Building a Better Game: A Theory of Gameful Learning & the Construction of Student Personas with Agency

by

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Dedication

To each and every one of the students and instructors who has shared the journey of gameful pedagogy with us, your critique has made us better, and your kind words have gotten us through. Thank you.

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Abstract

Gameful course design creates learning environments that support student motivation, drawing inspiration from well-designed games. This dissertation establishes the theoretical framework on which gameful pedagogy is founded. One key piece of gameful course design is that the instructor creates opportunities for students to make decisions about how they will complete course work. Designing these opportunities requires instructors to reflect on how different types of students are likely to behave, and to decide what grade outcomes can be earned through different routes of action.

The field of Human-Computer Interaction uses a design tool called *personas* to help software developers better understand target users and their respective goals as they build new technologies. This dissertation investigates what choices students made within a gameful course, with the intention of developing a method to systematically construct *student* personas, based on a combination of behavioral, performance, demographic, and psycho-social data. Such personas would ideally enable instructors to more finely tune gameful course structures to student needs.

While this research succeeded in establishing a method to describe the pathways students took through the gameful course studied, it identified very little commonality in students' choices at the assignment level: the 159 students studied took 158 unique pathways through the core assignment work. This finding speaks to the success of gameful course design in enabling students to have autonomy over their learning experience, but, in addition to a general lack of significant findings between basic student characteristics and assignment choice, did not allow

for the creation of data-driven personas that felt cohesive and representative of the students they represented. Three goals for future research into data-driven personas are identified: First, to confirm in a larger and more diverse context that the characteristics examined in this study do not have strong relationships to assignment choice. Second, to re-evaluate whether characteristics like ethnicity and gender need to be included in learner personas at all if they do not offer a better understanding of how similar learners are likely to behave. And third, to investigate whether it is more valuable to iterative course design to focus on how different behavior patterns relate to each and impact each other rather than assuming that the patterns themselves will relate to any particular learner characteristic.

Chapter 1: Introduction

Gameful design is a pedagogical approach that takes inspiration from well-designed games to create learning environments that support student motivation (Aguilar, Holman, & Fishman, 2013; De Schutter & Vanden Abeele, 2014; Nicholson, 2011). One key piece of gameful course design is that the instructor establishes multiple routes to earning a desired grade within the course. This can take a variety of forms, including: offering a series of optional assignments students can select from, recognizing alternate modes of demonstrating content mastery (for example allowing students to choose between writing an essay, taking an exam, or doing a project), and enabling students to customize due dates and assignment point totals to match their individual needs and interests. Designing these pathways requires instructors to reflect on how different types of students are likely to behave, and to decide what grade outcomes can be earned through different routes of action. But what makes for a "type" of strategy or behavior? To date instructors have relied on stereotypical impressions of student types and ad hoc modelling to guide the assignment and level design processes rather than leveraging available data on students' experiences within existing gameful courses. In this dissertation, I first establish the theoretical framework from which gameful pedagogy operates. Combining data gathered from a learning management system (LMS) called GradeCraft that is designed to support gameful courses with data from a student information system (SIS) and student survey responses, I then build a set of student personas to better inform instructors who are designing gameful courses. Because these personas depict patterns regarding students' selection and planning of their assignment pathways, and performance behavior within a gameful

course, they may help instructors to improve their course designs to better address different students' needs.

Designing a course is a significant undertaking with multiple requirements that can be challenging to address simultaneously. An instructor or instructional designer must define course goals, and connect overarching learning objectives with the sequence of subject matter and assessment. They must match the skills that are taught to those required to enter the course, and those that are needed to continue within the discipline (i.e., a Physics 200 level course should both build on the content learned in Physics 100, and prepare students with the requisite knowledge for Physics 300). As more and more learning technologies enter the classroom and users' perceptions of technology norms evolve, there is an increasing opportunity for, and expectation of, individualization. Specifically, this includes the use of learning analytics to highlight for instructors the state in which students enter and progress through the classroom: their content knowledge, their abilities, their understanding of how to be a successful student, their future academic and professional goals, and their expectations for this learning experience.

Traditional course models offer, at best, a median response to diversity in student background, interests, and goals. The content, assignments, and work schedule are expected to work satisfactorily for all participants, and issues faced and generally perceived to be the fault or responsibility of the student. Gameful course design aims to offer students the agency to construct a course experience that fits their individual interests and needs, while maintaining a collective set of learning objectives. But designing these pathways has proven challenging: How do we provide meaningful choice while upholding rigorous standards of assessment? What avenues will be appealing to students? How do different academic and life backgrounds translate into success in different types of assignments? How do we provide appropriate academic support

for students coming from such diverse experiences? How do the requirements of one course "fit" against students' other academic commitments and personal life? Course designers need more information regarding what choices students are likely to make, and how they are likely to achieve, to design effective and engaging pathways to success.

I propose in this dissertation that *personas* are one helpful method through which to communicate this information. *Persona design* is a technique used in the field of Human-Computer Interaction (HCI) to create composite characters that represent different aspects of the target audience, which can then act as figures around which interactive systems are designed. There are several schools of thought regarding what types of data should be used to inform these personas, and what role they should play within the design process (Cooper, 1999; Pruitt & Grudin, 2003). Cooper (1999) originally established a qualitative process for designing personas based on a small number of interviews and observations (Blomquist & Arvola, 2002), but after more than a decade of observations around persona use in the field there is an ongoing effort to include more quantitative data as a core piece of design. Quantitative data such as a system-use behavior and outcome metrics (purchasing habits, etc.) is perceived as grounding *what* users can be anticipated to do while the interviews are felt to describe the *why.* This creates an opportunity to merge an HCI approach with learning analytics techniques to create student personas.

When designing new gameful courses we (myself, and the faculty I have worked with) have historically relied on informal personas, experience-informed guesses as to how stereotypical students are perceived to behave to guide the assignment and level design processes. As a doctoral student in the School of Information at the University of Michigan (U-M), I have been privileged to lead the development of the GradeCraft learning management system, and to have collaborated with dozens of faculty, students, and staff members on the

design of gameful pedagogy over the last seven years. To help faculty design their courses, I built a series of spreadsheets that allowed us to map out the assignment pathways over the course of the semester and visualize potential outcomes. I have observed that it is particularly difficult for instructors to make decisions regarding *how much* assignment choice is sufficient to support student autonomy, and to determine what amount and quality of work should earn different grade levels. In order to ground these conversations, I used three *ad hoc* student models based on three characters from the *Harry Potter* book series (Rowling, 1997): Ron, Hermione, and Harry. These characters have been intuitive for instructors to work with, surfacing vivid recollections of past students who have seemed to approach their studies with similar attitudes: Ron represents the slacker student who *just* scrapes by, Hermione represents the overachiever with a strong identity of being top of the class, and Harry represents the capable student who struggles to find the balance between their academic work and their responsibility to save the world from evil. But with each semester I have questioned the extent to which these models matched up against how students *actually* behaved; did 'A+' students in gameful courses really do *all* of the assignments possible like we forecast Hermione would, or were they selective but high achieving in their work? Did the students we associated with Ron *always* attend class sporadically and submit mediocre work, maximizing their time for other classes and activities, or was there something else going on? Were there clues within the data that would allow us to distinguish them, either in how they used GradeCraft, or in the choices they made regarding what assignments to work on? It was this process that drew out my conviction that in order to realize the full potential of gameful course design, we need a more accurate approach to conceptualizing students' experiences–from demographic and behavioral characteristics to outcomes–in our classrooms.

The goal of this research is to explore the potential for a method to effectively and systematically create and describe student personas, based on a combination of behavioral, performance, demographic, and psycho-social data. Merging an HCI approach to personas with learning analytics techniques, in this dissertation I investigate multiple approaches to understanding how students in a gameful course behaved and demonstrate multiple methods to construct *learner* personas in an informed manner. Such personas will allow us to more finely tune course structures to meet students at their individual competency levels and provide engaging assignment pathways.

In this dissertation, I propose to investigate the following questions in the context of a 160-person introductory Honors course run at the University of Michigan:

Research Question 1: Are course and assignment achievement correlated with student demographics or academic history?

Research Question 2: How do measured student characteristics relate to different patterns of behavior in how they chose to:

a) Attend class

b) Attend discussion section

c) Engage in weekly low-stakes formative exercises

d) Engage in weekly assignments

e) Complete an end-of-semester final project

Research Question 3: What assignments do students select to do in combination?

Research Question 4: How do the findings from RQs 1-3 build to a holistic description of the patterns in student behavior in a gameful class, as summarized in student personas? Are there implications for how we should iterate course designs based on the patterns observed?

Implications

This work has implications for multiple fields of research working at the intersection of education and technology, which include: the HCI community interested in designing systems for educational spaces, including establishing personas practices that make multi-faceted use of academic data to understand students; for the learning analytics community, as we build a more nuanced understanding of what the various forms of data we gather mean about students' learning experiences; and for the higher education community, as we learn how to design courses that are motivating for a diverse set of students.

Dissertation Overview

In Chapter 2 I describe what gameful pedagogy is and the motivational theories it relies on. I will establish a set of core principles and practices that we in the gameful learning community use to enact these learning experiences. In Chapter 3 I outline the history and design of the persona methodology, and summarize the current understanding regarding what characteristics of students impact their academic achievement. Chapter 4 documents how I gathered and analyzed the data for this dissertation, and Chapter 5 details the results and analysis from the study. In Chapter 6 I discuss what these results mean, consider the limitations, and offer a look to future work.

Chapter 2: A Theory of Gameful Pedagogy

What is gameful learning? How is a gameful theory of teaching similar to and different from other pedagogies? What specific practices are involved when an instructor employs a gameful approach and what impact do they have on students? In this chapter, I will outline gameful pedagogy, including the motivational theory and explorations in grading system design that it depends on, the core principles that have emerged from that work, and the practices we use to bring them to life in learning environments. This chapter has the dual purpose of contributing to the field of gameful learning itself by mapping out why and how gameful pedagogy works, and establishing the context of the classroom in which the personas that are the focus of this dissertation will be constructed.

The last two decades have seen educators become increasingly fascinated with the power of games as learning environments–particularly the way that videogames encourage gamers to act as "an active problem solver, one who persists in trying to solve problems even after making mistakes; one who, in fact, does not see mistakes as errors but as opportunities for reflection and learning" (Gee, 2003, p. 43)–and in turn begin to actively examine their mechanics for opportunities to apply them to learning environments of all kinds. The effort to fundamentally alter how students approach their own learning has been particularly poignant as educators have faced a growing awareness that the jobs of the future will not be satisfied by the training of the past.

What makes games such powerful learning environments? And how can we even begin to answer that when we know intuitively that the answer may vary dramatically depending on the person playing the game? Games are a medium, an art form; as a body of work they offer an exception to every rule. Games without winners, without scores, without fun, without feedback or second chances–all exist. But these exceptions also serve to highlight central practices of the medium. There *are* consistently observable mechanics that encourage players to expend significant effort, to act creatively, collaboratively, and competitively, to learn new content and skills, and to become experts. There is no single answer to how games motivate, but there are many patterns of engagement mechanics revealed by motivation theories in principle, and game popularity practically. Through observation and experimentation, we can then begin to speak to what elements are motivating for whom, and under what circumstances.

One reason why games make such a valuable model from which to reflect on the design of learning experiences is the presence of a game designer: like an instructor, the game designer is an architect responsible for creating an environment for others to navigate; the success of a game designer lies in their ability to build an engaging experience that makes it possible for the player to learn how to succeed. There is no right way to design a game (or a course), but there are many choices that, when executed in combination with other choices, will have predictably positive (or negative) effects on player experience. A goal of gameful course design research, then, is to highlight the design components that an instructor can configure, and to characterize the effects these choices are likely to have when made in combination.

The Oxford-English Dictionary notes that historically "pedagogy" meant a "place of instruction; a school; a college"; in modern usage, it refers to the "art, occupation, or practice of teaching" and "the theory or principles of education; a method of teaching based on such a

theory." Examples of pedagogies range from the very broad "constructivist pedagogy," to the more explicit "project-based learning." The first leverages the learning theory of constructivism to guide teachers in how they approach their work; the second offers as a set of practices that are intended to guide the design of activities that will lead to better learning outcomes. Both have a particular sense of how learning works best (although project-based learning can be considered one of the many constructivist pedagogies, leveraging a particular aspect of the learning theory to ground its design).

A common question this work has faced is what exactly *is* gameful pedagogy? I propose that gameful pedagogy is a new approach to learning design because, rather than revolving around a specific *learning* theory, it centralizes *motivation* theory. Gameful pedagogy identifies that students learn better when they are motivated to take ownership over their learning. The challenge of precisely defining this pedagogy is by no means uniquely a gameful issue, as Richardson aptly characterized an ongoing "difficulty in translating a theory of learning into a theory or practice of teaching, a conversion that has always been difficult and less than satisfactory" (2003) in pedagogy more generally. None of the elements I will describe as core to gameful teaching are themselves new techniques; they are not *uniquely* gameful in and of themselves. Describing the practice of gameful pedagogy thus requires building on an extensive body of work to establish various best practices in teaching, while connecting these practices to theoretical work that focuses on the role of supporting learner motivation. The contribution here is the understanding of learning experience as an interactive and designed system, and the assertion that learner motivation is essential for teachers to consider in their role as system designers. When taking stock of the growing landscape of available educational technologies, James Duderstadt, former president of the University of Michigan, called out the potential value

for such a shift nearly 20 years ago, observing "It could well be that faculty members of the twenty-first century college or university will find it necessary to set aside their roles as teachers and instead become designers of learning experiences, processes, and environments" (2001).

I should note that by centralizing motivation theory, I am not implying that learning theory is peripheral to designing an effective learning experience. Rather, I consider gameful to be agnostic regarding which learning theory should be pursued; gameful pedagogy has been intentionally designed so that various forms of learning theory may inform the design of the learning experience.

Overview of Motivation Theories

> "…motivation is a psychological construct that is a combination of two dimensions: having energy to take action and then moving that energy in a specific direction (Rigby, 2014, p. 118)"

In the following section, I outline the core components of motivational theory concepts that we have found relevant to ground gameful pedagogy.

Self-Determination Theory

Self-determination theory (SDT) is a macro theory that frames human beings as naturally active and interested in learning, eager to "internalize the knowledge, customs, and values that surround them" (Niemiec & Ryan, 2009, p. 133). This process of internalization occurs most naturally in environments that offer support for the core psychological needs of autonomy, competence, and relatedness (Deci & Ryan, 2002). First put forward as a formal theory in Deci and Ryan's 1985 book, Intrinsic Motivation and Self-Determination in Human Behavior, SDT and its ability to guide the support of intrinsic motivation has been the subject of more than two hundred studies. Extensive experimental evidence and a growing body of fieldwork suggests that providing active support for the human needs described by SDT can create an environment

where students are more likely to engage in learning activities of their own volition, are able to achieve higher levels of creativity and conceptual learning, and are more likely to succeed.

Humans are innately curious beings who are happiest when they are engaged with opportunities to continuously develop their knowledge and skillsets (Niemiec & Ryan, 2009). The first need identified by SDT is termed *autonomy.* and refers to the ability to make meaningful choices about our own environment, expectations, and behaviors; autonomy is considered an essential precursor to experiencing intrinsic motivation (Deci, Connell, & Ryan, 1989). Having autonomy does not mean being given total freedom; without any form of guidance we "often become frustrated by not knowing what choices to make; feelings of insecurity and incompetence soon follow" (Raffini, 1993, p. 164). Rather, autonomy refers to individuals having "weight in decision-making" (Deci & Ryan, 2002, p. 303). Strategies that have been shown to create autonomy-supportive learning environments include allowing students to select the manner in which they will provide evidence of their learning, determine the timing and style of assessment, declare the order of work to be completed, and manage the amount of risk they wish to take on (Raffini, 1993). These strategies then become an example of a technique I encourage instructors implementing gameful design to use in their courses to support learner motivation.

