6-2-2022

Gamified Coding Platforms and Student Motivation: An Investigation into Motivation and Academic Performance in Computer Programming Students

David C. Freer
Florida International University, dfree001@fiu.edu

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

GAMIFIED CODING PLATFORMS AND STUDENT MOTIVATION:

AN INVESTIGATION INTO MOTIVATION AND ACADEMIC PERFORMANCE IN COMPUTER PROGRAMMING STUDENTS

A dissertation submitted in partial fulfillment of

the requirements for the degree of

DOCTOR OF BUSINESS ADMINISTRATION

by

David Freer

2022

To: Interim Dean William Hardin
College of Business

This dissertation, written by David C Freer, and entitled Gamified Coding Platforms and Student Motivation: An Investigation into Motivation and Academic Performance in Computer Programming Students, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Mido Chang

Mark Thibodeau

Frederick Perry

Manjul Gupta, Major Professor

Date of Defense: June 2, 2022

The dissertation of David C. Freer is approved.

Interim Dean William Hardin
College of Business

Andrés G. Gil
Vice President for Research and Economic Development
and Dean of the University Graduate School

Florida International University, 2022

DEDICATION

I dedicate this dissertation to my parents, Roberta Read and Richard Freer who generously helped support me in this endeavor. Additionally, my wife and children were excellent partners as I worked nights and weekends in this program.

ACKNOWLEDGMENTS

I want to thank Dr. Manjul Gupta for all his time, effort, and guidance. In addition, I would like to thank Dr. George Marakas for his leadership and guidance throughout the DBA program. My classmates in my group have provided me with incredible support throughout the journey.

I would like to thank my colleagues Ralph De Arazoza, Eric Meyer, and Nannette Bibby for their assistance in discussing motivation and helping to distribute the surveys. Other colleagues were also helpful in distributing the survey.

ABSTRACT OF THE DISSERTATION

GAMIFIED CODING PLATFORMS AND STUDENT MOTIVATION:

AN INVESTIGATION INTO MOTIVATION AND ACADEMIC PERFORMANCE IN COMPUTER PROGRAMMING STUDENTS

by

David Freer

Florida International University, 2022

Miami, Florida

Professor George Marakas, Major Professor

Students taking computer programming classes face several serious challenges: learning the syntax, problem solving, and interacting with new interfaces. In order to meet these challenges, instructors have been using Gamified Coding Platforms such as Codewars.com which offer students the opportunity to gain points, see other solutions, and practice in an online environment without the need to install extra software. The study seeks to build a psychological profile of students by measuring their intrinsic motivations along with their extrinsic motivations in the computer programming classroom. The surveys used for the intrinsic and extrinsic measures are based on the self-determination theory, which is also often used in the study of gamification. Additionally, students were questioned about goal setting, their perceptions of their instructor, and demographic questions. The dependent variable in question was the level of student engagement, which was based on the National Survey of Student Engagement. The initial pilot study involved 74 participants and the main study involved 159 completed student responses. A linear regression model was completed to examine the direct effects of the predictors on the dependent variable. Two components of intrinsic motivation: perceived competence and a greater desire to experience stimulation had a positive effect on student engagement. Additionally, students who perceived a greater instructor investment in their lives had a significant effect on student engagement.

The study highlights the importance of the role of the instructor and intrinsic motivations to encourage student engagement. The insights from the study can be used to increase student engagement by encouraging instructors to show a greater interest in their students studying computer programming.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

ABBREVIATIONS AND ACRONYMS

APA – Automated Programming Assignments

EVT – Expectancy-Value Theory

IM – Intrinsic Motivation

GPA – Grade Point Average

GSFQ – Goal Setting Formative Questionnaire

MSP – Many Small Programs Approach

NSSE - National Survey of Student Engagement

OCP – Online Coding Platform

SDT – Self Determination Theory

TSS – Teacher Support Scale

1. Introduction.

Students taking computer programming classes often encounter a challenging academic mission with high levels of failure relative to other subjects. There is an immense economic motivation to improve computer programming education as the number of jobs requiring computer programming has increased significantly and will likely continue to expand. Projections show occupations requiring computer and information technology skills to grow 13 percent this decade (*Computer and Information Technology Occupations*, 2022). Additionally, the median annual wage for the industry in 2020 is over twice the median wage in the United States, providing an added incentive for those looking to join the industry. Despite the importance to industry and the economic outlook of the prospective entrants, less than half of the students intending to major in a science, technology, engineering, and mathematics (STEM) field end up graduating with their degree (Graham et al., 2013).

