 instructors, 27 said yes resulting in a total potential N = 2,518 students. All courses have been assigned code numbers as pseudonyms to protect instructor and student identities.

I reviewed the syllabi for these 27 courses and assigned values on the ten autonomy-supportive course design dimensions. The only information I had access to was the course syllabi and course assignment descriptions if the instructor sent those along with the syllabus or if assignment descriptions were included in the syllabus itself. The coded values for these courses are shown in Table 4. In determining how the autonomy-supportive course dimensions would be coded I chose a range of values that would not unfairly favor courses with a large number of assignments. For instance, if I used the number of low-stakes assignments rather than the proportion of low-stakes assignments, a course with 40 quizzes would look overwhelmingly more autonomy-supportive than a course with 16 quizzes just through sheer quantity.

Next I describe coding difficulties as well as certain assumptions that I made if a course provided little information. If a course syllabus did not state the percentage of points needed a grade of A then I assumed that the course required 93% of points to get an A, which is the standard for the College of Literature, Science, and the Arts. Typically, each grade level is three points. Counting back from 100, 97-100 is an A+ (if a course awards A+'s), which would mean 93-96 is an A. There was very little variation in this dimension in part because most courses did not include information about their grading scale. If a syllabus did not explicitly mention that an assignment deadline was flexible, I assumed the deadline was fixed. Once again, this resulted in very little variation in the flexible deadline dimension either because courses did not explicitly identify deadlines that were flexible or more likely because instructors prefer fixed deadlines. Three courses presented coding difficulties. For one course, LI2, I was unable to calculate the percentage of low-stakes assignments because the exact number of quizzes in the class was unknown. For course PS4, the syllabus stated that quizzes would be administered "every two weeks" but did not give the exact number of quizzes that would be administered. I used this information along with the class schedule to infer the number of quizzes that would be given. Lastly, course AS3 contains a reading journal assignment and it is unclear from the syllabus whether the reading journal represented a single grade or whether students would receive multiple grades. For my analyses I counted it as a single assignment.

Table 4
Autonomy-Supportive Course Design Coding

Course name	*N*	1	2	3	4	5	6	7	8	9	10
AM1	17	4.00	0.93	0.00	0.00	0.00	0.00	3.00	0.22	0.22	0.22
AN1	48	3.00	0.94	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.50
AN2	68	6.00	0.95	0.00	0.00	0.00	0.00	1.00	0.25	0.00	0.25
AS1	70	4.00	0.93	0.21	0.00	1.00	0.00	0.00	0.83	0.21	0.00
AS2	43	3.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.50
AS3	28	4.00	0.93	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00
EC1	228	3.00	0.90	0.00	0.00	2.00	0.00	0.00	0.73	0.00	0.00
EC2	128	1.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ED3	77	7.00	0.58	0.00	1.00	1.00	1.00	2.00	0.87	0.93	0.50
EN1	207	5.00	0.93	0.00	0.00	1.00	0.00	2.00	0.89	0.53	0.21
EN2	21	5.00	0.93	0.00	0.00	0.00	0.00	0.00	0.71	0.57	0.00
EN3	69	7.00	0.93	0.00	0.00	0.00	0.00	1.00	0.60	0.00	0.07
HI1	53	4.00	0.93	0.00	0.00	1.00	0.00	0.00	0.83	0.00	0.07
HI2	46	4.00	0.93	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.20
HI3	37	4.00	0.93	0.00	0.00	0.00	0.00	1.00	0.69	0.00	0.56
LI1	55	3.00	0.94	0.00	0.00	1.00	0.00	0.00	0.83	0.00	0.00
LI2	39	4.00	0.94	0.00	0.00	1.00	0.00	0.00	NA	0.00	0.00
PO1	76	3.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.25
PS1	277	3.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.22
PS2	295	3.00	0.93	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
PS3	299	3.00	0.93	0.00	0.00	2.00	0.00	0.00	0.17	0.17	0.00
PS4	45	4.00	0.94	0.00	0.00	1.00	0.00	0.00	0.75	0.00	0.00
SO1	28	4.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
SO2	164	8.00	0.48	0.00	1.00	0.00	1.00	1.00	1.00	0.48	0.26
SO3	33	3.00	0.93	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00
SO4	46	4.00	0.93	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
SO5	21	6.00	0.94	0.00	0.00	1.00	0.00	1.00	0.50	0.50	0.30

Note. 1 = number of assignment types; 2 = proportion of total points available needed to get a grade of A; 3 = percent of assignments with flexible deadlines; 4 = use of a gameful LMS; 5 = number of recovery mechanisms; 6 = additive grading system; 7 = number of types of assignment scaffolds; 8 = percent of total assignments that are low-stakes; 9 = percent of total assignments that are optional; 10 = percent of assignments with within-assignment choice. Course name is a pseudonym to preserve instructor anonymity.

After coding all 27 classes I did preliminary descriptive analyses to check if there was sufficient variation along each of the ten autonomy-supportive course design dimensions. In addition, I looked at Pearson’s correlations between the autonomy-supportive course design dimensions to ascertain if there was significant overlap between different dimensions. See Table 5 for a summary of the descriptive analysis.

Table 5
Autonomy-Supportive Course Design Dimension Descriptive Statistics

Dimension	Number of classes with any	*Potential N*	Frequency or average	Min	Max
Number of assignment types	27	2518	4.18	1.00	8.00
Proportion of total points available needed for a grade of A	10	773	0.90	0.48	0.95
Percent of assignments with flexible deadlines	1	70	0.21	0.21	0.21
Use of a gameful LMS	2	241	---	---	---
Number of recovery mechanisms	11	1140	1.18	1.00	2.00
Additive grading system	2	241	---	---	---
Number of types of assignment scaffolds	10	736	1.50	1.00	3.00
Percent of total assignments that are low-stakes	19	1844	0.63	0.17	1.00
Percent of total assignments that are optional	11	1272	0.44	0.17	0.93
Percent of assignments with within-assignment choices	15	1231	0.30	0.07	0.56

Notes The average for continuous dimensions are calculated for only classes with greater than 0 on that dimension. For percent needed for a grade of A, the "number of classes with any" represents classes that do not require 93% of points for an A (the typical amount).

Only a single course in the sample employed flexible deadlines which made it impossible to analyze the impact of flexible deadlines on student motivation as there is no point of comparison. For this reason, the flexible deadline dimension was excluded from future analyses. The two courses that employed additive grading systems also happen to be the same two courses that employ a gameful LMS. Since there is 100% overlap between these two dimensions, only one can be included in statistical analyses. The use of a gameful LMS dimension was excluded from analyses. The number of assignment types is correlated with the amount of “free points” (1 minus the percentage of points needed for an A. For analyses, this dimension was recoded so that higher values represented fewer points needed to earn an A), $r = .70$, $p < .05$. This is a high correlation, but does not warrant exclusion before data analysis. The amount of “free points” was correlated with the use of an additive grading system, $r = .99$, $p < .05$. Only two of the eight courses that require something other than 93% of the points for an A use an additive grading system. The courses that use an additive grading system require that students earn a much smaller proportion of the points to get a grade of A which is what is driving this correlation. Although the correlation is very high, the dimensions did not completely overlap so both were included in initial analyses. After this initial analysis, the remaining dimensions were: number of assignment types (1), proportion of total points available needed to get a grade of A (2, reversed for analyses), number of recovery mechanisms (5), additive grading system (6), number of types of assignment scaffolds (7), percent of total assignments that are low-stakes (8), percent of total assignments that are optional (9), and percent of assignments with within-assignment choice (10). Despite the overlap between some dimensions and the lack of variation in others, there is suitable variation across courses in the employment of autonomy-supportive course design both in total and within dimension (see Table 5 for within-dimension variation). Figure 2 depicts the overall variation in autonomy-supportive course design across the 27 courses, indicating a range of autonomy support features from relatively few to many. To create this figure I took the sum of the codes on the eight dimensions (described above) that will be used in analyses.

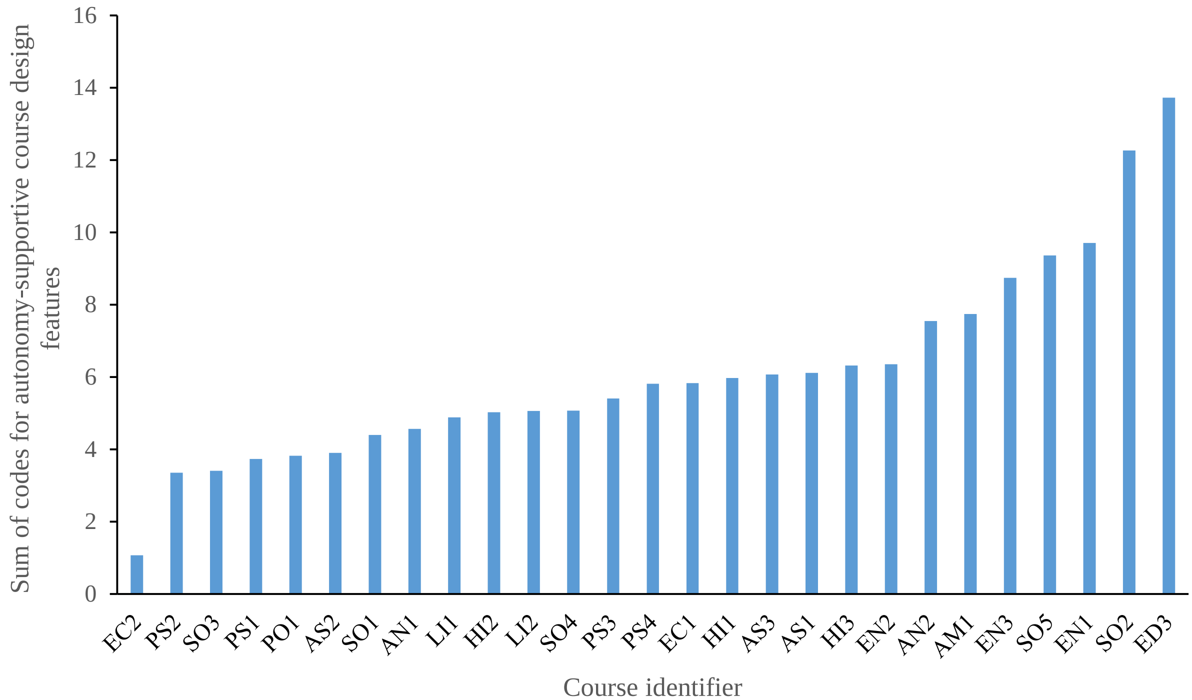

Figure 2. Sum of codes for the eight autonomy-supportive course design features used in this study representing the raw amount of autonomy-supportive course design employed in a course.

Data Collection Procedure

After obtaining consent from instructors to survey their classes I obtained all course rosters from the University of Michigan registrar. The survey was distributed to students via email using Qualtrics. Each student received their own individual link to the survey. Student names and uniqnames were linked to their survey data so that student demographic data could be linked to survey responses once it was obtained at the end of the term. The initial survey invites were sent to students on April 3rd, 2018, inviting them to participate in the survey and explaining the survey incentive structure. For every 200 students who completed the survey, one student would be chosen as the winner in a lottery style drawing for a $20 gift card. Students selected to opt themselves into the drawing at the end of the survey.

Student demographic data was obtained after the conclusion of the term on May 23, 2018 via the Learning Analytics Data Architecture (LARC). The demographic data used for this study includes class year, gender, cumulative GPA, final grade in their course (the one selected for this study), and ethnicity.

Survey Measures

Unless otherwise noted, students responded to all items on a 7-point scale with 1 = very untrue of me, 2 = untrue of me, 3 = somewhat untrue of me, 4 = neutral, 5 = somewhat true of me, 6 = True of me, and 7 = very true of me (Vagias, 2006). See Appendix A for the complete survey. The survey was designed to take students between eight and ten minutes to complete. On average, students took 8.75 minutes to complete the survey. Below I review each of the survey items and explain their applicability to this study. Students were asked to respond to each of the scales with respect to the specific course involved in the study.

Cost. A single item was used to measure cost in terms of task effort (based on cost items from Flake et al., 2015). Cost in this case represents the amount of energy and time it will take to complete an assignment. Students have to balance their workload across classes and putting in a lot of effort into an assignment in one class leaves them with less time to work on other assignments. Classes with more low-stakes assignments would represent a lower effort cost on average since it is relatively easy to complete low-stakes assignments throughout the semester compared to having to spend a lot of time on one of the few available high-stakes assignments.

Expectancy. Expectancy was measured using a single item to assess the degree to which a student expected to do well in the course (Wigfield & Eccles, 2000). The assignment structure in a course will influence the degree to which a student will expect to do well. If there are only a few assignments and few opportunities to boost one’s grade, students may not expect to do well.

In addition, if there are very few types of assignments, or just a single assignment type, students may not expect to do well if they don't feel like the assignments play to their strengths. On the other hand, a course that affords students more autonomy may increase their expectancy of doing well since they have more control over their grade.

Utility value. Utility value was measured using a single item to assess the degree to which students thought that the course material would be useful for them for future classes and/or their career (Wigfield & Eccles, 2000). Students may see more utility value in courses that afford them more autonomy since students would have more freedom to engage in assignments and activities that they find interesting and useful. Utility value also depends on how the course fits into a student's academic plan. If the course is required for their major or teaches key career skills then it may have a lot of utility value for a student as well.

Student grade tracking. Student grade tracking was measured using a single item that assesses the degree to which students kept track of their grades during the semester. The more assignments a course has the more difficult it is for students to keep track of their grades throughout the semester. This measure may also be influenced by student diligence as well as how quickly the teaching team returns assignment grades. If students are able to keep track of their grades during the semester it gives them more information with which to make decisions about what assignments to do and/or how much effort to put into assignments.

Grading system comprehension. Grading system comprehension was measured using a single item that assesses the degree to which students understood what they had to do to earn their desired grade in the course. Grading systems that afford students increased autonomy are also more complicated for students. Students have to not only put effort into their assignments but also into choosing which assignments to complete and making sure that they are doing enough to earn their desired grade. If students cannot understand what they have to do to earn their desired grade in a class, the amount of autonomy will not matter as it will not benefit students. This is why it is important to measure comprehension alongside autonomy.

Self-efficacy. Self-efficacy was measured using the four-item Perceived Competence Scale (Williams & Deci, 1996). While expectancy measures the degree to which students expect to do well, self-efficacy measures the degree to which students feel capable and confident in their ability to learn the material and perform well in the class. Students' expectancy of doing well will likely be related to their confidence in their own abilities yet these constructs are also distinct. In a course where students can recover from a low grade by putting in additional effort, they may not be confident in their ability to learn the material but they may know they will get an A since they can complete additional assignments to recover from a low grade. This scale demonstrated adequate reliability, $\alpha = .93$

Metacognitive strategies. Metacognitive strategies were measured using a 15-item scale (Berger & Karabenick, 2016) which was divided into three subscales for planning, monitoring, and self-regulation. The way in which students approach the task of planning, monitoring, and regulating could be related to how autonomous students feel in a course. A student who has trouble planning and monitoring their progress may feel overwhelmed rather than empowered by assignment choice. This scale demonstrated adequate reliability, $\alpha = 81$ for planning, $\alpha = .78$ for monitoring, and $\alpha = .77$ for regulation.

Autonomous motivation. Autonomous motivation was measured using two eight-item subscales of the Academic Self-Regulation Questionnaire (Deci et al., 1992) from which I calculated the relative autonomy index, an important outcome variable for this study. The relative autonomy index represents the degree to which a student has internalized their motivation for a given class.

The greater the internalization, the more autonomous a student's motivation for that class. The relative autonomy index (RAI) was calculated by taking the average of the items in each category and combining them using the following equation: 2 x intrinsic regulation + identified regulation – introjected regulation – 2 x external regulation. In essence the formula is autonomous regulatory styles minus controlling regulatory styles. Of the four regulatory styles used in the formula, intrinsic and external are the most extreme and thus they are weighted more heavily in the formula. The advantage of this formula is that it condenses the scores of four different regulatory styles into an overall figure representing a student's level of internalization (see Deci et al., 1992 for more information). The use of a single number greatly reduces the number of models necessary to understand the impact of autonomy-supportive course design on student autonomous motivation. The amount of autonomy that a student feels in a course is a function of the assignment structure. Optional assignments, a variety of assignment types, ways to recover from a low grade, as well as a student individual differences (e.g. in the degree to which they employ metacognitive strategies) may influence the amount of autonomy that they experience throughout the semester. These two subscales contained items belonging to one of four categories: external regulation, introjected regulation, identified regulation, or intrinsic regulation. This scale demonstrated adequate reliability, $\alpha = .86$.

Student Responsibility. Student responsibility was measured using a six-item scale designed to measure the relative responsibility (their own versus their instructor's) that they feel for various behaviors, thoughts, feelings, and outcomes (Lauermann & Karabenick, 2013). Students responded on a scale from zero to five separately for the degree that they feel responsible and the degree that they feel their instructor is responsible for a given behavior, thought, feeling, or outcome. The assignment structure in a course may influence the degree to which students feel responsible for their own performance and behavior in a course. In a course where students are responsible for choosing which assignments to complete they may feel more responsible for their performance as opposed to a course where a student's performance is entirely dependent on performance on a rigid set of assignments. This scale demonstrated adequate reliability, α = .71 for student responsibility and α = .75 for instructor responsibility.

Classroom goal structure. Classroom goal structure was measured using a 13-item scale (Midgley et al., 2000) divided into three subscales: mastery, performance avoidance, and performance approach structure. Responses on this scale indicated the relative prevalence of mastery goal structure, performance approach goal structure, and performance avoidance goal structure in a given course. The goal structure (performance approach, performance avoidance, or mastery) of a course is not only dependent on the assignment structure but also on the way the assignments are framed in course documents and by the instructor. A student's perception of the classroom goal structure is also likely dependent on a student's own disposition. The goal structure of the classroom may influence student self-efficacy depending on whether the class emphasizes comparison (e.g. grading on a curve) or if it promotes mastery and self-improvement. The classroom goal structure may affect the way that students approach assignments and the way that they react to assignment choice in courses that afford more autonomy. In a course with a mastery goal structure, students may be more likely to take risks on assignments than in a course with a performance orientation. This scale demonstrated adequate reliability, α = .80 for mastery classroom goal structure, α = .82 for performance approach classroom goal structure, and α = .78 for performance avoidant classroom goal structure.

Participants

The survey was distributed to a population of $N = 2,518$ students. For 23 cases a student was registered for more than one class in the sample and completed a survey for both classes. In these cases I deleted the second survey that the student completed before conducting analyses. Including responses from multiple students for different classes would violate the assumption of independence of errors. After deleting duplicate cases, $N = 249$ students submitted incomplete surveys containing analyzable data and $N = 819$ provided complete survey data yielding a total sample of $N = 1,068$ representing a response rate of 42.41%. The average response rate per class was 43.86% ranging from 30.30% to 70.13%. See Table 6 for survey completion statistics by class.

Table 6
Survey Completion

Course pseudonym	*N* Possible	*N* total	*N* completed	*N* partial	Percent completed (full and partial)
AM1	17	7	4	3	41.18%
AN1	48	19	15	4	39.58%
AN2	68	29	25	4	42.65%
AS1	70	22	16	6	31.43%
AS2	43	14	10	4	32.56%
AS3	28	12	8	4	42.86%
EC1	228	76	43	33	33.33%
EC2	128	54	38	16	42.19%
ED3	77	54	44	10	70.13%
EN1	207	100	71	29	48.31%
EN2	21	11	8	3	52.38%
EN3	69	32	27	5	46.38%
HI1	53	23	18	5	43.40%
HI2	46	22	17	5	47.83%
HI3	37	19	16	3	51.35%
LI1	55	26	18	8	47.27%
LI2	39	18	16	2	46.15%
PO1	76	28	22	6	36.84%
PS1	277	116	90	26	41.88%
PS2	295	129	110	19	43.73%
PS3	299	107	87	20	35.79%
PS4	45	23	19	4	51.11%
SO1	28	15	14	1	53.57%
SO2	164	73	56	17	44.51%
SO3	33	10	6	4	30.30%
SO4	46	19	13	6	41.30%
SO5	21	10	8	2	47.62%
Total	2518	1068	819	249	42.41%

Student demographic data were obtained from the university's Learning Analytics Data Architecture for all 2,518 students in the potential sample. Demographic figures are reported for the 1,068 students who provided at least partial data. Of those students, the majority were female (70.51%) and Caucasian (64.14%). Additionally, 4.12% students were African American, 15.45% were Asian, 5.62% were Hispanic, 6.45% were multi-racial, and for 4.21% the ethnicity was not indicated in the university database. Most students were either freshman (31.93%) or sophomores (32.68%). 20.13% of the students were juniors, and 13.11% were seniors. Additionally, 2.15% of students enrolled more than four years before this data collection and were classified as “other” in terms of their class year. See Table 7 for demographic data for individual courses. The average cumulative GPA of students in this sample was 3.44 and the average Winter 2018 semester GPA was 3.51. See Table 8 for academic performance data for each class.

Table 7
Demographic by Class

	Gender		Ethnicity						Class year				
	Female	Male	2 or more	Asian	Afr. Amer.	Hisp	Not indic.	Cauc.	Fresh	Soph	Jun	Sen	Other
AM1	6	1	0	5	0	0	1	1	0	2	5	0	0
AN1	17	2	3	4	0	3	0	9	4	6	6	1	2
AN2	19	10	1	6	4	2	2	14	12	9	7	1	0
AS1	10	12	1	14	1	0	2	4	10	8	2	2	0
AS2	8	6	0	1	0	0	2	11	5	3	3	2	1
AS3	6	6	0	6	0	0	1	5	0	0	5	5	2
EC1	31	45	4	17	0	1	9	45	11	32	23	9	1
EC2	25	29	1	21	2	2	7	21	15	16	13	10	0
ED3	27	27	3	8	1	2	3	37	1	8	11	32	2
EN1	70	30	6	12	1	5	6	70	46	39	4	9	2
EN2	9	2	0	0	0	0	2	9	1	5	3	2	0
EN3	25	7	0	3	0	2	1	26	8	3	14	6	1
HI1	21	2	2	3	0	5	0	13	2	9	5	5	2
HI2	14	8	1	1	1	3	1	15	0	9	4	7	2
HI3	15	4	2	0	0	0	2	15	3	7	7	1	1
LI1	14	12	0	1	0	1	3	21	12	6	3	5	0
LI2	12	6	1	3	1	1	0	12	6	3	5	4	0
PO1	15	13	1	1	2	2	1	21	2	9	12	4	1
PS1	102	14	5	9	4	7	6	85	56	36	19	3	2
PS2	110	19	7	14	6	7	8	87	74	35	16	3	1
PS3	91	16	1	13	5	3	6	79	32	57	14	4	0
PS4	15	8	0	5	2	1	0	15	1	7	6	8	1
SO1	10	5	1	3	0	2	1	8	2	3	5	3	2
SO2	54	19	4	9	12	7	4	37	31	25	13	4	0
SO3	5	5	0	1	0	3	0	6	3	3	3	1	0
SO4	13	6	1	4	0	0	1	13	2	6	3	8	0
SO5	9	1	0	1	2	1	0	6	2	3	4	1	0
Total	753	315	45	165	44	60	69	685	341	349	215	140	23

Note. This table represents demographic data for the sample of students included in the study, $N = 1068$, with at least partial survey data after removing duplicate survey responses.

Table 8
Academic Performance Data by Class

	GPA				Course grade					
	M Cum. GPA	*SD* Cum. GPA	*M* Sem. GPA	*SD* Sem. GPA	A	B	C	D	F	Other
AM1	3.30	0.51	3.33	0.65	5	2	0	0	0	0
AN1	3.38	0.39	3.38	0.48	8	8	2	0	0	1
AN2	3.58	0.38	3.65	0.36	26	2	0	0	0	1
AS1	3.54	0.41	3.53	0.40	13	9	0	0	0	0
AS2	3.35	0.62	3.64	0.44	11	3	0	0	0	0
AS3	3.33	0.53	3.63	0.40	10	0	0	0	0	2
EC1	3.43	0.43	3.51	0.47	52	19	4	0	0	1
EC2	3.35	0.58	3.28	0.76	18	17	12	4	0	3
ED3	3.49	0.34	3.60	0.62	41	4	0	0	0	9
EN1	3.54	0.33	3.59	0.36	80	17	0	0	0	3
EN2	3.21	0.46	3.37	0.41	3	8	0	0	0	0
EN3	3.36	0.33	3.41	0.46	12	16	3	0	0	1
HI1	3.41	0.42	3.58	0.39	10	10	0	0	0	3
HI2	3.27	0.41	3.35	0.60	13	4	0	0	0	5
HI3	3.38	0.46	3.36	0.61	6	11	1	0	0	1
LI1	3.58	0.30	3.56	0.37	18	7	0	0	0	1
LI2	3.40	0.40	3.51	0.48	10	4	3	0	0	1
PO1	3.47	0.37	3.63	0.34	20	5	0	0	0	3
PS1	3.42	0.44	3.48	0.55	93	19	2	1	0	1
PS2	3.43	0.43	3.47	0.48	91	34	2	2	0	0
PS3	3.50	0.41	3.60	0.43	86	17	2	2	0	0
PS4	3.58	0.33	3.67	0.33	14	8	0	0	0	1
SO1	3.35	0.44	3.46	0.48	11	3	1	0	0	0
SO2	3.34	0.49	3.49	0.48	63	8	1	0	0	1
SO3	3.16	0.46	3.03	0.67	2	5	1	1	1	0
SO4	3.49	0.32	3.62	0.36	13	3	0	0	0	3
SO5	3.55	0.27	3.62	0.26	10	0	0	0	0	0
Total	3.44	0.42	3.51	0.49	739	243	34	10	1	41

Note. This table represents demographic data for the sample of students included in the study, $N = 1068$, with at least partial survey data after removing duplicate survey responses. Students with a grade of "other" received either I, IA-, IB, IB-, IC-, P, W, or had no grade record.

Survey Non-Response Analysis

I ran correlations between survey completion, starting versus not starting the survey, and demographic variables to assess whether the sample of students who completed the survey were significantly different than students who did not based on the demographic variables. Table 9 shows the correlation between demographic variables and survey completion. Based on the correlations in Table 9, no demographic factor was a strong predictor of starting or finishing the survey. Even though some correlations were significant, the magnitude of the correlations were small. Freshman ($r = .04$), students with higher cumulative GPAs ($r = .09$), students with higher semester GPAs (*r* = .12), Caucasian students (*r* = .04), students who did not indicate their ethnicity (*r* = .04), women (*r* = .22), and students who earned an A in the course included in this study (*r* = .09) were more likely to have begun the survey. Asian students (*r* = -.06), students who earned a C in the course included in this study (*r* = -.07), and students that earned an F in the course included in this study (*r* = -.06) were less likely to have started the survey. Out of the students who started the survey, students with a higher semester GPA (*r* = .07), female students (*r* = .10), and students who earned an A in the course included in this study (*r* = .07) were more likely to finish the survey. Given the large sample size, one can expect even small correlations to be significant. Although some demographic variables were significantly related to survey completion, the magnitude of these correlations are small and do not pose a concern for the validity of the data. In particular, one would expect high achieving students to be more responsible and for high performers in a particular course to be more willing to answer questions about said course. While these correlations are not a concern for the analyses themselves, it is important to take them into consideration when interpreting findings. When speaking about relatively high and low achievers in this sample, it is important to remember that students in the sample are already relatively high achievers relative to students who did not respond to the survey.

Table 9
Survey Non-Response Correlations

	Started survey	Finished survey
Freshman	0.04*	-0.01
Sophomore	-0.03	0.05
Junior	0.02	-0.04
Senior	-0.03	-0.02
Other class year	-0.01	0.02
Cumulative GPA	0.09*	0.05
Semester GPA	0.12*	0.07*
Caucasian	0.04*	0.06
African American	-0.02	-0.04
Asian	-0.06*	-0.03
Hispanic	-0.02	0.00
Multi-ethnic	-0.01	-0.04
Ethnicity not indicated	0.04*	-0.01
Female	0.22*	0.10*
Course grade: A	0.09*	0.07*
Course grade: B	-0.04	-0.05
Course grade: C	-0.07*	-0.03
Course grade: D	0.01	-0.04
Course grade: F	-0.06*	-0.06
Course grade: Other	-0.03	-0.01

Note. $^{*}p < .05$.

The size of the sample relative to the magnitude of the correlations in Table 9 means that although the correlations are significant, the sample is resilient to bias based on demographic factors. Nevertheless, I entered the demographic variables into the research question two models that focused on student individual differences. In addition, when interpreting interaction effects involving cumulative GPA, I was attentive to the fact that higher achieving students were somewhat more likely to begin the survey. While two dimensions were excluded due to lack of variation (percent of assignments with flexible deadlines) and complete overlap with another dimension (use of a gameful LMS), Figure 3 shows that there is overall variation in the amount of autonomy-supportive course design across courses in the sample, despite a lack of variation in individual dimensions (e.g. percent of points needed for an A). In the following chapter I summarize my analysis strategy as well as the findings associated with each research question.

Chapter 5: Analyses

In this chapter I summarize the significant results from this study. Complete analyses tables for research questions 1 and 3 can be found in Appendix B. Before reviewing the findings associated with each research question I provide an overview of the analyses conducted. See Figures 3-5 for a graphical overview of the quantitative analyses broken for each research question. Above each set of models is a sample regression equation which shows class (1|class) as the random intercept. Within each research question, the progression from one set of models to the next is shown vertically to illustrate the way that the analyses evolved from the initial planned set of models.

- RQ1: How is the employment of autonomy-supportive course design dimensions related to student autonomous motivation?
- RQ2: How do student individual differences relate to student autonomous motivation?
- RQ3: How do student individual differences affect the relationship between autonomy-supportive course design dimensions and student autonomous motivation?

Research Question 1: Overview of Analyses

To investigate research question 1, I first ran linear mixed effects models regressing student autonomous motivation, measured as their relative autonomy index (RAI; Deci et al., 1992) on the "raw" (initial coding) autonomy-supportive course design dimensions with class as a random intercept to account for variation across classes. A student's RAI is a combination of four types of regulation: external, introjected, identified and intrinsic. The items in the scale are classified into one of those four categories and a mean score is generated for each type of regulation. A student's RAI is calculated with the following equation: 2 x intrinsic regulation + identified regulation – introjected regulation – 2 x external regulation. In essence the formula is autonomous regulatory styles minus controlling regulatory styles. Of the four regulatory styles used in the formula, intrinsic and external are the most extreme and thus they are weighted more heavily in the formula. The advantage of this formula is that it condenses the scores of four different regulatory styles into an overall figure representing a student's level of internalized motivation. Next, I recoded the autonomy-supportive course design dimensions by separating them out by type (assignment types, recovery mechanisms, and types of scaffolds) or binning them into categories (percent of low-stakes assignments, percent of assignments with within-assignment choice, and percent of optional assignments) in four different ways to account for potentially non-linear relationships. I regressed each of these recoded dimensions (alone) on RAI in the same way as the raw dimensions using class as a random intercept. Next I investigated the relationship between both the raw and recoded dimensions and other dependent variables: mastery classroom goal structure, performance approach classroom goal structure, expectancy, utility value, and cost using the same multilevel framework as previous analyses. See Figure 3 for a graphical overview of research question 1.