Competence, the second principle of SDT, was first suggested as a core psychological need by Robert White in 1959 when he reviewed the animal behavior and psychological literature at length to note the common animal drive to explore, but made the case that humans have a unique tendency to work toward and accomplish "diverse feats whereby we learn to deal with the environment" (White, 1959, p. 317). Competence requires that we feel skilled at something, and that our skill is constantly being developed by the presence of optimal challenges

at, or just above, our current ability level (White, 1959). Without this challenge, we become bored and ultimately disinterested; feeling a sense of competence that satisfies support for intrinsic motivation, as SDT understands it, thus pre-supposes constant learning opportunities and growth.

The third and final principle of SDT is *belongingness*, sometimes referred to in the literature as *relatedness*, which describes our need to feel connected to other people, particularly those we respect and wish to model ourselves after, as we experience new learning tasks. Belongingness has received less attention than autonomy and competence in the research on SDT and intrinsic motivation (Sheldon & Filak, 2008). The importance of belongingness has most commonly been researched in the context of mentor to mentee, examining relationships such as experimenter to subject, instructor to student, and parent to child. Strong, autonomy-supportive relationships where the mentor expresses interest in, and acknowledges the feelings of, the mentee show positive effects on intrinsic motivation (Ryan & Deci, 2000). Being part of something larger than yourself—part of a team, or a community, or a cohort—has not been studied extensively in this context.

Learners are likely to initially engage in an activity because they experience extrinsic motivation of some form—peer pressure, parental expectation, school requirements, financial compensation—but are naturally inclined to internalize their efforts if they perceive themselves to be competent in the area, to have autonomy over their development, and to have connections to other people within the space (Ryan & Deci, 2000). Intrinsic motivation has been shown to have such effects as boosting creativity (Amabile, 1985), attention, health, satisfaction, persistence, honesty, responsibility, concentration, and decreasing defensiveness (Deci & Ryan, 2002). While intrinsic and extrinsic motivation were originally thought to be "separate and

antagonistic," evidence now suggests that they are closer to being the idealized opposite ends of the same scale, with steps in-between that represent increasing levels of internalized interest paired with decreasing amounts of extrinsic motivators (Vansteenkiste, Niemiec, & Soenens, 2010, p. 112).

Learning often requires engaging in tasks that are less-than-interesting to an individual learner. Students must learn to self-regulate, finding a way "to become actively engaged in behaviors that are not in themselves intrinsically satisfying" in order to succeed in coursework (Raffini, 1993, p. 83). When learners have poor self-regulation skills, they are observed to avoid challenges, be unable to recover from failure, and be unwilling or unable to ask for help (Schunk & Ertmer, 2000). However, students cannot learn how to "self-regulate unless they have options available for learning and can control dimensions of learning" (Schunk & Ertmer, 2000, p. 632). Autonomy is a necessary pre-cursor to developing self-regulation skills.

Expectancy-Value Theory

Expectancy-Value Theory (EVT) proposes that learners' "choice, persistence, and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity" (Wigfield & Eccles, 2000, p. 68). While instructors add one form of value to tasks by assigning them points or percentage weights, Eccles (2005) put forward the idea that learners' establish their own value assessments by considering the following four components: attainment value (the degree to which the activity fits with one's self-image), interest value, utility value, and the opportunity cost of engagement.

In exploring how students' past performances impact their motivation, Gorges and Kandler (2012) observed that prior learning experiences positively predicted perceived-efficacy, while previous interest positively predicted attitude towards their learning; efficacy and attitude

then each impacted learners' overall motivation. Having a negative prior learning experience resulted in a small negative impact on motivation to learn that type of content in the future. Using this understanding to inform gameful design, we can infer that the more we can increase a students' expectation of a positive outcome, the more likely they will be motivated to engage with that work.

Achievement Goal Theory

Achievement Goal Theory (AGT) has historically proposed that there are two primary goal orientations through which learners engage: mastery goals, or performance goals (Ames, 1992; Dweck, 1986). Learners with mastery goals have been seen as having a growth mindset, believing that they can learn to be skillful, and are thus resilient in the face of failure and focus on developing competence. Learners with performance goals have been thought to have a fixed mindset, and so focus on demonstrating their ability. Performance-oriented learners fear that failure of any kind will reveal that they are incapable; their ability to withstand failure has been observed to depend upon on their self-efficacy (an individual's beliefs about whether or not they have the capacity to achieve (Bandura, 1997)) towards the content area, and those with low self-efficacy will struggle to recover from a negative experience. Mastery goals, similarly to the observed impact of intrinsic motivation, have been shown to have a significant and positive impact on learners, including that they "find their classes interesting, persist when facing difficulty, value cooperativeness, seek help when confused, self-regulate effectively, use deep learning strategies…navigate decisional conflict well, experience positive emotion, and perceive tasks as valuable" (Senko, Hulleman, & Harackiewicz, 2011). Mastery goals show no consistent relationship with performance, while performance goals occasionally do.

The impact of performance goals is less well-understood, in part because results from studies over the last thirty years have conflicted. More research is needed to tease apart what may actually be fundamentally different types of performance goals. A recent study by Senko and Tropiano (2016) has supported the hypothesis that there are two strands of performance goals, appearance goals (the desire to appear to be competent in social contexts) and normative goals (the desire to have your work succeed in being competent in comparison to your peers). Appearance goals are associated with maladaptive academic behaviors like self-handicapping and avoiding help-seeking, while normative goals relate positively to self-efficacy but have no observed relationship to either of the maladaptive outcomes studied. Senko and Tropiano were further able to tie learner outcomes as viewed under AGT to SDT: learners pursuing normative goals under an autonomous lens reported higher senses of self-efficacy, and in one study even showed greater interest in the course content. By contrast, learners pursuing normative goals under a controlling frame again experienced maladaptive outcomes, being unlikely to seek help and engaging in self-handicapping.

History of Course Design for Motivation

Over the past fifty years, instructors have investigated various alterations to their course designs and grading schemes intended to boost learner motivation. In this section I cover three of these: contract grading, cafeteria-style grading, and gamified grading.

Contract grading

Contract grading has a lengthy history, first appearing in the literature in the 1970s. Contract grading is an approach by which instructors empower students to negotiate what work they will do, to what level, and what grade they will earn as a result (Danielewicz & Elbow, 2009). Goals of contract grading include increasing intrinsic motivation and reducing focus on

grades through increased transparency regarding work expectations (Polczynski & Shirland, 1977; Youn & Chyung, 2007). Research on contract grading has shown an increase in effort from students in these learning environments (Polczynski & Shirland, 1977), a decrease in cheating and dishonesty (Stasz, 1976), and student work appears to be more diverse and creative (Stasz, 1976). Examples of student feedback include, "I am being treated as an adult being held responsible for my actions" (Polczynski & Shirland, 1977, p. 241).

Cafeteria-Style Grading

Goodwin and Gilbert (2001) proposed "cafeteria-style" grading, which offered students the opportunity to make decisions about what sorts of assessments they would engage in, and how significantly those would contribute to their course grade. Unfortunately, despite this approach receiving positive responses from both students and instructors, there have been very few published studies completed on this assessment design, with only three published studies available since its introduction in 2001. The approach has been documented in one introductory chemistry course, and two online technology management courses.

In the chemistry course, the percentage of students (compared to the same course, previously run in a traditional manner) who chose to participate in a peer-led team learning experience increased from 50% to 80% of course, and the ratio by which students' end-of-semester exam scores compared to their start-of-semester placement exam scores increased by 10% (Goodwin & Gilbert, 2001). End-of-semester survey responses showed that students felt that this system supported them in performing their best, learning efficiently, and that they wanted to see the approach implemented more broadly.

In the technology courses (both studies were completed at the same university and within the same program, but published by different teams of authors), Arendt, Trego, & Allred (2016),

and Hanewicz, Platt, & Arendt (2017), both observed consistently quality work products, and high grade outcomes. Across the courses, between 9 and 36% of the students opted to complete more assignments than necessary to earn the top grade in each course. Students responded positively to the design, sharing feedback such as, “It gave me the power to earn the grade I wanted with assignments I felt were useful for me” (Hanewicz et al., 2017, p. 281).

Gamified Grading

There has been an explosion of interest in gamifying education, with a focus on adding game-inspired incentives to motivate students (Kapp, 2012). In a literature review of gamified education, Nah, Zeng, Telaprolu, Ayyappa, & Eschenbrenner (2014) identified the following core features gamified courses are using to create engaging learning environments: points, levels, badges, leaderboards, prizes and rewards, progress bars, story, and feedback. Gamification has been observed to encourage students to increase LMS use (Barata, Gama, Jorge, & Gonçalves, 2013b), attend and participate in lecture (Barata et al., 2013b; de Freitas & de Freitas, 2013), increase participation in activities like blogging and forum use (Barata, Gama, Jorge, & Gonçalves, 2013a), engage in active content learning (Sepehr & Head, 2013), and increase downloading of digital resource material (Barata et al., 2013a). Minor decreases in lecture attendance were observed when attendance was *not* rewarded with points (Barata et al., 2013a), as SDT would predict when rewards are given for an action and then removed. Students describe gamified courses as more motivating and interesting, and requiring more work but not being more difficult (Barata et al., 2013a, 2013b). In some circumstances, grade outcomes improve (Barata et al., 2013b), but in many implementations they do not (Barata et al., 2013a).

Gameful vs. Gamification: What's the difference and does it matter?

Both gameful and gamified course design take inspiration from the motivational power of games. But gamification has thus far focused on implementing specific mechanics that incentivize learners to behave in ways that educators would like in exchange for the receipt of rewards. Gameful design instead focuses on designing experiences that offer the affordances that make games powerfully engaging, like a sense of control and connection to others.

Much of gamification revolves around rewards, and "on the face of it rewards seem to be fundamentally enhancing of an experience" (Rigby, 2014, p. 123). Extrinsic motivators are powerful, and more than capable of ensuring learner compliance: as Barata, et al. (2013b, p. 15), called out, "students can be engaged to pay attention to course material as long as it is rewarded". However the research literature has shown since the earliest days of SDT that when these rewards are removed, people stop engaging in the type of actions that were previously incentivized (Deci, 1971). Instructors need to be cognizant about their use of extrinsic incentives, what it implies for learners' behavior in future learning contexts, and what it implies for their orientation to learning across their whole life. Therefore, I choose to make a purposeful distinction in my use of language, acknowledging that both gamification and gameful design take inspiration from games, but do so with different intentions, different mechanics, and hopefully, different outcomes.

The Principles of Gameful Learning

With the foundations of motivational theory established, I now outline what I have identified as the three core principles essential to establishing an environment that fosters learner motivation. These principles are ideals that should be embedded in the design of the entire

learning experience, and describe a shift in thinking that is necessary for most instructors to undergo in order to have success running a gameful learning experience.

1. Learners have agency

"To be an agent is to intentionally make things happen" (Bandura, 2001, p. 3). In the context of games, players commonly have agency to customize their appearance, define their skillset and role, and choose the path and the sequence they will pursue through the experience. Instructors need to acknowledge learners as valuable and trustworthy agents of their own learning. This includes empowering students to make decisions about the work they will take on, engaging with their questions about the curriculum and the course design, and considering their feedback about the learning design. Not all feedback can be integrated on the fly, but should still be engaged with and, if valuable, incorporated in future course iterations. This principle rests on SDT's understanding of how essential autonomy is to support intrinsic motivation, and receives further support from AGT's framing that autonomously-driven performance goals support adaptive learning behaviors. It is re-affirmed by our understanding that learners cannot develop healthy and self-regulative learning behaviors unless they are empowered to make choices that they can learn and iterate from.

2. Failure is part of learning

Failure is a valuable part of the learning process. SDT highlights that when learners are working at the upper edge of their ability, they *should* fail sometimes, even after putting in significant effort. Video games have an advantage as a learning environment here, as compared to the typical instructor-led classroom, because the assessment of learning (winning a boss battle, for instance) is done by a computer that has no time constraints, and no feelings: players may take one try or one thousand to learn something, and the computer (if so programmed) will judge

both as equally successful at achieving the goal. The time burden of learning something slowly thus rests solely on the student (and perhaps the electricity bill). Instructors cannot usually offer this unlimited form of assessment to learners in a formal classroom, but that does not mean that they cannot do more to support students learning to see failure as a natural and important part of learning, and develop strategies to recover from it as necessary. One key piece of this is the instructor themselves recognizing that this is an important component of the learning process, and sharing this belief with their students. In the section on assessment design (later on in this chapter), I go into more detail as to the practices instructors can use to design support for this.

3. Learning experiences should be designed holistically

Backwards design practices have established the value and the process of starting course design with the holistic design of assessments that represent student accomplishment of the learning objectives of the course (Wiggins & McTighe, 2005). I consider this essential to designing an experience that learners will perceive as having well-ordered problems (Gee, 2004), the feeling of competency, and the potential for flow.

During the design process, instructors need to reflect on how the whole learning experience is constructed and critically assess whether the design is appropriately ordered, addresses the intended learning objectives, and feels cohesive for learners. When instructors make assessments transparent and enable students to select between them, they are often faced with establishing point values for each assessment. We know from EVT that students will use these values to inform their decisions—depending on my sense of self-efficacy, a student may select an "easy" assignment that he knows he can do well and earn full points on, or a harder assignment that he finds more interesting but anticipates he will perform worse on as a measure (while earning similar points). It becomes important when designing these systems to review

assignment point values before the course launches to consider if there are course elements that students will be naturally drawn towards and therefore may not need to be weighted as heavily, or assignments students may be inclined to avoid—where increasing point values may incentivize student uptake. It may also be helpful to consider offering opportunities that have no points attached at all, where students are either intrinsically or socially motivated to engage. As Stasz noted in an early class that used contract grading:

> "it takes some practice to work out a suitable quantification, though this is not likely to result in serious problems. The first time I used the system, I felt badly part way through because it seemed that the students had to do so much work to earn a high grade. More students earned A's and B's in that class than in any other I had taught, so I have continued to use what seem to be high requirements." (1976, p. 61)

This is also true of gameful courses. In almost all cases, the instructor is not fully satisfied with how points are assigned or weighted, and it takes several iterations to get it "right." I believe that learner personas will be valuable design tools to inform–and potentially streamline–this iteration process.

The Core Practices of Gameful Learning

With the three principles in place, I now describe the learning experience design methods I encourage instructors to implement to support them. Practices are not unique to a particular principle—in fact, many rely on the interaction between principles to be effective. In the following section I describe each practice, as well as how it may affect learner motivation.

Classroom Structure

1. Share a Clear Purpose

Despite being in the same cohorts and classes, students are motivated to learn for very different reasons. Motivationally, sharing a clear purpose (or multiple, where possible) for the class supports students in perceiving the information to be relevant to them, and helps them

answer the questions around “Why am I here?” and “What good is this information?” It is especially important to ground motivation in contexts where learners have little autonomy about being there, as when the course is required for their degree or necessary to take on next-level content that is interesting to the student. Clear purpose can help students to internalize the value of the work they need to engage in, and thus help shift their motivations from truly extrinsic to being more integrated to their identity. In studying how we move along the scale from being extrinsically motivated towards self-determined motivations, Deci, Eghrari, Patrick, & Leone (1994), showed that three independent tactics appeared to nudge participants in the right motivational direction in an experimental setting: acknowledging when the work itself may not be interesting, providing a rationale for why it should be done anyway, and using non-controlling language in the framing of the requests.

2.Establish Transparent Expectations

In addition to understanding the purpose of the learning that they are engaging in, students need to understand the assessment targets that they are expected to achieve to be successful in the course. Students should know explicitly from the beginning what is important, so that they are more able to focus on that material. The grading scheme expectations for the course should be established at the beginning of the semester and shared explicitly with the students. This does not mean that all assignments need to be known to students, but there should be enough available that they can make choices about how they wish to personalize their work, and have a sense of the choices they will have in the future.

3. Don’t Ration Mastery

Modern education infrastructure relies on the output of a final letter grade to represent learner's achievement in formal coursework (Schneider & Hutt, 2014). Grades conflate learners'

content mastery, effort, and class ranking into a single letter. Unfortunately, given how varied instructional practices are, there is no way to determine what any specific grade actually represents. Motivationally, one significant step we can take is removing pre-determined limits set on the number of students who can earn any particular grade outcome, often implemented as a grading curve. These limits mask the assessment value of grades and impose a risk for students' collaborative behaviors–one student's success could quite literally mean another's failure, building a negative interdependence between students that inhibits cooperation.