Students who pass their courses, graduate, and find work in software development may still struggle in their new roles (Begel & Simon, 2008). Therefore, examining new entrants' training is vital as recent graduates expect to perform well in their new employment. Many individuals are first exposed to the field during their college computer programming classes and those courses serve as the foundation for their careers. Consequently, measuring the level of student engagement during their college programming classes may be seen as a clear first step to improving their skills and meeting this challenge. Student engagement is a significant predictor of academic success which will help the graduates enter the well-paid and growing field (Trowler, 2010).

Thus, the more engaged computer programming students are in their classes, the better their chance for academic and future career success.

Computer programming instructors have tried various methods of improving student engagement and performance with varying levels of success. To better address issues within computer programming classes, such methods may be analyzed and compared. One such approach to improve student performance is the adoption of automated programming assignments (APA). In a study from 2017, higher-performing students found APAs more beneficial than lower performing students thus introducing the recognition that students will respond to different interventions based on their aptitude and interest (Pieterse & Liebenberg, 2017). Furthermore, the instructors benefit from using the automated assignments because they save a great deal of time when compared to the instructors utilizing programming assignments that require manual grading. Publicly available automated systems for aspiring and professional computer programmers such as HackerRank.com provide learners with problems and the opportunity to program solutions. These systems collectively are known as Online Coding Platforms (OCPs), and they have received a great deal of interest.

OCPs allow learners to receive instant feedback and even participate in public message boards to discuss issues they encountered with the programming problem (Zinovieva et al., 2021). Codewars.com, another popular OCP, offers the user the ability to earn points after submitting solutions. Performance is posted to public leaderboards to encourage competition (Horváth, 2018). Codewars has thousands of varying difficulty problems, from easy enough for a coding beginner (level 8) to very complex problems (level 1). Fewer than one hundred programmers have solved some level 1 problems on a site with hundreds of thousands of accounts, which clearly indicates the incredible difficulty of the problems. The recognition and adulation from other members is thought to be a driving force in solving more problems and increasing the difficulty of the problems solved. The use of public recognition, awards and points are components of gamification (Deterding et al., 2011).

The theory of motivation most often used to study gamification in computer programming is Self-Determination Theory (Buckley & Doyle, 2016; Chen & Jang, 2010). When Self-Determination Theory (SDT) is applied to educational research, it focuses primarily on intrinsic motivation and the extent to which it creates learner engagement. To better understand intrinsic motivation through the lens of SDT, several survey instruments have been created to capture information about the student's attitudes, beliefs, and drives. Especially relevant to this study, SDT has been used as a theoretical tool to examine student motivation among students in community college (Schuetz, 2008).

Related to student motivation is the concept of student goal setting and external rewards. In terms of tangible extrinsic rewards, incentives in proportion to the effort needed to complete the task are often found to generate more commitment among students (Locke et al., 1981). Also from the Locke study, it has been found that students who set reasonable and specific goals have a much better chance of staying engaged in their coursework. Thus, an instructor who promotes goal setting in a specific manner will likely be encouraging greater engagement. As some students are more likely to be motivated by external rewards because of their personal disposition, the presence of grades or other stimuli will likely serve to encourage those students (Lei, 2010). External reinforcements have been shown to increase the amount of time students devote to class activities (Evertson et al., 1981). Beyond short-term extrinsic rewards, the attraction to a higher paying job would also be considered an extrinsic incentive.

Various educational tactics used to improve motivation and engagement have been studied and reported for wider use. For instance, the uncomplicated act of an instructor merely providing a rationale for an uninteresting task can improve engagement in students and increase overall levels of learning (Jang, 2008). In terms of more technological methods, research has shown students in experimental groups using online educational simulations were found to show greater professional competencies over a control group not utilizing the e-learning strategies (Dotsenko, 2021). The aptitude and knowledge students bring to a class will impact their adoption of the various learning tools and will need to be considered by the instructors. It has been observed that students who already had a relatively high level of programming knowledge enjoyed a competitive online programming environment over the students who did not have the programming knowledge (Fischer et al., 2020). Thus, the student's comfort level with computer programming plays an important role in their usage of the tool. As this research clearly shows, instructor explanations and the choices in educational platforms certainly matter; the right programming e-learning environment has been shown to have a large influence on the learning and problem solving processes in a class (Horváth, 2018; Law et al., 2010).

In order to predict success in computer programming classes, an informative study was completed which examined twelve different factors including student attribution for success/failure, math skills, previous programming experience, among others (Wilson & Shrock, 2001). The most significant influence on programming success was found to be the course's comfort level. Comfort in the study referred to the perceived difficulty of assignments, perceived understanding of concepts, and the ability to ask questions of the instructors and other classmates. The math background of the student was the second most significant predictor after the comfort in the class. While students entering a computer programming class will not have much time to make up deficiencies in their math background before the start of class, there is the opportunity to improve their comfort in the class through some of the techniques mentioned.