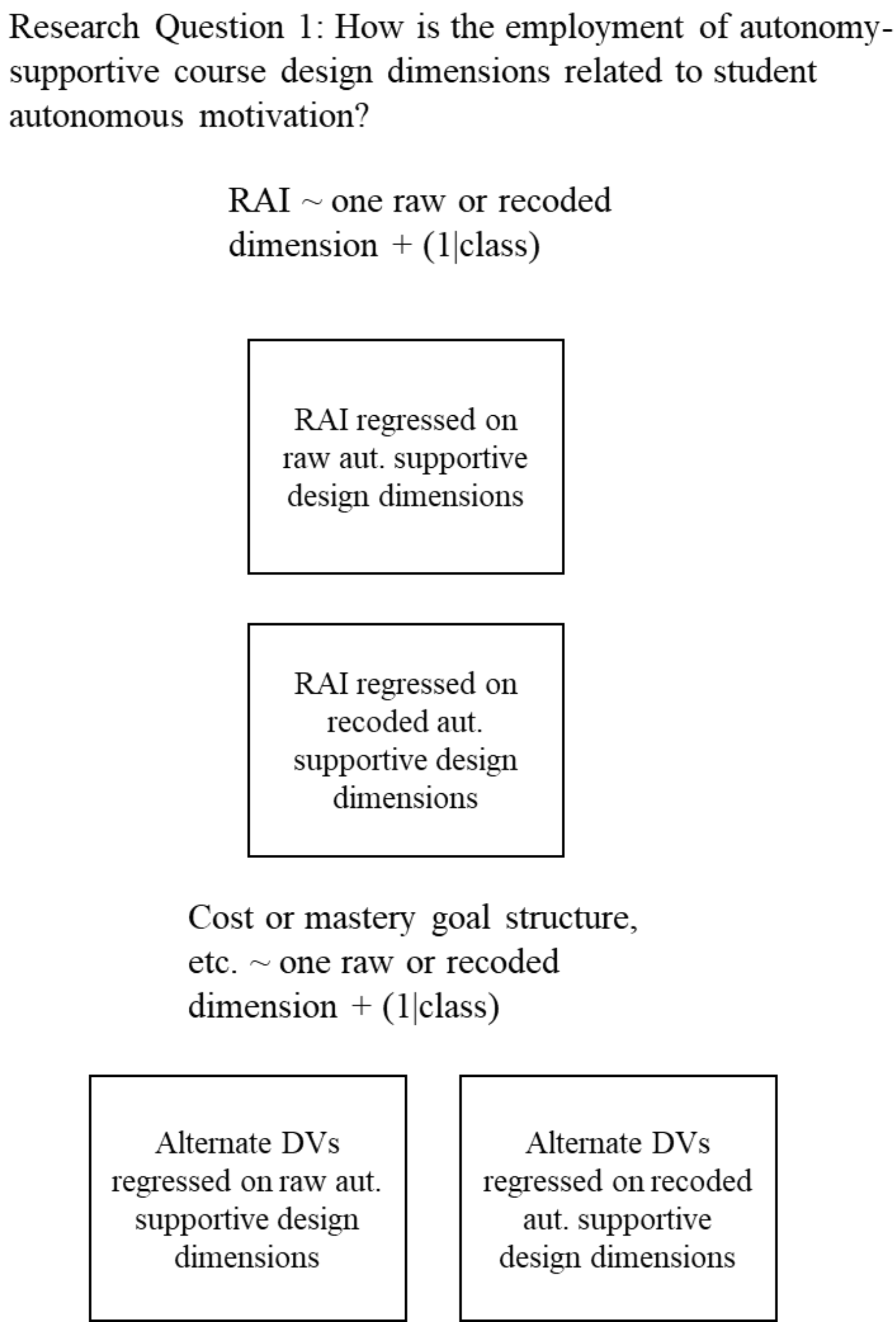

Figure 3. Graphical Overview of Research Question 1.

Research Question 2: Overview of Analyses

To investigate research question 2, I conducted a multilevel analyses of how student individual differences predicted RAI as well as cost once again using class as a random intercept. Some individual differences were collinear with one another so I ran multiple models and switched the collinear individual differences across models. See Figure 4 for a graphical overview of research question 2.

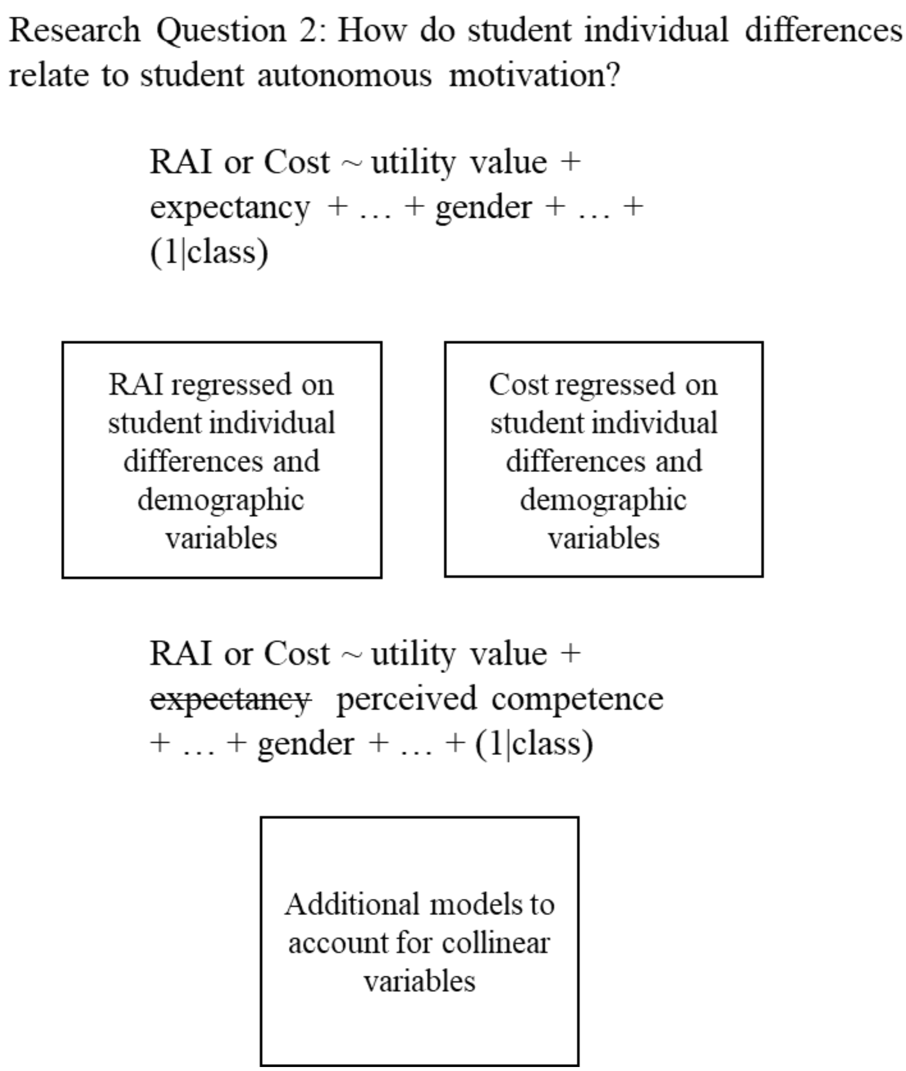

Figure 4. Graphical Overview of Research Question 2.

Research Question 3: Overview of Analyses

Based on the results of the analyses for research questions 1 and 2, I conducted moderation analyses to address research question 3. I used cumulative GPA (representing academic ability) and cost as moderators predicting RAI and I used cumulative GPA as a moderator predicting cost. I once again ran these analyses using both the raw and recoded dimensions. For example, I regressed RAI on number of assignment types, cumulative GPA, and the interaction term (number of assignment types x cumulative GPA). I express significant interactions with graphs using lines for average students, students who are one standard deviation above the average, and students who are one standard deviation below the average in the moderators. This means that when I describe students as high achieving or low achieving, I am speaking about students who have above average or below average cumulative GPAs relative to other students in this sample. Similarly when I describe students who think that a class demands too much of their time or that a class does not demand too much of their time I am speaking of students with above average and below average cost relative to other students in the sample. See Figure 5 for a graphical overview of research question 3.

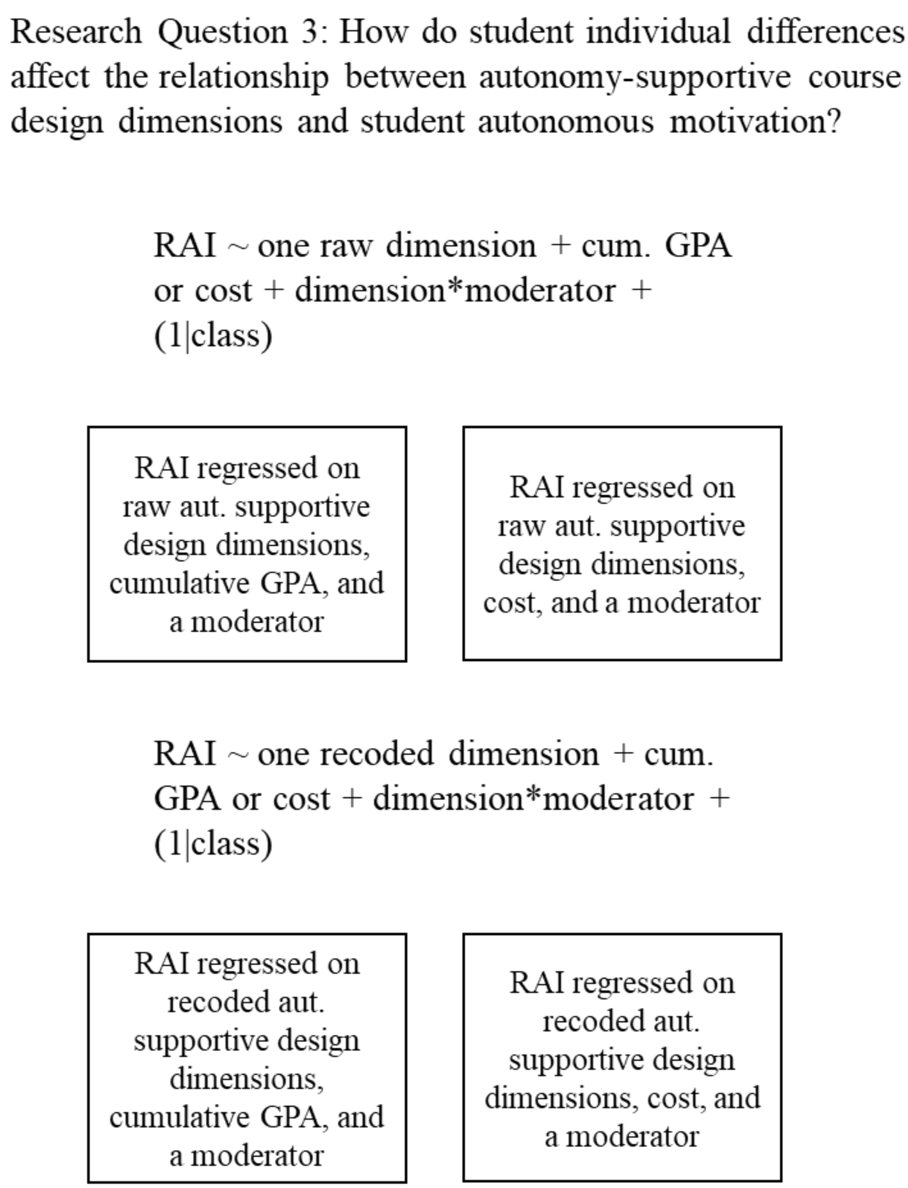

Figure 5. Graphical Overview of Research Question 3.

Lastly, I conducted a brief exploratory qualitative analysis of course syllabi to see if there was any evidence of instructors scaffolding the way that students engage with choice in their courses.

RQ1: Raw Autonomy-Supportive Course Design Dimensions Predicting Autonomous Motivation (RAI)

Research question 1 is: How is the employment of autonomy-supportive course design dimensions related to student autonomous motivation? To address this question, I ran a series of linear mixed effects models regressing RAI on each autonomy-supportive course design dimension in its raw form alone using class as a random intercept using the lme4 package in R. (RAI ~ raw dimension + (1|class)). No autonomy-supportive course design dimension was a significant predictor of RAI (Appendix B, Table B.2).

RQ1: Recoded Autonomy-Supportive Course Design Dimensions Predicting Autonomous Motivation (RAI)

Due to the null findings associated with the raw autonomy-supportive course design dimensions, I decided to recode the categorical dimensions by type and to bin the continuous dimensions in order to investigate the potential for non-linear relationships. The number of assignment types was recoded into types of assignments: essay, exam, presentation, project, participation, paper, homework/problem set, quiz, discussion board posts/blog posts, and other (assignment types that only showed up in one class: reading journals, lab reports, interviews, field assignments, Wikipedia editing, and concept maps). The number of recovery mechanisms was recoded into types of recovery mechanisms: extra credit, grade manipulation (e.g. drop lowest quiz grade, lowest exam grade is weighted less than others), and resubmission. The number of types of assignment scaffolds was recoded into types of assignment scaffolds: assignment proposal, instructor-reviewed draft, peer-reviewed draft, and other (scaffolds that only showed up in one class: literature review, outline, annotated bibliography, and other paper-related updates). I recoded the continuous dimensions into categorical bins. For percent of low-stakes assignments, percent of optional assignments, and percent of assignments with within-assignment choice I created four different sets of bins based on scatterplots of these dimensions (x axis) plotted against the mean RAI of each class (y axis). I examined the scatterplots to find levels of the course design dimension where I noticed a shift in RAI that may not have been captured as a linear trend. For instance, I looked for places where RAI dipped and later increased, which would appear as a null trend in a linear model. I also created conceptual bins, such as 0% of the feature versus any amount of the feature (more than zero). These bins are referred to as bin version A through D (Table 11) throughout the rest of this chapter. I could not recode the additive grading system dimension as it already represented a single category. In addition I could not recode the percent of assignments needed for a grade of A (reversed) due to lack of variation in that dimension. See Table 10 for a summary of the recoding process.

Table 10
Autonomy-Supportive Course Design Dimension Recoding Process

Dimension	**Recode Procedure**
Number of assignment types	Essay, exam, presentation, project, participation, paper, homework/problem set, quiz, discussion board posts/blog posts, or other
Percent needed for a grade of A (rev)	NA. Lack of variance
Number of recovery mechanisms	Extra credit, grade manipulation, or resubmission
Number of types of assignment scaffolds	Assignment proposal, instructor-reviewed draft, peer-reviewed draft, or other
Percent of low-stakes assignments	a. Binary: 0*; greater than 0 (0,1) b. Bin: 0-.2*; .21-.4; .41-.8; .81-1 (1-4) c. Bin: 0-.5*; .51-1 (1, 2) d. Bin: 0*; .not zero-.4; .41-.8; 81-1 (0-3)
Percent of optional assignments	a. Binary: 0*; greater than 0 (0,1) b. Bin: 0*; not zero-.4; .41-1 (0-2) c. Bin: 0*; not zero-.5; .51-1 (0-2) d. Bin: 0-.5*; .51-1 (1-2)
Percent of assignments with within-assignment choice	a. Binary: 0*; greater than 0 (0, 1) b. Bin: 0-.2*; .21-.4; .41-1 (1-3) c. Bin: 0*; not zero-.25; .26-1 (0-2) d. Bin: 0-.25*; .26-1 (1, 2)
Additive grading system	NA. Already a single category

Note. Categories marked by a * were the reference categories

I regressed each recoded dimension in the same way that I regressed the raw dimensions on student motivation using the lme4 package in R (RAI ~ recoded dimension + (1|class)). For continuous dimensions that were binned into multiple categories, I needed to choose a reference category to which to compare the other bins. I used the first category as the reference group (marked with a * in Table 11) and ran post-hoc comparisons to compare differences between the other categories using the multcomp package in R. No recoded dimension, or bin was a significant predictor of RAI. In addition, none of the post-hoc comparisons between categories were significant (Appendix B, Table B.3).

RQ1: Raw Autonomy-Supportive Course Design Dimensions Predicting Alternate Dependent Variables

For these analyses I looked beyond RAI for other potential dependent variables that represent additional theoretical perspectives beyond SDT. I chose mastery classroom goal structure, performance approach classroom goal structure (both of which represent Achievement Goal Theory), expectancy, utility value, and cost (representing Expectancy-Value Theory). I regressed each of these dependent variables on each of the raw autonomy-supportive course design dimensions adding class as a random intercept using the lme4 package in R (DV ~ raw dimension + (1|class)). The percent of assignments with within-assignment choice was a significant predictor of perceptions of cost (B = 1.28, $p < .05$). There were no other significant results of any autonomy-supportive course design dimension predicting any of the dependent variables. The results for each dependent variable are summarized in Appendix B in Table B.4.

RQ1: Recoded Autonomy-Supportive Course Design Dimensions Predicting Alternate Dependent Variables

I individually regressed each recoded dimension in the same way that I regressed the raw dimensions on the alternate dependent variables using the lme4 package in R (DV ~ recoded dimension + (1|class)). For continuous dimensions that were binned into multiple categories, I used the first category as the reference group and ran post-hoc comparisons to compare differences between the other categories using the multcomp package in R. Increased cost was associated with courses that contained a presentation assignment (B = .56, $p < .05$) and decreased cost was associated with courses that contained grade manipulation (B = -.69, $p < .05$). Increased cost was also associated with courses where 41-100% of the assignments involved within-assignment choice versus courses where 0-20% of the assignments involved within-assignment choice ($B = .77$, $p < .05$). Lower utility value was associated with courses that used peer review ($B = -.99$, $p < .05$). There were no other significant findings and none of the post-hoc comparisons were significant. The results of these models are summarized in Appendix B in Tables B.5-B.9.

RQ2: RAI and Cost Regressed on Student Individual Differences

Research question 2 was: How do student individual differences relate to student autonomous motivation? After examining the influence of class-level factors (autonomy-supportive course design dimensions) on various dependent variables such as RAI, I examined the influence of student-level individual differences on RAI and cost due to the fact that cost was the additional dependent variable that had the most relationships with autonomy-supportive course design. In these linear mixed effects models I entered all student-level individual differences into the same model, adjusting for collinearity (if a variable's variance inflation factor was greater than two), alongside demographic variables obtained from the University of Michigan's Learning Analytics Data Architecture. Class was once again entered as a random intercept. For these models I also report the marginal and the conditional R^2. The marginal R^2 is the proportion of variance explained by the fixed factors only and the conditional R^2 is the amount of variance explained by both the fixed factors and the random intercept. To assess collinearity between student individual differences I ran an initial model containing every self-report survey variable. The following three sets of variables were determined to be collinear: Feeling in control of one's grade, understanding how to earn one's desired grade, and perceived competence; Metacognitive skills: planning, monitoring, and regulation; and lastly performance approach and performance avoidance classroom goal orientations. I ran an initial model containing the non-collinear self-report survey variables, demographic variables, and the following variables from the collinear sets: Perceived competence, metacognitive skills: planning, and performance approach classroom goal structure. I ran additional models replacing a single collinear variable with another from the set in order to assess its impact on the dependent variable. Separate sets of models were run with RAI as the dependent variable and with cost as the dependent variable. The same collinear sets of variables were identified each time.

Perceived competence (B = .44, p < .01), metacognitive skills: planning (B = .54, p < .01), classroom goal structure: performance approach (B = -.27, p < .05), expectancy (B = -.31, p < .05), utility value (B = .40, p < .01), and cost (B = -.37, p < .01) significantly related to RAI. Gender was the only demographic variable that significantly related to RAI (B = -.74, p < .05) in that males reported a higher RAI on average than females. See Table 11 for a summary of these results. Feeling in control of one's grade (B = .34, p < .01), understanding how to earn one's desired grade (B = .30, p < .01), metacognitive skills: monitoring (B = .78, p < .01), metacognitive skills: regulation (B = .49, p < .01), and classroom goal structure: performance avoidance (B = -.54, p < .01) also significantly related to RAI. The fixed factors in these models explained between 21% and 24% of the variance in RAI. Between-class variance explained an additional 2% of the variance in RAI.

Table 11
RAI Regressed on Student-Level Individual Differences

	B	*SE*	df	*t* value	*p* value
(Intercept)	-4.98	1.67	737.60	-2.98	0.00
Perceived competence	0.44	0.16	730.80	2.74	0.01
Metacognitive skills: Planning	0.54	0.12	738.00	4.52	0.00
Classroom goal structure: Mastery	0.28	0.15	695.20	1.91	0.06
Classroom goal structure: Performance Approach	-0.27	0.11	695.30	-2.50	0.01
Monitored grade	-0.06	0.11	710.10	-0.49	0.62
Expectancy	-0.31	0.13	736.40	-2.39	0.02
Utility value	0.40	0.09	728.50	4.41	0.00
Cost	-0.37	0.09	725.50	-4.34	0.00
Personal responsibility: Student	0.32	0.24	736.10	1.31	0.19
Cumulative GPA	0.15	0.32	738.30	0.49	0.63
Female	-0.74	0.29	726.60	-2.58	0.01
Multi-ethnic	0.96	0.52	736.50	1.85	0.06
Asian	0.06	0.36	720.10	0.17	0.87
African American	0.88	0.66	737.50	1.34	0.18
Hispanic	0.36	0.60	735.50	0.59	0.55
Ethnicity not indicated	0.11	0.50	738.10	0.22	0.83
Sophomore	-0.07	0.30	720.30	-0.24	0.81
Junior	-0.32	0.36	584.60	-0.90	0.37
Senior	-0.66	0.43	383.50	-1.54	0.12
Other class year	0.97	0.87	732.00	1.12	0.26

Note. For ethnicity, Caucasian was used as the reference category and for class year, freshman was used as the reference category.

Perceived competence ($B = -.33$, $p < .01$), metacognitive skills: planning ($B = -.17$, $p < .01$), performance approach classroom goal structure ($B = .33$, $p < .01$), and RAI ($B = -.07$, $p < .01$) were related to student feelings of cost. No demographic variables were significantly related to cost. See Table 12 for a summary of these results. In addition, feeling in control of one's grades ($B = -.22$, $p < .01$), understanding how to earn desired grade ($B = -.20$, $p < .01$), metacognitive skills: regulation ($B = .15$, $p < .05$), and performance avoidance classroom goal structure ($B = .24$, $p < .01$). The fixed factors in these models explained between 16% and 20% of the variance in cost and between-class variation accounted for another 7% of the variance in cost.

Table 12
Cost Regressed on Student-Level Individual Differences

	B	*SE*	df	*t* value	*p* value
(Intercept)	2.66	0.70	738.40	3.78	0.00
Perceived competence	-0.33	0.07	736.30	-5.01	0.00
Metacognitive skills: Planning	0.17	0.05	733.90	3.36	0.00
Classroom goal structure: Mastery	0.12	0.06	737.10	1.88	0.06
Classroom goal structure: Performance Approach	0.33	0.04	738.60	7.62	0.00
Monitored grade	-0.07	0.05	735.50	-1.39	0.16
Expectancy	-0.03	0.06	737.70	-0.61	0.55
Utility value	0.03	0.04	738.30	0.64	0.52
RAI	-0.07	0.02	731.50	-4.51	0.00
Personal responsibility: Student	-0.01	0.10	728.80	-0.09	0.93
Cumulative GPA	0.23	0.13	729.40	1.70	0.09
Female	0.06	0.12	736.90	0.48	0.63
Multi-ethnic	0.07	0.22	727.00	0.30	0.76
Asian	0.21	0.15	738.60	1.39	0.17
African American	0.39	0.28	731.50	1.42	0.16
Hispanic	0.35	0.25	727.70	1.39	0.16
Ethnicity not indicated	-0.03	0.21	730.20	-0.16	0.88
Sophomore	0.08	0.13	736.40	0.66	0.51
Junior	0.15	0.15	731.90	1.00	0.32
Senior	0.15	0.19	674.30	0.82	0.41
Other class year	0.59	0.37	739.00	1.63	0.10

Note. For ethnicity, Caucasian was used as the reference category and for class year, freshman was used as the reference category.

RQ3: Raw Autonomy-Supportive Course Design Dimensions: Moderation Analyses

Research question 3 was: How do student individual differences affect the relationship between autonomy-supportive course design dimensions and student autonomous motivation? To address this question, I investigated the influence of two moderators, cumulative GPA and cost, on the relationship between autonomy-supportive course design and RAI and on the relationship between autonomy-supportive course design and cost. I used the raw autonomy-supportive course design dimensions in these models, running separate linear mixed effects models for each dimension as well as separate models for each moderator: cumulative GPA (RAI ~ raw dimension + cumulative GPA + interaction term + (1|class)) and cost (RAI ~ raw dimension + cost + interaction term + (1|class)). In addition I investigated how cumulative GPA moderated the relationship between autonomy-supportive course design dimensions and cost (Cost ~ raw dimension + cumulative GPA + interaction term + (1|class)). Class was entered as a random intercept. I chose RAI and cost as dependent variables for the moderation analyses due to their theoretical significance and pattern of initial findings. Cumulative GPA and cost were both centered when they were used as moderators. In the figures depicted in this chapter, the red bar represents students who are one standard deviation below the mean of the moderator, the green bar represents students who are at the mean of the moderator, and the blue bar represents students who are one standard deviation above the mean in the moderator. The colored error bands in the figures depicted in this section represent plus or minus one standard error.

The relationship between the number of assignment types and RAI was significantly moderated by cumulative GPA (B = .33, p < .05). As the number of assignments increased, students who were one standard deviation above the mean in GPA felt more autonomously motivated whereas students who were one standard deviation below the mean were less autonomously motivated (Figure 6).

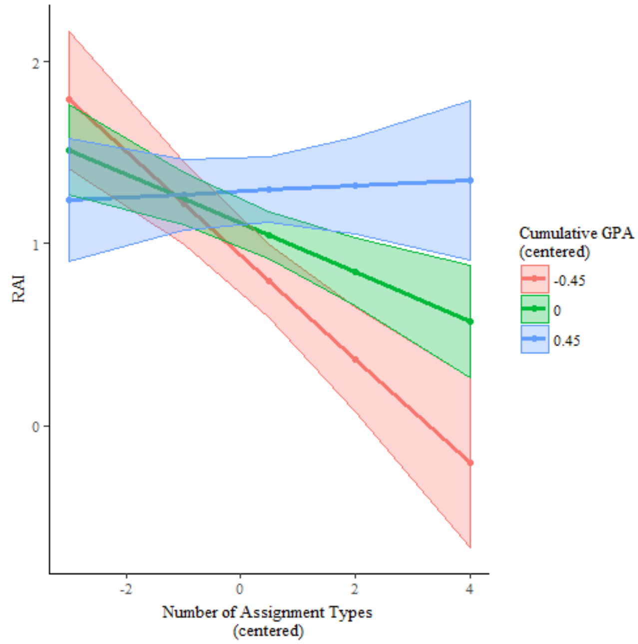

Figure 6. Interaction Between the Number of Assignment Types and Cumulative GPA Predicting RAI

The relationship between the percent of optional assignments and RAI was significantly moderated by cumulative GPA (B = 2.62, p < .05). As the percent of optional assignments increased, students who were one standard deviation above the mean in GPA felt more autonomously motivated whereas students who were one standard deviation below the mean were less autonomously motivated (Figure 7). See Appendix B, Table B.10 for a summary of the results of the raw autonomy-supportive course design dimensions predicting RAI with cumulative GPA as a moderator.

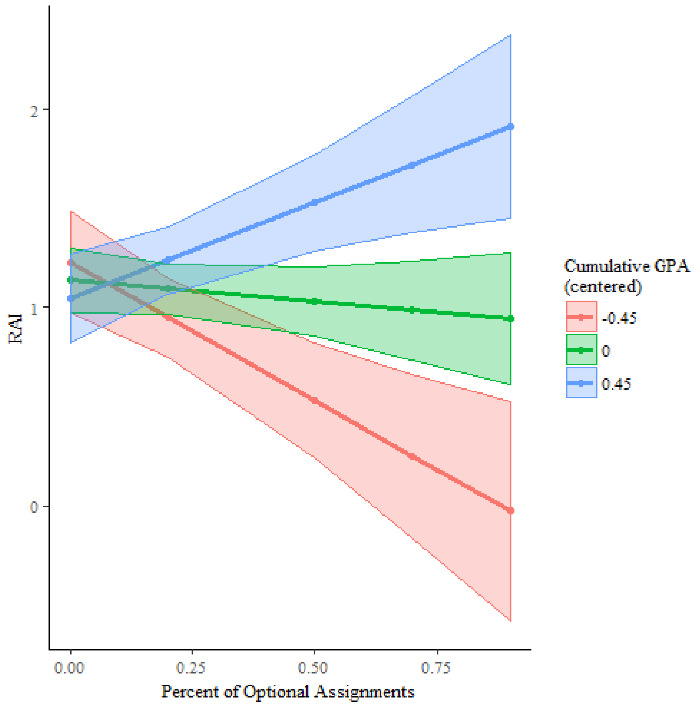

Figure 7. Interaction Between Percent of Optional Assignments and Cumulative GPA Predicting RAI.

The relationship between the number of assignment types and RAI was also significantly moderated by cost (B = -.10, p < .05). As the number of assignment types increases, students who are one standard deviation below the mean in cost felt more autonomously motivated whereas students who were one standard deviation above the mean in cost felt less autonomously motivated (Figure 8).

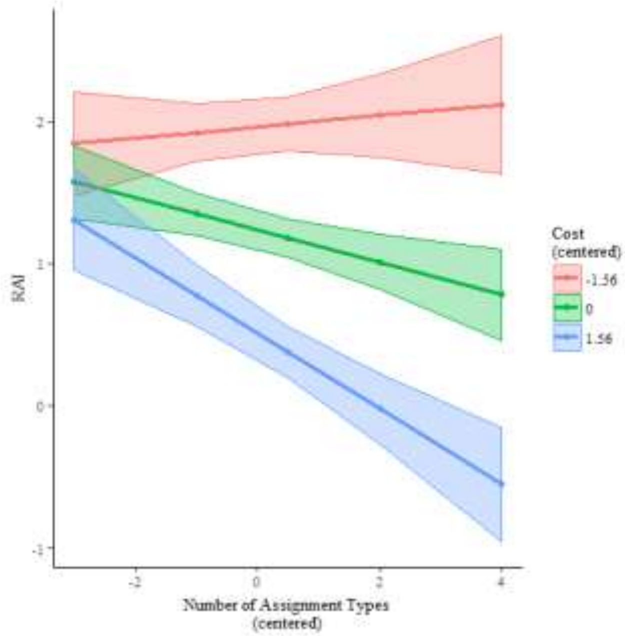

Figure 8. Interaction Between the Number of Assignment Types and Cost Predicting RAI

The relationship between the number of types of assignment scaffolds and RAI was significantly moderated by cost (B = -.23, p < .05). As the number of types of assignment scaffolds increased, students who were one standard deviation below the mean in cost felt more autonomously motivated whereas students who were one standard deviation above the mean in cost felt less autonomously motivated (Figure 9). See Appendix B, Table B.11 for a summary of the results of the raw autonomy-supportive course design dimensions predicting RAI with cost as a moderator.