Removing the rationing of grades can be a jarring change for students who have grown up with a core part of their identity revolving around "winning" the curve: I have repeatedly heard from a small group of students that they are frustrated that equal grade outcomes can be achieved by students who appear to have lower innate ability but have now had the opportunity to practice, revise, or put in more effort. This makes sense when understood through an AGT lens, identifying that "performance-oriented students…typically view competence as a characteristic of the privileged few; thus being able to demonstrate that one has competence indicates that one is more able than others" (Wentzel & Wigfield, 2009, p. 80) and that part of their motivation depends on that contextually-affirmed privilege. This response appears to be consistent as an example of the maladaptive behaviors likely to be produced by appearance-orientation under the thread of performance goals.

4. Provide Visible State & Progress

For students to be supported in competency, they need to be informed about their own state of progress and achievement in the material they are learning. Research has shown that to support intrinsic motivation, it is important to provide feedback (Ryan, Mims, & Koestner, 1983), and that the language used to share that information needs be autonomy-supportive rather

than controlling (Butler, 1988; Ryan, 1982). Supporting learners in their sense of progress also speaks to the distribution of assessments over the course of the experience: assessments cannot just be left till the end as cumulative, summative assessments. Learners need to be able to engage in formative work that allows them to course-correct in the event that they have misunderstood or are on the wrong path. If they do not know how they are doing, given either a lack of assessment, or a lack of informative feedback about that assessment, they are not able to feel competent in their learning, or autonomous in their choices about how to engage. This has implications for the design of learning technologies, and suggests that we should dedicate effort to highlighting for learners both their current state, as well as providing resources to address their gaps and identify appropriate next challenges.

Assessment Design

In this section I describe four principles that specifically apply to the design of the learning assessment.

5. Use Authentic Assessments

Learning is far more motivating, and more effective, when it is authentic to the learning goal(s) at hand. This means that the assessment should be as close to representative of the type of activity where the learning would be used as possible. Video games typically achieve this by giving users the opportunity to learn simple skills in low-stakes contexts that are then gradually strung together with other skills in increasingly complex sequences and scenarios. The separation between how you learned a skill and how you will use that skill is limited to the context and the outcome of your success. This principle can be enacted in modern classrooms but takes thinking beyond the traditional assessment formats of essays and exams. Instructors must make sense of

where and how, for their own specific material, the learner is likely to use the material being taught, and make the assessment of their learning as close to that real-world use case as possible.

6. Create Opportunities to Personalize

Supporting students in experiencing autonomy does not mean giving them total control, but it does mean giving them opportunities to make meaningful choices about how they will engage with their own learning. Next, I summarize four different methods to support learner autonomy in assessment:

a) Difficulty

Instructors often do not have complete knowledge about learners' current knowledge or skill level. By creating a variety of assignments at different levels of difficulty, students can choose the ones that feel appropriate to them. A variation on this is creating a base assignment paired with different difficulty levels of it (each with appropriate amounts of recognition or points attached) and allowing students to determine what version they would like to take on. This approach supports both learner's sense of autonomy and competency.

b) Modality

If the content is the primary learning goal, then allowing students to play with the modality in which they will demonstrate their knowledge can draw out truly creative work. In games, there are often multiple ways–as different characters, leveraging different skillsets or tools–to achieve any particular outcome. This principle supports learners' sense of autonomy and competency, hopefully empowering them to select a mode of assessment they feel competent in to explore content they may be less sure of.

c) Timing

If assignments do not need to be completed at a precise moment during the semester to allow other learning to build on that foundation, then enabling students to select when they will do work has the impact of helping them be able to better balance other activities and responsibilities, and to really put their all into the learning when they come to it. For assignments that do build on one other but do not necessarily require students to complete them in lockstep with each other, I recommend building an unlock strategy whereby each component can be completed independently, and success in one then opens up the next appropriate challenge. This allows for learning to build while also being flexible and respectful to students' time schedules. Non-traditional students, or those balancing jobs and/or family commitments are able to complete work within their own time constraints. Due dates can be excellent tools to help even the most motivated students avoid procrastination, so an alternate strategy is setting deadlines for specific assignments, but having the assignments themselves available at repeating intervals.

d) Content

Many classes have allowed students to personalize their learning and build the relevance and interest that an assignment holds for them by having them select from a list of options, or personally define a content area that they will specialize in. When possible, this can be especially effective to give students the opportunity to explore the many different identities that exist within a single content area and may be beyond the scope of the foundational content of the curriculum.

7. Design Pathways

It can be powerful to group assignments into sequenced pathways that expect learners to be able to carry increasing skills and/or content knowledge forward with them. Pathways are often framed around different identities that may be opportunities for learners to explore, for instance designing a sequence of assignments around learning how to program, another around learning to be a strong technical writer, and a third around the history of computer science. Students may be encouraged to explore the beginning of each pathway, but then required to complete at least one full pathway to succeed in the course. This supports autonomy and identity exploration, builds competence, and, if students are able to interact with others taking their same pathway, may increase belongingness.

8. Provide Space to Practice & Space to Recover

I noted above that understanding failure as part of learning is a key principle of gameful learning. In order to design a learning environment that is supportive of this knowledge, instructors must create opportunities for learners to practice their new knowledge, ideally from multiple perspectives that allow them to explore the boundaries of their knowledge and how to apply it. Failure cannot be safe if there is no option for learners to recover from it, re-emphasizing the importance of instructors creating multiple assessments for students to select from, and providing learners feedback about their performance in time for them to address if necessary. Creating practice environments that offer both continuous challenge and rich feedback has historically been impractical, if not impossible, for instructors to do given traditional time and effort constraints. Digital technologies, with infinite variation and auto-generated feedback, are beginning to make this possible in new ways.

Conclusion

In this chapter I have described a theory of gameful learning, including a summary of the motivation theory and history of innovative assessment approaches on which it rests, and a detailed outline of the principles and practices that we use to bring it to life. This work is the conceptual basis for the context of the gameful learning environment studied in this dissertation. In the next chapter I will review the HCI technique of personas and describe my goals for bringing this approach to educational settings.

Chapter 3: The History & Design of Personas

In this chapter, I summarize the history and design of personas within the field of Human-Computer Interaction (HCI). I describe how they have traditionally been created, what characteristics have been included in their depiction, and how the methodology is currently changing to include more (and more types of) data. I also provide a brief overview of how various student characteristics have been observed to impact learning behavior and performance, thus providing a foundation for the persona-building variables that I will explore in my analysis.

The History & Design of Personas

Alan Cooper is considered the originator of the persona technique with his book *The Inmates are Running the Asylum* (1999). Cooper argued that software developers were immersed in such a complex task that they inevitably designed applications that achieved a (necessary) technical standard, but in doing so created systems that were essentially unusable for non-programmers. He advocated for the creation of user personas through completing a series of interviews with stakeholders from across a product or system's landscape, identifying their goals, skill-levels, and requirements. These perspectives were then condensed into 3-12 different personas, each with names, detailed biographical backgrounds and interests, and technical skill levels. Each persona was designed to be a believable character–an ideal type–but not necessarily representing a real/particular person. At the core of the Cooperian persona design process is the goal of helping system creators consider multiple external perspectives in order to build more accessible and engaging systems.

How Personas Work (and How They Don't)

Humans constantly, and often subconsciously, alter everything from our attitude, speech, and behavior in response to our understanding of the people we interact with; personas are effective because they nudge us to use this talent in the process of design, even in situations where we cannot articulate specifically what features or design choices we have changed or why (Grudin, 2006). Personas at their best are an example of how relatively simple profile descriptions can help system designers have nuanced understanding and empathy towards the profile and its perspective, particularly when there are multiple contrasting personas expected to engage with a system.

One school of thought promotes the idea that personas should play to stereotypes (Bødker, 2000; Cooper, 1999), leveraging the ease with which designers can make sense of stereotypical characters' needs and connecting them to applicable use cases. A second perspective cautions that relying on stereotypes can result in serious mistakes if the design team is unable to make sense of how real data may contradict what they infer from a caricature (Grudin, 2006). In grappling with the pros and cons of leveraging stereotypes, Link, Büllesfeld, and Marsden (2015) showed that there has been an increase in the perceived competence of female personas over the last two decades, but no change in the way male personas are represented as lacking interpersonal warmth or emotion. Marsden and Haag (2016) again note the importance of establishing empathetic connections between designer and user, but also call out the way that such persona either perpetuate negative (and often, inaccurate) characteristics, or else selectively counter them in response to cultural shifts.

Serious issues have plagued personas as a design tool: the people who are supposed to rely on them (developers and designers) have reported them to feel inauthentic, and thus not been motivated to become even remotely familiar with their attributes or to take them seriously

(McGinn & Kotamraju, 2008). For all that personas have the ability to inspire empathy, it has proven challenging to know precisely what changes to make to an application in response to the details shared (Blomquist & Arvola, 2002; Pruitt & Grudin, 2003).

Redesigning a Method

Pruitt and Grudin (2003) have proposed a revised persona design process that begins with gathering a significant amount of both quantitative and qualitative data to build a robust understanding of the target audience, using it to define between three and six personas, assigning a specific team member to design and represent each one, and then establishing a 'foundation' document for each persona that "contains goals, fears, and typical activities that motivate and justify scenarios" for all team members to reference. Adding narrative and graphics to the persona biographies has been found to help designers conceptualize how intended users may face dramatically different conditions than their own, thus enabling the designers to identify contextually-appropriate user requirements (Putnam, Kolko, & Wood, 2012).

The extraneous and fictional details characteristic of Cooperian personas are considered a significant reason why designers have discounted personas' authenticity and thus not engaged with their needs (McGinn & Kotamraju, 2008). Persona creators are now including data sheets sourcing where the specific details regarding each aspect of a persona have been drawn from. Weighted priority matrices have been developed to describe how each persona is perceived to value and interact with different features in the application, addressing the gap between empathetic intuition and what explicit application changes are necessary. McGinn and Kotamraju showed that using factor analysis to transform survey responses into personas generated authentic groupings, and highlighted the nuanced overlaps between what might previously have been perceived as completely distinct subgroups. Personas constructed in this manner were faster

to produce than the standard ethnographic approach, and easier to defend (McGinn & Kotamraju, 2008).

O'Leary, Mtenzi, McAvinia, & Jose (2016) identified an additional challenge that personas have been designed so specifically for each context that it limits their value. If personas were designed to be reusable then the work it takes to construct them would be both more doable and more cost efficient and allow the focus to shift from "people and products" to "populations and practices."

Recent work by Hill, et al. (2017), explored using multiple pictures to illustrate persona profiles in an effort to reduce the incidence of gender stereotyping in response to traditional, single-gender personas. The personas used in the experiment were based on the GenderMag approach (Burnett, Peters, Hill, & Elarief, 2016) which has identified five facets that impact people's use of software: motivation, information processing style, self-efficacy towards computers and technology, attitudes towards risk, and approach to learning new technologies. Each GenderMag persona describes the expected behavior for each facet. Interestingly, the analysis revealed that the participants examined the persona portraits in both the single- and multi-image conditions only very briefly (approximately 2 seconds, or less than 2% of the average time spent browsing the profiles), and generally did not ascribe strong gender stereotypes to the profiles in either condition. Given that gender stereotyping has been observed around the use of other personas, more work needs to be done to investigate how multiple images might be used to alleviate this effect in contexts where it *is* present, but the GenderMag personas should also be considered a model for reducing the need for this effort. Their work appears to have successfully shifted users' attention to valuable behavioral attributes rather than relying on stereotypical impressions of gender.

Related Use Cases

Personas have been used to describe player styles in a prominent video game and been shown to help game designers envision pathways that would be engaging to each type of persona (Tychsen & Canossa, 2008). This approach of both embedding avenues that support different styles of play and recognizing persona characteristics in real game players such that they that can then be nudged in the direction of activities they will appreciate suggests the same may be possible for gameful classroom design. Brooks and Greer (2014) built predictive models to explore what types of students were in need of academic interventions, and then created personas to help learning specialists or advisers better understand where students were coming from. This speaks to the need to help practitioners make sense of both the wide array of students they are working with and share learning analytics data in an understandable form.

Student Characteristics

Many researchers have identified different categories for students, and measured how those categories relate to anticipated learning engagement and performance. A summary of that work highlights the following characteristics:

In exploring what factors were likely to predict retention at an Australian university, McKenzie and Schweitzer (2001) found grade point average (GPA), a single-number representation of a student's previous academic history, to be the biggest predictor of achievement. In a study on introductory large-scale physics sequences at U-M, prior GPA was found to be the biggest predictor of course performance (Wright, McKay, Hershock, Miller, & Tritz, 2014).

In a meta-analysis of literature on gender-performance differences, Voyer and Voyer (2014) showed that across nearly one hundred years of research women are observed to

consistently outperform men academically by a small margin, although the same does not hold true for achievement tests. One hypothesis behind these observed differences is that school "require effort and persistence over a long period of time" (Voyer & Voyer, 2014, p. 1175) thus requiring the development of self-regulation and social skills that are separate from one's raw ability. This work highlights that achievement tests and general school performance may be reflecting *different* characteristics of students, but does not presume to argue that either is fundamentally more valuable than the other.

Minority students, including ethnic minorities (Cohen, Garcia, Apfel, & Master, 2006) and students studying internationally (Rienties & Tempelaar, 2013), are observed to struggle academically in comparison to their majority peers. Having declared a major in college is an important part of students' identity; without a major, students are less likely to persist at university (Leppel, 2001).

There is comparatively little literature on Honors students (the focus of this study) as a population, or on Honors Programs as they are perceived to influence students (Slavin, Coladarci, & Pratt, 2008). The research that does exist highlights the degree to which the students are more likely to earn higher GPAs, achieve higher graduation rates, intend to pursue more schooling after their undergraduate education, and exhibit more perfectionist tendencies (Cosgrove, 2004; Rinn, 2005).

Research Questions

In order to advance our understanding of which characteristics will relate to learner behavior, and thus should be included in our data-driven student personas, this dissertation will address the following research questions:

RQ1: Student Characteristics & Course Performance

Are course achievement and assignment completion correlated with student demographics or academic history characteristics (GPA, major, year-in-school, gender, ethnicity, nationality, self-reporting as having different senses of autonomy, competency, relatedness, and resilience)? This research question will be explored using the following metrics:

- Total points earned in the course
- Total assignments completed in the course
- Total badges earned in the course
- Total assignments failed (submitting materials, but earning a zero)

RQ2: Student Characteristics & Choices

How do measured student characteristics relate to different patterns of behavior in how they:

- Attend class
- Attend discussion section
- Engage in weekly low-stakes formative exercises
- Engage in weekly assignments
- Complete an end-of-semester final project

RQ3: Assignment Combinations and Pathways

What assignments do students select to do in combination?

RQ4: Building Student Personas

How do these findings from RQs 1-3 build to a holistic description of the patterns in student behavior in a gameful class, as summarized in student personas? Are there implications for how we should we iterate course designs based on the patterns observed?

Conclusion

In this chapter I have provided an overview of persona design and use. I have described how they have traditionally been constructed, and the increasing call to use more data to inform their design. This framing establishes the primary methodological goal of my dissertation: to explore the creation of data-driven personas to aid in the improvement of gameful learning experience implementations. In the next chapter I will describe the educational environment my research will be conducted within and the procedure that I will use to explore my research questions.

Chapter 4: Methodology

In the following section I describe the context of the research for this dissertation, the processes used to gather the data, and the steps taken to complete the analyses. I close by summarizing the strengths and the limitations of this research design.