The research at hand sets out to establish a more complete psychological profile of a college computer programming student in 2022 along with their usage of an online coding platform, by first creating a new survey by combining modified existing instruments. In particular, this study seeks to answer the following research question: **What is the effect of motivation, instructor support, and the use of a gamified coding platform on student engagement in a college programming class?**

Answering this question allows us to identify a framework that will help identify variables relevant to student engagement. To develop this framework, it is necessary to survey students studying computer programming and analyze their responses.

2. Literature Review.

In order to explore the academic knowledge and theories underlying the research, the following sections will summarize relevant education research and models through the recent past. Next, there will be an examination of some recent statistics about the number of women studying computer programming currently and in the past. In order to better understand the concept of motivation and the role goal setting and instructor support provides, the history and relevant studies of the field will be considered. Following this will be an in-depth look into ways of measuring student engagement, including a look at the history and composition of the National Survey of Student Engagement. Outside of student engagement, a history of the tools used by computer programming instructors will help to understand the features and intentions behind modern systems including Codewars. Lastly, an examination of the principles underlying gamification and its usage within computer programming classrooms will conclude the literature review.

2.1 Educational Models

There is considerable educational research showing the type of instruction and classroom design plays a large role in student engagement and academic proficiency. For instance, a well-cited research article from nearly four decades ago demonstrates that a student receiving one-to-one tutoring will master the material at a much higher rate than students receiving group instruction (BLOOM, 1984). With the knowledge that one-to-one tutors would be prohibitively expensive on a large scale, there has been a determined effort to develop computerized systems to replicate the one-to-one experience. Research has shown intelligent tutoring systems have been found to approximate the effectiveness of human tutoring (VanLEHN, 2011). Outside of class sizes and tutoring systems, several other educational approaches have been attempted.

Another such attempt to boost academic success is to give students more agency in the class to increase their level of commitment to the course. Transferring some of the choices from the instructor to the student is known as self-directed learning (Knowles, 1975). By encouraging students to take the initiative in selecting problems and finding resources, students will be necessarily more active in the learning process. With the instructor as a guide rather than a sage, the student will be required to synthesize information and even find their own resources. The Staged Self-Directed Learning Model describes the stages students develop. However, when instructor personalities and student personalities clash about their roles within this learning model, there may be a disparity which can hinder the students' development (Grow, 1991).

In short, this self-directed view of education promotes the idea that instructors should act as facilitators in the class; if the personalities of the student and instructor are in harmony that will result in improved outcomes. Peer evaluation and relations among classmates often takes on greater importance when instructors occupy less of the attention in the classroom. Research has demonstrated the positive role peer assessments can play in computer science education (Machanick, 2007). Computer programming and computer science classes involve much more than merely cognitive skills directly related to field; peer evaluation will also help to develop written skills which will likely help the student in their career. Peer evaluation may help a student feel more connected with a community of learners as they have more interactions. Developing a feeling of kinship among learners will play a central role to the psychological theories used in this research.

Although there has been abundant research into what makes a classroom effective, the research has obviously not resolved the reality that many students attempting to take introductory computer programming are unsuccessful in their endeavor. Failure rates in introductory computer programming classes are quite high and have been for decades (Medeiros et al., 2019). Although failure rates in introductory programming classes dropped from 33% in 2007 to 28% in 2017, the rate is still much higher than other fields. Despite the poor success rate, the failure rate in computer programming is lower than College Algebra (Bennedsen & Caspersen, 2019).

2.2 Representation of Women Learning Computer Programming

Students tend to find computer programming to be a challenging subject, as evidenced by the statistics presented earlier. However, not all groups are equally represented in the field. Men and women and different ethnicities and races do not major in computer science or take computer programming classes at the same rates. For instance, women have been underrepresented in computer programming classes; despite earning nearly half of the undergraduate degrees in biology, chemistry, and mathematics, women are less than 20% of computer science students (Cheryan et al., 2017). There have been many theories to account for this discrepancy starting with the “innate” differences between men and women promoted by Lawrence Summers in 2005. Summers suggested that women and men had “fundamental gender differences in ability” (Thébaud & Charles, 2018). Others point out that the differences between men and women and can be attributed to the “distinctively masculine cultural beliefs, norms, and practices that pervade STEM educational and work environments (Cheryan et al., 2017).” Investigating the role, if any, gender plays in student engagement during a computer programming class has great relevance to society as representation in the field has taken on great importance.

2.3 Theories of Motivation

Because programming involves a great deal of practice, students need sufficient motivation to stay focused as they learn a challenging subject (Law et al., 2010). Motivation is not a capricious concept; studies have shown achievement motivation is stable across a semester (Coughlan-Mainard, 2002). To explain student motivation, a rather challenging concept to elucidate, there are several psychological theories. While Self-Determination Theory (SDT) will form much of the theoretical grounding for the study, it will be informative to compare differing theories to better understand the concept of human motivation.