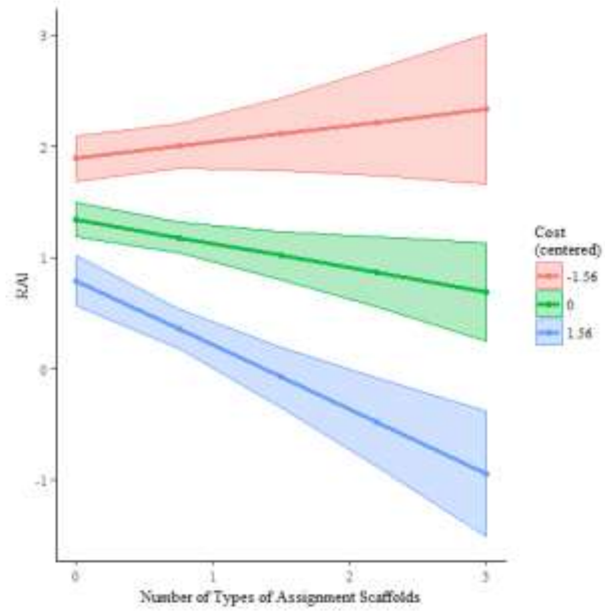

Figure 9. Interaction Between the Number of Types of Assignment Scaffolds and Cost Predicting RAI

There were no significant interactions between raw autonomy-supportive course design dimensions and cost moderated by cumulative GPA (Appendix B, Table B.12).

RQ3: Recoded Autonomy-Supportive Course Design Dimensions: Moderation Analyses

I investigated the influence of two moderators, cumulative GPA and cost, on the relationship between autonomy-supportive course design and RAI and on the relationship between autonomy-supportive course design and cost. I used the recoded course design dimensions in these models, running separate linear mixed effects models for each recoded dimension as well as separate models for each moderator: cumulative GPA (RAI ~ recoded dimension + cumulative GPA + interaction term + (1|class)) and cost (RAI ~ recoded dimension + cost + interaction term + (1|class)). In addition I investigated how cumulative GPA moderated the relationship between recoded autonomy-supportive course design dimensions and cost (Cost ~ recoded dimension + cumulative GPA + interaction term + (1|class)). Class was entered as a random intercept. These analyses are summarized by design dimension.

Assignment Types. There were no significant interactions between any particular assignment type and cumulative GPA predicting RAI or predicting cost. In addition there were no significant interactions between any assignment type and cost predicting RAI. See Appendix B, Tables B.13-B.14 for a summary of results pertaining to assignment types.

Recovery Mechanisms. There were no significant interactions between any recovery mechanism and cumulative GPA predicting RAI or predicting cost. In addition there were no significant interactions between any recovery mechanism and cost predicting RAI. See Appendix B, Table B.15-B.16 for a summary of results pertaining to recovery mechanisms.

Types of Assignment Scaffolds. There was a significant interaction between the use of instructor-reviewed drafts and cumulative GPA predicting RAI ($B = -3.18$, $p < .05$) In classes that used instructor-reviewed drafts, students with below average cumulative GPA felt more autonomously motivated compared to students with average or above average cumulative GPAs (Figure 10). There was a significant interaction between assignment proposals and cost predicting RAI ($B = -.45$, $p < .05$). In classes that employ assignment proposals, students who had one standard deviation below the mean of cost were more autonomously motivated whereas students who were one standard deviation above the mean in cost were less autonomously motivated (Figure 11).

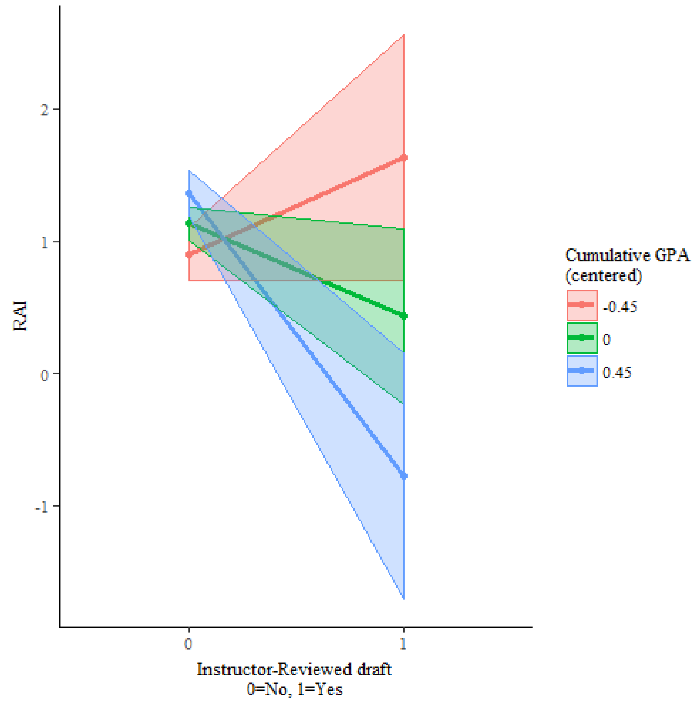

Figure 10. Interaction Between Instructor-Reviewed Draft and Cumulative GPA Predicting RAI

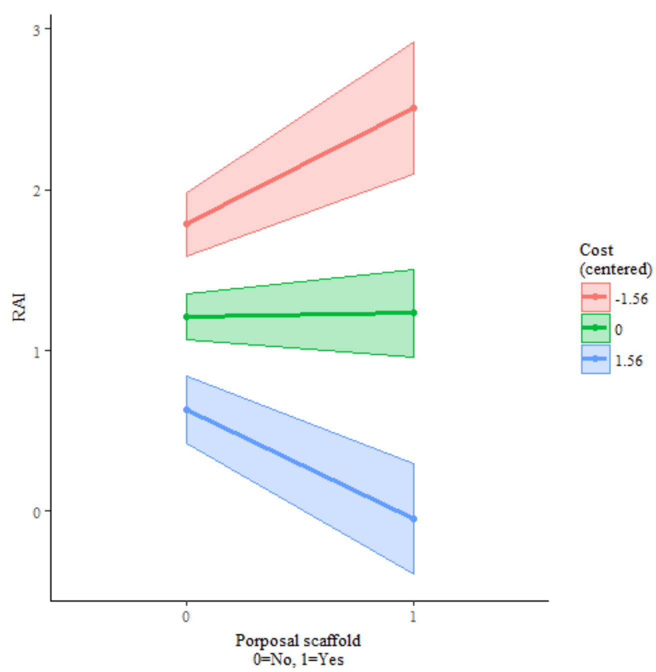

Figure 11. Interaction Between Proposal Scaffolds and Cost Predicting RAI

There were no significant interactions between any type of assignment scaffold and cumulative GPA predicting cost. See Appendix B, Tables B.17-B.18 for a summary of results.

Percent of Low-Stakes Assignments. For bin version D (0%, 1-40%, 41-80%, 81-100%) there was a significant interaction between 81-100% of low-stakes assignments (compared to the 0% baseline category) and cumulative GPA predicting RAI ($B = 1.70$, $p < .05$). In classes with 81-100% low-stakes assignments compared to classes with 0% low-stakes assignments, RAI is slightly higher for students one standard deviation above the mean in cumulative GPA whereas it is substantially lower for students one standard deviation below the mean in cumulative GPA (Figure 12). In Figure 12 the x-axis is labeled zero to three representing the four categorical bins (0%, 1-40%%, 41-80%, 81-100%) for this version of the percent of low-stakes assignments in a class.

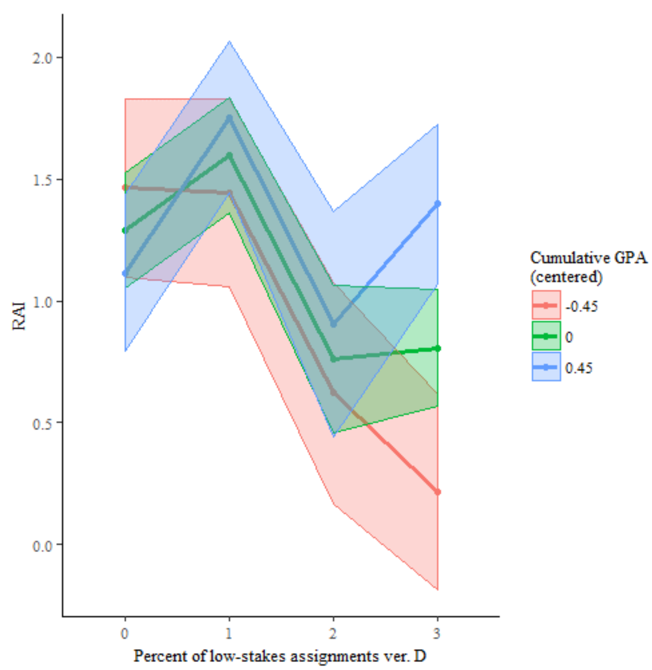

Figure 12. Interaction Between the Percent of Low-Stakes Assignments Version D (0%, 1-40%, 41-80%, 81-100%) and Cumulative GPA Predicting RAI

There were no significant interactions between any versions of the percent of low-stakes assignments and cost predicting RAI and there were no significant interactions between any versions of the percent of low-stakes assignments and cumulative GPA predicting cost. See Appendix B, Tables B.19-B.20 for a summary of results.

Percent of Optional Assignments. There was a significant interaction between bin version A (0% version more than 0%) of the percent of optional assignments and cumulative GPA predicting RAI (B = 1.28, $p < .05$). In classes with more than 0% of optional assignments students who were one standard deviation above the mean in cumulative GPA were more autonomously motivated compared to students who were one standard deviation below the mean in cumulative GPA (Figure 13). There was also a significant interaction between bin version B (0%, 1-40%, 41-100%) of the percent of optional assignments and cumulative GPA predicting RAI (B = 1.47, $p < .05$). In courses with 41-100% of optional assignments, students with one standard deviation above the mean in cumulative GPA were more autonomously motivated compared to similar students in courses with no (0%) of optional assignments. One the other hand, students who were one standard deviation below the mean were less autonomously motivated in courses with 41-100% of optional assignments compared to courses with 0% of optional assignments (Figure 14). Lastly, there was a significant interaction between bin version C (0%, 1-50%, 51-100%) of the percent of optional assignments and cumulative GPA predicting RAI (B = 2.07, $p < .05$). For all students, autonomous motivation was lower in courses with 51-100% of optional assignments than it was in courses with 1-50% of optional assignments. This difference was more pronounced in students who were one standard deviation below the mean in cumulative GPA compared to students who were one standard deviation above the mean in cumulative GPA (Figure 15).

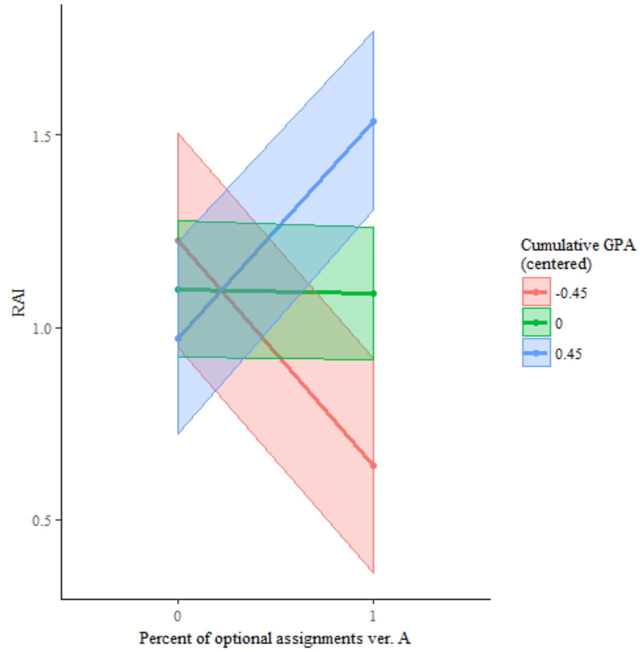

Figure 13. Interaction Between the Percent of Optional Assignments Version A (0%, more than 0%) and Cumulative GPA Predicting RAI

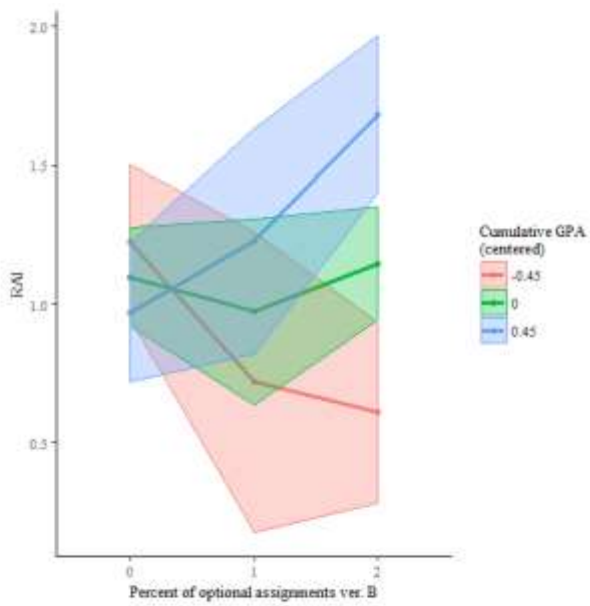

Figure 14. Interaction Between Percent of Optional Assignments Version B (0%, 1-40%, 41-100%) and Cumulative GPA Predicting RAI

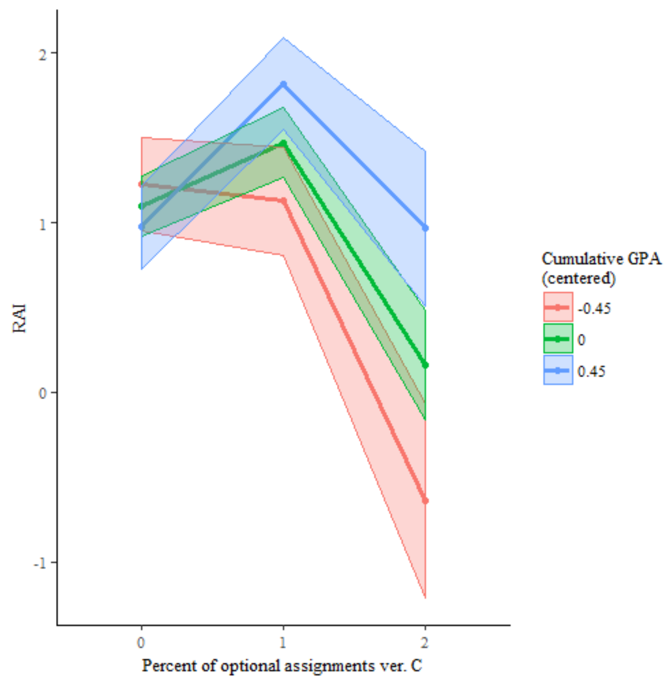

Figure 15. Interaction Between Percent of Optional Assignments Version B (0%, 1-50%, 51-100%) and Cumulative GPA Predicting RAI

There were no significant interactions between any version of the percent of optional assignments and cost predicting RAI nor were there any interactions between any version of the percent of optional assignments and cumulative GPA predicting cost. See Appendix B, Tables B.21 and B.22 for a summary of results.

Percent of Assignments with Within-Assignment Choice. There were no significant interactions between any version of the percent of assignments with within-assignment choice and cumulative GPA predicting RAI. There was a significant interaction between bin version A (0%, more than 0%) of the percent of assignments with within-assignment choice and cost predicting RAI (B = -.35, $p < .05$). In classes with some amount of assignments with within-assignment choice, students with below average cost were more autonomously motivated compared to students with above average cost (Figure 16). There was also a significant interaction between bin version B (0-20%, 21-40%, 41-100%) of the percent of assignments with within-assignment choice and cost predicting RAI ($B = -.39$, $p < .05$). In courses with 21-40% of assignments containing within-assignment choice, students who experienced above average cost were roughly as autonomously motivated as students in courses with 0-20% of assignments featuring within-assignment choice. On the other hand, students who experienced below average cost were more autonomously motivated in courses featuring 21-40% of assignments with within-assignment choice compared to courses with 0-20% of assignments having within-assignment choice (Figure 17).

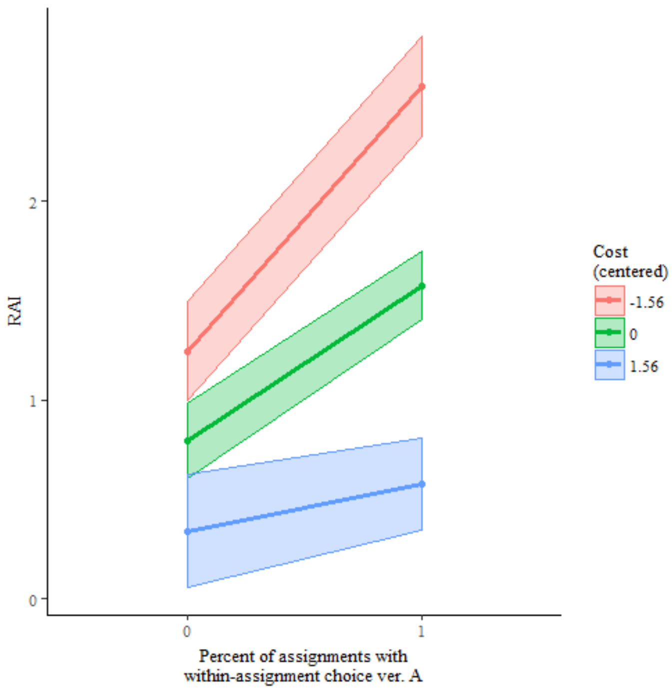

Figure 16. Interaction Between the Percent of Assignments with Within-Assignment Choice Version A (0%, more than 0%) and Cost Predicting RAI

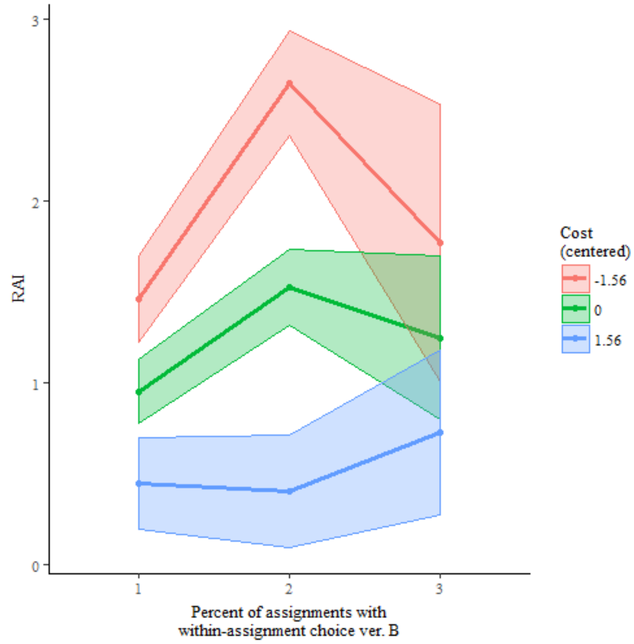

Figure 17. Interaction Between the Percent of Assignments with Within-Assignment Choice Version B (0-20%, 21-40%, 41-100%) and Cost Predicting RAI

There were no significant interactions between any version of the percent of assignments with within-assignment choice and cumulative GPA predicting cost. See Appendix B, Tables B.23 and B.24 for a summary of results. Below I have included a summary table (Table 13) that depicts the pattern of significant main effects and interactions in all of the quantitative analyses.

Table 13
Summary of Main Effects and Interactions of RAI and Cost Regressed on Autonomy-Supportive Course Design Dimensions

	RAI			Cost	
	Main effect	Interaction: Cumulative GPA	Interaction: Cost	Main effect	Interaction: Cumulative GPA
Number of assignment types	*ns*	Sig	Sig	*ns*	*ns*
Essay	*ns*	*ns*	*ns*	*ns*	*ns*
Exam	*ns*	*ns*	*ns*	*ns*	*ns*
Presentation	*ns*	Trend	Trend	Sig (pos)	*ns*
Project	*ns*	*ns*	*ns*	*ns*	*ns*
Participation	*ns*	*ns*	*ns*	*ns*	*ns*
Paper	*ns*	*ns*	*ns*	*ns*	*ns*
Homework/problem set	*ns*	*ns*	*ns*	*ns*	*ns*
Quizzes	*ns*	Trend	*ns*	*ns*	*ns*
Discussion/blog posts	*ns*	Trend	*ns*	*ns*	*ns*
Other	*ns*	*ns*	*ns*	*ns*	*ns*
Percent needed for A (rev.)	*ns*	*ns*	*ns*	*ns*	*ns*
Number of recovery mechanisms	*ns*	*ns*	*ns*	*ns*	Trend
Extra credit	*ns*	*ns*	*ns*	*ns*	*ns*
Grade manipulation	*ns*	*ns*	Trend	Sig (neg)	*ns*
Resubmission	*ns*	*ns*	*ns*	Trend (pos)	*ns*
Additive grading system	*ns*	*ns*	*ns*	*ns*	*ns*
Number of types of assignment scaffolds	*ns*	*ns*	Sig	*ns*	*ns*
Assignment proposal	*ns*	Trend	Sig	*ns*	*ns*
Instructor-reviewed draft	*ns*	Sig	*ns*	*ns*	*ns*
Peer review	Trend (neg)	Trend	*ns*	*ns*	*ns*
Other	*ns*	Trend	*ns*	*ns*	*ns*
Percent of low-stakes assignments	*ns*	Trend	*ns*	*ns*	*ns*
More than 0% versus 0% (A)	*ns*	*ns*	*ns*	*ns*	*ns*
21%-40% versus 0% (B)	*ns*	*ns*	*ns*	*ns*	*ns*
41%-80% versus 0% (B)	*ns*	*ns*	*ns*	*ns*	*ns*
81%-100% versus 0% (B)	*ns*	Trend	Trend	*ns*	*ns*
51%-100% versus 0-50% (C)	Trend (neg)	*ns*	*ns*	*ns*	*ns*
1%-40% versus 0% (D)	*ns*	*ns*	*ns*	Trend (neg)	*ns*
41%-80% versus 0% (D)	*ns*	*ns*	*ns*	*ns*	*ns*
81%-100% versus 0% (D)	*ns*	Sig	*ns*	*ns*	*ns*
Percent of optional assignments	*ns*	Sig	*ns*	*ns*	*ns*
More than 0% versus 0% (A)	*ns*	Sig	*ns*	*ns*	*ns*
1%-40% versus 0% (B)	*ns*	*ns*	*ns*	*ns*	*ns*
41%-100% versus 0% (B)	*ns*	Sig	Trend	*ns*	*ns*
1%-50% versus 0% (C)	*ns*	*ns*	*ns*	*ns*	*ns*
51%-100% versus 0% (C)	*ns*	Sig	*ns*	*ns*	*ns*
51%-100% versus 0-50% (D)	*ns*	Trend	*ns*	*ns*	*ns*

	RAI			Cost	
	Main effect	Interaction: Cumulative GPA	Interaction: Cost	Main effect	Interaction: Cumulative GPA
Percent of assignments with within-assignment choice	*ns*	*ns*	*ns*	Sig (pos)	*ns*
More than 0% versus 0% (A)	*ns*	*ns*	Sig	*ns*	*ns*
21%-40% versus 0-20% (B)	*ns*	*ns*	Sig	*ns*	*ns*
41%-100% versus 0-20% (B)	*ns*	*ns*	*ns*	Sig (pos)	*ns*
1%-25% versus 0% (C)	*ns*	*ns*	Trend	*ns*	*ns*
26%-100% versus 0% (C)	*ns*	*ns*	*ns*	Trend (pos)	*ns*
26%-100% versus 0-25% (D)	*ns*	*ns*	*ns*	*ns*	*ns*

Note. Raw dimensions are bolded and recoded dimensions are indented and listed below their respective raw dimension. For each significant or trending main effect the direction is listed (pos. or neg.). For more detail on significant ($p < .05$) interactions, see the interaction plots in this chapter. Main effects were drawn from models that included only the dimension in question. The main effects were not pulled from the models containing an interaction term.

Analysis of Course Syllabi

Based on the moderation analyses, relatively high achieving students respond differently to certain autonomy-supportive course design features than low achieving students. In addition, students who perceive a higher than average cost of engaging with a course respond differently to features than students perceive a lower than average cost. It may be that instructors can scaffold how to engage with the autonomy-supportive features of their course to as some students may not be used to or adept at making the kinds of choices in courses that use autonomy-supportive design features. I examined the course syllabi from the 27 courses in this study to see if there were any ways that instructors were helping students engage with the level of autonomy in their course. Before reviewing the syllabi I established three ways that instructors could scaffold the process of adapting to autonomy-supportive course design based on theoretical notions of instructor autonomy support (Reeve, 2009; Black & Deci, 2000). One way instructors could have helped students adapt to the autonomy-supportive course design features is to scaffold the process of making choices between assignments (if optional assignments were available in a class). For instance, an instructor could not only give students the choice between two assignments, but also explain what each option would entail in terms of planning and execution. I also looked for whether or not a course syllabi prioritized information about assignments, grades, and scoring, or information about the pedagogical style or philosophy about a course. Lastly, I examined if there was any evidence that the instructor provided students with any assistance or tools to keep track of their work outside of the due dates listed in the syllabi. Each class received a binary code for each category or "NA" if the class did not include any assignment choice. No emergent categories or trends emerged during the coding process. See Table 14 for a summary of the coding results.

Table 14
Summary of Syllabus Analysis

Class name	RAI	Has between-assignment choice	Has within-assignment choice	Does class scaffold assignment choice (between and/or within)?	Does the class prioritize information about grades or information about pedagogy?	Aside from listing the due dates and course schedule, does the syllabus point students toward resources to help them plan and keep track of work?
EN2	-2.10	Yes	No	No	Grades	No
SO4	-0.60	No	No	NA	Grades	No
EN3	-0.33	No	Yes	No	Grades	No
AS1	-0.18	Yes	No	No	Grades	No
AS3	-0.08	No	No	NA	Grades	No
EC1	0.13	No	No	NA	Grades	No
AN1	0.43	No	Yes	No	Grades	No
EC2	0.64	No	No	NA	Pedagogy	No
EN1	0.64	Yes	Yes	Yes	Grades	No
ED3	0.69	Yes	Yes	Yes	Pedagogy	Yes
LI2	0.72	No	No	NA	Grades	No
SO3	0.82	No	No	NA	Grades	No
PS4	0.87	No	No	NA	Grades	No
HI3	1.06	No	Yes	No	Grades	Yes
SO2	1.06	Yes	Yes	Yes	Pedagogy	Yes
AN2	1.18	No	Yes	No	Grades	No
PS1	1.36	Yes	Yes	No	Grades	Yes
AM1	1.43	Yes	Yes	Yes	Grades	No
PS3	1.44	Yes	No	No	Grades	No
AS2	1.53	Yes	Yes	No	Grades	No
LI1	1.75	No	No	NA	Pedagogy	Yes
HI1	1.83	No	Yes	No	Grades	No
PS2	2.37	No	No	NA	Grades	Yes
SO5	2.83	Yes	Yes	Yes	Grades	Yes
SO1	3.04	No	Yes	No	Pedagogy	No
HI2	3.07	No	Yes	No	Pedagogy	No
PO1	3.28	Yes	Yes	No	Pedagogy	No

Note. This table is sorted by RAI from lowest (more controlled motivation) to highest (more autonomous motivation).

18 of the 27 classes contained some sort of assignment choice (between or within-assignment). Out of those 18 courses, four courses scaffolded that assignment choice in some way. All four courses employed proposals as a scaffold for planning out one's topic. Another course (SO5) provided example topics in addition to having students turn in proposals ahead of time. A second course (SO2) offered between assignment choice and laid out a sample week by week timeline for each of the assignments that students could choose from. Out of these four

classes, three were in the top half of the 27 classes in terms of RAI and one course was in the top five classes. None of the classes were in the bottom five in terms of RAI

7 of the 27 courses prioritized information about the course's pedagogical or instructional style over information about assignment expectations and grading. For instance, one course syllabus (LI1) prioritized information about the course's team-based learning philosophy before discussing course assignments. Another course (HI2) drew attention to the emphasis on active learning and why the professor chose to design the course around active learning opportunities. Other courses, such as EC2, described the kind of student (academic background, learning style), that would be likely to thrive in the course. Of those seven courses, two of them were in the bottom half of classes in terms of RAI and five were in the top half. Three of classes were in the top five in terms of RAI and none were in the bottom half.

7 of the 27 courses provided students with additional resources to help them plan and keep track of work aside from listing assignment due dates. One class (HI3) provided study questions in the syllabus to help students focus their attention during the readings. Another class (PS2) encouraged students to begin reading the material necessary to write the papers at least two weeks before the papers were due thus helping students plan their work. Of these seven classes, one was in the bottom half of classes in terms of RAI and one was exactly at the halfway mark. Five classes were in the top half of classes in terms of RAI with two classes in the top five. No classes were in the bottom five in terms of RAI.

Overall, two classes fit into all three categories. One was in the bottom half and one was in the top half of classes in terms of RAI. All classes in the top five in terms of RAI fit into at least one of the three categories.

Summary of Findings

There were no main effects of autonomy-supportive course design dimensions on student autonomous motivation (RAI). However, this relationship was moderated by cumulative GPA and/or cost for certain dimensions. This means that students reacted in different ways to autonomy-supportive course design based on their level of academic achievement and their perceptions of the cost of engaging with the course. Cumulative GPA did not have a main effect on RAI or on cost, but cost did have a main effect on RAI. This means that high achieving students are not necessarily more autonomously motivated than others, but students who perceive that a course does not demand a lot of their time are more able to engage autonomously with a course. Combined with the interaction effects, this suggests that it takes time and effort to look past the logistical constraints of a course (e.g. grades, deadlines) to engage with it in an autonomous way. Given that students react to autonomy-supportive course design differently, instructors may need to find ways to scaffold the autonomy-supportive aspects of their course design. The syllabus analysis revealed potential ways that instructors introduce the autonomy-supportive aspects of their course although the effect of those aspects of the syllabus is unknown as it was not directly measured in this study. Interpretations and implications of these findings are discussed in more detail in the following two chapters.

Chapter 6: Discussion and Implications

The primary goal of this dissertation is to explore how variation in the employment of autonomy-supportive course design features affects the degree to which students internalize their motivation to do well in a course. Autonomy-supportive course design, a construct rooted in Self-Determination Theory, is a key component of gameful pedagogy. While the results of this study do not speak to the impact or likely impact gameful pedagogy on student motivation directly, they do provide valuable information to consider in terms of how autonomy-supportive course design is employed in the design of future gameful courses. Student individual differences, such as their perceptions of the cost of engaging with a course, as well as demographic factors, such as academic ability (cumulative GPA) affect the way that students react to course design. Adjusting to an autonomy-supportive course design is not a trivial task and instructors may wish to consider providing scaffolds to aid students in this adjustment.