Setting & Participants

This study was conducted at the University of Michigan (U-M), a large Midwestern public research-intensive university, and took place within an ongoing research and development project investigating the design and impact of gameful pedagogy in higher education. In this study, I analyzed a course that Honors students took as part of their undergraduate core curriculum. Students in the U-M Honors Program are admitted via an application process when they enter the university, and then need to take eight Honors courses over the next four semesters, while maintaining at least a 3.4 GPA, to stay in the program. They are also required to take three Honors "Core" seminars, one in each of the domains of Humanities, Social Science, and Natural Science.

The course under investigation in this study was an Honors Core seminar that satisfied both the Social Science requirement and a university-wide First Year Writing requirement. This meant that students were both asked to write significant amounts within the course, and that the course teaching team was structured so as to provide them constructive feedback on how to improve their writing. This course featured both lecture and discussion section components that

each met twice a week. It was managed by a senior professor with more than five years of experience with gameful teaching as well as with using GradeCraft.

The course was staffed by ten teaching assistants, each with training related to providing constructive feedback on student writing. In addition to assessing student work, each teaching assistant was also responsible for managing a twice-weekly discussion section. The lectures were held on Mondays and Wednesdays from 11 to 12pm, while the discussion section meetings were held on Tuesdays and Thursdays at the following time slots: Discussion Sections 2-3 at 11am-12pm, Discussion Sections 4-5 from 2-3pm, Discussion Sections 6-7 from 3-4pm, and Discussion Sections 8-10 from 4-5pm.

The course was designed to offer students choices regarding what to learn, when to take on work, and what skillsets within the content to specialize in. The instructor emphasized the importance of students building mastery through practice. This was fostered in the course design by encouraging students to resubmit work throughout the course for further feedback and assessment, scaffolding the process of seeking peer feedback. The course was designed to teach three core learning objectives: Social-Scientific Literacy (SSL), College Writing (CW), and Social-Scientific Research Processes (RP). This was a relatively unique approach in that it understood writing to mean both academic writing and writing code to enable students to complete basic data analysis and visualization tasks.

There were 107 opportunities in the course for students to earn points that would count towards their course grade. 26 were lecture attendance events, 25 were discussion section events, and 23 were reading quizzes. The course featured weekly practice assignments that students could choose from (22 different options in total, with between one and three available on any given week of the semester; students were able to complete one a week, for a total of 11 possible

assignments); students were encouraged by the instructor to complete approximately five of the weekly assignments to do well in the course. In addition, students were able to submit one peer review to any other student's practice assignment as an assignment of their own. Students were able to complete up to three surveys as assignments: a beginning-of-semester survey exploring their affinity for the course design and their orientation on several psychological scales, and two end-of-semester surveys, one focusing on the whole course experience and one on their experience in their discussion sections (for more detail on the contents and timing of these see the Survey Distribution & Measures section later in this chapter). The semester ended with a three-part project (a project proposal, a final project—the form of which varied depending on the group, but ranged from a podcast analyzing school pride to a research paper investigating gender identity and social media, and a learning reflection on their experience completing the project) that built on the students' work over the semester, and could be completed either individually or as a group (but not both). Students were required to successfully complete the proposal and get feedback as well as their instructors' approval before they were allowed to move on to the next phase. Finally, students were invited to participate in an Honors Core Symposium[1], and doing so counted towards their final grade in this course. *Table 1* provides a summary of the assignments and their respective points.

Each practice assignment was graded using a three-criteria rubric developed to assess students' achievement against each of the course learning objectives. Each criterion counted equally towards a student's grade for that assignment, and was assessed on a five-point scale: Not Yet (0 points), Some Promise (200 points), Almost (400 points), Meets Expectations (600

[1] The Honors Core Symposium is a special event put on by the Honors Program that encourages all Honors students to come together to address a real-world problem. The challenge for this specific Honors Core Symposium event was to identify policy recommendations that might be shared with the U.S. administration to mitigate the ongoing conflict in Syria.

points), and Exceeds Expectations (800 points). Students were told that only truly exceptional work would be marked as "Exceeds Expectations," and so they should expect to earn approximately 1,800 points (or "Meets Expectations" on each of the three criteria) for a well-executed assignment.

Table 1: Honors Course Assignment Structure

Assignment	***Point Value***	***Total Points Possible***
Lecture (24x)	300	7,200
Lecture Bonus (2x)	2,400	4,800
Discussion Section (25x)	800	20,000
Reading Quizzes (23x)	300	6,900
Practice Assignments (11x)	2,400	26,400
Peer Review (1x)	1,200	1,200
Honors Core Symposium (1x)	2,400	2,400
Pre-semester survey (1x)	500	500
Post-semester surveys (2x)	300	600
	Total Points Possible:	67,600

The class was comprised of 159 graded students (one student took the course Pass/Fail, and was excluded from analysis), with 88 women (55.3%) and 71 men (44.6%). The class was predominantly taken by Freshmen (129, at 81%), with an additional 29 Sophomores (18%) and one Junior. For analysis purposes, I have combined the Sophomores and Junior into one "non-Freshmen" category. The students' self-reported ethnicity descriptions were as follows: 106 White (66.7%), 38 Asian (23.9%), seven reported being multiple ethnicities (4.4%), two reported being Hispanic (1.3%), and six students chose not to indicate any ethnicity (3.77%).

Table 2: Students' Self-Reported Ethnicities

White	Asian	Hispanic	2+ Ethnicities	Undeclared

106	38	2	7	6

Table 3: Class Year by Sex

	Freshmen	*Sophomores*	*Juniors*
Men	57	13	0
Women	72	16	1

The majority of students had not yet declared majors (144 students, or 90.5%). Of the remaining 15 students, two reported being Economics majors, and the other 13 each represented unique areas, with 10 of those being STEM subjects (Astronomy, Biochemistry, Biomolecular Science, Cellular & Molecular Biology, Chemistry, Data Science, Ecology & Evolutionary Biology, Mathematics, Microbiology, and Neuroscience) and three being Humanities domains (English, History, and Spanish). For analysis purposes, I categorized these 15 students as "having a major" at this time, as compared to the 90% of their classmates who did not. Students in this course took an average of 15.31 academic credits (three of which were from the course being studied), with a minimum of 9 and a maximum of 18. During this semester, students earned an average GPA of 3.693 in their other courses (min: 2.55, max: 4.0).

GradeCraft Learning Management System

The course leveraged GradeCraft, an LMS designed specifically to support gameful courses. Begun in 2011, the platform features an additive gradebook as opposed to a weighted one, where all learners start at zero and earn up as they engage in coursework. Instructors define levels that are earned as students achieve increasing cumulative points— sometimes equating to letter grades, but not necessarily (this open-endedness has made GradeCraft accessible to learning environments that extend beyond the traditional, graded classroom). GradeCraft was

designed in response to the way that gameful courses offer students choices about their work—but that students didn't *really* have autonomy over their work without a gradebook that understood their progress (as weighted gradebooks could not) or a tool to help in forecasting the outcomes of different choices and efforts. Thus, the GradeCraft Grade Predictor was born, an interface that allows students to see all assignments in the entire course, their individual outcome if it has been completed, and a space for them to guess or predict how well they think they will perform on any assignment that has not yet occurred. The Grade Predictor then tallies all of the student's work to display their total predicted grade.

GradeCraft also offers students the ability to see on-demand analytics regarding their own performance. This includes 1) a boxplot representation of their total points earned as compared to other students in the class, 2) their performance in the aggregate on any single assignment, and 3) the rubric criteria level–students can see where they have met expectations and where they have not, and how this performance compares directly to their peers. GradeCraft also includes a number of features that are more directly inspired by games of different sorts: badges, leaderboards, unlocks, and personalized assignment weighting.

For the purposes of this dissertation I will only provide detailed descriptions of the badges and unlocks, as they were the key gameful features of GradeCraft used in this course. Earning badges can accrue additional points in the learning experience (at the instructor's discretion), and these achievements are often used to set positive goals for student behavior (i.e., the "Office Hours" badge) and recognize extraordinary effort (i.e., the "Team Leader" badge). Badges can be awarded via the assessment of a work product (for instance a student might earn the "Strong Writer" badge for an essay they wrote that was particularly good), and can be attached to specific levels of rubrics to establish an easy and consistent awarding pattern across

an instructional team.[2] Unlocks are "rules" that can be attached to assignments, badges, and final grade outcomes in order to require students to accomplish specific behaviors and achievements before they can earn access to the locked item. For instance, an instructor might "lock" a final project until learners have earned a specific amount of points total, or until they have completed several earlier, preparatory assignments.

Procedure

GradeCraft Data Collection

In order to investigate students' selection and completion of assignments in a gameful course I collected the following data from GradeCraft:

- assignment submission data (submission text, submission time, days before or after due date)
- badges awarded
- grade outcome data (score earned)

Student Information System (SIS) Data Collection

GradeCraft data can be matched to the data stored in the U-M Student Information System (SIS), including demographics, academic background, course load, course history and performance, socioeconomic information (self-reported at application to the university), and work-study data. This student data is made available to U-M researchers through the Learning Analytics Data Architecture (LARC) Data Set ("Learning Analytics Data Architecture (LARC),"

[2] I have observed instructional teams where some members believe very strongly in the power of badges, and so award them prolifically, while others are skeptical and either forget or refuse to award them at the frequency which the learners' work might merit. Learners' achievements are thus mediated by their teaching team's opinions—always a truth, but not one that is always *quite* so quantifiable by learners!

n.d.) and was pulled for analysis purposes at the beginning of the next semester (Winter 2017). Because so many students in the course were first semester freshmen and so had not yet declared a major, I also pulled students' majors one year later (Fall 2017) to allow me to investigate their trajectory at the University.

Survey Distribution and Measures

In order to better understand students' perceptions and experiences within the course I administered voluntary surveys at both the beginning and end of semester. The beginning-of-semester survey was distributed via email using Qualtrics survey software during the third week of the fall semester. Students were sent two email reminders during the week if they did not complete the survey after receiving the initial invitation. The end of semester survey was distributed in the same manner during the second to last week of the semester. Both surveys were completed outside of the official class time. 76% of students ($N = 121$) provided at least partial data on the beginning of semester survey and 50% ($N = 80$) students provided at least partial data on the end of semester survey. $N = 61$ students provided at least partial data on both the beginning and end of semester surveys.

For all survey measures, if the original items were framed around life in general then I altered the question stems to focus specifically on the learner's experience in the classroom. Unless otherwise noted, all survey items were administered on both the beginning and end of semester survey (see Appendix A for the surveys administered).

Basic Psychological Need Satisfaction

Students completed the 21-item Basic Psychological Need Satisfaction Scale (BPNS: (Ryan & Deci, 2000) Gagne, 2003, Deci & Ryan, 2000) to measure autonomy need satisfaction (7 items, e.g. "I am free to express my ideas and opinions in this class"), competence need

satisfaction (6 items, e.g. “People in this class tell me I am good at what I do”), and relatedness need satisfaction (8 items, e.g. “I really like the students in this class”). Students responded on a 7-point scale from 1 = Not at all true to 7 = Very true. For each student, I calculated a rating for autonomy, competence, and relatedness by taking the average of the respective survey items. Autonomy $\alpha_{beg} = .74$, $\alpha_{end} = .64$, competence $\alpha_{beg} = .74$, $\alpha_{end} = .71$, and relatedness $\alpha_{beg} = .86$, $\alpha_{end} = .83$.

Resilience

Students completed the 6-item Brief Resilience Scale (BRS: Smith et al., 2008) as a measure of students’ ability to recover from adversity (e.g. “I tend to bounce back quickly after hard times in my classes”). This measure offers important insight into students’ likely performance vs. mastery orientation (see Chapter 2’s section on Achievement Goal Theory), and something that is especially important in a course where students are likely to experience grades lower than what they may ever have earned before. Students responded on a 5-point scale from 1 = Strongly disagree to 5 = Strongly agree. Students’ ratings for this construct were an average of the survey items. $\alpha_{beg} = .87$, $\alpha_{end} = .82$.

Belonging

Students completed a belonging scale developed by Betoret & Atiga (2011) to assess the degree to which students felt like part of a community in the classroom context (e.g. “There was a strong feeling of friendship in this class”). Students responded on a 4-point scale from 1 = Strongly disagree to 4 = Strongly agree. Students’ ratings for this construct were an average of the survey items. This measure was only administered on the end-of-semester survey, $\alpha_{end} = .81$.

Perception of the grading system

I asked students two questions about their overall perception of the grading system: the degree to which they understood it, and how much they liked it. Students responded on a 5-point scale from 1 = Not at all true to 5 = Very true, with a mean response of 4.32 on both items.

Data Processing & Analysis

To answer RQ1, I used linear modeling to explore how student characteristics related to aggregate behavior at the course level. Then, I used cosine similarity (a method that creates a single numerical descriptor of how similar any student is to any other student) to investigate whether students exhibited different patterns of behavior in how they chose to engage in course assessments for RQ2. For RQ3, I used the cosine similarity results to group students by their behavior and then describe what components were done in combination. I then compared the types of students identified across all analyses to describe the observed student personas to answer RQ4.

Limitations

Findings from this study design are limited in their ability to be generalized given the specificity of the context being studied. The literature regarding Honors students suggests that they have a strong identity in both engaging and performing in academic contexts, and so personas built on their behaviors may describe patterns that are unlikely to be observed in non-Honors students. Given that the overall university context for this study is a large and selective institution that is dedicated to scholarly research but is limited in both its ethnic and socioeconomic student diversity, the insights gained in this study may not extend to institutions of other types, or courses where more diversity exists. The primary instructor of this course is one of the creators of gameful pedagogy and had years of experience running courses in this

fashion, and so I would not necessarily expect that a similar course design run by an instructor who was less familiar with gameful design would produce the same effects. Finally, that this work was done as a natural experiment, I cannot infer causation between student attributes and their choices or outcomes, only correlation. More work needs to be done to understand if and how the personas created carry forward to inform other gameful classes, as well as to investigate if there are components that are valuable for non-gameful classes.

Conclusion

In this chapter I have described the specific course where my dissertation work is set, including the assessment design, the student population, and the technology used. I have also shared a detailed picture of how data has been collected, and given an overview of the analyses used on the data. In Chapter 5, I present my analysis and findings for each research question.

Chapter 5: Results

In this chapter, I present the findings from each of my research questions. In RQ1 I explore the relationship between various student characteristics and their overall performance in the course. In RQ2 I investigate whether or not the characteristics investigated in RQ1 are related to students' attendance at lecture and discussion section meetings, their completion of weekly reading quizzes, their selection of weekly practice assignments, and their engagement with a final project in the course. In RQ3 I examine whether or not there are observable patterns in how students chose to complete different categories of assignments. In RQ4, I use the observed patterns as the foundation of student personas and use data from RQs 1-3 to color these personas' performance goals, submission habits, achievement outcomes. For all research questions, I report any relationships observed at the $p < .01$ significance level.

RQ1: Student Characteristics & Course Performance

Are course achievement (i.e., final score), engagement (i.e., whether or not a student attends a lecture), and assignment completion (i.e., whether or not a student chooses to complete an assignment) correlated with student demographics or academic history? The demographic and academic history variables investigated for each question are: gender, ethnicity, having declared a major, year in school, discussion section membership, concurrent GPA (GPA earned for all other courses taken during the semester being investigated, but excluding grade outcome from this course), current course load (quantified by the number of credits enrolled in), pre-

semester autonomy, pre-semester competence, pre-semester relatedness, and pre-semester resilience.

I used linear regression to explore the relationship between each of the characteristics listed above the outcome identified. There was a significant decrease in response rate between the beginning-of-semester (76% of students, $N = 121$) and end-of-semester surveys (50%, $N = 80$). Across both surveys, men and minorities responded at a lower rate than women and white students on both surveys. Due to the comparatively low response rate on the end-of-semester survey, I have not incorporated this data into the analysis. In order to address the skewed population responses in the pre-survey data, I ran linear models that included data from the psychological scales administered on the beginning-of-semester survey for each outcome variable separately from the model where I relied on data that was universally available from the U-M Student Information System (SIS) for all students. If I had chosen to bring the incomplete survey data into the other model, I would have either needed to impute the missing data based on how other students like them had responded, or excluded any students from the analysis where I did not have complete data. Imputing the missing data was a risk given that the populations needed to base this calculation on had not provided us with enough data to build an accurate picture of the range of their responses, whereas excluding students with missing data would have limited my sample dramatically (down to 61 students, only 38% of the total population) and done so in a skewed fashion. By running the academic history and performance model separately from the psychological scales data that was collected via the beginning-of-semester survey, I am able to explore how significant each set of characteristics is, but am not able to compare their relationship to each other.