To begin, Abraham Maslow described in 1943 there are a hierarchy of needs, from physiological requirements to self-actualization, each of which must be fulfilled for an individual to be sufficiently motivated to complete a task (Gawel, 1996). To take an extreme example, an individual who is starving will have no interest in reviewing computer programming problems on an online system. After physiological needs are met, safety is the next concern. A sense of belonging or love is next, which will be relevant to Self-Determination Theory. Next, we find the individual must fulfill their need for esteem, or the respect of others. Lastly, the individual can proceed to experience self-actualization and the full fulfillment of their potential.

The expectancy theory of motivation focuses on the belief that increased effort will result in improved results which hold some importance to the individual (Vroom, 1964). Expectancy Theory, or EVT, has been the basis for an instrument to measure the likelihood of a student persisting in an engineering degree program (Q. Li et al., 2008). To sum up the equation created by the expectancy-value theory, motivation is based on the function of the anticipation of success and the apparent value of the activity (Cook & Artino Jr, 2016). Both SDT and EVT theories place the intrinsic value and its relationship to the individual as central to motivating behavior.

Related to expectancy theory is the educational endeavor to instill a growth mindset within students. At the heart of the growth mindset is the belief that intelligence is not a fixed quantity; by working hard and exerting effort, students will be able to improve their performance in academic endeavors (Dweck, 2006). Dweck's research has been utilized within both gamification and learning goals as it promoted a "mastery-oriented response to failure regardless of perceived ability (Elliott & Dweck, 1988)." The growth-mindset has been thoroughly embraced by Khan Academy, one of the most popular online learning platforms. In fact, Sal Khan, the founder of Khan Academy, has said he will never tell his son that he is smart because he believes it will reduce his likelihood of working hard at solving problems.[1]

Another theory of motivation proposed by Albert Bandura places individual evaluations of self-efficacy as the process behind specific, motivated behaviors; "those who are plagued by self-doubts are erratic in their analytic thinking (Bandura, 1989)."

[1] https://www.khanacademy.org/college-careers-more/talks-and-interviews/talks-and-interviews-unit/conversations-with-sal/a/the-learning-myth-why-ill-never-tell-my-son-hes-smart

This psychological framework differs from Self-Determination Theory in the approach to motivation as a concept. Social-cognitive theory, as this motivational theory is known, "emphasizes self-efficacy as the primary driver of motivated action (Cook & Artino Jr, 2016)." Self-efficacy is task specific; one may show greater self-efficacy concerning a specific project (Sweet et al., 2012).

Self-Determination Theory (SDT), which incorporates a number of concepts from the preceding motivational theories, explains that the intrinsic, or internally driven, motivation to complete tasks is made up most broadly of autonomy, competence, and relatedness (Deci & Ryan, 1990). When competence, autonomy, or relatedness are lacking, enthusiasm suffers. Research from students at a junior college three decades ago who reported being more intrinsically motivated at the start of the school year were more likely to persist in the course (R. J. Vallerand & Bissonnette, 1992).

Students with higher overall intrinsic motivation have been shown to perform better in computer programming and those students have been found to use better self-regulated learning strategies (Bergin et al., 2005). Higher levels of extrinsic motivation, however, did not show such a clear connection with better learning strategies or performance. Therefore, it can be assumed that an instructor who can find a way to make programming more interesting may improve their students' intrinsic motivation and performance.

Autonomy is the belief that individuals have control over their actions, and they are not being controlled by outside forces. Feelings of autonomy can be heightened when one's behaviors are compatible with their innermost feelings for the subject (Ryan &

Deci, 2017). Within autonomous motivation, SDT further classifies three orientations: autonomy orientation, controlled orientation, and impersonal orientation. Those with autonomy orientations tend to take initiative and responsibility (Deci et al., 2005). Those who score high on the controlled orientation scale respond most to deadlines and external pressure. Lastly, the impersonal orientation refers to individuals who do not believe they have any control over outcomes (E. L. Deci et al., 2005).

While autonomy involves charting one's own course, competence refers to humanity's need for "effectance and mastery (Ryan & Deci, 2017)." Tasks which are too difficult or easy to complete will not activate feelings of competence (Deci, 1971). When questions are not tied to the preceding lessons or there is too much ambiguity in possible answers, perceived competence diminishes causing one's intrinsic motivation to suffer. In short, an individual experiences feelings of competence when performing well at an activity. Competence, or self-concept, is the most widely studied component of SDT (Moore et al., 2020).