SDT is an ideal lens through which to study the ways that autonomy-supportive course design features can inform gameful course design due to the way that the distinction between gamification and gameful design maps onto the SDT distinction between extrinsically and intrinsically motivating contexts. Support for student autonomy is a key facet of gameful course design, and while there are many possible avenues through which student autonomy might be supported, the depth and breadth of SDT research on autonomy support in education supports the use of research-driven ideas to guide course design and study how it affects student motivation. In this sense, SDT is both the inspiration for the identification of autonomy-supportive course design features as well as the framework for analyzing the effects of said course design on student autonomous motivation in this study. Autonomy-supportive course design in this dissertation is studied through the relationship between ten autonomy-supportive course design features (later reduced to 8 based on patterns in the data) and student autonomous motivation, operationalized as the relative autonomy index (RAI). The relative autonomy index represents the relative strength of a student's autonomous versus controlling motivation as it pertains to a particular environment or activity, which in this case was a particular class. Students answered items that fit into one of the following four subscales: external regulation, introjected regulation, identified regulation, or intrinsic regulation. The relative autonomy index was calculated using the following equation: 2 x intrinsic + identified – introjected – 2 x external. A student's RAI represents the quality or type rather than the amount of their motivation. Positive numbers meant a student felt more autonomous motivation and negative numbers meant that a student felt more controlled motivation toward their class. A student who approaches their class with autonomous motivation focuses on things like how class activities are relevant to their interests, their enjoyment of coursework, their interest in the material, and how coursework helps them develop competencies in their areas of interest. On the other hand, a student who approaches their class with controlled motivation focuses on more external factors such as deadlines, grades, time management and the cost of putting effort into an assignment, and how certain assignments would impact their grade (Deci & Ryan, 2000). It is not that students who are autonomously motivated do not think about external factors, but rather that more autonomously motivating aspects of the work are more salient. In other words, these students are able to go beyond the external factors to internalize the autonomously motivating aspects of the work.

I also draw on constructs from Expectancy-Value Theory, in particular cost, as well as Achievement Goal Theory in order to lend additional context to the impact that these design features have on student motivation. I studied how student individual differences impacted the relationship between autonomy-supportive course design and autonomous motivation as well as perceptions of cost. This exploratory study of autonomy-supportive course design is guided by the following research questions:

- RQ1: How is the employment of autonomy-supportive course design dimensions related to student autonomous motivation?
- RQ2: How do student individual differences relate to student autonomous motivation?
- RQ3: How do student individual differences affect the relationship between autonomy-supportive course design dimensions and student autonomous motivation?

Exploring data related to the first research question helped me understand if more autonomy-supportive course design was more beneficial for student motivation. The results revealed no significant main effects of autonomy-supportive course features, meaning that either the relationship is non-linear, the relationship is different for different types of students, that the autonomy-supportive course design dimensions were not optimally coded, or that there is no relationship between an autonomy-supportive course design dimension and RAI. I recoded the autonomy-supportive course design dimensions and found few main effects, lending credence to the idea that students may be responding differently to the design features and that more autonomy-supportive course design may not necessarily be better for autonomous motivation. The SDT literature suggests that autonomy support is beneficial as long as it is accompanied by the appropriate amount of structure (Vansteenkiste et al., 2012) which means that there is some precedent for increased levels of autonomy support not necessarily being more autonomously motivating for students. If students do respond differently to autonomy-supportive course design based on individual and demographic factors it will be important for instructors to consider ways that they can help students adapt to more novel course design features. I used the findings from the first and second research question to inform the moderation analyses in research question 3 to see if different students responded differently to autonomy-supportive course design.

In this chapter, I summarize the results and interpretations pertaining to the three research questions and discuss the potential interpretations and implications for the use of autonomy-supportive course design in gameful courses. Broadly, these results show that students react to autonomy-supportive course design features differently. Part of the differences in the way students respond to autonomy-supportive features (whether they approach the course from a controlled or an autonomous orientation) may have to do with the way they perceive the choices presented to them in the class. Even though they may be given choice between assignments or the choice to engage in extra credit to make up for a low grade, students may have felt a compulsion to choose one option or another. While I do not directly measure the way that students perceive choices, the results from the moderation analyses (research question 3) and research related to choice and autonomy suggests that there are individual differences in the way people perceive choices. This phenomenon is referred to as illusory choice (Sullivan-Toole et al., 2017). Individual factors such as academic ability (represented as cumulative GPA) and perceptions of the time and effort that a class demands (represented as cost) influence the way that students perceive some of the choices in their classes. These findings are analyzed with the consideration that the context for this study—the University of Michigan—is a highly competitive and demanding institution and thus students may be approaching their education from an efficiency perspective; looking for the quickest and easiest way to earn the grades that they want (Schwartz, 2000). Yet not every student adopts this perspective. While it is not fully clear how student perspectives or academic orientations differ, it is apparent that different perspectives (for instance, perceptions of cost) affect the way students react to autonomy-supportive course design.

Research Question 1: How is the employment of autonomy-supportive course design dimensions related to student autonomous motivation?

Autonomy-supportive course design dimensions, in their raw or recoded forms, had no main effects on student autonomous motivation (RAI). Out of the other potential dependent variables (expectancy, utility, cost, mastery classroom goal structure, performance approach classroom goal structure), cost was the only one that had any relationships to autonomy-supportive course design dimensions (aside from lower utility value relating to peer review). One possible reason for the lack of main effects is that autonomy-supportive course design may not be effective if it has to conform to a highly extrinsic grade-based system. When a student graduates from college, their grades and their GPAs are what is used to represent their knowledge and achievements. In this sense it does not matter how a student feels about a class (autonomous or controlled) so long as they earn a high grade. At institutions like the University of Michigan, where students have stressed and over-packed schedules, students may be looking for the quickest and most efficient path to an “A” in each of their courses as a first priority rather than looking for ways to autonomously relate to the content. While the autonomy-supportive course design dimensions in this study give students increased choices and control over their work, they also entail an additional task of managing choices and/or increased time management concerns due to more assignments (low-stakes assignments) or assignment components (scaffolds and recovery mechanisms). Thus rather than focusing on the autonomous benefits of autonomy-supportive course design (e.g. being able to tune course assignments to one’s interests, more opportunities to earn points), students may focus on the more controlling aspects of assignments like how long they will take to complete, and the impact of a particular assignment on their final grade. In a system where all that matters is one's final grade and GPA, the most efficient path to that grade involves the instructor clearly laying all expectations and assignments that students must complete without much autonomy. In fact, SDT researchers (Vansteenkiste et al., 2012; Hospel & Galand, 2016) have found that autonomy support coupled with the appropriate amount classroom structure is the best way to promote student autonomous motivation. In addition, autonomy support is not just about offering students increased choices, but also about creating an overall classroom climate where students feel valued and able to express their true thoughts and feelings (Reeve, 2009). It may be that increased choice, which is the primary driver behind the autonomy-supportive course design features in this study, is not a good fit for this particular university environment due to the reduced efficiency in earning the highest grade possible and that instructors should consider other ways of enacting autonomy support.

Another potential interpretation of the lack of main effects, and one that is more likely based on the moderation analyses, is that autonomy-supportive course design affects different students in different ways and that when looked at this phenomenon in aggregate, the effects appear null. In an article advocating for constrained choice in education, Barry Shwartz (2000) asks, "What kind of game is being a student? Are the objectives of the student game to get the best grades possible? If so, a good student will find the easy courses, borrow other students' assignments, and ingratiate himself or herself in every way possible with the relevant teachers" (p. 80). Yet he goes on to explain that this is just one possible student perspective. "The good student at this game will look very different from the good student at the other games" (p. 80). In other words, even though the “efficiency game” may be a popular perspective among students at Michigan, it may not be the only perspective from which students approach their schoolwork. Although I do not have any measures of a student’s overall orientation toward schoolwork, I did examine how student individual differences such as their academic ability (cumulative GPA) and perceptions of cost for a particular class influence their autonomous motivation for a course in research question 3.

These findings have important implications for the use gameful course design in college classes. Since autonomy-supportive course design features are just one component of gameful design, instructors employing gameful design should be sure that appropriate structural supports are in place, such as clear documentation and timely feedback, in order to help students navigate choices in gameful courses. In addition, gameful courses should not sacrifice student efficiency for extraneous systems and design features. If a feature of gameful course design, including increased choices, obscures what students need to do to earn the grade that they want without any tangible benefit, then that feature should not be used. As with all pedagogical techniques, instructors employing gameful pedagogy need to carefully consider student learning goals and how their course fits into the overall university climate.

Research Question 2: How do student individual differences relate to student autonomous motivation?

Perceived competence, metacognitive skills: planning, monitoring, and regulation, utility value, feeling in control of one’s grade, and understanding how to earn one’s desired grade were all positively related to RAI. Classroom goal structure: performance approach and performance avoidance, expectancy, and cost were all negatively related to RAI. The variables that significantly related to RAI represent an increased focus on extrinsic aspects of a course or constructs that represent a focus that goes beyond the extrinsic nature of the course to focus on the more autonomous aspects. One interpretation is that when a student feels confident in their ability to master material (perceived competence), and when they feel in control of their grade (autonomy) they are more autonomously motivated to engage in course work as they are more attuned to mastery and their ability to affect their outcomes rather than extrinsic constraints such as grades. On the other hand, students who expect to do well in a course (expectancy) have less autonomous motivation which symbolizes more of a focus on grades as doing well is dependent on one's grades. Students who perceive an increased cost of engaging with the course may also be more focused on grades, deadlines, and expectations. If a course demands too much of their time, students will likely only have the bandwidth to think about the bare minimum necessary to earn their desired grade. Increased focus on and use of planning as a metacognitive skill, knowing how to earn one's desired grade, as well as recognizing the utility value of a course are also representative of students looking beyond grades and deadlines and thinking about how a course relates to themselves (autonomy satisfaction) and how they can get the most out of a given course (planning and understanding how to earn desired grade).

These findings illustrate that, when designing gameful courses, instructors need to be careful not to inadvertently increase student focus on grades and points. Changing the grading structure of a course to be additive (student final grades are a sum of assignment grades rather than an average) is one potential feature of gameful courses. This feature is designed to promote risk taking and safe failure allowing students to recover from setbacks by putting in additional effort. While this kind of feature seems like it would reduce the need to focus on points, the novelty of the point structure may mean that students end up spending more time thinking about points to try and understand the alternative system. Instructors may wish to emphasize the benefits to planning (as the use of planning and knowing how to earn one's desired grade were related to increased autonomous motivation) that an additive system affords in order to help students become accustomed to a novel style of grading. Students may see the necessity to understand a gameful grading system as an extra external burden. By emphasizing the way that a gameful grading system theoretically promotes competence, grading transparency, and allows for more planning, instructors may be able to help students rationalize potential added costs of engaging with a gameful course and approach coursework from a more autonomous perspective.

Perceptions of performance approach and performance avoidance classroom goal structures related to lower autonomous motivation in students. Rather than a focus on mastery and learning the material, performance approach and performance avoidance goal structures embody a concern with performance as it relates to others which is characteristic of more controlled, extrinsic motivation.

It is worth noting that a mastery-oriented classroom goal structure was not a significant predictor of RAI, although it trended toward significance. This result was surprising since a mastery-oriented environment shares much in common with an autonomy- and competence-supportive environment. It may be that students are more attuned to the performance-oriented aspects of their classes thus in some ways the performance components may counteract the mastery components. This possibility would impact the use of gameful pedagogy as well. It is difficult to promote a mastery climate within a course when the rest of the university operates within a performance climate. While gameful course design has the potential to be mastery-oriented, in most settings it is situated within a performance climate meaning that instructors still need to think about how novel course practices impact student efficiency and whether the grading system is fully transparent. I expected that monitoring one's grade would have been associated with less autonomous motivation due to the focus that the act of monitoring brings to extrinsic aspects of a course. However, it may be that checking in on one's grade is a normative behavior and does not mean that students care any more or less about the grade. In the survey, the metacognitive skills: monitoring and regulation do not capture how often a student checked in on their grade but instead captured the way that a student monitors and adjusts their work process on course assignments which represents going beyond a focus on extrinsic logistics to focus on more how the individual is relating to course material.

Perceived competence, the metacognitive skills of planning, RAI, feeling in control of one's grade, and understanding how to earn one's desired grade were negatively associated with perceptions of cost. Classroom goal structure: performance approach and performance avoidance, and the metacognitive skill of regulation were positively associated with perceptions of cost. An increased perception of cost represents students feeling like they spend too much time worrying about the more controlling, extrinsic aspects of a course or variables like planning that represent an engagement that is separate from coursework. The variables that significantly predicted cost were variables that represented something that requires increased engagement in a course or things that indicate a boost in student confidence which may signify that students feel that they spend appropriate amount of time engaging with a course.

One possible explanation for these findings is that perceived competence was negatively related to cost because students who are confident in their ability to master concepts likely anticipate that a course will not demand too much of their time. Feeling in control of one's grade and understanding how to earn one's desired grade may be negatively related to cost for similar reasons in that they reduce unnecessary time that students need to spend worrying about grades, deadlines, and other extrinsic aspects of a course. In addition, students who feel more autonomously motivated to engage in a course are likely to be less concerned with extrinsic factors like time management and more concerned with delving deeper into a course to understand how it relates to themselves and enjoying the experience of learning. On the other hand, planning out one's work schedule takes a lot of time (metacognitive skills: planning) as does having to engage in a lot of self-regulatory behaviors. If students employed more self-regulatory behaviors it may mean that they were more distracted or frustrated and needed to bring themselves back on task often. This may relate to feeling like they spent too much time on assignments and coursework than they wanted to hence the increased perceptions of cost. Performance approach and performance avoidance orientations align with a concern with one's performance especially as it relates to others. Being overly concerned with looking good compared to classmates or trying to avoid looking bad may mean that students not only completed assignments to the best of their ability, but they also spent extra time worrying about whether or not what they did is better than everyone else.

Research Question 3: How do student individual differences affect the relationship between autonomy-supportive course design dimensions and student autonomous motivation?

The presence of autonomy-supportive course design features may necessitate that students adapt their work strategies and/or habits in order to successfully engage with a course and earn the grade they desire. For instance, optional assignments require that students think about their own abilities and how those abilities map onto the assignment choices, the amount of work each assignment choice would require, how the current choice would impact work on other assignments, and other factors that are not inherent to the assignment itself when making a decision about which assignment to choose out of a set of optional assignments. When completing a required assignment, students do not need to consider these things as there is no need to make a decision between different options. Adaptations may be easy or difficult for a student depending on their academic ability (represented in this study by cumulative GPA) and the adaptation may require a little bit or a lot of time (the latter of which could be problematic for students who perceive a high cost of engaging with the course). Through an analysis of the way that cumulative GPA and cost moderate the way that students react to gameful course design I have identified potential explanations for why autonomy-supportive course design impacts students in different ways.

Some of the autonomy-supportive course design dimensions in this study impacted high achieving students (one standard deviation above the mean cumulative GPA in this sample) differently than low-achieving students (one standard deviation below the mean cumulative GPA in this sample). In the following sections, when I talk about high and low achievers or students with high or low academic ability I am referring to students whose cumulative GPA is higher or lower relative to other students in this sample. Autonomy-supportive course design dimensions may require students to adapt to different kinds of work, make decisions, and have to keep track of extra deadlines that may throw off their work process. These can be difficult tasks. One potential explanation is that students with above average academic ability were not stressed by the tasks and behaviors associated with adapting one's work style to accommodate gameful course design elements and thus they felt more autonomously motivated because the variety, increased responsibility, and/or additional opportunities for feedback helped them see the value of the assignments for their own learning, increased their enjoyment of the work, and pushed them toward mastery. Students of below average, and sometimes average, academic ability may have seen these additional elements as constraints or just other things that they had to keep track of. Managing these extra elements potentially created additional stress which related to students approaching work with a more controlled orientation. Students approaching work from a more controlled orientation were focused more on extrinsic factors (Deci & Ryan, 2000) and could have been more concerned with deadlines, stress about time management, the actual task of adapting their work habits to different kinds of assignments, and adjusting their time commitments accordingly. There is some precedent for high achieving students being more receptive to choice in their courses. Seifried et al. (2018) studied the effectiveness of a series of optional activities in an educational psychology course. In this course there was a mandatory final exam and two required writing assignments. In addition there were six optional writing assignments that students could submit. They found that students who engaged with the optional assignments had better performance on the final exam (controlling for academic ability). However, students with high existing GPAs were more likely to seize those optional opportunities supporting the notion that higher academic ability students are better positioned to take advantage of assignment options in a course. This explanation was supported by significant interactions between cumulative GPA and the following autonomy-supportive course design dimensions predicting RAI: number of assignment types, the percent of low-stakes assignments (81%-100% versus 0%). This explanation was also supported by the lack of interactions between cumulative GPA and the following gameful course design dimensions predicting RAI: percent of points needed for an A (reversed), the number of recovery mechanisms, the use of an additive grading system, the number of types of assignment scaffolds, the percent of low stakes assignments, and the percent of assignments with within-assignment choice predicting RAI.

Sullivan-Toole et al. (2017) make a distinction between free choice and illusory choice. Whereas a free choice is unconstrained by external factors, an illusory choice is constrained by external factors and thus is not a true choice (hence the term “illusory”). This is another potential explanation for the moderation effects involving cumulative GPA. For instance, imagine that a course gave students the choice between completing an essay or an exam as an end-of-unit assessment. A high achieving student who is proficient in both types of assignments had a free choice between the essay and the exam. A low-achieving student who, for example is not a confident essay-writer, felt compelled to take the exam because they were not confident in their writing abilities. This latter situation is an example of an illusory choice. Even though the low achiever had the same choice as the high achiever, an external compulsion (perceptions of their own ability) made it so it did not feel as though they were making a choice. Moller et al. (2006) came to a similar conclusion when they found that students were more likely to persist at an impossible figure tracing task when they were given an autonomous choice over which side to take in a persuasive speech compared to when they were given a controlled choice over which side to take (the experimenter told them that they really needed more participants to choose a certain side). The different ways that students can perceive the same choice is another potential explanation for the different ways that high achievers and low achievers reacted to gameful course design.

A student's desire or ability to put effort into a course is represented by cost ("this class demands too much of my time"). If a student perceived a high cost of engaging with the class they may have approached the necessity of putting more effort into a course from a controlled perspective. If they perceived that a class did not demand much of their time (low cost) then they might have been more open to putting more effort into a course if necessary and approached it from an autonomous perspective if, for instance, gameful course design dimensions prompt a change in work habits. Perceived cost changed the way that students reacted (RAI) to the prospect of having to adapt their work habits. Adapting to different kinds of work, making decisions, and having to keep track of extra deadlines represented an increased time commitment. This extra time commitment could have prompted a student who already felt that a course demands too much of their time (high cost) to approach their work from a more controlled orientation as they may have already been more fixated on time management and other external factors. It is possible that a student who already felt a strong demand on their time only had the bandwidth to interpret the need to adapt to accommodate different kinds of work as a function of logistical concerns (controlled motivation). Students who perceived a low cost, on the other hand, potentially had the time to go beyond the logistical interpretation of this adaptation and consider it from a more autonomous perspective. If a student perceived that a course did not demand too much of their time, then they would potentially have had the time to engage autonomously with these additional course elements. Since they perceived that they had the time to engage with them, they could approach them from an autonomous orientation and take the time to enjoy the process, and recognize the importance for their own learning. Students who felt that a course demanded too much of their time approached their work from a more controlled orientation and, based on SDT, were likely concerned with: time management, meeting deadlines, and doing enough to get the grade they wanted and no more. The relationship between autonomy-supportive course design features that require you to spend more time engaging with a course (either on the assignments themselves or on the time you spend having to think about aspects of a course) and RAI were moderated by cost. This interpretation is supported by significant interactions between cost and the number of assignment types, the number of types of assignment scaffolds, the use of assignment proposals, and certain amounts of within-assignment choice predicting RAI.

In a study where they manipulated both illusory versus true control as well as low versus high effort cost, Sullivan-Toole et al., (2017) found that students were more motivated by autonomous (as opposed to controlled or illusory) choice when the effort cost of engaging in an activity was low rather than high. For activities that students perceive as high in effort cost, they were likely to approach choices and autonomy in those activities from a controlled perspective even if the choice was autonomous without constraints. This is one potential explanation behind the interactions with cost in the current study. Students who perceive that a class demands much of their time and effort may have been more likely to approach choice, or other elements that prompt an increase in time commitment, from a controlled perspective.

Additionally, it is possible to be autonomously motivated despite the known presence of extrinsic constraints. If a person recognizes the existence of extrinsic constraints but also internally endorses their decision then they will feel more autonomously motivated whereas if someone feels that they are only making the choice because of external constraints without an internal endorsement then they are more likely to feel controlled motivation (Ryan & Deci, 2006). For example, imagine that there are two students in the same pre-med required class. One student thinks that they need to earn a good grade because they would get in trouble with their parents if they did not. Another student thinks that they want to earn a good grade because they value the class as part of their career goals. Both students recognize the existence of an external constraint, their grade in the class, but the former student lacks an internal endorsement for putting time and effort into the class whereas the latter student has internally endorsed their decision to put time and effort in to earn a high grade. Based on SDT, one would expect the first student to approach the course from a more controlled perspective and the latter student to approach the course from a more autonomous perspective. In other words, a student may recognize that a class demands a lot of time and effort (extrinsic constraint), yet they may recognize the value in the way that the particular class affords them the autonomy to shape their own learning and thus approach that increased time commitment from an autonomous perspective. They may even report a low perceived cost as even though this class demands a lot of time, they do not feel as if it demands too much time. Thus, the presence and strength of a student's internal endorsement of their decision to put time and effort into a class could be another driver behind the interactions between gameful course design dimensions and cost predicting autonomous motivation. Part of this internal endorsement may have been captured in the survey item that measured cost, but not directly so it is impossible to say definitively.

In employing autonomy-supportive course design in gameful courses, instructors should consider the difficulty that comes with having to make high-stakes choices (students are concerned about their final grades so any choice they make in a course is potentially high-stakes). The qualitative analyses of syllabi suggests that instructors can help students engage with autonomy-supportive course design by calling attention to and explaining the rationale behind novel pedagogies, helping students make choices by providing additional information about key choices, and by giving students suggestions for how to manage their time when completing work for their course. This kind of scaffolding may help the lower-achieving students approach choices from a more autonomous perspective since the instructor would be providing the additional information that these students may be struggling to figure out. In addition, it could conceivably take some of the load off of students who perceive a high cost of engaging with a course since considering and making choices would not take as much time. Even though these scaffolding methods were not directly studied quantitatively it could be important for instructors of gameful courses to consider providing this kind of additional scaffolding to help students adapt to gameful course design.

Chapter 7: Conclusion

In this final chapter, I discuss potential limitations of the current study as well as directions for future research to address those limitations and to expand upon the implications addressed in the previous chapter. The chapter ends with an overall conclusion in which I discuss how my findings might inform the way that autonomy-supportive course design can be employed in gameful courses.

Limitations

While this study was successful in that autonomy-supportive course design was studied across a large number of courses with varying amounts of autonomy-supportive course design, it is not without its limitations. The current study was cross-sectional in that students only completed the survey at a single time point. In addition, due to time constraints, I was not able to obtain trait measures of motivation, only measures of motivation as they pertained to a particular class. Thus, all claims in these final two chapters are tentative in that students could have entered their classes with a certain level of motivation and that motivation could have been unaltered by autonomy-supportive course design. While there was significant variation in RAI across courses it is still difficult to make definitive conclusions with certainty. Despite this limitation, the study drew attention to the way that different types of students responded to gameful course design.

Another survey-related limitation was that the survey did not contain any questions about students' orientation to specific autonomy-supportive course design dimensions. These questions were omitted once again due to completion time considerations to maximize student response rate. While the survey questions asked students to respond about their feelings about a course as a whole, knowing how they reacted to specific course design dimensions could have provided additional context for interpreting the interaction effects.

Data from this study came only from the student perspective. I have no information about instructor intentions behind the implementation of the autonomy-supportive course design dimensions or if instructors were explicitly thinking about supporting student autonomy when they made course design decisions. In addition I do not have any observational data on how instructors acted during the class itself. While course design certainly played a role in student motivation, the way that an instructor interacts with students also plays a major role. These data would have been compelling but they were beyond the scope of this particular study.

Lastly, while not necessarily a limitation, this study represents only a small slice of potential enactments of autonomy support. The design dimensions that I chose represent a fraction of the potential ways that instructors could use course design to support student autonomy. I examined the impact of autonomy-supportive course design on students at a large, competitive research institution. It may be that students would react differently to autonomy-supportive course design at small liberal arts colleges or other types of institutions.

Future Directions for Research

Based on the results of this study there are a number of compelling directions for future research. A potential future direction is to administer this same survey in a different type of institution to see if the institutional climate is related to the way that students react to autonomy-supportive course design.

In future studies it would be valuable to examine the impact of autonomy-supportive course design alongside instructor intentions. The analysis of course syllabi in the current study suggests that instructors could influence the way students respond to gameful course design by providing additional support and scaffolding through course documents. This raises the question about whether an instructor's intent influences the way students react to autonomy-supportive course design. If an instructor explicitly adopts a gameful course design philosophy this shift in pedagogy could also change the way they interact with students in class or during office hours and this may in turn affect student motivation in response to particular design features.

Another compelling future direction would be to conduct the study in a smaller sample with increased instructor and student investment using both a pre- and a post-semester survey containing not only measures of motivation pertaining to the particular class, but also trait measures of motivation. These data would allow me to explore interactions between trait-level need satisfaction and gameful course design as it relates to student motivation, cost, and perceptions of the classroom climate. In addition, this lengthier survey could also contain measures about student reactions to specific course design features as well as their motivational orientation toward the class as a whole.

Studying autonomy-supportive course design in a sample of exclusively gameful courses matched to non-gameful courses of similar size, difficulty, and subject matter, that employ the same amount of autonomy-supportive course design could reveal the role that gameful course design plays in framing choice to students and if this framing helped students of all abilities feel more autonomously motivated when making choices.

Conclusion

One of the potential underlying explanations for the conclusions in this study is that students at Michigan approach their education from an efficiency perspective (Schwartz, 2000). Since grades and one's GPA are very important as those are the metrics that are carried through graduation, students look for the quickest and easiest path to an A. Having to make a lot of choices about assignments in a course, keeping track of additional deadlines, or otherwise having to adapt one's typical work style is often not the most efficient way to earn an A in a course. Thus it is important to keep in mind that in many ways autonomy-supportive course design may reduce student efficiency. Autonomy-supportive course design features are just one component of a gameful course. Gameful courses introduce even more novelty than courses that just employ autonomy-supportive course design. When designing gameful courses, instructors not only need to make sure that increased choice and novelty is accompanied by the appropriate amount of increased structure, but they also need to be sure that any features that add complexity to a course have a tangible, measureable benefits to student grades that is understood by students. Features that promote a gameful atmosphere, but do not benefit student performance or affect add needless complexity and may relate to students approaching choice and autonomy from a controlled rather than an autonomous perspective. This complexity without benefit is especially detrimental for students who approach their college education from an efficiency perspective (e.g. figuring out the easiest way to earn the highest grade possible).

Autonomy-supportive course design, as I have conceptualized it in this study, was not related to student motivation overall. Students reacted differently to this loss of efficiency and the necessity to adapt their work strategies in different ways. Another possibility is that students perceived choices differently based on individual factors (Seifried et al., 2018; Sullivan-Toole et al., 2017; Moller et al., 2006; Ryan & Deci, 2006). One student may have perceived a decision as an autonomous choice between a number of options whereas another student may have approached that same choice and felt compelled to choose a certain option. In this sense the choice was not actually a free choice as it was dictated by extrinsic concerns.

One explanation for the interactions between autonomy-supportive course design features and cumulative GPA predicting RAI is that high achieving students had an easier time adapting their work habits to autonomy-supportive course design than low achieving students. This results in increased autonomous motivation for high achieving students, but more controlled motivation for lower achieving students. It could be that low achieving students faced the challenge of adapting their work habits to accommodate an autonomy-supportive course in terms of more extrinsic factors like worrying about figuring out how to meet deadlines, concerns over how decisions impact grades, and over how much effort and time to devote to different kinds of assignments including making decisions about how to work on assignments or which assignments to work on. On the other hand, if high achieving students were more adept at this task, then they may not have been as stressed by the more extrinsic, logistical issues and instead were able to focus on the more autonomously motivating opportunities that autonomy-supportive course design presents, such as more ways to make course material personally meaningful, enjoying assignments more due to increased control, and knowing how to properly budget effort between important and less important assignments in order to maximize learning. Gameful pedagogy, at this time, is a novel course design philosophy for most students, thus engaging with a gameful course has the potential to create logistical concerns for students as they work to understand their grade within a new frame and different expectations for how they work on assignments. Even a well-designed course could engender these concerns. One of the potential interpretations of the moderation analyses in this study is that high achieving students deal with these logistical concerns more easily than low achieving students and thus are able to experience the autonomy-supportive course design from an autonomous rather than a controlled perspective. Gameful pedagogy and autonomy-supportive course design share the same goal of promoting student autonomous motivation. When employing autonomy-supportive course design in gameful courses, instructors should take care to minimize logistical issues through scaffolding or by scaling back the more logistically challenging features for the sake of all students, but especially low-achieving students.

Similarly, students who felt as if a course did not demand much of their time may have been more likely to approach this adaptation from an autonomous perspective whereas students who felt like a course demanded too much of their time were more likely to approach this adaptation from an efficiency perspective: how could they spend the least amount of cognitive effort adapting to this course design and still get the grade that they want? This line of thinking promoted a focus on the same kinds of extrinsic aspects of a course that low-achieving students may have focused on.

An analysis of course syllabi suggested that there were ways that instructors could help students adjust to the use of autonomy-supportive course design. It could be that the more autonomy-supportive course design features an instructor employs, the more scaffolding is needed to help students adjust to it. Of course some students do not need help with this adjustment, but to ensure that all students benefit from the choice in autonomy-supportive courses, additional attention to student individual differences is needed and additional scaffolds around decision making and effort allocation could be a potential solution. Lastly, instructors should carefully consider if an autonomy-supportive course design feature adds enough value to their course design by aligning with the student learning goals to warrant the increase in complexity. For instance, it may make sense to give students a choice between writing an essay or taking an exam in an introductory psychology course, but not in a first year writing course where exams do not align with the learning goal of introducing students to college-level academic writing. In an upper-level writing course, part of the learning goals of the course are to help students gain competence in the writing process. Thus it may be beneficial to have students submit assignment scaffolds at different stages (e.g. proposal, outline, rough draft) to get constructive feedback on different areas of their writing. In a lower-level course a professor may be more concerned with content than with writing quality and those additional scaffolds may not be necessary.