RQ1a: Final grade earned in the course

The average grade earned in the class was an A, equating to a 4.0 on the grading scale used by U-M. Concurrent GPA was positively related to students' final grade, with each one point increase in GPA relating to a .26 (a quarter letter grade) increase in final grade points ($p < .001$).

RQ1b: Total points earned in the course

For each point increase in concurrent GPA, students' final score increased by an average of 4,229 points ($p < .001$). While there was an observed decrease in final grade points in relation to ethnicity, the same was not true at the $p < 0.01$ significance level for total points: white students were observed to, on average, earn 854 points less than their non-white peers, but it was only significant at a $p < 0.1$ level.

RQ1c: Total assignments completed in the course

For every point increase in concurrent GPA, students on average increased the number of assignments they completed in the course by 2.3 ($p < .01$).

RQ1d: Total badges earned in the course

For every point increase in concurrent GPA, students on average earned an additional 1.82 badges ($p < 0.001$).

RQ1e: Total assignments failed (submitting materials, but earning a zero)

No observed characteristics related to students being significantly more or less likely to "earn" a zero on an assignment.

RQ1 Findings Summary

Concurrent GPA is the only learner characteristic observed to be significantly related to course-level outcomes, positively relating to increases in final grade, total points earned, total assignments completed, and total badges earned.

RQ2: Student Characteristics & Choices

How do measured student characteristics relate to different patterns of behavior in how they choose to engage in different types of class assessments?

I used logistic regression to explore potential relationships between student characteristics and their choices regarding which individual assignments to do, and to what degree they completed work within five different assignment categories (lecture, discussion section attendance, reading quizzes, weekly practice assignments, and end-of-semester projects).

RQ2a: Lecture Attendance Analysis

No observed characteristics related to students being significantly more or less likely to individual lecture attendance, or to their overall attendance rate for the course.

RQ2b: Discussion Section Attendance Analysis

No observed characteristics related to students being significantly more or less likely to individual discussion section attendance, or to their overall discussion section attendance rate for the course.

RQ2c: Weekly Reading Quiz Completion Analysis

In six instances, an increase in concurrent GPA was correlated with an increase in the likelihood of students completing reading quizzes. **Reading Quiz 9**, with an increase of 44 times ($p < .01$); **Reading Quiz 14**, with an increase of 28 times ($p < .01$); and finally, **Reading Quiz**

18, with an increase of 37 times. Looking at overall reading quiz completion rates, students with higher concurrent GPAs were likely to complete an addition 1.61 reading quizzes ($p < .0001$) more than their peers.

Pre-semester autonomy satisfaction related to an increase in completion for **Reading 22** (2.81 times, $p < .01$).

RQ2d: Weekly Assignments Selection Analysis

To identify patterns in student behavior I grouped my analysis in this subsection by the *type* of weekly assignments students engaged in: Essays, Interviews and Surveys, Wikipedia Contribution and Analysis, Data and Visual Analysis, Book Quests, and Archive Visits. There is a final category of "Revision", which consisted of only one assignment, and students were able to choose any assignment that they had already completed and resubmit it to replace their earlier work. In the context of RQ2d I describe the patterns I observed around choosing to revise an assignment, but in RQ4 I identify what assignment the student personas would have chosen to resubmit, and to what degree their work improved, if applicable.

Essays:

Men were 5.81 times more likely to do **Week 6 Essay** than women ($p < .01$).

Students in Discussion Sections 9 (16 times, $p < .01$) were more likely to do the **Week 10 Essay** than those in Section 2.

The higher a student's concurrent GPA, the less likely they were to complete the **Week 12 Essay** (.17 times, $p < .01$).

Interviews & Surveys:

Men were less likely to do the **Week 5 Create a Survey** assignment (.29, $p < .01$). Students in Discussion Section 6 were .05 times less likely to do this assignment than those in Discussion Section 2 ($p < .01$).

Wikipedia Contributions:

Freshmen were 5.4 times more likely than upperclassmen to do the **Week 3 Wikipedia Analysis** ($p < .01$).

Data & Visual Analysis:

White students were .25 times less likely than non-white students to complete the **Week 6 Visual Evidence Analysis** ($p < .01$).

Book Quests:

No observed characteristics related to students being significantly more or less likely to complete **Book Quest** assignments.

Archive Visits

No observed characteristics related to students being significantly more or less likely to complete **Archive Visit** assignments.

Revision

Discussion Section 10 was significantly less likely to complete the **Week 9 Revision** assignment .04 ($p < .01$) than Discussion Section 2.

Overall

Students in Discussion Section 9 completed 1.27 weekly practice assignments more than students in Discussion Section 2. No other observed characteristics appeared to relate to student engagement with weekly practice assignments at an aggregate level.

RQ2e: End-of-semester final project

The end-of-semester project consisted of three parts—a proposal, the project itself, and a learning reflection on the whole experience. Students were able to complete this series as part of a group or individually (tracked as separate assignments), but they were not able to do both. Students were required to complete each phase in order to be able to work on the next one—students could not start doing the project without having submitted a proposal, and they could not do the learning reflection without having completed a project. *Table 4* shows how many students engaged in each phase of the project as part of a group context, individually, and total.

Table 4: End-of-Semester Assignment Engagement Counts by Phase

	Proposal	*Project*	*Reflection*
Group	80	46	25
Individual	77	20	15
Total	157	66	40

Group Assignments:

No observed characteristics related to students being significantly more or less likely to complete the **Group Project** assignments.

Individual Assignments:

Freshmen (.07, $p < .01$) were less likely to do the **Individual Project**. Students who reported a higher sense of relatedness at the beginning of the semester were again less likely to do the **Individual Project** (.21 times, $p < .01$).

White students were more likely to do the **Individual Learning Reflection** than those who were not (76.21 times $p < .01$). Students with higher concurrent GPAs were less likely to do this assignment (.02 times, $p < .01$).

RQ2 Findings Summary

Looking across the observed correlations between characteristic and behavior, I now summarize patterns observed for each characteristic in order to consider which ones are most valuable (i.e., show relationships to how students behaved and what they chose to do) for inclusion in the personas in RQ4.

Year in School

Year in school showed significant relationships with student behavior on two assignments: freshmen were more likely complete the **Week 3 Wikipedia Analysis** assignment, but less likely to complete the **Individual Project**.

Gender

There were no observations of gender differences observed across all of lecture attendance, discussion section attendance, and reading quiz completion analysis. Gender was associated with selection patterns for two of the large weekly assignments: men were more likely to complete a mid-semester essay, while women were more likely to create a survey.

Major Declaration

Whether or not a student had declared a major had no relationship to course-level outcome measures, lecture and discussion section attendance, reading quiz completion, or weekly assignment selection patterns.

Concurrent GPA

In addition to the correlations to final grade, total assignments completed, and total badges earned, concurrent GPA was correlated with learner completion of reading quizzes (three separate significant instances were identified, and at an aggregate level students with higher GPAs were observed to complete 1.61 more reading quizzes total). Concurrent GPA was negatively associated with completing work at the end of the semester; students with higher concurrent GPAs opted out of completing an essay at the end of the semester, and the individual project stages. This may suggest that they were focused on managing their performance in other classes. It does imply that they were also able to distribute their work in this class such that they achieved an excellent grade earlier in the semester, given that concurrent GPA was positively correlated with final grade and total points overall in the course.

Ethnicity

Students who described themselves as white were less likely to complete a mid-semester visual analysis assignment. However, white students were more likely to complete all stages of the individual form of the end-of-semester project. More analysis is needed to explore whether or not ethnicity played a role in the formation of groups for this final project.

Psychological Scales

Students who had a strong sense of autonomy at the beginning of the class were the most likely to complete a late-in-semester Reading Quiz.

Students who had a higher sense of relatedness at the beginning of the semester were less likely to engage with the **Individual Project** assignment form of the end-of-semester project.

Students' beginning-of-semester self-reported sense of competency was negatively related to the likelihood of completing the Group Project Learning Reflection.

Pre-semester resilience showed no relationship to student choices throughout the semester.

Discussion Sections

Students' discussion section assignment showed three relationships to weekly assignment completion. In addition, students in Discussion Section 9 engaged in significantly more weekly practice assignments than students in Discussion Section 2. Looking across the relationships observed, there do not appear to be any that suggest that a particular section was more likely to engage in or avoid a whole category of assignments. I hypothesize that these relationships may suggest that students found peers within their discussion sections with whom they collectively agreed to work on assignments.

RQ3: Assignment Pathways

What assignments do students select to do in combination?

I used cosine similarity to identify any patterns[3] within student behavior for each of the assessment categories that were investigated for their relationship to student characteristics in RQ2. I then tabulated the number of students whose behavior matched each identified pattern. The number of patterns observed for each assessment category are summarized below in *Table 5*. I reviewed all pathways that at least two students followed with the goal of identifying patterns that could be merged with others to create more descriptive (but less specific) patterns. For instance, in the Lecture Attendance category I combined the three separate sets of observations describe students who missed one of the last three lectures into a single category, prioritizing the behavior (missing one, but only one, of the final lectures) over the detail (precisely which of the

[3] By pattern, I mean any pattern of completion within an assessment type that was completed by more than one student. Paths that were taken by only one student were merged into the described paths during the consolidation process.

three lectures they missed). Having consolidated the observed patterns, I then reviewed each of the unique pathways to see if they fit within the newly identified groupings, with the goal of having no un-described patterns, while retaining the most amount of detail regarding student choices possible. I categorized patterns in attending lecture and discussion section meetings, and completing the weekly reading quizzes, as being in the first half (Weeks 2-13) or the second half (Weeks 14-26) to provide some insight into the way that these behaviors are embedded in the time and pacing of the semester. *Table 5* shows the breakdown of course components analyzed, how many patterns cosine similarity identified on the first pass, and how many patterns were established after consolidation.

Table 5: Assessment types paired with the raw and consolidated counts of student engagement patterns

Assessment Type	***Raw patterns***	***Consolidated patterns***
Lecture Attendance	15 (41 students each took unique paths)	9
Discussion Section Attendance	11 (26 students each took unique paths)	10
Weekly Readings	7 (50 students each took unique paths)	12
Weekly Assignments	1 (157 students each took unique paths)	9
End-of-Semester Project	7	7

RQ3a: Lecture Attendance Patterns

Attendance at lecture was high throughout the term, with an average attendance rate of 93%. There were four classes all students attended, Lectures 1, 4, 17, and 20. Attendance tapered at the end of the course: the final three lectures of the course had the lowest attendance rates observed in the semester. *Table 6* shows the overall attendance rate per lecture throughout the term.

Table 6: Lecture Attendance Count & Rate

Lecture Event	*# of Students*	*Attendance Rate*
Lecture #1	160	100%
Lecture #2	155	96.88%
Lecture #3	154	96.25%
Lecture #4	160	100%
Lecture #5	159	99.38%
Lecture #6	157	98.13%
Lecture #7	156	97.5%
Lecture #8	154	96.25%
Lecture #9	156	97.5%
Lecture #10	157	98.13%
Lecture #11	153	95.63%
Lecture #12	157	98.13%
Lecture #13	154	96.25%
Lecture #14	157	98.13%
Lecture #15	156	97.5%
Lecture #16	156	97.5%
Lecture #17	160	100%
Lecture #18	153	95.63%
Lecture #19	153	95.63%
Lecture #20	160	100%
Lecture #21	146	91.25%
Lecture #22	152	95%
Lecture #23	154	96.25%
Lecture #24	115	71.88%
Lecture #25	93	58.13%
Lecture #26	83	51.88%

The raw attendance patterns that cosine similarity revealed are summarized in *Table 7*. Pattern 1 included 44 students (28% of the class) who attended every lecture. Pattern 2 was comprised of 16 students (10% of the class) who went to every lecture—until the end of the term when they missed the last three lectures (24 through 26). Patterns 3 and 4, with 13 and 12 students respectively, each had perfect attendance before deciding to skip one of the last two lectures of the semester (lecture 25 or 26). Pattern 5 was comprised of eight students (5% of the

course) who chose to skip *both* final lectures. Patterns 1-5 collectively describe the behavior of 58% of the student population in the course, and depict a high rate of attendance until the very end of the semester. *Table 7* provides a description of each observed lecture attendance pattern, and the number of students whose behavior matched it.

Table 7: Lecture Attendance Groups

Pattern	***# of Students***	***Characterization***
1	44	Attended every lecture
2	16	Missed the last 3 lectures (#24-26)
3	13	Missed the last lecture (#26)
4	12	Missed the second to last lecture (#25)
5	8	Missed the last two lectures (#25-26)
6	5	Missed lecture #24
7	4	Missed lectures #24-25
8	3	Missed lectures #21 and #24-26
9	2	Missed lecture #2
10	2	Missed lectures #16 and #25-26
11	2	Missed lectures #22, #24-26
12	2	Missed lectures #19, #24-26
13	2	Missed lectures #2 and #23
14	2	Missed lectures #11 and #26
15	2	Missed lectures #23 and #25
Unique	41	

After consolidating the raw patterns observed in the cosine similarity analysis, and incorporating the behavior of students who took unique paths through their lecture attendance, a total of eight distinct patterns emerged. The consolidated lecture attendance patterns 1 and 2 remained the same as the raw patterns—100% attendance, and perfect attendance until being absent for the final three lectures. Pattern 3 describes the 48 students who chose to miss one of the final three lectures, while Pattern 4 describes 17 students who missed one of the final three lectures and an additional lecture in the second half of the semester. Pattern 5 describes five students who missed 1-3 lectures, but only in the first half. Pattern 6 describes the 21 students

who missed one lecture in the first half, and one in the second half. Pattern 7 depicts the seven students who missed 1-2 lectures in the first half but then 3-4 in the second half. Pattern 8 describes the one lone student who missed four lectures in the first half of the semester, but then only two in the latter half of the semester. *Table 8* provides an overview of how many students fit into each of the eight observed patterns.

Table 8: Lecture Attendance Patterns (Consolidated)

Pattern	***# of Students***	***Characterization***
1	44	Attended every single lecture
2	16	Missed the last 3 lectures (#24-26)
3	48	Missed 1-3 lectures in the last half
4	17	Missed 1-2 lectures between #18-22, and 1-3 from #24-26
5	5	Missed 1-3 lectures in the first half
6	21	Missed 1-2 lectures in the first half, and 1-2 in the last half
7	7	Missed 1-2 in the first half and 3-4 in the second half
8	1	Missed 4 lectures in the first half and 2 lectures in the second half

Looking across these patterns it is clear that the week of the semester has a significant impact on whether or not students are likely to attend lecture, although in my earlier analysis there was only one characteristic (pre-semester resilience) that correlated with one early-semester lecture attendance event. Patterns 2-4 describe students only missing lectures in the last half of the semester. Pattern 5 describes five students who missed a small number of lectures in the first half of the semester. Pattern 6, missing 1-2 classes in each half of the class was more common (13% of the class). Pattern 7 is a combination of Patterns 2 and 5—these students missed very few lectures in the first half, but then missed an extended amount of the second half of the semester. Future analysis should explore students' reasons for when to skip (and when to attend) class, including exploring whether a drop-off like we observed here is related to students achieving their goal letter grade/outcome in the course.

RQ3b: Discussion Section Attendance Patterns

Discussion section attendance was even higher than Lecture attendance, with an average rate of 95.58%. There were fewer sessions where every single student attended (only one discussion section had perfect attendance, as compared to four lecture events). While participation also dropped off at the end, it did so less significantly than lecture attendance, with the lowest observed participation rate at 70% in the final discussion section as compared to 51.88% in the final lecture. *Table 9* provides an overview of discussion section attendance.