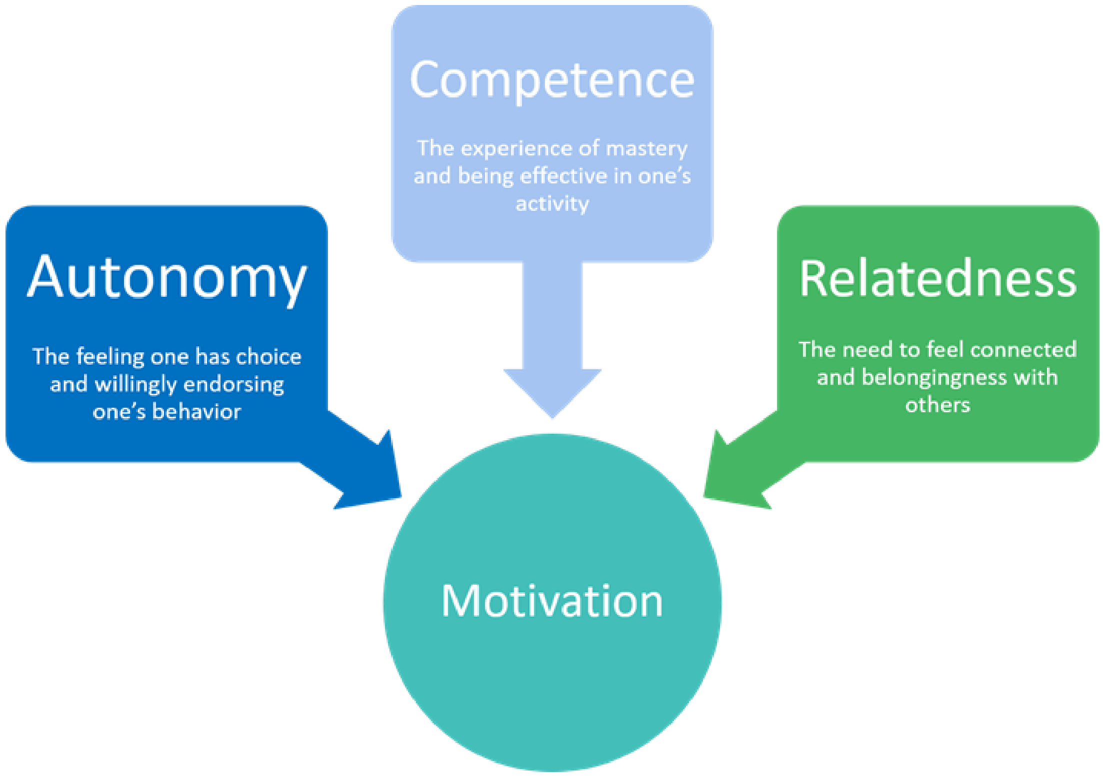


Figure 1 Self-Determination Theory.2

Social connections are the third tenant of SDT; within the theory such ties are known as relatedness. In an educational context, when individuals can form social connections with each other and their instructor, they will experience a richer educational environment to explore and grow. Reflecting on our development as humans, as infants grow they necessarily need a relationship with their caregivers because without one they would be helpless to the elements. In this sense, SDT is based on biological and social realities of the human experience.

By creating the educational environment most conducive to enhancing intrinsic motivation, educators can enhance student retention and learning. One such enhancement has been a shift towards student-centered instructional methods (Hsu & Malkin, 2011).

[2] https://www.urmc.rochester.edu/community-health/patient-care/self-determination-theory.aspx

Such a change has the possibility of increasing student feelings of autonomy within the classroom. Intrinsic motivation, according to SDT, is our natural prerogative as curious beings and students deserve to be paired with a course of study that works with their innermost feelings. When educators stifle and isolate students, motivation suffers. Thus, intrinsic motivation is determined relative to situational factors:

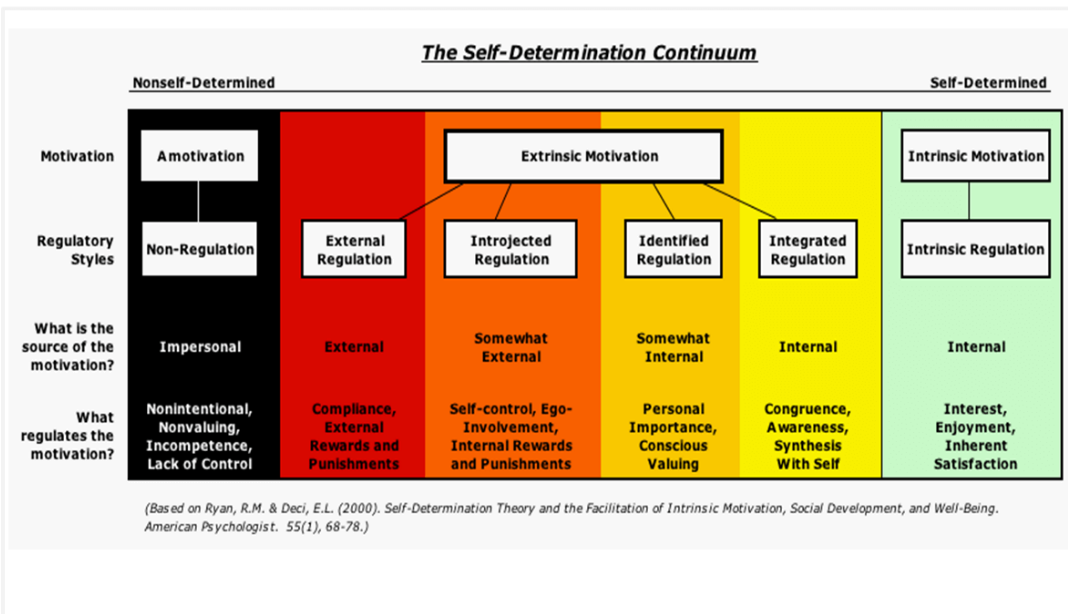
> Yet, despite the fact that humans are liberally endowed with intrinsic motivational tendencies, the evidence is now clear that the maintenance and enhancement of this inherent propensity requires supportive conditions, as it can be fairly readily disrupted by various nonsupportive conditions (Ryan & Deci, 2000).