The current study represents an examination of a relatively small number of potential autonomy-supportive course design features, yet it examines those design features across a relatively large number of courses. While autonomy-supportive course design has an enormous potential to support students' need for autonomy, an attention to individual differences and the way that different students view increased choice (e.g. autonomous versus illusory) is essential. Autonomy-supportive course design is a major component of gameful courses thus concerns and considerations about the way that different students perceive choice should inform the design of gameful courses as well. Despite its limitations, this exploratory study of autonomy-supportive course design revealed much about the way that different students perceived autonomy-supportive course design features and raised important implications for the use of autonomy-supportive course design in gameful courses.

APPENDICES

APPENDIX A

Post-Semester Survey

NOTE: ${m://ExternalDataReference} was replaced with your course name

(Intro) Our research team is interested in how different course design decisions affect how students approach work in a given class. We are surveying a number of courses across campus including ${m://ExternalDataReference}. We are interested in how, if at all, the grading system in ${m://ExternalDataReference} affects the way you approach your work in this class.

This survey should take you about 10 minutes to complete, and your answers will inform ongoing work to make learning more engaging at Michigan. Thank you for helping!

Your participation in this survey is voluntary, and your answers will not affect your course grade. Your instructor may see data from this survey for the purpose of improving this course, but only ever in aggregate and de-identified form so they will never know your individual answers. Information in this survey is collected and managed by Professor Barry Fishman from the School of Information, as part of research designed to improve the design of grading systems like this across the university.

Your responses to this survey will be anonymized so that your responses cannot be linked back to you. Only aggregate and anonymous information will ever be shared with people other than Professor Fishman or his research team.

What we learn from the responses to this survey may be published in journals or presented at conferences, to help others understand how different types of course design might affect student effort and engagement. By completing this survey, you consent to participate in this research.

If you have any questions about this survey, please contact Dr. Fishman at fishman@umich.edu.

(incentive) At the end of the survey you will be able to opt into a drawing for a chance to win a $20 MasterCard gift card. In order to be entered into the drawing you must complete the survey then select "yes, I would like to opt into the drawing." After the survey closes, one winner will be randomly drawn for every (approximately) 200 students who completed the survey. You can only win one gift card and you will only be entered into the drawing once.

For example, the first drawing will include participants 1-200, the second will include participants 201-400, and so on. If you are selected as a winner you will be contacted by a member of Dr. Fishman's research team to provide a mailing address to which we can send the $20 gift card.

(Targeted items about the grading system, cost, utility value, and expectancy)

Read the following statements and choose the answer choice that best represents how true each of the statements is for you regarding the grading system in **${m://ExternalDataReference}**.

	Very untrue of me	Untrue of me	Somewhat untrue of me	Neutral	Somewhat true of me	True of me	Very true of me
I kept track of my grades throughout the semester.							
I understood what I had to do to earn the grade I wanted in this course.							
I felt like I was in control of my grades in this course.							
I expected that I would do well in this course.							
The material in this course is useful for me (e.g. for future classes, for a career).							
This class demands too much of my time.							
I wish my other classes used a grading system like the one in this course.							

(Responsibility) For each area listed below, please indicate the extent to which you believe that YOU and YOUR INSTRUCTOR are "responsible" for certain behaviors, thoughts, feelings, or outcomes **in ${m://ExternalDataReference}**. The more responsibility the higher the numbers you should select, according to the following scale:

No responsibility 0 1 2 3 4 5 Considerable responsibility

	Extent of MY RESPONSIBILITY						Extent of MY INSTRUCTOR'S RESPONSIBILITY					
	0	1	2	3	4	5	0	1	2	3	4	5
How well I learned the material												
My grade in the class												

Knowing how well I was doing in the class												
Whether I was interested in the class												
Getting the help I needed in this class												
How well I kept up with the assignments												

(Perceived Competence) Please respond to each of the following items in terms of how true it is for you with respect to your learning **in ${m://ExternalDataReference}**.

	Very untrue of me	Untrue of me	Somewhat untrue of me	Neutral	Somewhat true of me	True of me	Very true of me
I felt confident in my ability to learn this material							
I was capable of learning the material in this course							
I was able to achieve my goals in this course							
I felt able to meet the challenge of performing well in this course							

(Metacognitive Strategies) The following questions ask about your learning strategies and study skills for **${m://ExternalDataReference}**. Think back to your experiences in **${m://ExternalDataReference}** and how you studied and learned the material, then rate each question based on how true it is for you in **${m://ExternalDataReference}**.

	Very untrue of me	Untrue of me	Somewhat untrue of me	Neutral	Somewhat true of me	True of me	Very true of me
I planned how I was going to complete							

work in this course before I began.							
Before I began an assignment in this course I thought about what and how I was going to complete it.							
Before I completed work in this course, I planned how much time I would need to do an assignment.							
When I completed work in this course, I first figured out the best way to do so.							
Before I completed work in this course, I set goals for myself to help me learn.							
When I completed work in this course, I asked myself questions to make sure I knew I was completing the assignment correctly.							
When completing work in this course I tried to determine how well I had achieved the assignment's objectives and how well I learned what I needed to know.							
When I was completing work in this course I tested myself to make sure I knew the material.							
I checked whether I had learned the							

course material in this course.							
If I got confused with something I was doing in this course, I went back and tried to figure it out.							
If the coursework I was doing was difficult to learn, I slowed down and took my time.							
If I was having trouble completing work I tried other ways to do it.							
If I thought I didn't know a particular topic, skill, or concept well enough I made sure I learned it before completing additional work.							
If I was having trouble with a topic or assignment in this course I asked one of my peers for help.							
If I was having trouble with a topic or assignment in this course I asked an instructor or teaching assistant for help.							

(SRQ-A, relative autonomy index) Think about the question: **Why do I do my assignments in ${m://ExternalDataReference}?** Your assignments include things readings, studying for an exam, and the exam itself as well as assignments like problem sets or papers.

Respond to each of the items below based on how true it is for you regarding the question **Why do I do my assignments in ${m://ExternalDataReference}?**

	Very untrue of me	Untrue of me	Somewhat untrue of me	Neutral	Somewhat true of me	True of me	Very true of me
Because I want the professor to think I'm a good student.							
Because I'll get in trouble if I don't.							
Because it's fun.							
Because I will feel bad about myself if I don't do it.							
Because I want to understand the subject.							
Because that's what I'm supposed to do.							
Because I enjoy doing my assignments.							
Because it's important to me to do my assignments.							

Think about the question: **Why do I try to do well in ${m://ExternalDataReference}?**
Respond to each of the items below based on how true it is for you regarding the question **Why do I try to do well in ${m://ExternalDataReference}?**

	Very untrue of me	Untrue of me	Somewhat untrue of me	Neutral	Somewhat true of me	True of me	Very true of me
Because that's what I'm supposed to do.							
So my professor will think I'm a good student.							
Because I enjoy doing my course work well.							

Because I will get in trouble if I don't do well.							
Because I'll feel really bad about myself if I don't do well.							
Because it's important to me to try to do well in this course.							
Because I will feel really proud of myself if I do well.							
Because I might get a reward if I do well.							

(AGT-Classroom) The following questions are about **${m://ExternalDataReference}** as a learning environment. Please answer each question in terms of how true it is of **${m://ExternalDataReference}** as a learning environment.

	Very untrue	Untrue	Somewhat untrue	Neutral	Somewhat true	True	Very true
In this course, it's important to understand the work, not just memorize it.							
In this course, really understanding the material is the main goal.							
In this course, learning new ideas and concepts is very important.							
In this course, how much you improve is really important.							
In this course, the instructor thinks how much you learn is more important than your grades.							
In this course, it's important to get							

higher scores on assignments and/or tests than other students.							
In this course, it is important to get better grades than other students.							
In this course, it's important to show how smart you are compared to other students.							
The instructor encourages competition for better grades among students in this course.							
In this course, it's important not to get lower scores on assignments and/or tests than other students.							
In this course, it's important that you don't say something stupid in front of everyone.							
In this course, the instructor stresses not to do worse than other students.							
In this course, it's very important not to look dumb compared to others.							

(opting into the drawing) Would you like to be entered into a drawing to win a $20 MasterCard gift card? For more details about the drawing see below

- Yes, I would like to opt into the drawing
- No, I would not like to enter the drawing

You can only be entered into the drawing once and you can only win one gift card. For example, the first drawing will include participants 1-200, the second will include participants 201-400, and so on.

The amount of students in each drawing will vary somewhat based on the number of students who complete the survey. For instance, if 900 students complete the survey each drawing will contain 225 students rather than having 4 drawings with 200 students and one drawing with 100 students. If 850 students complete the survey then 2 drawings will contain 212 students and 2 drawings will contain 213 students.

If you are selected as a winner then you will be contacted by Ben Plummer (bdplum@umich.edu), a member of the research team, at your University of Michigan email address and asked to provide a mailing address where we can send you the gift card.

(End of Survey Message) Thank you so much for completing our survey! Our understanding of university course design is constantly evolving and your survey responses help us shape our system and understand how it impacts you and your peers.

We wish you the best of luck with the remainder of your coursework this semester.