Table 9: Discussion Section Attendance Counts and Rates

Discussion Section Event	*# of Students*	*Attendance Rate*
Discussion #1	159	99.38%
Discussion #2	157	98.13%
Discussion #3	160	100%
Discussion #4	157	98.13%
Discussion #5	159	99.38%
Discussion #6	158	98.75%
Discussion #7	158	98.75%
Discussion #8	156	97.5%
Discussion #9	155	96.88%
Discussion #10	159	99.38%
Discussion #11	157	98.13%
Discussion #12	156	97.5%
Discussion #13	158	98.75%
Discussion #14	159	99.38%
Discussion #15	158	98.75%
Discussion #16	155	96.88%
Discussion #17	157	98.13%
Discussion #18	158	98.75%
Discussion #19	158	98.75%
Discussion #20	157	98.13%
Discussion #21	142	88.75%
Discussion #22	155	96.88%
Discussion #23	141	88.13%
Discussion #24	118	73.75%
Discussion #25	112	70%

Using cosine similarity analysis, eleven patterns of discussion session attendance were revealed (in addition to 27 unique pathways). Seventy-three students (almost 47%) are described by Pattern 1 and had perfect discussion section attendance. Mirroring lecture attendance patterns, a subset of 15 students (almost 10%) chose to miss both of the final discussion sections, while 12 missed just the final section meeting. Patterns 4, 5, and 7 describe small groups of students missing a single section meeting at the end of the course, while Pattern 6, 8, and 10 describe small clusters of students missing multiple end-of-semester meetings.

After consolidation, nine distinct discussion section attendance patterns emerged. Patterns 1 and 2 were again the same as the raw patterns. Pattern 3 describes students who missed one of the final three section meetings. Patterns 4 and 5 depict the pattern of missing 1-2 sessions somewhere in the second and first halves of the semester, respectively. 11 students missed 3-4 of the final five section meetings, while an additional seven students distributed their absences, missing 1-2 in each half of the semester. *Table 11* lists the breakdown of how many students are characterized by each pattern, and what each pattern consisted of.

Table 10: Discussion Section Attendance Groups

Pattern	***# of Students***	***Characterization***
1	73	Attended every section meeting
2	15	Missed the last two (#24-25)
3	12	Missed the last one (#25)
4	8	Missed #21
5	6	Missed #24
6	6	Missed the last three (#23-25)
7	4	Missed #23
8	3	Missed #21 and #25
9	2	Missed #2
10	2	Missed the last four (#22-25)
11	2	Missed #21, #24-25
Unique	26	

These analyses demonstrate that students were significantly more likely to miss discussion section in the latter half of the semester, just as they were with lectures. Only three of the patterns describe any absences in the first half, and none of those are higher than 1-2 per student. More research is needed to understand why some students chose to miss discussion section at the end of the semester.

Table 11: Discussion Section Attendance Groups Consolidated

Pattern	*# of Students*	*Characterization*
1	73	Attended every section meeting
2	15	Missed the last two (#24-25)
3	22	Missed one of the last three (#23-25)
4	18	Missed 1-2 in the last half
5	9	Missed 1-2 in the first half
6	11	Missed 3-4 of #21-25
7	7	Missed 1-2 in the first half and 1-2 in the second half
8	2	Missed 4 in the last half
9	2	Missed 1-2 in the first half and 3-4 in the latter half

RQ3c: Weekly Reading Engagement Patterns

Average engagement with weekly reading quizzes was 92.72%. While there was no single week where every student completed the reading quiz, the engagement stayed above 93% until the last four weeks of the semester, when it dipped significantly.

Cosine similarity analysis of reading quiz engagement produced what was naturally the most condensed set of seven patterns, but the highest number of observations (50) that were unique. 47 students completed every single Reading Quiz, and 27 students only missed the final one. Across Patterns 2-6, a total of 62 students only missed 1-2 reading quizzes, all of them at the end of the semester.

Table 12: Weekly Reading Quiz Completion Rate

Reading	*# of Students*	*Completion Rate*
Reading 1	159	99.38%
Reading 2	156	97.5%
Reading 3	159	99.38%
Reading 4	155	96.88%
Reading 5	155	96.88%
Reading 6	158	98.75%
Reading 7	154	96.25%
Reading 8	154	96.25%
Reading 9	153	95.63%
Reading 10	153	95.63%
Reading 11	155	96.88%
Reading 12	156	97.5%
Reading 13	150	93.75%
Reading 14	151	94.38%
Reading 15	155	96.88%
Reading 16	153	95.63%
Reading 17	156	97.5%
Reading 18	154	96.25%
Reading 19	152	95%
Reading 20	136	85%
Reading 21	142	88.75%
Reading 22	117	73.13%
Reading 23	79	49.38%

Table 13: Weekly Reading Groups

Pattern	***# of Students***	***Characterization***
1	47	Completed all
2	27	Missed the last one (#23)
3	17	Missed the last two (#22-23)
4	7	Missed #20
5	5	Missed #22
6	4	Missed #20 and #23
7	3	Missed #13
Unique	50	

By consolidating the patterns, we can more clearly see that a significant percentage of students (73, or 46% of the class) only missed 1-2 quizzes during the latter half of the semester. 10% of students (16) missed a few quizzes in the first half of the semester as well as the second half. 21 students (13%) chose not to complete this work a substantial percentage of the time.

Table 14: Weekly Reading Groups Consolidated

Pattern	***# of Students***	***Characterization***
1	47	Completed all
2	27	Missed the last one (#23)
3	17	Missed the last two (#22-23)
4	20	Missed 1 in the last half
5	9	Missed 2 in the last half
6	8	Missed 2-3 in the first half, and 1-3 in the last half
7	8	Missed 1 in the first half, 1-2 in the second half
8	6	Missed 1-2 in the first half, and 3-6 in the second half
9	14	Missed 3-5 in the second half
10	2	Missed 1-2 in the first half
11	1	Missed 5 in the first half, 3 in the latter half

RQ3d: Weekly Assignment Selection Patterns

There were 22 weekly "practice" assignments in the course that students could choose to complete. Students were encouraged by the instructor to complete five; on average, each student completed 6.51, with the minimum being three and the maximum being ten. The most frequently completed assignments were the **Week 2 Essay** (73.13% completion rate) and the **Week 4 Data Analysis with R** assignment (71.88% completion rate).

Table 15: Weekly Assignment Completion Counts & Rates

Assignment	*Completion Count (Rate)*
Week 2 Assignment: Essay	117 (73.13%)
Week 3 Assignment: Interview	8 (5%)
Week 3 Assignment: Wikipedia Analysis	65 (40.63%)
Week 4 Assignment: Essay	26 (16.25%)
Week 4 Assignment: Data Analysis with R	115 (71.88%)
Week 5 Assignment: Archive Visit	49 (30.63%)
Week 5 Assignment: Create a Survey	65 (40.63%)
Week 5 Assignment: Book Quest I	20 (12.5%)
Week 6 Assignment: Essay	20 (12.5%)
Week 6 Assignment: Visual Evidence Analysis	84 (52.5%)
Week 6 Assignment: Archive Visit	9 (5.63%)
Week 7 Assignment: Wikipedia Analysis	66 (41.25%)
Week 8 Assignment: Essay	55 (34.38%)
Week 8 Assignment: Wikipedia Contribution	39 (24.38%)
Week 8 Assignment: Analyze your Data	25 (15.63%)
Week 9 Assignment: Revision	72 (45%)
Week 9 Assignment: Wikipedia Visual Contribution	33 (20.63%)
Week 9 Assignment: Book Quest II	15 (9.38%)
Week 10 Assignment: Essay	40 (25%)
Week 10 Assignment: More Data Analysis with R	25 (15.63%)
Week 11 Assignment: Interview	33 (20.63%)
Week 12 Assignment: Essay	61 (38.13%)
Total: 22	mean=29.6%

Cosine similarity analysis of the weekly assignment pathways revealed that only two students in the course chose to do the exact same assignments. Those two students each did six assignments, and chose to develop significant experience with Wikipedia. Their assignment pathway consisted of the following: Week 2 Essay, Week 3 Wikipedia Analysis, Week 4 Data Analysis with R, Week 5 Create a Survey, Week 8 Wikipedia Contribution, Week 9 Wikipedia Visual Contribution.

Table 16: Weekly Assignments

Pattern	***# of Students***	***Characterization***
1	2	Week 2 Essay
		Week 3 Wikipedia Analysis
		Week 4 Data Analysis with R
		Week 5 Create a Survey
		Week 8 Wikipedia Contribution
		Week 9 Wikipedia Visual Contribution
Unique	158	

Given that the previous analysis was unable to reveal student pathways at the explicit assignment level, I decided to code each assignment's primary task, creating the following categories: Essays, Questioning (combining the two interview assignments and one survey), Wikipedia, Data Analysis & Visualization, Archive Visits, and Book Quests. *Table 16* summarizes the number of assignments within each category, as well as how many students completed an assignment within each grouping.

Table 17: Assignment Categories and Participation Rates

Assessment Type	*# of Assignments*	*Participation Count*	*Participation Rate*
Essays	6	149	93.13%
Questioning (Interviews & Surveys)	3	87	54.38%
Wikipedia	4	103	64.38%
Data Analysis & Visualization	4	141	88.13%
Archive Visits	2	55	34.38%
Book Quests	2	21	13.13%
Revision	1	72	45%

With these categories in hand, I compiled a datasheet that described each students' engagement with each category, using a one to describe that they had done any assignment within that category, and a zero to reflect that they had not. I used cosine similarity to analyze whether or not there were any observable patterns in what categories students had chosen to do

in combination. This analysis revealed eighteen patterns that were followed by 151 students total, and 8 students who pursued a unique grouping of assignment categories. *Table 17* describes each observed pattern, the categories that it consisted of, and the number of students who completed the work that the pattern described.

Table 18: Weekly Assignment Categories

Pattern	***Characterization***	***# of Students***
1	• Essays • Questioning • Wikipedia • Data Analysis	40
2	• Essays • Questioning • Data Analysis	18
3	• Essays • Wikipedia • Data Analysis • Archive Visits	15
4	• Essays • Data Analysis • Archive Visits	12
5	• Essays • Wikipedia • Data Analysis	10
6	• Essays • Questioning • Data Analysis • Archive Visits	9
7	• Essays • Wikipedia • Data Analysis • Book Quests	8
8	• Essays • Wikipedia • Archive Visits	8

9	• Essays • Questioning • Wikipedia • Data Analysis • Archive Visits	6
10	• Essays • Data Analysis • Book Quests	5
11	• Essays • Wikipedia	4
12	• Essays • Data Analysis	3
13	• Essays • Questioning • Data Analysis • Book Quests	3
14	• Questioning • Data Analysis	3
15	• Essays • Questioning • Wikipedia	2
16	• Questioning • Wikipedia • Data Analysis	2
17	• Wikipedia • Data Analysis	2
18	• Essays • Wikipedia • Book Quests	2
Unique		8

I then completed the same consolidation process for the weekly assignment patterns, merging similar patterns in order to create more general groupings. My goals were: to accommodate for all unique patterns, produce no more than 10 patterns, and have no group with fewer than 5 students. In this round of consolidation, making categories more inclusive meant

framing one (or more) categories as being optional to engage in. I used the number that cosine similarity produces, describing how similar any given student is to any other based on the processed observations, to determine where to place 35 students. *Table 18* summarizes the new groups, including which assignment categories they all completed, and how many students were assigned to each group. Assignment categories marked with one star were not always completed by the students who were added in the consolidation round; categories marked with two stars were added to the pattern during consolidation, and so were *only* completed by a subset of the students.

Table 19: Weekly Assignment Categories

Pattern	***Characterization***	***# of Students***
1	• Essays* • Questioning • Wikipedia • Data Analysis* • Archive Visits**	45
2	• Essays* • Questioning • Data Analysis*	23
3	• Essays* • Wikipedia • Data Analysis • Archive Visits	16
4	• Essays • Data Analysis* • Archive Visits*	16
5	• Essays* • Wikipedia • Data Analysis	12
6	• Essays • Questioning • Data Analysis • Archive Visits	9

7	• Essays • Wikipedia • Data Analysis • Book Quests*	15
8	• Essays • Questioning • Wikipedia • Data Analysis* • Archive Visits	15
9	• Essays • Questions* • Wikipedia** • Data Analysis • Archive Visits • Book Quests**	9

Essays were the most frequent assignment category students engaged with, appearing in every pattern—although there were three raw patterns that described seven students who did not complete any essays, these patterns were obscured by the consolidation process due to how few students chose this approach. Data Analysis was the next most frequent category students completed. 12 students across three of the raw patterns avoided Data Analysis assignments, but these unusual behaviors were again lost in the consolidation round. Book Quests were the least frequently pursued assignment category, and only appeared in four of the eighteen raw patterns, and two of the nine consolidated patterns.

RQ3e: End of Semester Project Selection Patterns

The majority of the class (157 students, or 98.1%) submitted a proposal for the end-of-semester project. Only 42% of those students (66, 41% of the whole class) went on to complete the project, and then 61% (40 students, or 25% of the whole class) completed the learning reflection. While the proposals were almost perfectly split between group and individual

submissions, there were nearly twice the number of project submissions for the group assignment as opposed to individual assignment. For those individuals who had completed the project, they were very likely to complete the learning reflection (there were 20 project submissions, and 15 of the students submitted a learning reflection), while nearly half of the students who did a group project did not submit a learning reflection (46 students submitted a group project, but only 25 submitted reflections). There were two students who did not engage with the project sequence at all. With only three components, and the requirement to complete each stage before moving on to the next, cosine similarity analysis only identified seven patterns; no pattern was followed by only one student. As a result, I did no further consolidation to make sense of the patterns. *Table 19* shows the pathways taken through the three stages of the end-of-semester project.

Table 20: End-of-Semester Project

Pattern	***# of Students***	***Characterization***
1	57	Completed just the individual project proposal
2	34	Completed just the group project proposal
3	25	Did all three parts of the group project
4	15	Did all three parts of the individual project
5	3	Completed no parts of the project
6	21	Completed the group proposal and the project, but not the reflection
7	5	Completed the individual proposal and the project, but not the reflection

RQ3 Findings Summary

To answer RQ3, I used cosine analysis to identify patterns of behavior that describe how students engaged with the five categories of assessment within the course. I took the raw patterns observed for each category and consolidated them into slightly more general patterns in order to create more manageable ways to describe student behavior. Patterns observed for lecture and discussion section attendance, and weekly reading quiz completion emphasize the degree to which this student population was highly engaged with the learning experience, although their participation did wane slightly towards the end of the semester. Analysis of the weekly

assignment completion revealed 158 unique pathways through this core component of the course. In order to explore what *was* similar about how students engaged with these assignments I analyzed whether or not each student engaged with a particular type of weekly assignment as opposed to each specific instance. This analysis revealed 18 distinct patterns, which I was then able to consolidate into nine.

RQ4: Student Personas

How do these findings build to a holistic description of the patterns in student behavior in a gameful class, as summarized in student personas?

To answer this final question, I took the consolidated weekly assignment combinations identified in RQ3d and used them as a lens to look back on the students who took these pathways. I assigned each student to a group based on the weekly assignment pattern that matched their work. For all numeric student data, I calculated the mean, mode, and median for the subgroup of students, and used them to determine a number that best summarized those students. For qualitative data I identified the most common characteristic, and again considered how accurately it represented the whole group of students. Not all characteristics could be satisfactorily summarized across the group of students, in which case I noted that there was no pattern present in the final persona summary. For each persona, I identified the following characteristics:

- Year in school
- Credit load
- Concurrent GPA
- Major
- Total weekly assignments completed

- Lecture attendance pattern
- Discussion section attendance pattern
- Reading quiz completion pattern
- End-of-semester project engagement pattern
- Revision assignment engagement, including assignment choice, original score, and improvement
- Likelihood of earning a zero on any weekly assignment
- Likelihood of submitting an assignment late
- Likelihood of submitting an assignment early

The nine personas produced by this work are included in Appendix B.