Outside of Self-Determination Theory, goal setting has been the focus of considerable educational research. Organizational research has also involved studying goal setting, which can originally be traced to the father of the field, Fred Taylor (Locke et al., 1981). Recently goal setting has been largely divided into two components; mastery goals focus on individual competence and performance goals focus on beating others (Senko et al., 2011). In order to quantify the process of setting different types of goals, the Goal Setting Formative Questionnaire has been designed and used in a number of educational settings (Gaumer et al., 2018).

The qualities an instructor brings to a class plays a pivotal role in students' engagement. Instructor support has been shown to improve student engagement in research with undergraduate students (Rodriguez-Keyes et al., 2013). An instrument to quantify teacher support has been designed and validated. The Teacher Academic Support Scale measures a student's perceived support from teachers (Teacher Academic

Support Scale, 2020). There have been many substantial positive associations between faculty behaviors and student measures of engagement (Umbach & Wawrzynski, 2005).

As intrinsic motivation focuses on the internal drives to complete an activity, extrinsic motivation refers to the external “carrots and sticks” that drive individuals to either carry out a behavior or avoid it. The Academic Motivation Scale, developed thirty years ago, includes seven constructs of intrinsic motivation: to know, toward accomplishment, to experience stimulation as well as components of extrinsic motivation- identified, introjected, external regulation. Amotivation is the absence of motivation (R. Vallerand et al., 1992).



[3]

Figure 2 Extrinsic motivation continuum.

[3] https://positivepsychology.com/self-determination-theory/

External regulation, a subset of extrinsic motivation, refers to a focus completely on the punishments or rewards associated with the activity. Introjection, the second form of motivation within the extrinsic motivation construct, involves guilt and shame taking on a larger role in the decision to participate with the activity. Integration follows, which is when an individual completely agrees with an activity including the goals and methods (Ryan & Connell, 1989). While rewards and punishments can be powerful incentives, the issue is with the maintenance and transfer of the motivation when the rewards and punishments stop (Ryan & Deci, 2000). According to this line of reasoning, students merely learning programming to satisfy their parents or instructors are less likely to keep up their skills as they progress through their courses and careers. Furthermore, we know instructor support can move individuals towards integration. In an educational setting, allowing students greater power to initiate activities and ownership of process provide opportunities for students to internalize the activity, despite the initial motivation being an external reward.

2.4 Student Engagement

There are four perspectives to understanding engagement: behavioral, psychological, socio-cultural, and holistic (Kahu, 2013). The behavioral perspective, which includes the National Survey of Student Engagement (NSSE) focuses primarily on effective teaching practices. The psychological perspective explains engagement as principally an inner process using intellect and affect. Socio-cultural descriptions of engagement incorporate societal and cultural factors. Lastly, the holistic viewpoint attempts to weave the previous three perspectives into a coherent whole.

The NSSE was introduced in 2000 and has been used nationwide since its introduction (Kuh, 2001b). The engagement construct, or meta-construct as some argue, is broadly defined as the necessary effort from the participants to meet the academic challenge. Engagement has been described by the scope of a student's "active and productive involvement in a learning activity (Reeve et al., 2020)." About five million students have finished the NSSE since it was introduced which indicates its widespread acceptance by academia. The NSSE asks several questions about time spent and the perceived challenge of different challenges throughout college.

The NSSE's responses are broadly across the following categories: participation in educationally purposeful activities, institutional requirements and the challenging nature of coursework, perceptions of the college environment, estimates of educational and personal growth, and demographic information (*NSSE*, 2021). For example, questions within "Questions Learning with Peers/ Collaborative Learning" include how many times students chose to work with their classmates on projects or exams during the semester.