APPENDIX B

Analysis Tables by Research Question

Table 15
Descriptive Statistics

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
Perceived competence								
AM1	17	5	6.00	0.35	0.16	5.50	6.50	29.41%
AN1	48	19	5.70	1.09	0.25	3.00	7.00	39.58%
AN2	68	26	6.50	0.69	0.13	4.75	7.00	38.24%
AS1	70	18	5.14	1.30	0.31	1.00	7.00	25.71%
AS2	43	10	5.88	0.88	0.28	4.00	7.00	23.26%
AS3	28	8	6.06	0.99	0.35	4.00	7.00	28.57%
EC1	228	49	5.60	1.23	0.18	1.00	7.00	21.49%
EC2	128	41	4.84	1.30	0.20	1.50	7.00	32.03%
ED3	77	47	6.09	0.85	0.12	3.00	7.00	61.04%
EN1	207	81	5.84	0.87	0.10	1.50	7.00	39.13%
EN2	21	9	5.69	0.45	0.15	4.75	6.00	42.86%
EN3	69	28	4.99	1.59	0.30	1.75	7.00	40.58%
HI1	53	18	5.94	1.38	0.33	1.00	7.00	33.96%
HI2	46	19	5.88	1.10	0.25	3.75	7.00	41.30%
HI3	37	16	5.56	1.01	0.25	3.00	7.00	43.24%
LI1	55	21	6.02	0.84	0.18	4.00	7.00	38.18%
LI2	39	18	5.51	1.31	0.31	1.00	7.00	46.15%
PO1	76	25	6.11	0.78	0.16	4.50	7.00	32.89%
PS1	277	98	6.30	0.82	0.08	2.00	7.00	35.38%
PS2	295	116	6.12	0.99	0.09	1.00	7.00	39.32%
PS3	299	96	6.13	0.86	0.09	2.50	7.00	32.11%
PS4	45	21	6.08	0.80	0.17	4.25	7.00	46.67%
SO1	28	15	6.40	0.90	0.23	3.75	7.00	53.57%
SO2	164	60	5.81	0.93	0.12	3.50	7.00	36.59%
SO3	33	6	5.92	1.25	0.51	4.00	7.00	18.18%
SO4	46	15	5.80	0.96	0.25	3.75	7.00	32.61%
SO5	21	10	6.40	0.97	0.31	4.00	7.00	47.62%
Total	2518	895	5.91	1.06	0.04	1.00	7.00	35.54%
External regulation								
AM1	17	4	4.45	0.70	0.35	3.60	5.20	23.53%
AN1	48	17	4.69	1.35	0.33	1.80	6.80	35.42%
AN2	68	26	4.69	1.14	0.22	2.40	7.00	38.24%
AS1	70	19	4.31	1.29	0.30	1.00	6.60	27.14%
AS2	43	11	4.35	1.00	0.30	3.00	6.00	25.58%
AS3	28	9	4.49	1.27	0.42	2.40	6.40	32.14%
EC1	228	48	4.67	1.22	0.18	2.40	7.00	21.05%
EC2	128	42	3.99	1.15	0.18	1.00	6.00	32.81%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
ED3	77	47	4.34	0.88	0.13	2.80	6.40	61.04%
EN1	207	77	4.42	1.00	0.11	1.60	7.00	37.20%
EN2	21	8	4.73	0.54	0.19	4.00	5.40	38.10%
EN3	69	28	4.48	0.81	0.15	2.80	6.00	40.58%
HI1	53	18	4.60	0.92	0.22	2.40	6.00	33.96%
HI2	46	17	3.84	1.36	0.33	1.00	6.00	36.96%
HI3	37	16	4.44	1.01	0.25	2.60	6.40	43.24%
LI1	55	19	4.57	0.93	0.21	2.60	6.20	34.55%
LI2	39	17	4.60	1.05	0.26	2.60	6.60	43.59%
PO1	76	26	3.89	0.99	0.19	2.40	6.40	34.21%
PS1	277	100	4.47	1.05	0.10	1.00	6.80	36.10%
PS2	295	114	4.43	1.08	0.10	1.00	7.00	38.64%
PS3	299	95	4.53	0.95	0.10	1.80	6.60	31.77%
PS4	45	19	4.22	1.17	0.27	2.20	7.00	42.22%
SO1	28	15	4.19	1.19	0.31	1.60	5.80	53.57%
SO2	164	59	4.22	1.10	0.14	1.60	6.60	35.98%
SO3	33	6	4.47	1.05	0.43	3.20	5.60	18.18%
SO4	46	16	4.74	0.75	0.19	3.40	6.20	34.78%
SO5	21	9	4.33	1.04	0.35	3.00	6.20	42.86%
Total	2518	882	4.41	1.06	0.04	1.00	7.00	35.03%
Introjected regulation								
AM1	17	4	6.00	0.28	0.14	5.60	6.20	23.53%
AN1	48	17	5.73	1.51	0.37	2.00	7.00	35.42%
AN2	68	26	5.71	0.85	0.17	3.60	7.00	38.24%
AS1	70	19	4.54	1.32	0.30	1.00	6.60	27.14%
AS2	43	11	5.78	0.75	0.22	4.20	6.80	25.58%
AS3	28	9	5.18	1.29	0.43	3.00	7.00	32.14%
EC1	228	48	4.94	1.15	0.17	2.40	7.00	21.05%
EC2	128	40	4.40	0.93	0.15	1.60	6.20	31.25%
ED3	77	48	5.23	0.97	0.14	2.00	6.80	62.34%
EN1	207	77	5.11	1.21	0.14	1.00	7.00	37.20%
EN2	21	8	5.78	0.82	0.29	4.40	6.80	38.10%
EN3	69	28	5.07	1.10	0.21	3.20	7.00	40.58%
HI1	53	19	5.57	0.88	0.20	3.60	7.00	35.85%
HI2	46	17	5.05	1.26	0.31	2.00	6.60	36.96%
HI3	37	15	5.52	0.84	0.22	3.80	6.60	40.54%
LI1	55	20	5.79	0.78	0.17	4.20	7.00	36.36%
LI2	39	17	5.73	0.93	0.23	3.20	7.00	43.59%
PO1	76	26	4.94	1.31	0.26	2.00	7.00	34.21%
PS1	277	100	5.35	1.02	0.10	2.80	7.00	36.10%
PS2	295	114	5.35	0.92	0.09	3.00	7.00	38.64%
PS3	299	95	5.16	0.95	0.10	2.40	7.00	31.77%
PS4	45	19	4.94	1.56	0.36	1.00	7.00	42.22%
SO1	28	15	5.43	1.34	0.35	1.00	7.00	53.57%
SO2	164	59	4.87	1.40	0.18	1.60	7.00	35.98%
SO3	33	6	4.80	1.48	0.60	2.60	6.40	18.18%
SO4	46	17	5.80	0.75	0.18	4.20	7.00	36.96%
SO5	21	9	5.47	1.39	0.46	2.00	6.60	42.86%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
Total	2518	883	5.21	1.12	0.04	1.00	7.00	35.07%
Identified regulation								
AM1	17	4	5.50	0.79	0.40	4.33	6.00	23.53%
AN1	48	17	6.33	0.57	0.14	5.00	7.00	35.42%
AN2	68	26	6.06	0.61	0.12	4.00	7.00	38.24%
AS1	70	19	5.25	1.51	0.35	1.00	7.00	27.14%
AS2	43	11	6.00	0.82	0.25	4.33	7.00	25.58%
AS3	28	9	5.33	1.58	0.53	2.67	7.00	32.14%
EC1	228	47	5.89	1.03	0.15	2.67	7.00	20.61%
EC2	128	42	5.36	1.10	0.17	2.67	7.00	32.81%
ED3	77	48	5.63	0.91	0.13	2.67	6.67	62.34%
EN1	207	77	5.73	1.23	0.14	1.00	7.00	37.20%
EN2	21	8	5.54	0.83	0.30	4.67	7.00	38.10%
EN3	69	28	5.54	0.90	0.17	4.00	7.00	40.58%
HI1	53	19	6.18	0.72	0.17	4.00	7.00	35.85%
HI2	46	17	5.67	1.06	0.26	4.00	7.00	36.96%
HI3	37	16	5.92	0.74	0.18	4.00	6.67	43.24%
LI1	55	19	6.04	0.80	0.18	4.33	7.00	34.55%
LI2	39	17	5.96	0.99	0.24	2.67	7.00	43.59%
PO1	76	26	5.97	0.67	0.13	4.33	7.00	34.21%
PS1	277	100	6.13	0.79	0.08	2.67	7.00	36.10%
PS2	295	115	6.27	0.69	0.06	3.67	7.00	38.98%
PS3	299	95	5.98	0.70	0.07	4.00	7.00	31.77%
PS4	45	19	5.61	1.43	0.33	1.00	7.00	42.22%
SO1	28	15	6.18	0.74	0.19	4.67	7.00	53.57%
SO2	164	59	5.77	0.96	0.12	2.33	7.00	35.98%
SO3	33	6	5.89	0.69	0.28	5.33	7.00	18.18%
SO4	46	17	5.96	1.01	0.24	3.67	7.00	36.96%
SO5	21	9	6.22	0.91	0.30	4.33	7.00	42.86%
Total	2518	885	5.91	0.94	0.03	1.00	7.00	35.15%
Intrinsic motivation								
AM1	17	4	5.42	0.83	0.42	4.33	6.33	23.53%
AN1	48	17	4.61	1.30	0.31	1.67	6.33	35.42%
AN2	68	26	5.10	0.96	0.19	2.67	6.67	38.24%
AS1	70	19	3.86	1.47	0.34	1.00	7.00	27.14%
AS2	43	11	5.00	1.13	0.34	2.67	6.67	25.58%
AS3	28	9	4.37	1.98	0.66	1.00	6.67	32.14%
EC1	228	48	4.31	1.28	0.19	1.33	7.00	21.05%
EC2	128	42	3.85	1.44	0.22	1.00	6.33	32.81%
ED3	77	48	4.47	1.26	0.18	1.00	6.67	62.34%
EN1	207	76	4.43	1.34	0.15	1.00	7.00	36.71%
EN2	21	8	3.79	1.15	0.41	2.33	6.00	38.10%
EN3	69	28	4.08	1.40	0.27	1.67	6.67	40.58%
HI1	53	19	5.28	0.89	0.20	3.33	7.00	35.85%
HI2	46	17	5.06	1.36	0.33	2.33	7.00	36.96%
HI3	37	16	4.65	1.10	0.27	2.67	6.00	43.24%
LI1	55	20	5.30	1.08	0.24	3.00	7.00	36.36%
LI2	39	17	4.84	1.31	0.32	1.33	6.33	43.59%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
PO1	76	26	5.01	0.93	0.18	3.33	6.67	34.21%
PS1	277	99	4.75	1.20	0.12	1.33	7.00	35.74%
PS2	295	114	5.14	1.23	0.11	1.67	7.00	38.64%
PS3	299	94	4.85	1.04	0.11	1.00	6.67	31.44%
PS4	45	19	4.32	1.68	0.38	1.00	7.00	42.22%
SO1	28	15	5.33	1.11	0.29	3.00	7.00	53.57%
SO2	164	58	4.29	1.32	0.17	1.00	6.33	35.37%
SO3	33	6	4.33	1.05	0.43	3.00	6.00	18.18%
SO4	46	17	4.31	1.35	0.33	1.33	6.33	36.96%
SO5	21	9	5.37	1.66	0.55	1.67	6.67	42.86%
Total	2518	882	4.66	1.30	0.04	1.00	7.00	35.03%
Relative autonomy index								
AM1	17	4	1.43	2.60	1.30	-1.47	4.53	23.53%
AN1	48	17	0.43	2.41	0.59	-5.60	5.07	35.42%
AN2	68	26	1.18	3.46	0.68	-5.00	11.60	38.24%
AS1	70	19	-0.18	3.61	0.83	-7.33	7.20	27.14%
AS2	43	11	1.53	4.03	1.22	-6.73	7.73	25.58%
AS3	28	9	-0.08	5.42	1.81	-9.13	10.53	32.14%
EC1	228	47	0.13	3.81	0.56	-7.33	10.07	20.61%
EC2	128	40	0.64	3.74	0.59	-8.53	9.87	31.25%
ED3	77	47	0.69	3.38	0.49	-7.73	7.00	61.04%
EN1	207	76	0.64	3.96	0.45	-6.87	14.47	36.71%
EN2	21	8	-2.10	2.58	0.91	-6.07	1.20	38.10%
EN3	69	28	-0.33	3.70	0.70	-6.20	5.53	40.58%
HI1	53	18	1.83	2.42	0.57	-1.80	9.00	33.96%
HI2	46	17	3.07	4.60	1.12	-3.93	12.80	36.96%
HI3	37	15	1.06	2.95	0.76	-4.20	5.80	40.54%
LI1	55	18	1.75	2.20	0.52	-2.40	6.20	32.73%
LI2	39	17	0.72	3.23	0.78	-4.80	8.00	43.59%
PO1	76	26	3.28	3.47	0.68	-3.00	10.13	34.21%
PS1	277	99	1.36	3.34	0.34	-7.53	8.60	35.74%
PS2	295	112	2.37	3.81	0.36	-9.27	12.60	37.97%
PS3	299	94	1.44	2.95	0.30	-8.07	8.33	31.44%
PS4	45	19	0.87	3.41	0.78	-5.33	7.33	42.22%
SO1	28	15	3.04	4.13	1.07	-3.13	11.80	53.57%
SO2	164	58	1.06	3.71	0.49	-6.67	10.73	35.37%
SO3	33	6	0.82	3.19	1.30	-3.40	3.73	18.18%
SO4	46	16	-0.60	3.27	0.82	-7.13	4.47	34.78%
SO5	21	9	2.83	5.50	1.83	-10.73	7.20	42.86%
Total	2518	871	1.21	3.63	0.12	-10.73	14.47	34.59%
Metacognition: Planning								
AM1	17	4	4.60	1.23	0.62	3.00	6.00	23.53%
AN1	48	17	5.34	0.72	0.18	4.40	7.00	35.42%
AN2	68	27	4.53	1.21	0.23	1.00	6.20	39.71%
AS1	70	17	4.27	1.26	0.31	1.00	7.00	24.29%
AS2	43	11	5.05	0.89	0.27	3.40	6.20	25.58%
AS3	28	8	4.33	0.68	0.24	3.40	5.40	28.57%
EC1	228	46	4.47	1.23	0.18	1.60	7.00	20.18%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
EC2	128	39	4.47	1.25	0.20	1.00	6.80	30.47%
ED3	77	46	5.24	1.01	0.15	1.60	6.80	59.74%
EN1	207	76	4.80	1.11	0.13	1.00	7.00	36.71%
EN2	21	9	5.07	0.95	0.32	4.00	6.60	42.86%
EN3	69	28	4.99	0.83	0.16	3.20	6.40	40.58%
HI1	53	20	4.97	1.22	0.27	2.40	6.40	37.74%
HI2	46	18	4.69	1.54	0.36	1.60	7.00	39.13%
HI3	37	16	4.33	0.93	0.23	2.80	6.00	43.24%
LI1	55	22	4.54	1.53	0.33	1.00	7.00	40.00%
LI2	39	16	4.94	0.95	0.24	2.80	6.60	41.03%
PO1	76	23	5.12	1.11	0.23	2.20	7.00	30.26%
PS1	277	98	5.31	1.06	0.11	2.00	7.00	35.38%
PS2	295	113	5.11	1.08	0.10	2.00	7.00	38.31%
PS3	299	95	4.89	1.09	0.11	2.00	7.00	31.77%
PS4	45	20	4.51	1.22	0.27	2.00	7.00	44.44%
SO1	28	13	5.48	1.06	0.29	3.60	7.00	46.43%
SO2	164	59	5.13	1.06	0.14	1.60	7.00	35.98%
SO3	33	5	5.12	1.42	0.63	3.40	6.60	15.15%
SO4	46	16	4.79	1.03	0.26	2.80	6.20	34.78%
SO5	21	9	5.33	0.72	0.24	3.80	6.00	42.86%
Total	2518	871	4.93	1.13	0.04	1.00	7.00	34.59%
Metacognition: Monitoring								
AM1	17	4	5.19	0.83	0.41	4.25	6.00	23.53%
AN1	48	17	5.25	0.90	0.22	3.50	7.00	35.42%
AN2	68	27	5.06	1.27	0.25	1.00	7.00	39.71%
AS1	70	17	4.28	1.49	0.36	1.00	7.00	24.29%
AS2	43	11	4.73	1.08	0.32	2.00	5.75	25.58%
AS3	28	8	4.44	1.20	0.42	2.00	6.00	28.57%
EC1	228	45	4.84	1.23	0.18	1.75	7.00	19.74%
EC2	128	40	4.97	0.99	0.16	2.25	6.75	31.25%
ED3	77	48	4.64	1.00	0.14	2.00	6.50	62.34%
EN1	207	76	4.61	1.08	0.12	1.25	7.00	36.71%
EN2	21	9	4.69	1.11	0.37	2.75	6.25	42.86%
EN3	69	28	4.61	1.18	0.22	1.50	6.50	40.58%
HI1	53	20	5.20	1.13	0.25	2.75	6.75	37.74%
HI2	46	18	4.64	1.18	0.28	2.75	7.00	39.13%
HI3	37	16	4.91	0.95	0.24	2.50	7.00	43.24%
LI1	55	22	4.88	1.32	0.28	1.00	7.00	40.00%
LI2	39	16	4.83	0.87	0.22	2.75	6.25	41.03%
PO1	76	22	5.28	1.15	0.25	2.75	7.00	28.95%
PS1	277	96	5.56	1.04	0.11	2.25	7.00	34.66%
PS2	295	114	5.38	1.04	0.10	1.50	7.00	38.64%
PS3	299	95	5.28	0.92	0.09	1.75	7.00	31.77%
PS4	45	20	4.95	1.08	0.24	2.25	7.00	44.44%
SO1	28	14	5.55	0.83	0.22	3.75	7.00	50.00%
SO2	164	58	4.57	1.11	0.15	1.25	6.75	35.37%
SO3	33	5	5.25	0.95	0.43	3.75	6.25	15.15%
SO4	46	16	5.06	0.96	0.24	3.50	7.00	34.78%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
SO5	21	9	4.89	1.23	0.41	2.75	6.50	42.86%
Total	2518	871	5.02	1.12	0.04	1.00	7.00	34.59%
Metacognition: Regulation								
AM1	17	4	5.13	0.32	0.16	4.75	5.50	23.53%
AN1	48	17	5.10	1.08	0.26	3.00	7.00	35.42%
AN2	68	27	4.85	1.10	0.21	1.00	6.25	39.71%
AS1	70	16	4.86	0.96	0.24	3.25	7.00	22.86%
AS2	43	11	5.09	0.78	0.23	3.25	6.00	25.58%
AS3	28	8	4.91	0.48	0.17	4.25	5.50	28.57%
EC1	228	46	5.03	1.17	0.17	2.75	7.00	20.18%
EC2	128	40	4.93	1.08	0.17	2.50	7.00	31.25%
ED3	77	48	4.93	0.91	0.13	2.75	6.25	62.34%
EN1	207	76	4.96	1.06	0.12	1.00	7.00	36.71%
EN2	21	9	4.83	0.94	0.31	3.25	6.00	42.86%
EN3	69	28	4.71	1.14	0.22	2.00	7.00	40.58%
HI1	53	20	5.26	0.95	0.21	3.00	7.00	37.74%
HI2	46	18	4.72	1.37	0.32	2.25	7.00	39.13%
HI3	37	15	4.72	1.08	0.28	2.25	6.00	40.54%
LI1	55	22	5.13	0.87	0.19	3.25	7.00	40.00%
LI2	39	16	5.16	0.88	0.22	4.00	7.00	41.03%
PO1	76	23	5.37	0.89	0.19	4.00	7.00	30.26%
PS1	277	98	5.41	1.11	0.11	2.25	7.00	35.38%
PS2	295	114	5.26	0.98	0.09	2.00	7.00	38.64%
PS3	299	96	5.23	0.89	0.09	1.75	7.00	32.11%
PS4	45	19	4.67	0.92	0.21	2.00	5.50	42.22%
SO1	28	14	5.59	0.95	0.25	3.75	7.00	50.00%
SO2	164	59	4.84	1.00	0.13	2.00	7.00	35.98%
SO3	33	5	5.30	1.15	0.51	3.75	6.75	15.15%
SO4	46	16	5.39	0.69	0.17	3.75	6.75	34.78%
SO5	21	9	4.81	1.04	0.35	2.50	6.00	42.86%
Total	2518	874	5.09	1.02	0.03	1.00	7.00	34.71%
Classroom goal structure: Mastery								
AM1	17	6	5.97	0.59	0.24	5.00	6.60	35.29%
AN1	48	15	5.76	0.71	0.18	4.60	7.00	31.25%
AN2	68	26	6.07	0.68	0.13	4.60	7.00	38.24%
AS1	70	18	4.61	1.16	0.27	1.00	6.20	25.71%
AS2	43	11	6.00	0.66	0.20	4.80	6.60	25.58%
AS3	28	8	6.23	0.55	0.19	5.20	7.00	28.57%
EC1	228	53	5.02	1.30	0.18	1.00	7.00	23.25%
EC2	128	40	4.64	1.26	0.20	1.60	7.00	31.25%
ED3	77	46	5.63	0.95	0.14	2.60	7.00	59.74%
EN1	207	77	5.23	0.96	0.11	1.60	7.00	37.20%
EN2	21	10	5.42	0.82	0.26	4.40	6.60	47.62%
EN3	69	29	5.19	0.99	0.18	3.20	6.80	42.03%
HI1	53	18	5.76	1.01	0.24	3.00	7.00	33.96%
HI2	46	20	6.06	0.66	0.15	4.40	7.00	43.48%
HI3	37	16	5.83	0.87	0.22	3.80	7.00	43.24%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
LI1	55	20	6.02	0.80	0.18	4.00	7.00	36.36%
LI2	39	17	5.76	0.81	0.20	3.80	7.00	43.59%
PO1	76	26	5.86	0.62	0.12	4.60	7.00	34.21%
PS1	277	95	5.46	0.90	0.09	2.40	7.00	34.30%
PS2	295	115	5.66	0.80	0.07	3.00	7.00	38.98%
PS3	299	94	5.40	0.82	0.08	3.20	7.00	31.44%
PS4	45	22	5.25	0.71	0.15	4.00	6.40	48.89%
SO1	28	15	6.05	0.84	0.22	3.60	7.00	53.57%
SO2	164	58	5.29	1.02	0.13	1.80	7.00	35.37%
SO3	33	5	5.80	1.11	0.50	4.00	6.80	15.15%
SO4	46	17	5.47	1.21	0.29	2.20	6.60	36.96%
SO5	21	8	6.08	0.81	0.29	4.80	7.00	38.10%
Total	2518	885	5.48	0.98	0.03	1.00	7.00	35.15%
Classroom goal structure: Performance approach								
AM1	17	6	2.13	0.74	0.30	1.00	3.25	35.29%
AN1	48	15	2.40	1.16	0.30	1.00	4.25	31.25%
AN2	68	27	2.52	1.13	0.22	1.00	5.25	39.71%
AS1	70	18	3.10	1.28	0.30	1.00	4.75	25.71%
AS2	43	11	3.05	0.79	0.24	1.75	4.50	25.58%
AS3	28	8	1.78	0.81	0.29	1.00	3.25	28.57%
EC1	228	52	3.10	1.43	0.20	1.00	6.00	22.81%
EC2	128	40	4.43	1.17	0.18	1.75	6.25	31.25%
ED3	77	46	2.74	1.29	0.19	1.00	6.00	59.74%
EN1	207	78	3.09	1.19	0.14	1.00	6.00	37.68%
EN2	21	10	3.43	1.44	0.45	1.25	5.00	47.62%
EN3	69	29	2.76	1.19	0.22	1.00	5.50	42.03%
HI1	53	18	2.74	1.14	0.27	1.00	4.75	33.96%
HI2	46	20	2.51	1.16	0.26	1.00	6.00	43.48%
HI3	37	16	2.55	1.33	0.33	1.00	4.75	43.24%
LI1	55	20	2.65	1.29	0.29	1.00	5.00	36.36%
LI2	39	17	2.76	1.25	0.30	1.00	5.25	43.59%
PO1	76	26	2.99	1.12	0.22	1.00	4.75	34.21%
PS1	277	95	2.54	1.21	0.12	1.00	6.75	34.30%
PS2	295	116	2.62	1.08	0.10	1.00	6.75	39.32%
PS3	299	94	2.69	1.15	0.12	1.00	6.25	31.44%
PS4	45	22	2.48	0.95	0.20	1.00	4.25	48.89%
SO1	28	15	2.18	1.17	0.30	1.00	5.25	53.57%
SO2	164	58	2.77	1.28	0.17	1.00	6.00	35.37%
SO3	33	5	2.75	1.65	0.74	1.00	4.75	15.15%
SO4	46	17	2.76	1.33	0.32	1.00	5.50	36.96%
SO5	21	8	1.56	0.73	0.26	1.00	3.25	38.10%
Total	2518	887	2.79	1.26	0.04	1.00	6.75	35.23%
Classroom goal structure: Performance avoidance								
AM1	17	6	2.33	0.97	0.40	1.00	3.25	35.29%
AN1	48	15	2.83	1.28	0.33	1.00	4.75	31.25%
AN2	68	27	2.74	1.09	0.21	1.00	4.50	39.71%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
AS1	70	18	3.06	1.16	0.27	1.00	4.75	25.71%
AS2	43	11	2.77	0.60	0.18	1.50	3.50	25.58%
AS3	28	8	1.41	0.40	0.14	1.00	2.00	28.57%
EC1	228	53	2.89	1.46	0.20	1.00	6.00	23.25%
EC2	128	40	3.69	1.07	0.17	1.75	6.00	31.25%
ED3	77	46	2.38	1.23	0.18	1.00	6.00	59.74%
EN1	207	78	3.12	1.12	0.13	1.00	6.00	37.68%
EN2	21	10	3.03	1.08	0.34	1.50	4.50	47.62%
EN3	69	29	2.91	1.22	0.23	1.00	5.25	42.03%
HI1	53	18	2.81	1.18	0.28	1.00	5.75	33.96%
HI2	46	20	2.54	1.31	0.29	1.00	6.25	43.48%
HI3	37	16	2.70	1.14	0.29	1.00	5.00	43.24%
LI1	55	20	2.68	1.32	0.30	1.00	5.00	36.36%
LI2	39	17	3.12	1.23	0.30	1.25	5.25	43.59%
PO1	76	26	2.91	1.25	0.25	1.00	6.00	34.21%
PS1	277	95	2.37	1.16	0.12	1.00	7.00	34.30%
PS2	295	116	2.46	1.05	0.10	1.00	6.50	39.32%
PS3	299	94	2.65	1.03	0.11	1.00	6.00	31.44%
PS4	45	22	2.48	1.18	0.25	1.00	5.25	48.89%
SO1	28	15	1.80	1.05	0.27	1.00	4.50	53.57%
SO2	164	57	2.93	1.29	0.17	1.00	6.75	34.76%
SO3	33	5	2.70	0.89	0.40	1.75	4.00	15.15%
SO4	46	17	2.87	1.10	0.27	1.25	5.00	36.96%
SO5	21	8	1.78	0.82	0.29	1.00	3.00	38.10%
Total	2518	887	2.71	1.20	0.04	1.00	7.00	35.23%
Personal responsibility: Student								
AM1	17	5	4.00	0.78	0.35	2.67	4.67	29.41%
AN1	48	17	4.14	0.56	0.14	2.67	5.00	35.42%
AN2	68	25	4.42	0.44	0.09	3.50	5.00	36.76%
AS1	70	18	3.69	0.82	0.19	1.00	4.67	25.71%
AS2	43	11	4.38	0.53	0.16	3.17	5.00	25.58%
AS3	28	8	4.21	0.41	0.14	3.67	4.67	28.57%
EC1	228	46	4.30	0.58	0.08	3.00	5.00	20.18%
EC2	128	41	4.14	0.69	0.11	2.50	5.00	32.03%
ED3	77	47	4.21	0.54	0.08	3.00	5.00	61.04%
EN1	207	77	4.31	0.45	0.05	3.00	5.00	37.20%
EN2	21	8	4.50	0.42	0.15	3.83	5.00	38.10%
EN3	69	29	4.19	0.55	0.10	3.00	5.00	42.03%
HI1	53	17	4.42	0.53	0.13	3.33	5.00	32.08%
HI2	46	17	4.38	0.55	0.13	3.33	5.00	36.96%
HI3	37	15	4.27	0.45	0.12	3.00	5.00	40.54%
LI1	55	21	4.30	0.67	0.15	3.00	5.00	38.18%
LI2	39	17	4.51	0.45	0.11	3.50	5.00	43.59%
PO1	76	27	4.43	0.52	0.10	3.17	5.00	35.53%
PS1	277	97	4.50	0.46	0.05	2.67	5.00	35.02%
PS2	295	109	4.45	0.55	0.05	2.00	5.00	36.95%
PS3	299	93	4.37	0.54	0.06	2.50	5.00	31.10%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
PS4	45	18	4.17	0.63	0.15	2.50	5.00	40.00%
SO1	28	15	4.69	0.41	0.11	3.50	5.00	53.57%
SO2	164	59	4.31	0.51	0.07	3.00	5.00	35.98%
	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
SO3	33	5	4.13	0.64	0.29	3.33	5.00	15.15%
SO4	46	15	4.37	0.37	0.10	3.33	5.00	32.61%
SO5	21	9	4.52	0.34	0.11	4.00	5.00	42.86%
Total	2518	866	4.34	0.55	0.02	1.00	5.00	34.39%
Personal responsibility: Instructor								
AM1	17	5	3.03	0.70	0.31	2.17	3.83	29.41%
AN1	48	17	2.81	0.98	0.24	0.00	4.17	35.42%
AN2	68	25	2.89	0.93	0.19	1.00	4.67	36.76%
AS1	70	18	3.10	0.96	0.23	1.50	5.00	25.71%
AS2	43	11	3.24	0.71	0.21	2.00	4.17	25.58%
AS3	28	8	2.56	0.97	0.34	1.17	3.67	28.57%
EC1	228	44	2.92	1.25	0.19	0.33	5.00	19.30%
EC2	128	42	2.62	0.86	0.13	0.00	4.00	32.81%
ED3	77	44	2.55	0.94	0.14	1.17	5.00	57.14%
EN1	207	77	2.56	0.85	0.10	0.00	4.33	37.20%
EN2	21	8	2.98	0.38	0.14	2.50	3.50	38.10%
EN3	69	29	2.56	0.84	0.16	1.00	4.17	42.03%
HI1	53	17	3.32	0.90	0.22	1.33	5.00	32.08%
HI2	46	18	3.00	1.08	0.25	0.00	4.50	39.13%
HI3	37	15	2.47	0.98	0.25	1.17	4.17	40.54%
LI1	55	21	2.76	1.10	0.24	1.00	4.67	38.18%
LI2	39	16	2.58	1.07	0.27	0.00	4.00	41.03%
PO1	76	27	2.96	1.08	0.21	1.00	5.00	35.53%
PS1	277	95	2.70	0.87	0.09	0.67	5.00	34.30%
PS2	295	109	2.60	0.91	0.09	0.17	5.00	36.95%
PS3	299	88	2.36	0.84	0.09	0.50	4.17	29.43%
PS4	45	18	2.75	0.86	0.20	1.33	5.00	40.00%
SO1	28	15	3.02	1.37	0.35	0.50	5.00	53.57%
SO2	164	57	2.41	0.96	0.13	0.00	4.67	34.76%
SO3	33	5	3.17	1.52	0.68	1.50	5.00	15.15%
SO4	46	16	2.80	0.84	0.21	1.17	4.17	34.78%
SO5	21	9	2.98	1.28	0.43	1.33	5.00	42.86%
Total	2518	854	2.68	0.96	0.03	0.00	5.00	33.92%
Monitored grade								
AM1	17	4	5.25	1.26	0.63	4.00	7.00	23.53%
AN1	48	14	5.79	1.63	0.43	1.00	7.00	29.17%
AN2	68	25	5.84	1.14	0.23	2.00	7.00	36.76%
AS1	70	16	5.25	1.44	0.36	1.00	7.00	22.86%
AS2	43	10	5.60	1.78	0.56	2.00	7.00	23.26%
AS3	28	8	5.50	1.41	0.50	3.00	7.00	28.57%
EC1	228	43	5.95	1.15	0.18	1.00	7.00	18.86%
EC2	128	37	5.81	1.00	0.16	3.00	7.00	28.91%
ED3	77	43	6.09	1.21	0.18	2.00	7.00	55.84%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
EN1	207	69	5.70	1.51	0.18	1.00	7.00	33.33%
EN2	21	7	6.14	1.46	0.55	3.00	7.00	33.33%
EN3	69	26	6.19	0.90	0.18	4.00	7.00	37.68%
HI1	53	18	6.22	1.00	0.24	3.00	7.00	33.96%
HI2	46	16	4.06	1.84	0.46	1.00	7.00	34.78%
HI3	37	16	4.69	1.49	0.37	1.00	6.00	43.24%
LI1	55	17	5.65	1.27	0.31	2.00	7.00	30.91%
LI2	39	15	5.67	1.63	0.42	1.00	7.00	38.46%
PO1	76	22	5.73	1.20	0.26	2.00	7.00	28.95%
PS1	277	89	6.37	0.86	0.09	2.00	7.00	32.13%
PS2	295	109	6.27	0.94	0.09	3.00	7.00	36.95%
PS3	299	87	5.99	1.13	0.12	2.00	7.00	29.10%
PS4	45	19	5.95	1.27	0.29	2.00	7.00	42.22%
SO1	28	14	6.00	1.11	0.30	3.00	7.00	50.00%
SO2	164	56	6.29	0.95	0.13	3.00	7.00	34.15%
SO3	33	5	5.40	1.52	0.68	3.00	7.00	15.15%
SO4	46	13	5.46	1.76	0.49	2.00	7.00	28.26%
SO5	21	8	5.50	1.07	0.38	4.00	7.00	38.10%
Total	2518	806	5.93	1.24	0.04	1.00	7.00	32.01%
Understood how to earn desired grade								
AM1	17	4	6.00	1.15	0.58	5.00	7.00	23.53%
AN1	48	15	5.53	1.41	0.36	3.00	7.00	31.25%
AN2	68	25	6.08	0.86	0.17	4.00	7.00	36.76%
AS1	70	16	4.56	1.82	0.46	1.00	7.00	22.86%
AS2	43	10	5.40	1.17	0.37	3.00	7.00	23.26%
AS3	28	8	5.88	1.46	0.52	3.00	7.00	28.57%
EC1	228	43	6.00	1.00	0.15	3.00	7.00	18.86%
EC2	128	37	4.86	1.60	0.26	1.00	7.00	28.91%
ED3	77	43	6.30	0.96	0.15	3.00	7.00	55.84%
EN1	207	69	5.09	1.35	0.16	1.00	7.00	33.33%
EN2	21	7	4.29	1.60	0.61	2.00	6.00	33.33%
EN3	69	26	4.85	1.89	0.37	1.00	7.00	37.68%
HI1	53	18	5.78	1.35	0.32	3.00	7.00	33.96%
HI2	46	16	5.81	1.11	0.28	3.00	7.00	34.78%
HI3	37	16	5.25	1.39	0.35	3.00	7.00	43.24%
LI1	55	17	5.88	1.11	0.27	4.00	7.00	30.91%
LI2	39	15	4.93	1.62	0.42	1.00	7.00	38.46%
PO1	76	22	6.00	1.07	0.23	3.00	7.00	28.95%
PS1	277	89	6.31	0.87	0.09	2.00	7.00	32.13%
PS2	295	109	6.13	0.93	0.09	2.00	7.00	36.95%
PS3	299	86	5.94	1.00	0.11	3.00	7.00	28.76%
PS4	45	19	6.00	1.05	0.24	4.00	7.00	42.22%
SO1	28	14	6.43	1.16	0.31	3.00	7.00	50.00%
SO2	164	56	5.88	1.57	0.21	1.00	7.00	34.15%
SO3	33	5	5.40	0.89	0.40	4.00	6.00	15.15%
SO4	46	13	5.46	1.33	0.37	3.00	7.00	28.26%
SO5	21	8	6.13	1.13	0.40	4.00	7.00	38.10%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
Total	2518	806	5.78	1.30	0.05	1.00	7.00	32.01%
In control of grade								
AM1	17	4	5.75	0.96	0.48	5.00	7.00	23.53%
AN1	48	14	4.36	1.08	0.29	3.00	6.00	29.17%
AN2	68	25	5.80	1.08	0.22	3.00	7.00	36.76%
AS1	70	16	4.06	1.65	0.41	1.00	6.00	22.86%
AS2	43	10	5.30	1.64	0.52	1.00	7.00	23.26%
AS3	28	8	5.50	1.07	0.38	4.00	7.00	28.57%
EC1	228	43	5.49	1.50	0.23	1.00	7.00	18.86%
EC2	128	37	4.46	1.76	0.29	1.00	7.00	28.91%
ED3	77	43	6.16	1.02	0.16	3.00	7.00	55.84%
EN1	207	69	4.81	1.50	0.18	1.00	7.00	33.33%
EN2	21	7	3.00	1.83	0.69	1.00	6.00	33.33%
EN3	69	26	4.19	2.00	0.39	1.00	7.00	37.68%
HI1	53	18	5.28	1.71	0.40	1.00	7.00	33.96%
HI2	46	16	5.50	1.46	0.37	3.00	7.00	34.78%
HI3	37	16	4.75	1.61	0.40	1.00	6.00	43.24%
LI1	55	17	5.59	1.28	0.31	3.00	7.00	30.91%
LI2	39	15	4.87	1.41	0.36	2.00	6.00	38.46%
PO1	76	22	5.41	1.10	0.23	3.00	7.00	28.95%
PS1	277	88	6.10	1.03	0.11	3.00	7.00	31.77%
PS2	295	109	5.82	1.06	0.10	1.00	7.00	36.95%
PS3	299	87	5.78	1.19	0.13	1.00	7.00	29.10%
PS4	45	19	5.74	1.24	0.28	3.00	7.00	42.22%
SO1	28	14	6.07	1.14	0.30	4.00	7.00	50.00%
SO2	164	56	5.66	1.60	0.21	1.00	7.00	34.15%
SO3	33	5	5.20	1.92	0.86	2.00	7.00	15.15%
SO4	46	13	5.15	1.57	0.44	1.00	7.00	28.26%
SO5	21	8	5.50	1.31	0.46	3.00	7.00	38.10%
Total	2518	805	5.45	1.46	0.05	1.00	7.00	31.97%
Expectancy of doing well								
AM1	17	4	5.75	0.96	0.48	5.00	7.00	23.53%
AN1	48	14	5.57	1.22	0.33	3.00	7.00	29.17%
AN2	68	25	6.04	0.73	0.15	5.00	7.00	36.76%
AS1	70	16	5.06	1.61	0.40	1.00	7.00	22.86%
AS2	43	10	5.30	0.48	0.15	5.00	6.00	23.26%
AS3	28	8	4.75	1.39	0.49	2.00	6.00	28.57%
EC1	228	43	5.84	1.04	0.16	3.00	7.00	18.86%
EC2	128	37	4.92	1.67	0.28	1.00	7.00	28.91%
ED3	77	43	6.02	1.03	0.16	2.00	7.00	55.84%
EN1	207	70	5.51	0.97	0.12	3.00	7.00	33.82%
EN2	21	7	4.71	1.70	0.64	2.00	7.00	33.33%
EN3	69	26	5.73	1.12	0.22	3.00	7.00	37.68%
HI1	53	18	5.72	0.96	0.23	4.00	7.00	33.96%
HI2	46	16	5.50	0.97	0.24	3.00	7.00	34.78%
HI3	37	16	5.06	1.34	0.34	1.00	7.00	43.24%
LI1	55	17	6.12	1.11	0.27	4.00	7.00	30.91%
LI2	39	15	5.40	0.99	0.25	4.00	7.00	38.46%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
PO1	76	22	5.86	0.89	0.19	4.00	7.00	28.95%
PS1	277	89	6.18	0.83	0.09	3.00	7.00	32.13%
PS2	295	109	5.93	0.89	0.09	3.00	7.00	36.95%
PS3	299	87	6.03	0.92	0.10	3.00	7.00	29.10%
PS4	45	19	5.63	1.01	0.23	3.00	7.00	42.22%
SO1	28	14	6.50	0.65	0.17	5.00	7.00	50.00%
SO2	164	56	6.13	0.83	0.11	4.00	7.00	34.15%
SO3	33	5	5.80	1.30	0.58	4.00	7.00	15.15%
SO4	46	13	5.77	1.36	0.38	2.00	7.00	28.26%
SO5	21	8	6.25	1.04	0.37	4.00	7.00	38.10%
Total	2518	807	5.81	1.08	0.04	1.00	7.00	32.05%
Utility value								
AM1	17	4	6.25	0.96	0.48	5.00	7.00	23.53%
AN1	48	14	5.93	1.21	0.32	3.00	7.00	29.17%
AN2	68	25	5.60	1.22	0.24	3.00	7.00	36.76%
AS1	70	16	4.25	2.02	0.50	1.00	7.00	22.86%
AS2	43	10	4.30	1.70	0.54	1.00	7.00	23.26%
AS3	28	8	4.63	2.26	0.80	1.00	7.00	28.57%
EC1	228	43	5.81	1.07	0.16	3.00	7.00	18.86%
EC2	128	37	5.03	1.80	0.30	1.00	7.00	28.91%
ED3	77	43	4.98	1.49	0.23	1.00	7.00	55.84%
EN1	207	69	5.38	1.72	0.21	1.00	7.00	33.33%
EN2	21	7	5.57	1.72	0.65	2.00	7.00	33.33%
EN3	69	26	4.50	1.94	0.38	1.00	7.00	37.68%
HI1	53	18	6.44	0.98	0.23	4.00	7.00	33.96%
HI2	46	16	5.94	1.61	0.40	2.00	7.00	34.78%
HI3	37	16	5.50	1.46	0.37	2.00	7.00	43.24%
LI1	55	17	4.94	1.85	0.45	1.00	7.00	30.91%
LI2	39	15	5.53	1.46	0.38	1.00	7.00	38.46%
PO1	76	22	6.23	1.15	0.25	2.00	7.00	28.95%
PS1	277	89	5.93	1.25	0.13	2.00	7.00	32.13%
PS2	295	109	5.98	1.20	0.12	2.00	7.00	36.95%
PS3	299	86	5.78	1.32	0.14	1.00	7.00	28.76%
PS4	45	19	4.79	1.93	0.44	1.00	7.00	42.22%
SO1	28	14	6.00	1.80	0.48	1.00	7.00	50.00%
SO2	164	56	5.48	1.39	0.19	1.00	7.00	34.15%
SO3	33	5	5.60	1.14	0.51	4.00	7.00	15.15%
SO4	46	13	5.31	1.70	0.47	1.00	7.00	28.26%
SO5	21	8	5.75	1.83	0.65	2.00	7.00	38.10%
Total	2518	805	5.56	1.53	0.05	1.00	7.00	31.97%
Effort cost								
AM1	17	4	2.50	0.58	0.29	2.00	3.00	23.53%
AN1	48	14	4.14	0.95	0.25	3.00	6.00	29.17%
AN2	68	25	3.12	1.54	0.31	1.00	7.00	36.76%
AS1	70	16	3.81	1.72	0.43	1.00	7.00	22.86%
AS2	43	10	4.30	1.34	0.42	2.00	6.00	23.26%
AS3	28	8	4.00	1.60	0.57	2.00	6.00	28.57%
EC1	228	43	3.26	1.62	0.25	1.00	7.00	18.86%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
EC2	128	37	4.19	1.68	0.28	1.00	7.00	28.91%
ED3	77	43	4.28	1.68	0.26	1.00	7.00	55.84%
EN1	207	69	3.71	1.55	0.19	1.00	7.00	33.33%
EN2	21	7	3.71	1.38	0.52	2.00	6.00	33.33%
EN3	69	26	3.77	1.58	0.31	1.00	7.00	37.68%
HI1	53	18	3.56	1.50	0.35	1.00	7.00	33.96%
HI2	46	16	4.75	1.29	0.32	2.00	7.00	34.78%
HI3	37	16	4.31	1.25	0.31	2.00	7.00	43.24%
LI1	55	17	2.71	1.31	0.32	1.00	5.00	30.91%
LI2	39	15	4.27	1.39	0.36	2.00	6.00	38.46%
PO1	76	22	3.55	1.50	0.32	1.00	7.00	28.95%
PS1	277	89	3.03	1.58	0.17	1.00	7.00	32.13%
PS2	295	109	3.22	1.41	0.14	1.00	7.00	36.95%
PS3	299	87	2.80	1.42	0.15	1.00	7.00	29.10%
PS4	45	18	2.67	1.46	0.34	1.00	6.00	40.00%
SO1	28	14	3.14	1.70	0.46	1.00	7.00	50.00%
SO2	164	56	3.64	1.48	0.20	1.00	7.00	34.15%
SO3	33	5	2.80	1.30	0.58	1.00	4.00	15.15%
SO4	46	13	3.15	1.28	0.36	1.00	5.00	28.26%
SO5	21	8	2.88	1.36	0.48	1.00	4.00	38.10%
Total	2518	805	3.45	1.56	0.06	1.00	7.00	31.97%
Wished other classes used similar grading system								
AM1	17	4	5.75	1.50	0.75	4.00	7.00	23.53%
AN1	48	14	3.29	2.02	0.54	1.00	6.00	29.17%
AN2	68	25	4.80	1.44	0.29	2.00	7.00	36.76%
AS1	70	16	3.63	1.41	0.35	1.00	5.00	22.86%
AS2	43	10	4.80	1.32	0.42	2.00	6.00	23.26%
AS3	28	8	4.25	1.91	0.67	1.00	6.00	28.57%
EC1	228	43	6.07	1.37	0.21	1.00	7.00	18.86%
EC2	128	37	3.65	1.90	0.31	1.00	7.00	28.91%
ED3	77	43	5.98	1.63	0.25	1.00	7.00	55.84%
EN1	207	69	4.12	1.61	0.19	1.00	7.00	33.33%
EN2	21	7	3.14	1.86	0.70	1.00	5.00	33.33%
EN3	69	26	4.27	1.99	0.39	1.00	7.00	37.68%
HI1	53	18	5.50	1.25	0.29	4.00	7.00	33.96%
HI2	46	16	5.38	1.63	0.41	1.00	7.00	34.78%
HI3	37	16	4.25	1.69	0.42	1.00	7.00	43.24%
LI1	55	17	5.24	1.82	0.44	1.00	7.00	30.91%
LI2	39	15	3.40	1.88	0.49	1.00	6.00	38.46%
PO1	76	22	4.23	1.63	0.35	1.00	7.00	28.95%
PS1	277	89	5.47	1.25	0.13	2.00	7.00	32.13%
PS2	295	109	5.12	1.26	0.12	2.00	7.00	36.95%
PS3	299	87	5.11	1.43	0.15	1.00	7.00	29.10%
PS4	45	19	4.37	1.57	0.36	1.00	7.00	42.22%
SO1	28	14	5.93	1.21	0.32	3.00	7.00	50.00%
SO2	164	56	5.29	1.97	0.26	1.00	7.00	34.15%
SO3	33	5	3.80	2.39	1.07	1.00	7.00	15.15%

	Possible *N*	*N*	*M*	*SD*	*SE*	Min	Max	Percent complete
SO4	46	13	4.15	1.63	0.45	2.00	7.00	28.26%
SO5	21	8	5.88	1.13	0.40	4.00	7.00	38.10%
Total	2518	806	4.91	1.71	0.06	1.00	7.00	32.01%

RQ1: Raw Autonomy-Supportive Course Dimensions Predicting Autonomous Motivation

Table 16

RAI Regressed on Raw Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Num. of assignment types	-0.13	0.13	13.95	-1.01	0.33	0.60	0.78
Percent needed for an A (rev)	-0.71	1.74	12.84	-0.41	0.69	0.66	0.81
Num. of recovery mechanisms	-0.31	0.30	13.87	-1.02	0.33	0.59	0.77
Num. of types of scaffolds	-0.32	0.27	17.63	-1.19	0.25	0.55	0.74
Percent of low-stakes assignments	-0.63	0.58	15.38	-1.10	0.29	0.61	0.78
Percent of optional assignments	-0.06	0.80	16.35	-0.08	0.94	0.67	0.82
Percent with within-assignment choice	1.40	1.19	24.08	1.17	0.25	0.65	0.81
Additive grading system	-0.26	0.71	12.93	-0.36	0.72	0.66	0.81

RQ1: Recoded Autonomy-Supportive Course Dimensions Predicting Autonomous Motivation

Table 17

RAI Regressed on Recoded Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Assignment Types							
Essay	0.14	0.46	18.33	0.31	0.76	0.65	0.81
Exam	-0.46	0.52	21.52	-0.87	0.39	0.66	0.81
Presentation	-0.58	0.48	15.49	-1.23	0.24	0.58	0.76
Project	0.43	0.48	21.54	0.89	0.38	0.68	0.82
Participation	0.13	0.67	20.91	0.20	0.85	0.65	0.81
Paper	0.47	0.46	22.88	1.02	0.32	0.64	0.80
Homework/problem set	-0.39	0.62	21.88	-0.63	0.54	0.62	0.79
Quizzes	-0.68	0.41	19.33	-1.64	0.12	0.52	0.72
Discussion/blog posts	-0.01	0.61	20.00	-0.02	0.98	0.66	0.81
Other	-0.59	0.51	18.88	-1.15	0.27	0.63	0.79
Recovery Mechanisms							
Extra credit	-0.26	0.57	15.97	-0.46	0.65	0.64	0.80
Grade manipulation	-0.25	0.50	18.13	-0.51	0.62	0.65	0.80
Resubmission	-0.45	0.77	17.61	-0.58	0.57	0.64	0.80
Scaffolds							

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Instructor-reviewed draft	-0.72	0.85	47.66	-0.85	0.40	0.61	0.78
Peer review	-1.45	0.83	27.47	-1.75	0.09	0.51	0.72
Other (e.g. outline, lit review)	-0.28	0.54	16.67	-0.51	0.62	0.63	0.80
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.69	0.83
More than 0% (1)	-0.21	0.48	19.12	-0.44	0.67	0.69	0.83
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.61	0.78
21%-40% (2)	0.42	0.69	11.40	0.61	0.55	0.61	0.78
41%-80% (3)	-0.55	0.56	14.77	-0.97	0.35	0.61	0.78
81%-100% (4)	-0.38	0.54	11.08	-0.70	0.50	0.61	0.78
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.48	0.69
51%-100% (2)	-0.73	0.40	13.85	-1.84	0.09	0.48	0.69
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.63	0.79
1%-40% (1)	0.35	0.63	11.31	0.56	0.58	0.63	0.79
41%-80% (2)	-0.52	0.59	16.38	-0.87	0.40	0.63	0.79
81%-100% (3)	-0.35	0.57	12.56	-0.61	0.55	0.63	0.79
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.66	0.81
More than 0% (1)	0.06	0.43	18.15	0.13	0.90	0.66	0.81
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.72	0.85
1%-40% (1)	-0.07	0.68	19.77	-0.10	0.92	0.72	0.85
41%-100% (2)	0.11	0.50	16.43	0.22	0.83	0.72	0.85
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.61	0.78
1%-50% (1)	0.44	0.47	17.72	0.92	0.37	0.61	0.78
51%-100% (2)	-0.86	0.65	15.26	-1.32	0.21	0.61	0.78
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.58	0.76
51%-100% (2)	-1.01	0.62	14.61	-1.62	0.13	0.58	0.76
Percent of assignments with within-choice ver. A							

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
More than 0% (1)	0.70	0.43	22.32	1.62	0.12	0.66	0.81
0-20% (1)*	---	---	---	---	---	0.65	0.81
21%-40% (2)	0.83	0.48	19.22	1.73	0.10	0.65	0.81
41%-100% (3)	0.01	0.64	25.65	0.02	0.98	0.65	0.81
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.70	0.84
1%-25% (1)	0.76	0.51	20.20	1.49	0.15	0.70	0.84
26%-100% (2)	0.65	0.55	23.91	1.19	0.25	0.70	0.84
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.67	0.82
26%-100% (2)	0.33	0.50	21.95	0.66	0.52	0.67	0.82

Note. *Indicates that the category was used as a reference group in the model.