Conclusion

In this chapter I have shared my analysis and findings for each research question. This work has included exploring how student characteristics related to performance in the course overall, and completion of 107 different assessment opportunities. Using cosine analysis, I have analyzed how similarly students behaved around completing work in five different types of assessment categories. I have then used these analyses to inform the design of nine different learner personas within the course. In the next chapter I will discuss the strengths and weaknesses of the analysis I have completed, and set a vision for future work in this space.

Chapter 6: Discussion

Introduction

In this dissertation, I analyzed the relationship between students' characteristics and the assessment choices that they made in a gameful (Aguilar et al., 2013; Fishman et al., 2013; Waltz & Deterding, 2015) Honors course taught at the University of Michigan. The course used GradeCraft, a learning management system that I designed and built (Holman et al., 2015; Holman, Aguilar, & Fishman, 2013), to support the gameful learning design that empowered students to make decisions regarding their assessment. My goal for this research was to better understand what decisions students would make regarding which components of the course assessment structure to complete. In this final chapter, I summarize my findings from each of the four research questions, highlight the important takeaways from my analyses, and discuss the benefits and challenges of data-driven learner personas. I close by considering opportunities for future work on the design of data-driven learner personas.

Research Questions: A Review

I began this work by exploring whether any of the academic history or demographic characteristics that have historically been observed to impact student performance (Cohen et al., 2006; Leppel, 2001; McKenzie & Schweitzer, 2001; Voyer & Voyer, 2014; Wright et al., 2014) were connected to the students' overall success within the gameful Honors course (RQ1). While the whole class performed well (only five students out of 159 earned a final grade lower than an A-), students with higher concurrent GPAs were more likely to be at the top of the class; they

completed more assignments, earned more badges and more points, and ultimately received higher final grades. None of the other student characteristics studied here related to any course-level outcomes.

I then explored whether there were meaningful relationships between the student characteristics studied in RQ1 and students' decision to attend or complete each of the 107 point-earning opportunities in the course (RQ2). While there were no statistically significant relationships observed between student characteristics and the decision to attend lecture and discussion section, students with higher concurrent GPAs were likely to complete an additional 1.61 weekly reading quizzes. Additional analysis for RQ2 showed that gender and year in school each related to a few weekly assignment choices: men were more likely to choose a mid-semester essay rather than creating a survey, while freshmen were more likely to complete an early Wikipedia assignment but less likely to complete the Individual Project. These findings suggest that there is reason to investigate the impact of gender and year in school on selection strategies further, particularly in larger and more diverse contexts.

Which discussion section a student was in related to their weekly practice assignment choice in three separate instances: students in Discussion Section 6 were less likely to complete the Week 5 Survey, students in Discussion Section 10 were less likely to complete the Week 9 Revision assignment, and students in Discussion Section 9 were more likely to do the Week 10 Essay. These relationships suggest that these meetings develop their own sub-culture within the larger course. Different discussion sections meet at different times of the day, making it is possible that the student makeup of each section acts as a natural grouping mechanism, whereby similar students wind up in the same section to accommodate scheduling requirements of other courses they are taking together. Second, students may be forming peer relationships within

these sections that guide the assignment selections or participation choices they make. Finally, the teaching assistants are one of the students' primary points of contact for the course, and they are likely to influence students by sharing their own perspective on the course, its content, and the assessment opportunities. More investigation is needed to understand if any of these explanations is likely, and, if so, to what degree they are each responsible for the discussion sections appearing to relate students' assessment choices.

Unfortunately, the psychological scale data from the beginning-of-semester survey was not ideal for investigating relationships to student choice, being neither complete nor uniformly representative of the various sub-populations. Two relationships, one each for autonomy and relatedness, were observed. Autonomy was positively associated with students completing a single end-of-semester Reading Quiz. Relatedness were negatively associated with students completing the Individual Project. No assignment choice relationships were observed for competency or resilience. More investigation is merited given the lack of complete data to power this investigation, but as it stands this data does not suggest that these traits play a strong role in assignment selection.

In RQ3 I used cosine similarity analysis to identify common behaviors in how students approached each assessment type within the course. The patterns identified for lecture attendance, discussion section attendance, and reading quizzes describe that more than ninety percent of the students participated fully throughout the course, but there was an observable drop-off in engagement at the end of the semester. More research is needed to understand whether students are making intentional choices around their own completion behavior, whether a pattern of behavior applied in one course is a strategy that students apply to multiple contexts, and under what conditions students vary their approaches. Particularly important to understand

as an instructional design challenge is what motivates students to *stop* participating—if earning an A-grade early means students no longer complete the basic work of the course then instructors need to be especially mindful of how content is distributed across the course timeline (perhaps more so than they even already are), ensuring that efficient students do not end the learning experience having neglected crucial topics.

Learning from Personas

Constructing the personas required making decisions about how to describe small numbers of students with what was often divergent behaviors that could not easily be characterized as a single pattern of action. I chose to describe a number of characteristics by giving the degree to which that behavior was observed among the students who made up the persona, and then describing how frequently that same behavior was observed across the whole population. I decided not to include gender and ethnicity in the persona description because if I reported only the single dominant characteristic observed in each grouping then all of the personas would have been white, and only one would have been male (despite men making up almost half the class population). This has shown me that in order to depict diversity (on any metric) in personas, the designer must explicitly consider those characteristics at every level and choose to include them, they will not simply emerge from data analysis if it is allowed to solely prioritize frequency.

An issue to address is the question of how to proceed with persona design if we discover that some behaviors do not have relationships to others—for instance, it seems possible that students adopt different approaches to their engagement with the course reading material than they do with their discussion section attendance behavior, and that those behaviors may *not* be intertwined. In the analyses used to construct student personas, a pattern of behavior in one

assessment type (i.e., lecture attendance, discussion section attendance, reading quizzes, etc.) was not necessarily directly related to a behavior pattern for another assessment type. Students with perfect attendance records skipped many of the reading quizzes, and vice versa. In future work, I plan to explore directly how these patterns of behavior are related to each other.

There are many behaviors identified in the broad literature as being important to learning, and to being a student. Creating a data-rich picture of how students behave is a significant analysis task. Doing so in a way which faithfully represents student behavior and is helpful to instructors may require expanding our understanding of what form a persona should take. Based on the analysis from this dissertation, demographic characteristics and psychological scales appear to only be minimally helpful in describing patterns in student behavior in gameful courses. If this continues to hold true in other analyses, then these characteristics should not be included in learner personas. While biographical characteristics are traditionally part of the profile, there is no reason why they have to be, and plenty of reason why they should be removed if they both reinforce stereotypes and yet are not actually related to the behaviors being represented.

As an alternative to removing some characteristics altogether, imagine if data-driven personas included a range of values observed, or the probability of seeing a specific trait. Pushing this farther, we could design digital persona displays that would randomize unassociated characteristics and, on each display, the characteristic values could *change* to reflect the full diversity of the overall population. Adding probabilities, ranges, and randomized values may serve to make student personas more accurate, but they may also increase the difficulty involved in making sense of them. The target audience for such personas should be consulted regularly

throughout the process of designing such profiles, with a clear eye towards improving their use and understanding of the data-driven personas.

If we look across all of the results from this dissertation analysis, students completed assignments in a way that worked for *them*, taking almost entirely unique pathways through the core weekly work. Interviewing students to understand why they chose specific assignments is crucial to understanding this landscape. There are some indications that these choices are made in the context of their peers (reflective of the Discussion Section relationships), and that a social network analysis might be an appropriate method to investigate assignment selection. Additionally, student behavior around lecture attendance, discussion section attendance, and reading quizzes, and the relative drop-off at the end of the semester, suggest that time also impacts students' decisions and may be a valuable lens from which to consider choices as well. Among the 159 graded students, only two selected an identical pathway through the weekly assignments. One perspective from which to assess how well the assignment pathway-based persona construction did at summarizing student profiles is to consider those two students who took the same pathway—how similar were they? Both were first-year women without majors, and both earned an A in the course. They completed the same six practice assignments (Week 2: Essay, Week 3: Wikipedia Analysis, Week 4: Data Analysis with R, Week 5: Create a Survey, Week 8: Wikipedia Contribution, Week 9: Wikipedia Visual Contribution), which amounted to a deep-dive on Wikipedia work. Neither completed the Revision assignment. By the next fall they had both declared majors in different domains—one a double-major in English and History, and one in Neuroscience. The Neuroscience major earned nearly 2,000 more points overall, but went to lecture far less frequently (84% attendance rate, as opposed to the English/History major's perfect lecture attendance rate). They both went to every discussion section meeting. Neither

student ever submitted any assignments late, but only the Neuroscience major ever submitted an assignment more than a week before the due date (something that was relatively common in the course, with 48% of students in the course doing so on at least one assignment). They were taking the same number of credits that semester, but a different number of courses (four for the Neuroscience major, five for the English/History major; the English/History major was taking three Honors courses simultaneously). Their shared pathway is backed by a surprising amount of difference.

However, these two students were enrolled in the same Discussion Section. That increases the likelihood that these students were friends, or at least familiar with each other, and consulted with each other about which assignments to complete. Outside of their common Discussion Section, no other demographic or academic history characteristic within this dataset would have grouped them together. Given that there are *no* other examples of students taking identical paths in the whole course, I can neither confirm nor reject the idea that students are guided in their assignment selection by their peers. The presence of consistent Discussion Section relationships to the weekly assignment selections does suggest that this may be occurring.

Grade outcomes offer a different perspective from which to consider behavior that could guide persona design. Students who earned the highest and lowest final grades in the course are distributed across each the personas I created; there was no one assignment pathway that appears to have yielded definitively higher or lower final grades. Students who earned B/B+ went to 96% of lecture events, on average, while the A+ students had an average attendance rate of 88% (the class average was 93%). Both groups of students had near-perfect discussion attendance patterns, but the B/B+ students were more likely to complete all the reading quizzes. The A+ students

were evenly split on gender, whereas four out of the five B/B+ students were men. The B/B+ students were all freshmen who had not yet declared majors, but eight of the ten students who earned A+'s also fit this profile. All but one of the A+ students chose to do an individual project rather than a group one. B/B+ students did half a weekly assignment (average 7.2) more than A+ students (average 6.7), but were more likely to earn a zero at least once during the semester. Notably, for both the A+ students and the B/B+ students their achievement in this course was a near perfect representation of their performance outside of this course: The B/B+ students earned an average concurrent GPA of 2.99 (the highest observed was a 3.3), and the A+ students earned on average a concurrent GPA of 3.95 (the lowest observed was 3.82). What happened to these B/B+ students? They demonstrated what appeared to be good student behavior around class attendance and content engagement, they put in above-average effort in terms of the sheer quantity of assignments submitted, yet they earned what amounts to an unusually poor grade in comparison to their peers–an outcome that is apparently consistent with their experience across the semester. More research needs to be done to understand what these students are doing that results in such a different final outcome, including how significantly a gameful approach can overcome students' orientations to and strategies towards their academics that have been established over the course of many experiences with traditional course design.

Implications for Gameful Pedagogy

In order to give students a sense of progress in gameful courses, we commonly advise instructors to award points for behaviors like attending class. In this study, it was observed that that around the 21st lecture of the semester, right at the time when students are finally achieving total point values that equate to earning an A in the course, a significant percentage of students stopped engaging in the more basic components of the learning design, including attending class

and discussion section, and completing reading quizzes. Is this an example of how, by using extrinsic motivators to entice students to engage in an activity, we have decreased their intrinsic motivation (Deci & Ryan, 2002)? Would students, even these Honors students who likely have a sense of identity tied to behaving as a "good" student should (Cosgrove, 2004), have attended as consistently if they had not received points for showing up? Or does the observed shift in behavior at the end of the semester have little to do with type of motivation and instead reflect the many pressures and distractions of the time of the academic calendar? It is important that students do these core components, but finding the right balance between extrinsic incentives and intrinsic motivation may require us to question and iterate our design recommendations. Future work might explore how to incentivize engagement with these activities directly, ideally by shifting away from points altogether and using mechanics like access to new content and assignments, connection with peers, and increased self-direction as recognition for positive behaviors. Certainly, at the content and lesson design level, instructors should be taking into account the significant percentage of the class that is likely to miss out on these final sessions under the current incentive scheme. This challenge is by no means unique to gameful classrooms, but the transparent incentive and assessment structure has the potential to exacerbate the issue.

In many ways, gameful pedagogy acts as a self-driven method of personalization; we rely on the assumption that agency is valuable for motivation, and are therefore able to take advantage of the way that the individual knows their own interests (and hopefully, abilities) best. Despite this, I had never imagined just *how* significantly gameful pedagogy has empowered students to personalize their course experience; the idea that in a class of 159, only two students took the same route through just 22 of the assignments is, in my opinion, a deep affirmation of

the value of the approach. My future research will focus on how to help students who are not currently thriving in gameful contexts.

Conclusion

Gameful learning design faces a tension between the goal of empowering students to have control over their own learning experience, while simultaneously convincing them to complete activities that we believe are important for their learning. For instructional design purposes, the more we can understand about what drives student interest and selection strategies, the better we can design learning experiences to match them. The data-driven personas produced in this dissertation revealed more challenges with the inherently reductive process of persona design than they were able to depict commonalities in students' behavior—although that complexity alone did serve to highlight how sincerely gameful course design structures empower students to personalize their learning and assessment. In future work, I hope to both extend this analysis to confirm how *little* the characteristics studied here relate to student choice, and begin the work of investigating how the behaviors identified relate to each other rather than trying to find relationships between behaviors and student attributes. I believe that this dissertation has shown that patterns of student behavior are both identifiable and valuable for informing iterative course design, and that this is an important contribution to our understanding of both gameful pedagogy and learner behavior in autonomy-supportive learning environments.

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Appendices

Appendix A: Surveys

Fall 2016 Pre-Survey

This course has a grading system where much of your grade depends on which assignments you choose to pursue. This grading system may be different than systems you have encountered in other classes. Your professor is interested in how, if at all, this grading system affects the way you approach your work in this class. This survey should take you less than 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 will not see the results of this survey until after the semester is over, and even then only in aggregate and de-identified form. 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 a grading system like the one in this course 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.

Have you ever participated in a course with an assessment system like the one in this class?

- ❍ Yes (1)
- ❍ No (0)

Have you used GradeCraft before?

- ❍ Yes (1)
- ❍ No (0)

Before you registered for this class, were you aware that the instructor would be using

GradeCraft?

- ❍ Yes (1)
- ❍ No (0)

(conditional on previous response)

Did the use of GradeCraft in this class influence your decision to enroll?

- ❍ Yes (1)
- ❍ No (0)

Are you taking this class pass/fail?

- ❍ Yes (1)
- ❍ No (0)

(conditional on previous response)

What grade do you expect to earn in this course?

- ❍ Pass (1)
- ❍ Fail (0)

(conditional on previous response)

What grade do you expect to earn in this course?

- ❍ E (1)
- ❍ D+ (2)
- ❍ C- (3)
- ❍ C (4)
- ❍ C+ (5)
- ❍ B- (6)
- ❍ B (7)
- ❍ B+ (8)
- ❍ A- (9)
- ❍ A (10)
- ❍ A+ (11)

The following questions are about the grading system in this class.

	Not at all true (1)	(2)	Somewhat true (3)	(4)	Very true (5)
I have a good understanding of the grading system (1)	❍	❍	❍	❍	❍
I like the grading system (2)	❍	❍	❍	❍	❍

Please respond to each of the following items in terms of how true it is for you with respect to your learning in this class.