When measuring student engagement, rather than relying on student observation or secondary data from course management systems, self-reported data can be trusted for educational research (Gonyea, 2005). Self-reported data for student engagement has been used to examine the impact of learning communities on growth and development (Rocconi, 2011). The NSSE itself relies on self-reported data about student engagement and challenges during a class or multiple classes and does not require cross-referencing actual student data about grades or attendance.

The NSSE is divided into four broad constructs: Academic Challenge, Learning with Peers, Experiences with Faculty, and Campus Environment. Academic Challenge refers to scholarly and imaginative work undertaken during their classes. Questions relating to the academic challenge will incorporate many levels of understanding on Bloom’s taxonomy including complex reasoning. Learning with Peers involves working with groups to complete an activity. Questions related to diversity are also included within the Learning with Peers theme. Experiences with Faculty, as a theme, involves the quantity and quality of student-faculty interactions as well as the effectiveness of the teaching practices in class. The Campus Environment is the last theme within the NSSE and focuses on the quality of interactions at the institution. Additionally, the NSSE measures the support that the student feels at the institution within the Campus Environment.

The qualities of student engagement have been investigated for decades, even before the NSSE. Thirty-eight years ago engagement was measured as an indicator of quantitative academic behaviors (Astin, 1984). The theory of student involvement recognizes that student time is limited and how the student directs their attention is of utmost importance. A more engaged student is one who spends more time in school versus skipping classes, reaches out to classmates and instructors versus staying silent, and one who utilizes course materials instead of disregarding them.

Engagement involves attention, cognitive effort, participation with enthusiasm, and the enjoyment of processing new information (Schuetz, 2008). SDT argues that engagement should be a common rather than extraordinary event (Ryan & Deci, 2000). Engaged students are more likely to persevere, achieve success and acquire credentials (Kuh et al., 2006). Student engagement is clearly recognized as an important component of education.

2.5 Assessing Programming Skills.

Assessing students' programming skills is necessary to help guide their progress during their class. Without practice, students would not be able to learn the material and assignments help guide the students to learn the necessary skills. Over sixty years ago, Jack Hollingsworth published "Automatic Grades for Programming Classes" which was created and used at Rensselaer Polytechnic Institute (Hollingsworth, 1960). The automated system offered a considerable time savings for the instructors as well as faster feedback for the students. Consequently, programming instructors began to use automated programming systems inside their classes. Thirty nine years later, RoboProf went live, an early online programming book with automated graded assignments (Daly, 1999). Beyond merely using command line programs with automated assessments, JEWL was designed to automate testing of Graphical User Interface (GUI) programs (English, 2004).

Automatic assessments in the programming education environment gained more and more features and began to be developed for web programming. By 2008, systems for students to submit web programming assignments that involved more than computer programming syntax. The APOGEE tool was primarily designed in an academic environment and allowed students the ability to check the configuration of their web programming projects (Fu et al., 2008). The automated assessment tool utilized during this research, Codewars, is promoted as a tool for programmers who are already able to solve the most basic scripts in an integrated development environment. Codewars was founded in 2012 by Nathan Doctor and Jake Hoffner.[4] Codewars incorporates several attributes to improve user motivation; such attributes are known as gamification.

2.6 Gamification.

Gamified coding platforms have been found to be beneficial for student achievement (Landers, 2014). *Gamified* comes from the term gamification which involves the use of scoring, challenges, levels, and public achievements to encourage student participation (Deterding et al., 2011). Gamified platforms often offer the freedom to fail and the ability for users to adjust their solutions until they fully solve the problem (Dicheva et al., 2015). Gamification has become a popular research topic over the past decade as educators are looking to increase student engagement.

When gamified elements from Codecademy, another online coding platform, were introduced to a Python programming class, attendance and final grades improved (Fotaris et al., 2016). Codecademy offers instant feedback and public badges like Codewars to encourage participation. Codecademy does not allow users to create their own questions and requires a more standardized path on their website than Codewars.

---

[4] Codewars - Crunchbase Company Profile & Funding

There are many other gamified coding platforms, such as Hacker Rank, Robocode, and CodeCombat to name some other popular platforms.

Table 1 Game elements in Codewars by Self-Determination Theory.

Autonomy	Competence	Relatedness
Ability to choose the next question, profile customization, notifications	Progressively more difficult problems, points, levels, leaderboards	Messages related to problems, groups (known as clans on Codewars).

Self-Determination Theory is a commonly used framework to analyze gamification; thus one can divide up the gamified components by the corresponding construct within SDT (Aparicio et al., 2012). Codewars exhibits many aspects of a gamified platform.