RQ1: Raw Autonomy-Supportive Course Design Dimensions Predicting Alternate Dependent Variables

Table 18

Alternate Dependent Variables Regressed on Raw Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Mastery Goal Orientation							
Num. of assignment types	0.02	0.05	20.77	0.41	0.69	0.15	0.39
Percent needed for an A (rev)	-0.50	0.74	19.35	-0.67	0.51	0.15	0.39
Num. of recovery mechanisms	-0.20	0.12	21.38	-1.58	0.13	0.14	0.37
Num. of types of scaffolds	0.09	0.11	28.42	0.88	0.39	0.15	0.38
Percent of low-stakes assignments	-0.28	0.24	22.73	-1.20	0.24	0.15	0.39
Percent of optional assignments	-0.10	0.33	22.38	-0.30	0.77	0.15	0.39
Percent with within-assignment choice	0.93	0.43	25.70	2.17	0.04	0.12	0.35
Additive grading system	-0.13	0.30	19.41	-0.44	0.67	0.15	0.39
Performance Approach Orientation							
Num. of assignment types	-0.10	0.06	19.49	-1.71	0.10	0.17	0.41
Percent needed for an A (rev)	0.14	0.87	18.23	0.16	0.87	0.20	0.45
Num. of recovery mechanisms	0.03	0.15	20.40	0.17	0.87	0.20	0.45
Num. of types of scaffolds	-0.19	0.12	29.09	-1.54	0.14	0.19	0.43
Percent of low-stakes assignments	0.06	0.29	21.69	0.20	0.84	0.21	0.46
Percent of optional assignments	0.11	0.38	21.53	0.28	0.78	0.20	0.45
Percent with within-assignment choice	-0.73	0.53	25.45	-1.38	0.18	0.18	0.42
Additive grading system	0.01	0.35	18.25	0.03	0.97	0.20	0.45

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Expectancy							
Num. of assignment types	0.07	0.05	17.82	1.41	0.18	0.13	0.36
Percent needed for an A (rev)	0.98	0.71	15.93	1.38	0.19	0.13	0.36
Num. of recovery mechanisms	0.11	0.13	19.32	0.84	0.41	0.14	0.38
Num. of types of scaffolds	-0.03	0.11	25.67	-0.23	0.82	0.14	0.38
Percent of low-stakes assignments	-0.03	0.24	20.24	-0.13	0.90	0.15	0.38
Percent of optional assignments	0.28	0.32	19.28	0.86	0.40	0.14	0.37
Percent with within-assignment choice	0.37	0.47	23.88	0.79	0.44	0.14	0.37
Additive grading system	0.41	0.29	16.06	1.43	0.17	0.13	0.36
Utility Value							
Num. of assignment types	-0.07	0.07	16.85	-1.00	0.33	0.22	0.47
Percent needed for an A (rev)	-0.51	0.96	15.89	-0.53	0.61	0.23	0.48
Num. of recovery mechanisms	-0.02	0.17	18.67	-0.13	0.90	0.24	0.49
Num. of types of scaffolds	-0.12	0.14	23.32	-0.80	0.43	0.22	0.47
Percent of low-stakes assignments	-0.31	0.31	19.27	-0.97	0.34	0.23	0.48
Percent of optional assignments	-0.10	0.43	19.65	-0.23	0.82	0.24	0.49
Percent with within-assignment choice	0.24	0.63	24.46	0.39	0.70	0.24	0.49
Additive grading system	-0.25	0.39	15.84	-0.65	0.52	0.23	0.48
Cost							
Num. of assignment types	0.04	0.07	17.89	0.55	0.59	0.23	0.48
Percent needed for an A (rev)	1.03	0.95	15.92	1.09	0.29	0.22	0.47
Num. of recovery mechanisms	-0.26	0.17	18.99	-1.59	0.13	0.21	0.46
Num. of types of scaffolds	0.15	0.14	23.19	1.01	0.32	0.21	0.46
Percent of low-stakes assignments	0.23	0.31	20.12	0.72	0.48	0.22	0.47
Percent of optional assignments	0.28	0.43	19.92	0.66	0.52	0.23	0.48
Percent with within-assignment choice	1.28	0.58	24.13	2.22	0.04	0.18	0.42
Additive grading system	0.45	0.38	15.81	1.19	0.25	0.22	0.47

RQ1: Recoded Autonomy-Supportive Course Design Dimensions Predicting Alternate Dependent Variables

Table 19
Mastery Classroom Goal Structure Regressed on Recoded Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Assignment Types							
Essay	0.10	0.18	24.55	0.58	0.57	0.15	0.39
Exam	-0.27	0.20	25.69	-1.36	0.19	0.14	0.37
Presentation	-0.15	0.20	22.54	-0.78	0.44	0.15	0.39
Project	0.31	0.18	25.07	1.73	0.10	0.13	0.36
Participation	0.16	0.26	23.57	0.59	0.56	0.15	0.39
Paper	0.37	0.16	23.57	2.25	0.03	0.11	0.34
Homework/problem set	0.04	0.25	26.25	0.15	0.88	0.15	0.39

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Quizzes	-0.16	0.17	24.84	-0.94	0.36	0.15	0.38
Discussion/blog posts	0.16	0.23	23.73	0.67	0.51	0.15	0.38
Other	-0.04	0.21	24.87	-0.17	0.86	0.15	0.39
Recovery Mechanisms							
Extra credit	-0.41	0.22	22.35	-1.87	0.08	0.13	0.36
Grade manipulation	-0.14	0.20	23.01	-0.70	0.49	0.15	0.39
Resubmission	0.12	0.32	22.47	0.39	0.70	0.15	0.39
Scaffolds							
Assignment proposal	-0.01	0.22	23.63	-0.07	0.95	0.15	0.39
Instructor-reviewed draft	0.43	0.29	39.61	1.47	0.15	0.14	0.37
Peer review	0.04	0.34	28.25	0.12	0.91	0.15	0.39
Other (e.g. outline, lit review)	0.16	0.22	23.71	0.75	0.46	0.15	0.38
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.16	0.39
More than 0% (1)	-0.10	0.19	24.05	-0.50	0.62	0.16	0.39
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.15	0.39
21%-40% (2)	0.26	0.28	23.34	0.92	0.37	0.15	0.39
41%-80% (3)	-0.09	0.23	22.27	-0.40	0.69	0.15	0.39
81%-100% (4)	-0.19	0.23	19.94	-0.81	0.43	0.15	0.39
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.14	0.38
51%-100% (2)	-0.27	0.17	23.82	-1.57	0.13	0.14	0.38
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.16	0.40
1%-40% (1)	0.11	0.26	22.12	0.41	0.69	0.16	0.40
41%-80% (2)	-0.12	0.24	23.04	-0.52	0.61	0.16	0.40
81%-100% (3)	-0.22	0.24	20.79	-0.91	0.38	0.16	0.40
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.15	0.38
More than 0% (1)	-0.13	0.17	24.03	-0.74	0.47	0.15	0.38
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.15	0.39
1%-40% (1)	-0.20	0.26	25.58	-0.78	0.45	0.15	0.39
41%-100% (2)	-0.09	0.20	21.84	-0.46	0.65	0.15	0.39
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.16	0.39
1%-50% (1)	-0.10	0.19	23.60	-0.49	0.63	0.16	0.39
51%-100% (2)	-0.21	0.27	21.55	-0.75	0.46	0.16	0.39

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.15	0.39
51%-100% (2)	-0.17	0.26	22.19	-0.66	0.52	0.15	0.39
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	0.13	0.35
More than 0% (1)	0.31	0.16	24.43	1.96	0.06	0.13	0.35
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	0.14	0.37
21%-40% (2)	0.25	0.19	22.87	1.33	0.20	0.14	0.37
41%-100% (3)	0.34	0.24	25.27	1.38	0.18	0.14	0.37
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.13	0.36
1%-25% (1)	0.27	0.19	22.60	1.42	0.17	0.13	0.36
26%-100% (2)	0.37	0.20	24.91	1.83	0.08	0.13	0.36
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.14	0.37
26%-100% (2)	0.26	0.19	25.97	1.36	0.19	0.14	0.37

Table 20

Performance Approach Classroom Goal Structure Regressed on Recoded Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Assignment Types							
Essay	-0.29	0.21	23.74	-1.42	0.17	0.18	0.42
Exam	0.38	0.24	25.92	1.62	0.12	0.18	0.43
Presentation	0.16	0.23	21.83	0.67	0.51	0.20	0.44
Project	-0.27	0.22	25.22	-1.23	0.23	0.19	0.43
Participation	-0.69	0.27	20.92	-2.55	0.02	0.14	0.37
Paper	-0.28	0.21	25.14	-1.34	0.19	0.18	0.43
Homework/problem set	0.11	0.29	25.73	0.38	0.71	0.20	0.44
Quizzes	-0.02	0.21	23.41	-0.11	0.92	0.20	0.45
Discussion/blog posts	0.03	0.28	23.35	0.10	0.92	0.20	0.45
Other	-0.26	0.24	24.30	-1.11	0.28	0.19	0.43
Recovery Mechanisms							
Extra credit	-0.04	0.28	22.06	-0.15	0.88	0.20	0.45
Grade manipulation	0.00	0.24	22.22	0.00	1.00	0.20	0.45
Resubmission	0.01	0.37	21.94	0.02	0.99	0.20	0.45

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Scaffolds							
Assignment proposal	-0.19	0.26	23.17	-0.74	0.47	0.20	0.45
Instructor-reviewed draft	-0.67	0.35	44.70	-1.95	0.06	0.17	0.41
Peer review	-0.40	0.40	28.88	-1.01	0.32	0.19	0.44
Other (e.g. outline, lit review)	-0.09	0.26	22.94	-0.37	0.72	0.20	0.45
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.20	0.45
More than 0% (1)	-0.13	0.22	22.99	-0.57	0.58	0.20	0.45
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.22	0.47
21%-40% (2)	-0.29	0.34	22.33	-0.85	0.40	0.22	0.47
41%-80% (3)	-0.15	0.27	21.68	-0.55	0.59	0.22	0.47
81%-100% (4)	0.04	0.28	19.18	0.14	0.89	0.22	0.47
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.21	0.46
51%-100% (2)	0.16	0.21	22.94	0.75	0.46	0.21	0.46
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.22	0.47
1%-40% (1)	-0.26	0.31	20.62	-0.84	0.41	0.22	0.47
41%-80% (2)	-0.17	0.28	22.06	-0.60	0.56	0.22	0.47
81%-100% (3)	0.02	0.29	19.63	0.07	0.94	0.22	0.47
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.20	0.45
More than 0% (1)	0.05	0.20	23.36	0.22	0.83	0.20	0.45
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.21	0.46
1%-40% (1)	0.06	0.31	25.18	0.19	0.85	0.21	0.46
41%-100% (2)	0.04	0.24	21.18	0.17	0.87	0.21	0.46
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.20	0.45
1%-50% (1)	-0.07	0.23	23.16	-0.29	0.78	0.20	0.45
51%-100% (2)	0.32	0.32	20.87	1.00	0.33	0.20	0.45
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.19	0.44
51%-100% (2)	0.34	0.30	21.41	1.11	0.28	0.19	0.44

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	0.18	0.42
More than 0% (1)	-0.30	0.19	23.81	-1.57	0.13	0.18	0.42
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	0.19	0.44
21%-40% (2)	-0.31	0.22	22.40	-1.36	0.19	0.19	0.44
41%-100% (3)	-0.19	0.29	25.34	-0.64	0.53	0.19	0.44
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.18	0.43
1%-25% (1)	-0.22	0.23	21.97	-0.97	0.34	0.18	0.43
26%-100% (2)	-0.41	0.24	24.59	-1.67	0.11	0.18	0.43
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.18	0.43
26%-100% (2)	-0.32	0.22	25.78	-1.41	0.17	0.18	0.43

Table 21

Expectancy Regressed on Recoded Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Assignment Types							
Essay	0.16	0.18	21.56	0.87	0.39	0.14	0.37
Exam	-0.10	0.21	22.77	-0.48	0.64	0.14	0.38
Presentation	-0.03	0.20	20.34	-0.15	0.88	0.14	0.38
Project	0.03	0.19	22.89	0.16	0.87	0.14	0.38
Participation	0.29	0.26	20.56	1.13	0.27	0.13	0.36
Paper	0.29	0.18	25.18	1.65	0.11	0.13	0.36
Homework/problem set	0.11	0.25	24.91	0.44	0.67	0.14	0.38
Quizzes	-0.02	0.18	22.31	-0.12	0.91	0.14	0.38
Discussion/blog posts	0.01	0.24	22.29	0.04	0.97	0.14	0.38
Other	0.05	0.21	21.87	0.23	0.82	0.14	0.38
Recovery Mechanisms							
Extra credit	0.11	0.24	20.63	0.46	0.65	0.14	0.38
Grade manipulation	0.21	0.20	21.35	1.05	0.31	0.14	0.37
Resubmission	0.05	0.32	20.58	0.17	0.87	0.14	0.38

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Scaffolds							
Assignment proposal	0.27	0.22	21.40	1.25	0.23	0.14	0.37
Instructor-reviewed draft	-0.40	0.31	41.15	-1.29	0.21	0.13	0.36
Peer review	-0.39	0.34	27.20	-1.14	0.26	0.14	0.37
Other (e.g. outline, lit review)	0.05	0.21	21.87	0.23	0.82	0.14	0.38
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.15	0.38
More than 0% (1)	0.10	0.19	22.00	0.51	0.61	0.15	0.38
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.15	0.39
21%-40% (2)	0.22	0.29	20.79	0.76	0.46	0.15	0.39
41%-80% (3)	-0.14	0.23	20.85	-0.59	0.56	0.15	0.39
81%-100% (4)	0.08	0.23	17.91	0.34	0.74	0.15	0.39
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.14	0.38
51%-100% (2)	-0.15	0.18	21.16	-0.87	0.40	0.14	0.38
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.14	0.38
1%-40% (1)	0.31	0.26	18.91	1.17	0.26	0.14	0.38
41%-80% (2)	-0.08	0.24	21.28	-0.35	0.73	0.14	0.38
81%-100% (3)	0.13	0.24	18.33	0.56	0.58	0.14	0.38
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.14	0.37
More than 0% (1)	0.11	0.17	21.01	0.65	0.52	0.14	0.37
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.14	0.37
1%-40% (1)	-0.09	0.26	23.35	-0.33	0.74	0.14	0.37
41%-100% (2)	0.21	0.20	19.28	1.06	0.30	0.14	0.37
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.14	0.37
1%-50% (1)	0.21	0.19	20.37	1.06	0.30	0.14	0.37
51%-100% (2)	-0.12	0.27	18.40	-0.43	0.67	0.14	0.37
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.14	0.38
51%-100% (2)	-0.19	0.27	19.96	-0.70	0.49	0.14	0.38

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	0.13	0.36
More than 0% (1)	0.27	0.17	23.05	1.63	0.12	0.13	0.36
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	0.11	0.33
21%-40% (2)	0.45	0.18	22.13	2.50	0.02	0.11	0.33
41%-100% (3)	-0.04	0.23	25.90	-0.16	0.87	0.11	0.33
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.14	0.37
1%-25% (1)	0.25	0.20	21.12	1.27	0.22	0.14	0.37
26%-100% (2)	0.30	0.21	23.36	1.42	0.17	0.14	0.37
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.14	0.37
26%-100% (2)	0.20	0.20	23.60	1.01	0.33	0.14	0.37

Table 22
Cost Regressed on Recoded Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Assignment Types							
Essay	0.01	0.25	22.85	0.03	0.97	0.24	0.49
Exam	-0.45	0.26	22.35	-1.74	0.10	0.19	0.44
Presentation	0.56	0.24	18.74	2.33	0.03	0.17	0.42
Project	0.31	0.24	21.75	1.26	0.22	0.21	0.45
Participation	-0.23	0.36	23.01	-0.65	0.52	0.23	0.48
Paper	0.09	0.25	24.29	0.36	0.73	0.24	0.49
Homework/problem set	-0.28	0.33	26.31	-0.84	0.41	0.23	0.48
Quizzes	0.15	0.24	22.50	0.63	0.53	0.23	0.48
Discussion/blog posts	0.27	0.32	23.49	0.84	0.41	0.23	0.48
Other	-0.08	0.28	23.06	-0.27	0.79	0.24	0.49
Recovery Mechanisms							
Extra credit	-0.44	0.30	19.52	-1.47	0.16	0.21	0.45
Grade manipulation	-0.69	0.23	21.74	-3.02	0.01	0.14	0.38
Resubmission	0.80	0.39	20.12	2.05	0.05	0.18	0.43

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Scaffolds							
Assignment proposal	0.08	0.30	19.81	0.28	0.78	0.24	0.49
Instructor-reviewed draft	0.21	0.43	45.02	0.48	0.63	0.23	0.48
Peer review	0.34	0.46	28.43	0.74	0.47	0.23	0.48
Other (e.g. outline, lit review)	0.23	0.29	20.38	0.80	0.43	0.22	0.47
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.23	0.48
More than 0% (1)	-0.19	0.25	23.59	-0.74	0.47	0.23	0.48
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.23	0.48
21%-40% (2)	-0.49	0.38	20.71	-1.30	0.21	0.23	0.48
41%-80% (3)	0.10	0.30	22.21	0.34	0.74	0.23	0.48
81%-100% (4)	0.13	0.30	18.39	0.42	0.68	0.23	0.48
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.20	0.45
51%-100% (2)	0.32	0.22	20.57	1.44	0.17	0.20	0.45
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.19	0.44
1%-40% (1)	-0.67	0.32	17.72	-2.08	0.05	0.19	0.44
41%-80% (2)	-0.02	0.30	22.31	-0.06	0.95	0.19	0.44
81%-100% (3)	0.01	0.29	18.29	0.04	0.97	0.19	0.44
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.24	0.49
More than 0% (1)	-0.06	0.24	22.41	-0.27	0.79	0.24	0.49
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.25	0.50
1%-40% (1)	-0.20	0.36	23.73	-0.57	0.58	0.25	0.50
41%-100% (2)	0.00	0.27	19.46	0.01	1.00	0.25	0.50
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.21	0.46
1%-50% (1)	-0.24	0.25	19.86	-0.94	0.36	0.21	0.46
51%-100% (2)	0.36	0.35	17.56	1.03	0.32	0.21	0.46
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.21	0.46
51%-100% (2)	0.44	0.34	18.49	1.29	0.21	0.21	0.46

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	0.21	0.46
More than 0% (1)	0.32	0.22	22.32	1.43	0.17	0.21	0.46
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	0.16	0.40
21%-40% (2)	-0.19	0.23	20.49	-0.82	0.42	0.16	0.40
41%-100% (3)	0.77	0.30	25.77	2.54	0.02	0.16	0.40
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.20	0.45
1%-25% (1)	0.18	0.26	19.45	0.70	0.49	0.20	0.45
26%-100% (2)	0.49	0.27	22.11	1.79	0.09	0.20	0.45
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.20	0.45
26%-100% (2)	0.42	0.25	23.18	1.66	0.11	0.20	0.45

Table 23
Utility Value Regressed on Autonomy-Supportive Course Design Dimensions

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Assignment Types							
Essay	-0.38	0.23	22.55	-1.64	0.12	0.20	0.45
Exam	-0.10	0.28	23.39	-0.36	0.72	0.24	0.49
Presentation	-0.26	0.26	18.61	-0.99	0.34	0.22	0.46
Project	0.26	0.25	24.26	1.04	0.31	0.23	0.48
Participation	0.36	0.35	21.99	1.02	0.32	0.22	0.47
Paper	0.39	0.24	26.34	1.67	0.11	0.21	0.46
Homework/problem set	0.02	0.33	25.09	0.05	0.96	0.24	0.48
Quizzes	-0.49	0.21	19.56	-2.37	0.03	0.16	0.40
Discussion/blog posts	0.20	0.32	22.84	0.63	0.53	0.23	0.48
Other	-0.16	0.28	22.62	-0.58	0.57	0.23	0.48
Recovery Mechanisms							
Extra credit	-0.03	0.31	20.35	-0.09	0.93	0.24	0.49
Grade manipulation	0.10	0.27	20.98	0.38	0.71	0.23	0.48
Resubmission	-0.27	0.42	19.99	-0.66	0.52	0.23	0.48

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Scaffolds							
Assignment proposal	-0.03	0.29	19.89	-0.12	0.91	0.24	0.49
Instructor-reviewed draft	0.10	0.43	43.11	0.23	0.82	0.23	0.48
Peer review	-0.99	0.41	27.31	-2.39	0.02	0.17	0.41
Other (e.g. outline, lit review)	-0.04	0.29	20.50	-0.15	0.88	0.23	0.48
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.25	0.50
More than 0% (1)	-0.03	0.26	22.18	-0.14	0.89	0.25	0.50
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.24	0.49
21%-40% (2)	0.31	0.38	19.07	0.81	0.43	0.24	0.49
41%-80% (3)	-0.15	0.31	20.06	-0.50	0.63	0.24	0.49
81%-100% (4)	-0.27	0.30	16.79	-0.90	0.38	0.24	0.49
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.21	0.46
51%-100% (2)	-0.33	0.22	19.34	-1.48	0.16	0.21	0.46
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.24	0.49
1%-40% (1)	0.33	0.34	17.67	0.97	0.35	0.24	0.49
41%-80% (2)	-0.11	0.31	20.83	-0.35	0.73	0.24	0.49
81%-100% (3)	-0.23	0.31	17.58	-0.73	0.47	0.24	0.49
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.24	0.49
More than 0% (1)	-0.04	0.23	21.77	-0.18	0.86	0.24	0.49
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.23	0.48
1%-40% (1)	-0.38	0.35	25.32	-1.09	0.29	0.23	0.48
41%-100% (2)	0.12	0.26	20.74	0.44	0.66	0.23	0.48
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.24	0.49
1%-50% (1)	0.03	0.26	20.51	0.11	0.91	0.24	0.49
51%-100% (2)	-0.22	0.37	18.34	-0.60	0.56	0.24	0.49
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.23	0.48
51%-100% (2)	-0.23	0.35	18.55	-0.67	0.51	0.23	0.48

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	0.23	0.48
More than 0% (1)	0.27	0.23	23.68	1.20	0.24	0.23	0.48
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	0.21	0.46
21%-40% (2)	0.40	0.25	20.79	1.63	0.12	0.21	0.46
41%-100% (3)	-0.18	0.33	24.69	-0.54	0.59	0.21	0.46
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.23	0.48
1%-25% (1)	0.41	0.27	21.68	1.56	0.13	0.23	0.48
26%-100% (2)	0.10	0.28	24.33	0.36	0.72	0.23	0.48
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.23	0.48
26%-100% (2)	-0.07	0.26	23.47	-0.27	0.79	0.23	0.48

RQ3: Raw Autonomy-Supportive Course Design Dimensions: Moderation Analyses

Table 24

RAI Regressed on Raw Autonomy-Supportive Course Design Dimensions Moderated by Cumulative GPA

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Number of assignment types							
Number of assignment types	-0.13	0.13	14.40	-1.07	0.30	0.61	0.78
Cumulative GPA	0.39	0.30	863.50	1.31	0.19	0.61	0.78
Interaction term	0.33	0.16	858.20	2.03	0.04	0.61	0.78
Percent needed for an A (reversed)							
Percent needed for an A (reversed)	-0.74	1.76	13.00	-0.42	0.68	0.67	0.82
Cumulative GPA	0.03	0.40	863.20	0.08	0.94	0.67	0.82
Interaction term	2.74	2.09	856.70	1.31	0.19	0.67	0.82
Number of recovery mechanisms							
Number of recovery mechanisms	-0.33	0.30	14.20	-1.07	0.30	0.58	0.76
Cumulative GPA	0.48	0.36	861.50	1.32	0.19	0.58	0.76
Interaction term	-0.15	0.40	856.90	-0.38	0.70	0.58	0.76
Additive grading system							
Additive grading system	-0.29	0.72	13.10	-0.41	0.69	0.67	0.82
Cumulative GPA	0.21	0.32	863.60	0.66	0.51	0.67	0.82
Interaction term	1.27	0.89	857.90	1.43	0.15	0.67	0.82
Number of types of assignment scaffolds							
Number of types of assignment scaffolds	-0.34	0.27	18.00	-1.28	0.22	0.55	0.74
Cumulative GPA	0.20	0.35	864.30	0.58	0.56	0.55	0.74
Interaction term	0.41	0.41	860.50	0.99	0.32	0.55	0.74
Percent of low-stakes assignments							
Percent of low-stakes assignments	-0.70	0.58	15.90	-1.21	0.24	0.61	0.78
Cumulative GPA	0.42	0.30	847.80	1.38	0.17	0.61	0.78
Interaction term	1.45	0.81	845.70	1.80	0.07	0.61	0.78
Percent of optional assignments							
Percent of optional assignments	-0.22	0.79	17.20	-0.27	0.79	0.64	0.80
Cumulative GPA	-0.20	0.40	863.60	-0.51	0.61	0.64	0.80
Interaction term	2.62	1.17	863.60	2.24	0.03	0.64	0.80
Percent of assignments with within-assignment choice							
Percent of assignments with within-assignment choice	1.35	1.20	24.40	1.12	0.27	0.67	0.82
Cumulative GPA	0.07	0.40	864.10	0.18	0.86	0.67	0.82
Interaction term	2.16	1.81	861.10	1.20	0.23	0.67	0.82

Table 25
RAI Regressed on Raw Autonomy-Supportive Course Design Dimensions Moderated by Cost

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Number of assignment types							
Number of assignment types	-0.11	0.13	13.00	-0.89	0.39	0.59	0.77
Cost	-0.46	0.08	775.60	-5.64	0.00	0.59	0.77
Interaction term	-0.10	0.05	784.70	-2.11	0.04	0.59	0.77
Percent needed for an A (reversed)							
Percent needed for an A (reversed)	-0.15	1.76	11.70	-0.09	0.93	0.65	0.81
Cost	-0.39	0.11	779.50	-3.51	0.00	0.65	0.81
Interaction term	-0.69	0.60	779.40	-1.14	0.26	0.65	0.81
Number of recovery mechanisms							
Number of recovery mechanisms	-0.41	0.30	11.80	-1.38	0.19	0.53	0.73
Cost	-0.53	0.11	776.60	-5.00	0.00	0.53	0.73
Interaction term	0.08	0.11	782.60	0.70	0.48	0.53	0.73
Additive grading system							
Additive grading system	0.01	0.72	12.00	0.01	0.99	0.65	0.81
Cost	-0.44	0.09	775.80	-4.99	0.00	0.65	0.81
Interaction term	-0.25	0.24	780.00	-1.00	0.32	0.65	0.81
Number of types of assignment scaffolds							
Number of types of assignment scaffolds	-0.22	0.27	17.40	-0.79	0.44	0.56	0.75
Cost	-0.35	0.10	770.40	-3.56	0.00	0.56	0.75
Interaction term	-0.23	0.11	783.00	-2.20	0.03	0.56	0.75
Percent of low-stakes assignments							
Percent of low-stakes assignments	-0.53	0.60	14.70	-0.88	0.40	0.66	0.81
Cost	-0.48	0.08	765.60	-5.76	0.00	0.66	0.81
Interaction term	-0.26	0.22	768.60	-1.16	0.25	0.66	0.81
Percent of optional assignments							
Percent of optional assignments	-0.07	0.80	15.20	-0.09	0.93	0.63	0.79
Cost	-0.37	0.11	762.10	-3.38	0.00	0.63	0.79
Interaction term	-0.43	0.29	781.80	-1.47	0.14	0.63	0.79
Percent of assignments with within-assignment choice							
Percent of assignments with within-assignment choice	2.19	1.20	24.70	1.83	0.08	0.59	0.77
Cost	-0.39	0.11	776.40	-3.54	0.00	0.59	0.77
Interaction term	-0.63	0.51	773.30	-1.24	0.22	0.59	0.77

Table 26

Cost Regressed on Raw Autonomy-Supportive Course Design Dimensions Moderated by Cumulative GPA

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Number of assignment types							
Number of assignment types	0.04	0.07	17.90	0.56	0.58	0.23	0.48
Cumulative GPA	-0.13	0.13	793.30	-1.02	0.31	0.23	0.48
Interaction term	-0.06	0.07	787.60	-0.85	0.40	0.23	0.48
Percent needed for an A (reversed)							
Percent needed for an A (reversed)	1.01	0.93	15.70	1.09	0.29	0.22	0.46
Cumulative GPA	-0.16	0.17	794.00	-0.94	0.35	0.22	0.46
Interaction term	0.25	0.89	787.80	0.28	0.78	0.22	0.46
Number of recovery mechanisms							
Number of recovery mechanisms	-0.23	0.16	19.20	-1.41	0.17	0.20	0.45
Cumulative GPA	0.03	0.16	791.40	0.17	0.87	0.20	0.45
Interaction term	-0.29	0.17	785.60	-1.67	0.09	0.20	0.45
Additive grading system							
Additive grading system	0.45	0.38	15.60	1.19	0.25	0.21	0.46
Cumulative GPA	-0.15	0.14	794.60	-1.05	0.29	0.21	0.46
Interaction term	0.12	0.38	788.80	0.31	0.76	0.21	0.46
Number of types of assignment scaffolds							
Number of types of assignment scaffolds	0.15	0.14	23.00	1.05	0.31	0.21	0.45
Cumulative GPA	-0.09	0.15	794.40	-0.57	0.57	0.21	0.45
Interaction term	-0.10	0.18	791.30	-0.59	0.56	0.21	0.45
Percent of low-stakes assignments							
Percent of low-stakes assignments	0.23	0.31	20.10	0.73	0.48	0.22	0.47
Cumulative GPA	-0.11	0.13	780.50	-0.87	0.39	0.22	0.47
Interaction term	0.05	0.35	778.90	0.13	0.90	0.22	0.47
Percent of optional assignments							
Percent of optional assignments	0.28	0.43	19.90	0.66	0.52	0.22	0.47
Cumulative GPA	-0.15	0.17	792.80	-0.86	0.39	0.22	0.47
Interaction term	0.07	0.51	792.50	0.15	0.88	0.22	0.47
Percent of assignments with within-assignment choice							
Percent of assignments with within-assignment choice	1.28	0.57	24.30	2.23	0.03	0.17	0.41
Cumulative GPA	-0.09	0.17	796.40	-0.52	0.60	0.17	0.41
Interaction term	-0.28	0.78	793.50	-0.36	0.72	0.17	0.41

RQ3: Recoded Autonomy-Supportive Course Design Dimensions: Moderation Analyses

Table 27
Moderation Analyses of RAI Regressed on Assignment Types

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Cumulative GPA as moderator	---	---	---	---	---	---	---
Essay							
Essay	0.16	0.46	18.60	0.36	0.72	0.65	0.81
Cumulative GPA	0.48	0.38	864.60	1.25	0.21	0.65	0.81
Interaction term	-0.25	0.62	860.60	-0.41	0.68	0.65	0.81
Exam							
Exam	-0.47	0.52	21.70	-0.90	0.38	0.66	0.81
Cumulative GPA	0.46	0.69	863.10	0.67	0.50	0.66	0.81
Interaction term	-0.09	0.76	863.00	-0.12	0.91	0.66	0.81
Presentation							
Presentation	-0.57	0.48	16.00	-1.18	0.25	0.60	0.77
Cumulative GPA	0.02	0.34	857.50	0.07	0.94	0.60	0.77
Interaction term	1.35	0.69	867.00	1.95	0.05	0.60	0.77
Project							
Project	0.38	0.49	22.00	0.77	0.45	0.72	0.85
Cumulative GPA	0.17	0.33	861.30	0.51	0.61	0.72	0.85
Interaction term	1.06	0.76	865.60	1.40	0.16	0.72	0.85
Participation							
Participation	0.16	0.68	21.70	0.24	0.81	0.65	0.81
Cumulative GPA	0.52	0.99	859.50	0.53	0.60	0.65	0.81
Interaction term	-0.16	1.04	859.90	-0.15	0.88	0.65	0.81
Paper							
Paper	0.45	0.46	23.60	0.98	0.34	0.64	0.80
Cumulative GPA	0.36	0.33	863.40	1.11	0.27	0.64	0.80
Interaction term	0.03	0.79	861.70	0.04	0.97	0.64	0.80
Homework/problem set							
Paper	-0.34	0.63	22.30	-0.54	0.60	0.64	0.80
Cumulative GPA	0.48	0.32	862.80	1.51	0.13	0.64	0.80
Interaction term	-0.97	0.99	864.10	-0.98	0.33	0.64	0.80
Quizzes							
Quizzes	-0.77	0.42	19.80	-1.85	0.08	0.53	0.73
Cumulative GPA	0.08	0.35	862.20	0.22	0.82	0.53	0.73
Interaction term	1.21	0.68	866.60	1.77	0.08	0.53	0.73
Discussion/blog posts							
Discussion/blog posts	0.08	0.61	20.50	0.12	0.90	0.66	0.81
Cumulative GPA	0.14	0.33	857.00	0.43	0.67	0.66	0.81
Interaction term	1.50	0.82	865.80	1.83	0.07	0.66	0.81