	Not at all true (1)	(2)	(3)	Somewhat true (4)	(5)	(6)	Very true (7)
I feel like I have a lot of input on deciding how my work gets done in this class (1)	❍	❍	❍	❍	❍	❍	❍
I really like the students in this	❍	❍	❍	❍	❍	❍	❍

class (2)							
I do not feel very competent when I am in this class (3)	❍	❍	❍	❍	❍	❍	❍
People in this class tell me I am good at what I do (4)	❍	❍	❍	❍	❍	❍	❍
I feel pressured in this class (5)	❍	❍	❍	❍	❍	❍	❍
I get along with people in this class (6)	❍	❍	❍	❍	❍	❍	❍
I pretty much keep to myself in this class (7)	❍	❍	❍	❍	❍	❍	❍
I am free to express my ideas and opinions in this class (8)	❍	❍	❍	❍	❍	❍	❍

I consider the people in this class to be my friends (9)	❍	❍	❍	❍	❍	❍	❍
I have been able to learn interesting new things in this class (10)	❍	❍	❍	❍	❍	❍	❍
When I am in this class, I have to do what I am told (11)	❍	❍	❍	❍	❍	❍	❍
Most days I feel a sense of accomplishment from doing work in this class (12)	❍	❍	❍	❍	❍	❍	❍
My feelings are taken into consideration in	❍	❍	❍	❍	❍	❍	❍

this class (13)							
In this class I do not get much of a chance to show how capable I am (14)	❍	❍	❍	❍	❍	❍	❍
People in this class care about me (15)	❍	❍	❍	❍	❍	❍	❍
There are not many people in this class that I am close to (16)	❍	❍	❍	❍	❍	❍	❍
I feel like I can pretty much be myself in this class (17)	❍	❍	❍	❍	❍	❍	❍
The people in this class do not seem to like me very much (18)	❍	❍	❍	❍	❍	❍	❍

When I am in this class I do not feel very capable (19)	❍	❍	❍	❍	❍	❍	❍
There is not much opportunity for me to decide for myself how to go about my work in this class (20)	❍	❍	❍	❍	❍	❍	❍
People in this class are pretty friendly towards me (21)	❍	❍	❍	❍	❍	❍	❍

Please respond to each of the following items in terms of how much you agree or disagree with it with respect to your feelings about your classes in general.

	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
I tend to bounce back quickly after	❍	❍	❍	❍	❍

hard times in my classes (1)					
I have a hard time making it through stressful events in my classes (2)	❍	❍	❍	❍	❍
It does not take me long to recover from stressful events in my classes (3)	❍	❍	❍	❍	❍
It is hard for me to snap back when something bad happens in my classes (4)	❍	❍	❍	❍	❍
I usually come through difficult times in my classes with little trouble (5)	❍	❍	❍	❍	❍
I tend to take a	❍	❍	❍	❍	❍

long time to get over set-backs in my classes (6)					

Thank you so much for completing our survey! Our understanding of game-inspired grading systems 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 in your coursework this semester!

Fall 2016 Post-Survey

This course used a grading system where much of your grade depends on which assignments you chose to pursue. This grading system may be different than systems you have encountered in other classes. Your professor is interested in how, if at all, this grading system affected the way

you approached your work in this class. This survey builds on the questions we asked you at the start of the term, now that you have had some experience with both the grading system and with GradeCraft.

This survey should take you less than 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 will not see the results of this survey until after the semester is over, and even then only in aggregate and de-identified form. 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 they 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 a grading system like the one in this course 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.

The following questions are about the grading system in this class.

	Not at all true		Somewhat true		Very true
I had a good understanding of the grading system	❍	❍	❍	❍	❍
I liked the grading system	❍	❍	❍	❍	❍

Please list up to 4 reasons you like the grading system.

Reason 1

Reason 2

Reason 3

Reason 4

Please list up to 4 reasons you dislike the grading system.

Reason 1

Reason 2

Reason 3

Reason 4

I wish my other classes used a grading system like the one in this class.

- ❍ Not at all true
- ❍
- ❍ Somewhat true
- ❍
- ❍ Very true

I wish my other classes used GradeCraft.

- ❍ Not at all true
- ❍
- ❍ Somewhat true
- ❍
- ❍ Very true

Please use the space below to share any general comments you have about the grading system in this class.

Please use the space below to share any specific comments that you have about GradeCraft as a tool to support your work in this course

Please respond to each of the following items in terms of how true it is for you with respect to your learning in this class.

	Not at all true			Somewhat true			Very true
I felt like I had a lot of input on deciding how my school work got done in this class	❍	❍	❍	❍	❍	❍	❍
I really liked the students in this class	❍	❍	❍	❍	❍	❍	❍
I did not feel very competent when I was in this class	❍	❍	❍	❍	❍	❍	❍
People in this class told me I was good at what I did	❍	❍	❍	❍	❍	❍	❍
I felt pressured in this class	❍	❍	❍	❍	❍	❍	❍

I got along with people in this class	❍	❍	❍	❍	❍	❍	❍
I pretty much kept to myself when I was in this class	❍	❍	❍	❍	❍	❍	❍
I was free to express my ideas and opinions in this class	❍	❍	❍	❍	❍	❍	❍
I considered the people in this class to be my friends	❍	❍	❍	❍	❍	❍	❍
I have been able to learn interesting new things in this class	❍	❍	❍	❍	❍	❍	❍
When I was in	❍	❍	❍	❍	❍	❍	❍

this class, I had to do what I was told							
Most days I felt a sense of accomplishment from doing work for this class	❍	❍	❍	❍	❍	❍	❍
My feelings were taken into consideration in this class	❍	❍	❍	❍	❍	❍	❍
In this class I did not get much of a chance to show how capable I am	❍	❍	❍	❍	❍	❍	❍
People in this class cared about me	❍	❍	❍	❍	❍	❍	❍

There were not many people in this class that I was close to	❍	❍	❍	❍	❍	❍	❍
I felt like I could pretty much be myself in this class	❍	❍	❍	❍	❍	❍	❍
The people in this class did not seem to like me very much	❍	❍	❍	❍	❍	❍	❍
When I was in this class I did not feel very capable	❍	❍	❍	❍	❍	❍	❍
There was not much opportunity for me to decide for myself how to go about my	❍	❍	❍	❍	❍	❍	❍

work in this class People in this class were pretty friendly towards me	❍	❍	❍	❍	❍	❍	❍

Please respond to each of the following items in terms of how much you agree or disagree with it with respect to your feelings about your classes in general.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I tend to bounce back quickly after hard times in my classes	❍	❍	❍	❍	❍
I have a hard time making it through stressful events in my classes	❍	❍	❍	❍	❍
It does not take me long to recover from stressful events in my classes	❍	❍	❍	❍	❍
It is hard for me to snap	❍	❍	❍	❍	❍

back when something bad happens in my classes					
I usually come through difficult times in my classes with little trouble	❍	❍	❍	❍	❍
I tend to take a long time to get over set-backs in my classes	❍	❍	❍	❍	❍

To what extent do the following behaviors, thoughts, and feelings describe you in this class?

	Not at all characteristic of me	Not really characteristic of me	Moderately characteristic of me	Characteristic of me	Very characteristic of me
Made sure to study on a regular basis	❍	❍	❍	❍	❍
Put forth effort	❍	❍	❍	❍	❍
Did all the homework problems	❍	❍	❍	❍	❍
Stayed up on the readings	❍	❍	❍	❍	❍
Looked over class notes between classes to make sure I understood the material	❍	❍	❍	❍	❍
Was organized	❍	❍	❍	❍	❍
Took good	❍	❍	❍	❍	❍

notes					
Listened carefully in class	❍	❍	❍	❍	❍
Came to all class sessions	❍	❍	❍	❍	❍
Found ways to make the course material relevant to my life	❍	❍	❍	❍	❍
Applied course material to my life	❍	❍	❍	❍	❍
Found ways to make the course interesting to me	❍	❍	❍	❍	❍
Thought	❍	❍	❍	❍	❍

about the course between class meetings					
Really desired to learn the material	❍	❍	❍	❍	❍
Raised my hand in class	❍	❍	❍	❍	❍
Asked questions when I didn't understand the material	❍	❍	❍	❍	❍
Had fun in class	❍	❍	❍	❍	❍
Participated actively in small-group discussions	❍	❍	❍	❍	❍
Went to the	❍	❍	❍	❍	❍

professor's office hours to review assignments or tests or to ask questions					
Helped fellow students	❍	❍	❍	❍	❍
Got a good grade	❍	❍	❍	❍	❍
Did well on tests	❍	❍	❍	❍	❍
Was confident that I could learn and do well in class	❍	❍	❍	❍	❍

Please respond to each of the following items in terms of how much you agree or disagree with it with respect to your learning in this class.

	Strongly disagree	Disagree more than I agree	Agree more than I disagree	Strongly agree
There was a strong feeling of friendship in this class	❍	❍	❍	❍
I felt at ease in this class	❍	❍	❍	❍
Being in this class felt like belonging to a large family	❍	❍	❍	❍
I got the feeling that we formed a large team in this class	❍	❍	❍	❍
I will remember my classmates from this class affectionately in the future	❍	❍	❍	❍

Thank you so much for completing our survey! Our understanding of game-inspired grading systems 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: Student Personas

Persona 1

# of Students	45
Assignment Type Pattern	Essays, Questions, Wikipedia, Data Analysis
Lecture Pattern	Missed 1-3 lectures in the latter half
Discussion Pattern	Perfect attendance
Reading Quiz Pattern	Skipped 1-2 in the second half
End-of-Semester Project Pattern	No pattern
Did they revise?	Yes
If so, what?	One of the essays
How did their revision improve?	800 originally, 1,800 on revision
Final Grade	A
Final Score	50,000
Major during course	Undeclared
Major next fall	50% chance declared, slight trend towards STEM
Average Concurrent GPA	3.7
Class Year	Freshman
Weekly Assignment Count	8 – above average
Did they submit any assignment more than a week early?	69% - above average
Did they submit any assignment late?	6.6% - slightly below average
More than a week late?	4.4% - average
Semester Credit Load	16 – one credit higher than average
Did they fail any weekly assignments?	29% - slightly below average

Persona 2

# of Students	23
Assignment Type Pattern	Essays, Questioning, Data Analysis
Lecture Pattern	Missed 1-3 lectures in the latter half
Discussion Pattern	Missed a handful of discussion sections in the latter half of the semester
Reading Quiz Pattern	Perfect completion
End-of-Semester Project Pattern	More likely to do group work, likely to only make it through the proposal
Did they revise?	Yes
If so, what?	Week 2 Essay
How did they improve?	1,000 points originally, 1,800 on revision
Final Grade	A
Final Score	49,000
Major during course	Undeclared
Average Concurrent GPA	3.77
Class Year	Freshman
Weekly Assignment Count	6 – below average
Did they submit any assignment more than a week early?	45% - average
Did they submit any assignment late?	4.5% - below average
More than a week late?	4.5% - average
Semester Credit Load	15 - average
Did they fail any weekly assignments?	33% - average

Persona 3

# of Students	16
Assignment Type Pattern	Essays, Wikipedia, Data Analysis, Archive Visits
Lecture Pattern	Missed 1-3 lectures in the latter half
Discussion Pattern	Missed a handful of discussion sections in the latter half of the semester
Reading Quiz Pattern	Missed a handful of quizzes in the latter half of the semester
End-of-Semester Project Pattern	Only got through the proposal stage, split on group vs. individual
Did they revise?	No
If so, what?	–
How did they improve?	–
Final Grade Range	A
Final Score	49,700
Major during course	Undeclared
Average Concurrent GPA	3.71
Class Year	Freshman
Weekly Assignment Count	7 – average
Did they submit any assignment more than a week early?	38% – below average
Did they submit any assignment late?	8.8% – average
More than a week late?	0% – below average
Semester Credit Load	16 – 1 credit above average
Did they fail any weekly assignments?	25% – slightly below average

Persona 4

# of Students	16
Assignment Type Pattern	Essays, Data Analysis, Archive Visits
Lecture Pattern	Perfect attendance
Discussion Pattern	Perfect attendance
Reading Quiz Pattern	Perfect engagement
End-of-Semester Project Pattern	Just the individual proposal
Did they revise?	Yes
If so, what?	An essay assignment
How did they improve?	1,100 originally, 1,800 on revision
Final Grade Range	A
Final Score	49,400
Major during course	Undeclared
Average Concurrent GPA	3.62
Class Year	Freshman
Weekly Assignment Count	6 – slightly below average
Did they submit any assignment more than a week early?	38% – below average
Did they submit any assignment late?	12.5% –above average
More than a week late?	6.25% – slightly above average
Semester Credit Load	15 – average
Did they fail any weekly assignments?	30% - slightly below average

Persona 5

# of Students	12
Assignment Type Pattern	Essays, Wikipedia, Data Analysis
Lecture Pattern	Missed 1-3 lectures in the latter half
Discussion Pattern	Missed 1-2 in the second half
Reading Quiz Pattern	No pattern
End-of-Semester Project Pattern	Split between group and individual
Did they revise?	No
If so, what?	–
How did they improve?	–
Final Grade Range	A
Final Score	50,250
Major during course	Undeclared
Average Concurrent GPA	3.68
Class Year	Freshman
Weekly Assignment Count	6 – below average
Did they submit any assignment more than a week early?	17% - below average
Did they submit any assignment late?	8.3% – average
More than a week late?	8.3% – above average
Semester Credit Load	15 – average
Did they fail any weekly assignments?	33% – average

Persona 6

# of Students	9
Assignment Type Pattern	Essays, Questioning, Data Analysis, Archive Visits
Lecture Pattern	Missed 1-3 lectures in the latter half
Discussion Pattern	Perfect attendance
Reading Quiz Pattern	Missed a substantial amount of readings
End-of-Semester Project Pattern	Just the individual proposal
Did they revise?	Yes
If so, what?	Week 5 Archives Visit
How did they improve?	1,050 originally, 1,925 on revision
Final Grade	A
Final Score	48,800
Major during course	Undeclared
Concurrent GPA	3.62
Class Year	Freshman
Weekly Assignment Count	7
Did they submit any assignment more than a week early?	67% – above average
Did they submit any assignment late?	11% - above average
More than a week late?	0% - below average
Semester Credit Load	15 – average
Did they fail any weekly assignments?	11% - below average

Persona 7

# of Students	15
Assignment Type Pattern	Essays, Wikipedia, Data Analysis, Book Quests
Lecture Pattern	Missed 1-2 in the first half and 1-2 in the latter half
Discussion Pattern	Perfect attendance
Reading Quiz Pattern	No pattern
End-of-Semester Project Pattern	Split between group and individual
Did they revise?	No
If so, what?	–
How did they improve?	–
Final Grade	A
Final Score	50,200
Major during course	Undeclared
Concurrent GPA	3.63
Class Year	Freshman
Weekly Assignment Count	6 – below average
Did they submit any assignment more than a week early?	67% – above average
Did they submit any assignment late?	13.3% – above average
More than a week late?	6.6% – below average
Semester Credit Load	16 – one credit above average
Did they fail any weekly assignments?	26% – below average

Persona 8

# of Students	15
Assignment Type Pattern	Essays, Wikipedia, Archive Visits
Lecture Pattern	Missed 1 lecture
Discussion Pattern	Perfect attendance
Reading Quiz Pattern	Missed 1 quiz in the second half
End-of-Semester Project Pattern	More likely to do the group project
Did they revise?	Yes
If so, what?	Week 2 Essay
How did they improve?	850 originally, 1,850 on revision
Final Grade	A
Average Final Score	49,000
Major during course	Undeclared
Average Concurrent GPA	3.7
Class Year	Freshmen
Weekly Assignment Count	6 – below average
Did they submit any assignment more than a week early?	40% – below average
Did they submit any assignment late?	6.7% – below average
More than a week late?	6.7% – above average
Semester Credit Load	16 – 1 credit above average
Did they fail any weekly assignments?	44% – above average

Persona 9

# of Students	9
Assignment Type Pattern	Essays, Questioning, Wikipedia, Data Analysis, Archive Visits
Lecture Pattern	Missed 1 lecture
Discussion Pattern	Missed 1-2 at the very end
Reading Quiz Pattern	Missed 1 in the latter half
End-of-Semester Project Pattern	Completed just the individual proposal
Did they revise?	No
If so, what?	–
How did they improve?	–
Final Grade Range	A
Average Final Score	49,000
Major during course	Undeclared
Average Concurrent GPA	3.66
Class Year	Freshmen
Weekly Assignment Count	6 – below average
Did they submit any assignment more than a week early?	33% – below average
Did they submit any assignment late?	22% – above average
More than a week late?	11% – above average
Semester Credit Load	15 – average
Did they fail any weekly assignments?	43% - above average