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Other							
Other	-0.56	0.51	18.90	-1.10	0.29	0.62	0.79
Cumulative GPA	0.26	0.35	862.20	0.75	0.46	0.62	0.79
Interaction term	0.36	0.67	861.50	0.54	0.59	0.62	0.79
Cost as moderator	---	---	---	---	---	---	---
Essay							
Essay	0.06	0.45	15.90	0.14	0.89	0.62	0.79
Cost	-0.44	0.10	768.00	-4.24	0.00	0.62	0.79
Interaction term	-0.11	0.17	780.40	-0.63	0.53	0.62	0.79
Exam							
Exam	-0.78	0.52	20.60	-1.48	0.15	0.60	0.78
Cost	-0.60	0.19	783.60	-3.16	0.00	0.60	0.78
Interaction term	0.14	0.21	783.30	0.67	0.50	0.60	0.78
Presentation							
Presentation	-0.30	0.51	14.90	-0.59	0.56	0.67	0.82
Cost	-0.38	0.10	779.70	-3.89	0.00	0.67	0.82
Interaction term	-0.32	0.18	784.40	-1.72	0.09	0.67	0.82
Project							
Project	0.68	0.48	20.10	1.40	0.18	0.64	0.80
Cost	-0.44	0.10	783.30	-4.55	0.00	0.64	0.80
Interaction term	-0.18	0.19	778.20	-0.96	0.34	0.64	0.80
Participation							
Participation	-0.05	0.69	20.20	-0.07	0.94	0.65	0.81
Cost	-0.32	0.28	711.90	-1.15	0.25	0.65	0.81
Interaction term	-0.17	0.29	720.80	-0.58	0.56	0.65	0.81
Paper							
Paper	0.62	0.45	20.90	1.36	0.19	0.56	0.75
Cost	-0.44	0.09	776.10	-4.76	0.00	0.56	0.75
Interaction term	-0.17	0.20	770.80	-0.82	0.41	0.56	0.75
Homework/problem set							
Paper	-0.38	0.63	19.30	-0.61	0.55	0.60	0.77
Cost	-0.51	0.09	775.50	-5.82	0.00	0.60	0.77
Interaction term	0.30	0.27	767.10	1.09	0.28	0.60	0.77
Quizzes							
Quizzes	-0.59	0.43	18.00	-1.38	0.19	0.54	0.74
Cost	-0.44	0.10	779.10	-4.50	0.00	0.54	0.74
Interaction term	-0.09	0.18	768.10	-0.49	0.63	0.54	0.74
Discussion/blog posts							
Discussion/blog posts	0.12	0.61	17.30	0.20	0.85	0.65	0.81
Cost	-0.47	0.09	779.00	-5.30	0.00	0.65	0.81
Interaction term	-0.06	0.25	768.60	-0.23	0.82	0.65	0.81

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Other							
Other	-0.86	0.49	16.00	-1.76	0.10	0.51	0.71
Cost	-0.42	0.10	755.60	-4.38	0.00	0.51	0.71
Interaction term	-0.24	0.19	784.80	-1.24	0.21	0.51	0.71

Table 28

Moderation Analyses of Cost Regressed on Assignment Types

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Essay							
Essay	-0.01	0.24	22.80	-0.02	0.98	0.23	0.48
Cumulative GPA	-0.23	0.17	794.70	-1.39	0.16	0.23	0.48
Interaction term	0.26	0.27	791.60	0.97	0.33	0.23	0.48
Exam							
Exam	-0.44	0.26	22.20	-1.72	0.10	0.19	0.43
Cumulative GPA	0.08	0.29	793.50	0.27	0.79	0.19	0.43
Interaction term	-0.26	0.32	793.40	-0.80	0.43	0.19	0.43
Presentation							
Presentation	0.55	0.24	18.60	2.30	0.03	0.17	0.41
Cumulative GPA	-0.17	0.15	791.10	-1.11	0.27	0.17	0.41
Interaction term	0.17	0.30	798.00	0.57	0.57	0.17	0.41
Project							
Project	0.31	0.24	21.80	1.29	0.21	0.20	0.45
Cumulative GPA	-0.12	0.15	792.90	-0.84	0.40	0.20	0.45
Interaction term	-0.06	0.32	796.10	-0.18	0.86	0.20	0.45
Participation							
Participation	-0.20	0.36	23.20	-0.56	0.58	0.23	0.48
Cumulative GPA	0.32	0.42	788.10	0.77	0.44	0.23	0.48
Interaction term	-0.50	0.44	788.70	-1.14	0.25	0.23	0.48
Paper							
Paper	0.10	0.25	24.60	0.39	0.70	0.23	0.48
Cumulative GPA	-0.12	0.14	793.30	-0.86	0.39	0.23	0.48
Interaction term	-0.04	0.34	792.60	-0.13	0.89	0.23	0.48
Homework/problem set							
Paper	-0.25	0.33	26.70	-0.75	0.46	0.23	0.47
Cumulative GPA	-0.08	0.14	793.80	-0.61	0.54	0.23	0.47
Interaction term	-0.49	0.44	791.00	-1.11	0.27	0.23	0.47
Quizzes							
Quizzes	0.16	0.23	22.70	0.69	0.50	0.22	0.47
Cumulative GPA	-0.11	0.15	789.60	-0.76	0.45	0.22	0.47
Interaction term	-0.07	0.29	798.30	-0.24	0.81	0.22	0.47
Discussion/blog posts							
Discussion/blog posts	0.26	0.32	23.50	0.80	0.43	0.23	0.48
Cumulative GPA	-0.12	0.14	789.60	-0.88	0.38	0.23	0.48
Interaction term	-0.01	0.35	799.00	-0.02	0.99	0.23	0.48
Other							
Other	-0.09	0.28	22.90	-0.32	0.76	0.23	0.48
Cumulative GPA	-0.09	0.15	792.10	-0.60	0.55	0.23	0.48
Interaction term	-0.15	0.29	791.70	-0.51	0.61	0.23	0.48

Table 29
Moderation Analyses of Recovery Mechanisms Regressed on RAI

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Cumulative GPA as moderator	---	---	---	---	---	---	---
Extra credit							
Extra credit	-0.25	0.58	16.60	-0.42	0.68	0.65	0.81
Cumulative GPA	0.47	0.33	863.70	1.41	0.16	0.65	0.81
Interaction term	-0.46	0.77	856.90	-0.60	0.55	0.65	0.81
Grade manipulation							
Grade manipulation	-0.21	0.51	19.20	-0.43	0.68	0.65	0.81
Cumulative GPA	0.54	0.34	861.50	1.61	0.11	0.65	0.81
Interaction term	-0.73	0.73	861.30	-1.00	0.32	0.65	0.81
Resubmission							
Resubmission	-0.53	0.78	18.40	-0.68	0.50	0.64	0.80
Cumulative GPA	0.32	0.31	863.50	1.06	0.29	0.64	0.80
Interaction term	1.01	1.33	850.10	0.76	0.45	0.64	0.80
Cost as moderator	---	---	---	---	---	---	---
Extra credit							
Extra credit	-0.52	0.57	13.70	-0.92	0.38	0.58	0.76
Cost	-0.49	0.09	774.20	-5.33	0.00	0.58	0.76
Interaction term	0.05	0.21	784.80	0.25	0.80	0.58	0.76
Grade manipulation							
Grade manipulation	-0.47	0.49	16.50	-0.95	0.35	0.57	0.75
Cost	-0.56	0.09	781.70	-6.00	0.00	0.57	0.75
Interaction term	0.35	0.20	784.10	1.77	0.08	0.57	0.75
Resubmission							
Resubmission	-0.11	0.82	19.00	-0.13	0.90	0.65	0.80
Cost	-0.49	0.09	780.50	-5.65	0.00	0.65	0.80
Interaction term	0.16	0.31	762.70	0.51	0.61	0.65	0.80

Table 30
Moderation Analyses of Recovery Mechanisms Regressed on Cost

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Extra credit							
Extra credit	-0.36	0.31	20.20	-1.20	0.25	0.21	0.46
Cumulative GPA	-0.04	0.14	793.20	-0.25	0.81	0.21	0.46
Interaction term	-0.51	0.34	787.60	-1.50	0.14	0.21	0.46
Grade manipulation							
Grade manipulation	-0.63	0.23	22.60	-2.77	0.01	0.14	0.37
Cumulative GPA	-0.02	0.15	795.70	-0.14	0.89	0.14	0.37
Interaction term	-0.47	0.31	794.50	-1.50	0.14	0.14	0.37
Resubmission							
Resubmission	0.80	0.38	20.40	2.09	0.05	0.18	0.42
Cumulative GPA	-0.14	0.13	795.30	-1.03	0.31	0.18	0.42
Interaction term	-0.03	0.56	785.30	-0.05	0.96	0.18	0.42

Table 31
Moderation Analyses of Types of Scaffolds Regressed on RAI

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Cumulative GPA as moderator	---	---	---	---	---	---	---
Assignment proposal							
Project	-0.12	0.55	15.90	-0.23	0.82	0.68	0.82
Cumulative GPA	0.09	0.33	863.80	0.27	0.78	0.68	0.82
Interaction term	1.40	0.74	859.30	1.89	0.06	0.68	0.82
Instructor-reviewed draft							
Instructor-reviewed draft	-0.70	0.85	47.80	-0.83	0.41	0.61	0.78
Cumulative GPA	0.51	0.31	863.30	1.68	0.09	0.61	0.78
Interaction term	-3.18	1.46	847.40	-2.18	0.03	0.61	0.78
Peer review							
Peer review	-1.45	0.83	27.50	-1.74	0.09	0.53	0.73
Cumulative GPA	0.46	0.30	863.90	1.52	0.13	0.53	0.73
Interaction term	-2.64	1.58	847.70	-1.68	0.09	0.53	0.73
Other (e.g. outline, lit review)							
Other	-0.43	0.55	17.40	-0.78	0.44	0.64	0.80
Cumulative GPA	0.14	0.32	863.10	0.44	0.66	0.64	0.80
Interaction term	1.62	0.84	855.50	1.92	0.06	0.64	0.80
Cost as moderator	---	---	---	---	---	---	---
Assignment proposal							
Project	0.02	0.54	14.20	0.04	0.97	0.62	0.79
Cost	-0.37	0.09	769.70	-3.92	0.00	0.62	0.79
Interaction term	-0.45	0.19	784.90	-2.32	0.02	0.62	0.79
Instructor-reviewed draft							
Instructor-reviewed draft	-0.48	0.89	54.80	-0.54	0.59	0.62	0.79
Cost	-0.48	0.08	777.70	-5.75	0.00	0.62	0.79
Interaction term	0.29	0.58	730.80	0.50	0.62	0.62	0.79
Peer review							
Peer review	-1.35	0.83	25.40	-1.63	0.12	0.44	0.67
Cost	-0.45	0.08	761.40	-5.30	0.00	0.44	0.67
Interaction term	-0.49	0.40	764.20	-1.23	0.22	0.44	0.67
Other (e.g. outline, lit review)							
Other	-0.08	0.55	15.60	-0.14	0.89	0.64	0.80
Cost	-0.42	0.09	776.90	-4.58	0.00	0.64	0.80
Interaction term	-0.24	0.20	783.80	-1.18	0.24	0.64	0.80

Table 32
Moderation Analyses of Types of Assignment Scaffolds Predicting Cost

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Assignment proposal							
Assignment proposal	0.09	0.29	19.60	0.30	0.77	0.23	0.48
Cumulative GPA	-0.14	0.15	794.10	-0.94	0.35	0.23	0.48
Interaction term	0.03	0.32	790.00	0.09	0.93	0.23	0.48
Instructor-reviewed draft							
Instructor-reviewed draft	0.20	0.43	45.30	0.46	0.65	0.22	0.47
Cumulative GPA	-0.13	0.13	793.30	-0.95	0.34	0.22	0.47
Interaction term	-0.09	0.63	781.70	-0.14	0.89	0.22	0.47
Peer review							
Peer review	0.31	0.46	28.60	0.69	0.50	0.23	0.48
Cumulative GPA	-0.11	0.13	793.20	-0.86	0.39	0.23	0.48
Interaction term	-0.39	0.68	778.70	-0.57	0.57	0.23	0.48
Other (e.g. outline, lit review)							
Other (e.g. outline, lit review)	0.26	0.29	20.50	0.91	0.37	0.22	0.47
Cumulative GPA	-0.08	0.14	794.00	-0.59	0.56	0.22	0.47
Interaction term	-0.33	0.36	786.50	-0.92	0.36	0.22	0.47

Table 33

Moderation Analyses of Percent of Low-Stakes Assignments Predicting RAI

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Cumulative GPA as moderator	---	---	---	---	---	---	---
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.67	0.82
More than 0% (1)	-0.26	0.48	19.60	-0.55	0.59	0.67	0.82
Cumulative GPA	-0.39	0.55	834.70	-0.71	0.48	0.67	0.82
Interaction term: 1	1.08	0.66	840.90	1.65	0.10	0.67	0.82
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.63	0.80
21%-40% (2)	0.39	0.69	12.10	0.56	0.59	0.63	0.80
41%-80% (3)	-0.55	0.57	15.40	-0.96	0.35	0.63	0.80
81%-100% (4)	-0.50	0.55	11.80	-0.91	0.38	0.63	0.80
Cumulative GPA	-0.18	0.47	832.60	-0.37	0.71	0.63	0.80
Interaction term: 2	0.47	0.84	833.40	0.55	0.58	0.63	0.80
Interaction term: 3	0.49	0.90	843.10	0.55	0.59	0.63	0.80
Interaction term: 4	1.49	0.77	839.60	1.92	0.05	0.63	0.80
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.49	0.70
51%-100% (2)	-0.77	0.40	14.40	-1.91	0.08	0.49	0.70
Cumulative GPA	-0.01	0.39	836.70	-0.02	0.99	0.49	0.70
Interaction term: 2	0.90	0.62	849.50	1.45	0.15	0.49	0.70
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.65	0.80
1%-40% (1)	0.31	0.64	12.00	0.49	0.64	0.65	0.80
41%-80% (2)	-0.53	0.60	16.90	-0.88	0.39	0.65	0.80
81%-100% (3)	-0.48	0.58	13.20	-0.83	0.42	0.65	0.80
Cumulative GPA	-0.39	0.55	830.50	-0.71	0.48	0.65	0.80
Interaction term: 1	0.73	0.79	832.10	0.93	0.35	0.65	0.80
Interaction term: 2	0.70	0.94	844.80	0.75	0.46	0.65	0.80
Interaction term: 3	1.70	0.82	838.30	2.08	0.04	0.65	0.80
Cost as moderator	---	---	---	---	---	---	---
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.67	0.82
More than 0% (1)	-0.35	0.49	17.70	-0.71	0.49	0.67	0.82
Cost	-0.42	0.16	765.40	-2.63	0.01	0.67	0.82
Interaction term: 1	-0.09	0.19	764.90	-0.46	0.65	0.67	0.82

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.61	0.78
21%-40% (2)	0.28	0.69	10.30	0.41	0.69	0.61	0.78
41%-80% (3)	-0.65	0.57	13.60	-1.14	0.27	0.61	0.78
81%-100% (4)	-0.23	0.55	10.30	-0.42	0.68	0.61	0.78
Cost	-0.36	0.14	742.50	-2.66	0.01	0.61	0.78
Interaction term: 2	-0.06	0.25	762.70	-0.24	0.81	0.61	0.78
Interaction term: 3	0.02	0.24	687.10	0.09	0.93	0.61	0.78
Interaction term: 4	-0.36	0.21	762.20	-1.75	0.08	0.61	0.78
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.57	0.76
51%-100% (2)	-0.61	0.43	13.90	-1.43	0.17	0.57	0.76
Cost	-0.41	0.11	767.90	-3.59	0.00	0.57	0.76
Interaction term: 2	-0.14	0.17	764.60	-0.87	0.39	0.57	0.76
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.64	0.80
1%-40% (1)	0.10	0.65	11.00	0.16	0.87	0.64	0.80
41%-80% (2)	-0.70	0.61	15.80	-1.16	0.26	0.64	0.80
81%-100% (3)	-0.28	0.59	12.30	-0.48	0.64	0.64	0.80
Cost	-0.42	0.16	755.40	-2.63	0.01	0.64	0.80
Interaction term: 1	0.08	0.23	765.80	0.35	0.73	0.64	0.80
Interaction term: 2	0.08	0.26	709.40	0.30	0.76	0.64	0.80
Interaction term: 3	-0.30	0.22	763.80	-1.36	0.17	0.64	0.80

Note. *Indicates that the category was used as a reference group in the model.

Table 34

Moderation Analyses of Percent of Low-Stakes Assignments Predicting Cost

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of low-stakes assignments ver. A							
0% (0)*	---	---	---	---	---	0.22	0.47
More than 0% (1)	-0.17	0.25	23.60	-0.68	0.50	0.22	0.47
Cumulative GPA	0.11	0.24	771.30	0.45	0.65	0.22	0.47
Interaction term: 1	-0.32	0.29	775.10	-1.11	0.27	0.22	0.47
Percent of low-stakes assignments ver. B							
0%-20% (1)*	---	---	---	---	---	0.22	0.47
21%-40% (2)	-0.49	0.37	20.30	-1.33	0.20	0.22	0.47
41%-80% (3)	0.10	0.30	22.10	0.34	0.74	0.22	0.47
81%-100% (4)	0.12	0.30	18.30	0.40	0.70	0.22	0.47
Cumulative GPA	-0.17	0.21	769.60	-0.85	0.40	0.22	0.47
Interaction term: 2	0.13	0.36	769.20	0.35	0.72	0.22	0.47
Interaction term: 3	-0.19	0.40	782.00	-0.48	0.64	0.22	0.47
Interaction term: 4	0.24	0.33	776.00	0.73	0.47	0.22	0.47
Percent of low-stakes assignments ver. C							
0%-50% (1)*	---	---	---	---	---	0.20	0.44
51%-100% (2)	0.32	0.22	20.60	1.42	0.17	0.20	0.44
Cumulative GPA	-0.15	0.17	771.40	-0.86	0.39	0.20	0.44
Interaction term: 2	0.07	0.27	782.50	0.27	0.79	0.20	0.44
Percent of low-stakes assignments ver. D							
0% (0)*	---	---	---	---	---	0.18	0.43
1%-40% (1)	-0.64	0.32	17.40	-2.01	0.06	0.18	0.43
41%-80% (2)	-0.01	0.29	22.00	-0.03	0.97	0.18	0.43
81%-100% (3)	0.01	0.29	18.10	0.04	0.97	0.18	0.43
Cumulative GPA	0.10	0.24	769.30	0.43	0.66	0.18	0.43
Interaction term: 1	-0.47	0.34	768.70	-1.38	0.17	0.18	0.43
Interaction term: 2	-0.48	0.41	782.00	-1.16	0.25	0.18	0.43
Interaction term: 3	-0.04	0.35	776.20	-0.10	0.92	0.18	0.43

Note. *Indicates that the category was used as a reference group in the model.

Table 35
Moderation Analyses of the Percent of Optional Assignments Predicting RAI

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Cumulative GPA as moderator	---	---	---	---	---	---	---
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.64	0.80
More than 0% (1)	-0.01	0.43	18.80	-0.03	0.98	0.64	0.80
Cumulative GPA	-0.28	0.43	863.80	-0.66	0.51	0.64	0.80
Interaction term: 1	1.28	0.60	863.20	2.14	0.03	0.64	0.80
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.69	0.83
1%-40% (1)	-0.12	0.67	21.00	-0.19	0.85	0.69	0.83
41%-100% (2)	0.05	0.49	17.10	0.10	0.92	0.69	0.83
Cumulative GPA	-0.28	0.43	862.20	-0.65	0.51	0.69	0.83
Interaction term: 1	0.85	0.86	859.50	0.98	0.33	0.69	0.83
Interaction term: 2	1.47	0.66	861.40	2.23	0.03	0.69	0.83
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	---	---
1%-50% (1)	0.37	0.46	18.20	0.81	0.43	0.57	0.75
51%-100% (2)	-0.94	0.64	15.80	-1.47	0.16	0.57	0.75
Cumulative GPA	-0.28	0.43	863.10	-0.66	0.51	0.57	0.75
Interaction term: 1	1.05	0.64	860.40	1.66	0.10	0.57	0.75
Interaction term: 2	2.07	0.99	861.80	2.08	0.04	0.57	0.75
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.55	0.74
51%-100% (2)	-1.06	0.61	15.00	-1.74	0.10	0.55	0.74
Cumulative GPA	0.20	0.32	862.40	0.63	0.53	0.55	0.74
Interaction term: 2	1.59	0.95	863.60	1.67	0.09	0.55	0.74
Cost as moderator	---	---	---	---	---	---	---
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.62	0.79
More than 0% (1)	-0.13	0.43	16.10	-0.30	0.77	0.62	0.79
Cost	-0.36	0.12	760.00	-2.99	0.00	0.62	0.79
Interaction term: 1	-0.22	0.17	774.70	-1.34	0.18	0.62	0.79

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.69	0.83
1%-40% (1)	-0.20	0.68	18.00	-0.29	0.77	0.69	0.83
41%-100% (2)	-0.08	0.50	14.70	-0.15	0.88	0.69	0.83
Cost	-0.36	0.12	759.40	-3.00	0.00	0.69	0.83
Interaction term: 1	0.05	0.25	763.30	0.21	0.83	0.69	0.83
Interaction term: 2	-0.32	0.18	780.50	-1.78	0.08	0.69	0.83
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.68	0.83
1%-50% (1)	0.13	0.49	16.80	0.27	0.79	0.68	0.83
51%-100% (2)	-0.73	0.69	14.90	-1.06	0.31	0.68	0.83
Cost	-0.36	0.12	759.90	-3.00	0.00	0.68	0.83
Interaction term: 1	-0.18	0.18	778.90	-0.97	0.33	0.68	0.83
Interaction term: 2	-0.28	0.24	781.20	-1.16	0.25	0.68	0.83
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.62	0.79
51%-100% (2)	-0.77	0.65	14.20	-1.18	0.26	0.62	0.79
Cost	-0.44	0.09	773.90	-4.85	0.00	0.62	0.79
Interaction term: 2	-0.20	0.22	779.10	-0.89	0.38	0.62	0.79

Note. *Indicates that the category was used as a reference group in the model.

Table 36

Moderation Analyses of the Percent of Optional Assignments Predicting Cost

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of optional assignments ver. A							
0% (0)*	---	---	---	---	---	0.24	0.49
More than 0% (1)	-0.05	0.23	22.40	-0.23	0.82	0.24	0.49
Cumulative GPA	-0.04	0.19	792.20	-0.21	0.83	0.24	0.49
Interaction term: 1	-0.18	0.26	793.10	-0.68	0.50	0.24	0.49
Percent of optional assignments ver. B							
0% (0)*	---	---	---	---	---	0.24	0.49
1%-40% (1)	-0.17	0.36	23.90	-0.48	0.64	0.24	0.49
41%-100% (2)	0.00	0.27	19.30	0.02	0.99	0.24	0.49
Cumulative GPA	-0.04	0.19	790.60	-0.20	0.84	0.24	0.49
Interaction term: 1	-0.39	0.38	794.30	-1.04	0.30	0.24	0.49
Interaction term: 2	-0.08	0.29	790.10	-0.28	0.78	0.24	0.49
Percent of optional assignments ver. C							
0% (0)*	---	---	---	---	---	0.21	0.46
1%-50% (1)	-0.22	0.25	19.60	-0.88	0.39	0.21	0.46
51%-100% (2)	0.36	0.35	17.30	1.03	0.32	0.21	0.46
Cumulative GPA	-0.04	0.19	791.50	-0.24	0.81	0.21	0.46
Interaction term: 1	-0.25	0.28	790.90	-0.91	0.37	0.21	0.46
Interaction term: 2	0.12	0.43	798.40	0.29	0.77	0.21	0.46
Percent of optional assignments ver. D							
0%-50% (1)*	---	---	---	---	---	0.20	0.45
51%-100% (2)	0.43	0.34	18.30	1.29	0.21	0.20	0.45
Cumulative GPA	-0.16	0.14	792.60	-1.15	0.25	0.20	0.45
Interaction term: 2	0.24	0.41	800.50	0.58	0.56	0.20	0.45

Note. *Indicates that the category was used as a reference group in the model.

Table 37

Moderation Analyses of the Percent of Assignments with Within-Assignment Choice Predicting RAI

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Cumulative GPA as moderator	---	---	---	---	---	---	---
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	0.68	0.82
More than 0% (1)	0.68	0.44	22.70	1.57	0.13	0.68	0.82
Cumulative GPA	-0.01	0.43	864.20	-0.03	0.98	0.68	0.82
Interaction term: 1	0.77	0.60	863.00	1.29	0.20	0.68	0.82
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	0.67	0.82
21%-40% (2)	0.78	0.48	19.50	1.61	0.12	0.67	0.82
41%-100% (3)	-0.01	0.65	25.80	-0.01	0.99	0.67	0.82
Cumulative GPA	-0.05	0.41	864.60	-0.13	0.89	0.67	0.82
Interaction term: 2	0.98	0.64	860.80	1.53	0.13	0.67	0.82
Interaction term: 3	0.71	1.03	859.10	0.69	0.49	0.67	0.82
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.72	0.85
1%-25% (1)	0.74	0.52	20.50	1.43	0.17	0.72	0.85
26%-100% (2)	0.65	0.56	24.10	1.16	0.26	0.72	0.85
Cumulative GPA	-0.01	0.43	862.50	-0.03	0.98	0.72	0.85
Interaction term: 1	0.69	0.69	861.70	1.00	0.32	0.72	0.85
Interaction term: 2	0.88	0.77	858.30	1.14	0.25	0.72	0.85
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.68	0.82
26%-100% (2)	0.33	0.50	22.20	0.67	0.51	0.68	0.82
Cumulative GPA	0.25	0.34	863.50	0.73	0.47	0.68	0.82
Interaction term: 2	0.62	0.72	858.00	0.86	0.39	0.68	0.82
Cost as moderator	---	---	---	---	---	---	---
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	---	---
More than 0% (1)	0.78	0.44	20.90	1.77	0.09	0.67	0.82
Cost	-0.29	0.12	781.00	-2.36	0.02	0.67	0.82
Interaction term: 1	-0.35	0.17	782.10	-2.12	0.03	0.67	0.82

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	---	---
21%-40% (2)	0.57	0.49	16.90	1.17	0.26	0.66	0.81
41%-100% (3)	0.29	0.69	27.90	0.43	0.67	0.66	0.81
Cost	-0.33	0.11	764.80	-2.86	0.00	0.66	0.81
Interaction term: 2	-0.39	0.18	782.90	-2.24	0.03	0.66	0.81
Interaction term: 3	-0.01	0.30	771.50	-0.03	0.98	0.66	0.81
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	---	---
1%-25% (1)	0.71	0.52	18.60	1.37	0.19	0.72	0.85
26%-100% (2)	0.91	0.57	22.80	1.60	0.12	0.72	0.85
Cost	-0.29	0.12	779.00	-2.35	0.02	0.72	0.85
Interaction term: 1	-0.34	0.19	781.50	-1.86	0.06	0.72	0.85
Interaction term: 2	-0.37	0.22	781.50	-1.67	0.10	0.72	0.85
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.60	0.78
26%-100% (2)	0.60	0.50	21.10	1.21	0.24	0.60	0.78
Cost	-0.44	0.09	780.30	-4.73	0.00	0.60	0.78
Interaction term: 2	-0.23	0.21	783.40	-1.10	0.27	0.60	0.78

Note. *Indicates that the category was used as a reference group in the model.

Table 38

Moderation Analyses of the Percent of Assignments with Within-Assignment Choice Predicting Cost

	Fixed Effects					Random effects	
	B	*SE*	df	*t* value	*p* value	Var.	*SD*
Percent of assignments with within-choice ver. A							
0% (0)*	---	---	---	---	---	0.20	0.45
More than 0% (1)	0.31	0.22	22.50	1.41	0.17	0.20	0.45
Cumulative GPA	-0.11	0.19	794.90	-0.58	0.56	0.20	0.45
Interaction term: 1	-0.03	0.26	793.20	-0.12	0.90	0.20	0.45
Percent of assignments with within-choice ver. B							
0-20% (1)*	---	---	---	---	---	0.16	0.40
21%-40% (2)	-0.18	0.23	20.40	-0.78	0.45	0.16	0.40
41%-100% (3)	0.77	0.30	25.70	2.56	0.02	0.16	0.40
Cumulative GPA	-0.07	0.18	797.60	-0.40	0.69	0.16	0.40
Interaction term: 2	-0.16	0.28	793.20	-0.58	0.56	0.16	0.40
Interaction term: 3	-0.05	0.44	792.80	-0.11	0.92	0.16	0.40
Percent of assignments with within-choice ver. C							
0% (0)*	---	---	---	---	---	0.20	0.45
1%-25% (1)	0.18	0.26	19.60	0.69	0.50	0.20	0.45
26%-100% (2)	0.49	0.27	22.20	1.78	0.09	0.20	0.45
Cumulative GPA	-0.11	0.19	793.50	-0.58	0.56	0.20	0.45
Interaction term: 1	-0.02	0.30	791.90	-0.05	0.96	0.20	0.45
Interaction term: 2	-0.05	0.33	790.20	-0.15	0.88	0.20	0.45
Percent of assignments with within-choice ver. D							
0-25% (1)*	---	---	---	---	---	0.19	0.44
26%-100% (2)	0.41	0.25	23.20	1.66	0.11	0.19	0.44
Cumulative GPA	-0.12	0.15	794.60	-0.82	0.41	0.19	0.44
Interaction term: 2	-0.04	0.31	790.80	-0.13	0.90	0.19	0.44

Note. *Indicates that the category was used as a reference group in the model.

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