Codewars has thousands of problems related to many different topics such as math, text processing, business applications and logic puzzles. Problems may often be solved with multiple programming languages. If a user chooses to view solutions without first solving the problem themselves, the user loses the possibility of acquiring those points. After viewing the solutions, it may be evident there are multiple approaches, with each offering a unique perspective on problem solving. The public environment of the site affords participants an opportunity to learn from each other and to realize that their solutions are appreciated by other users.

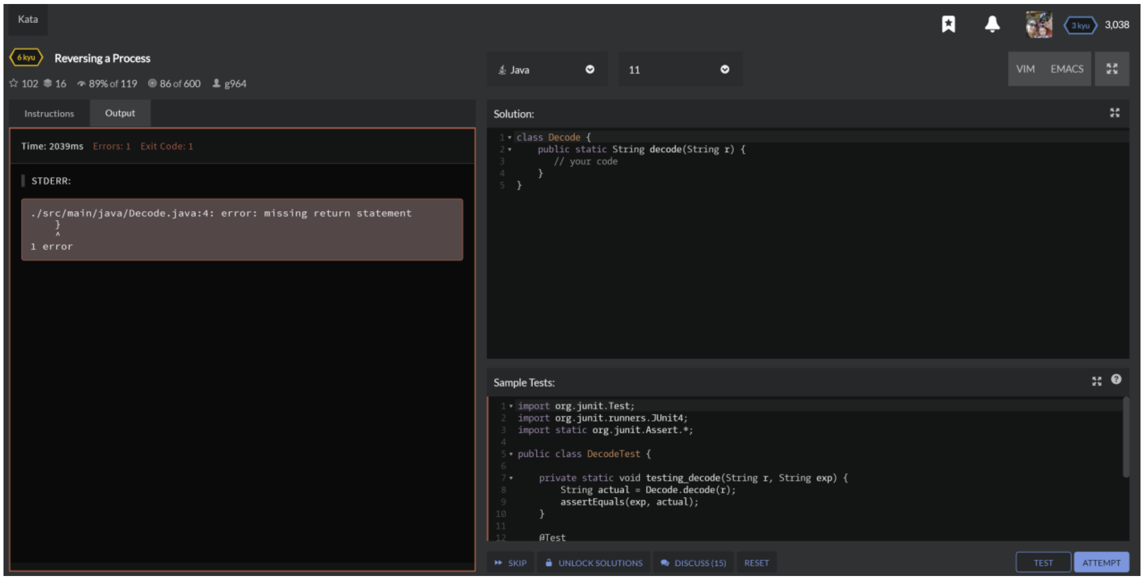


Figure 3 Codewars interface showing the output of an error, sample tests, and the user's code for the attempted solution.

After the Codewars user is satisfied with their coding solution, Codewars applies two levels of tests. The first tests, known as sample tests, are completely visible to the user. Once the sample tests are solved, the hidden tests may be applied. The second level of tests are often so numerous with random values passed in that it would be nearly impossible to hard code a solution without fully understanding the problem. Points are only awarded for a Codewars solution when both levels of tests are passed.

Codewars is an example of an auto-graded many-small programs (MSP) approach. Auto-graded programs may enable more student participation because students can receive immediate feedback and complete more projects per week. Students using MSPs were found to have higher better course experiences and higher scores on final exams (Allen et al., 2018). The public nature of the solutions and the message boards on Codewars gives a collaborative feel to the site. The programming tasks on the site are project-based and many of the problem have an authentic focus on real-world problems. Because of these three attributes, Codewars, as it is designed, fits well into the *engagement theory* for technology-based teaching and learning (Kearsley & Shneiderman, 1998).

Gamification has been shown to provide students with pleasure as they experience the excitement of showing off their educational progress (Lee & Hammer, 2011). However, such results are by no means conclusive. In a longitudinal study, students in a gamified course had lower motivation, satisfaction, and inspiration than those in the non-gamified course (Hanus & Fox, 2015). The length of the entire semester was hypothesized as serving to diminish the excitement over the gamified platform. Utilizing elements of gamification in computer programming classes has been shown to increase the engagement of the class, however the conflicting research showing motivation can be reduced in the gamified course must be considered.

Outside of gamification approaches, colleges and universities have attempted to improve programming pass rates by changing the programming language used in the class. Instructors have switched from C based languages to Python due to perceived ease of use with Python. By switching from C++ to Python and moving towards online problem sets versus weekly homework assignments, there was a statistically significant improvement in student performance (Norman & Adams, 2015). In this study C++, Java, and Python make up the bulk of the languages being studied in the classes. Classes are taught entirely using the specified language during the semester and instructors do not have the freedom to switch the language.

While students and instructors do not have any choice in the programming language used in the classes within this study, instructors would have the academic freedom to decide on the course tools and activities. However, any evidence that posits the language choice correlates with student engagement should be noted by college officials when deciding upon the first programming language introduced to the students.

3. Initial Research Model and Hypotheses.

3.1 Research Model

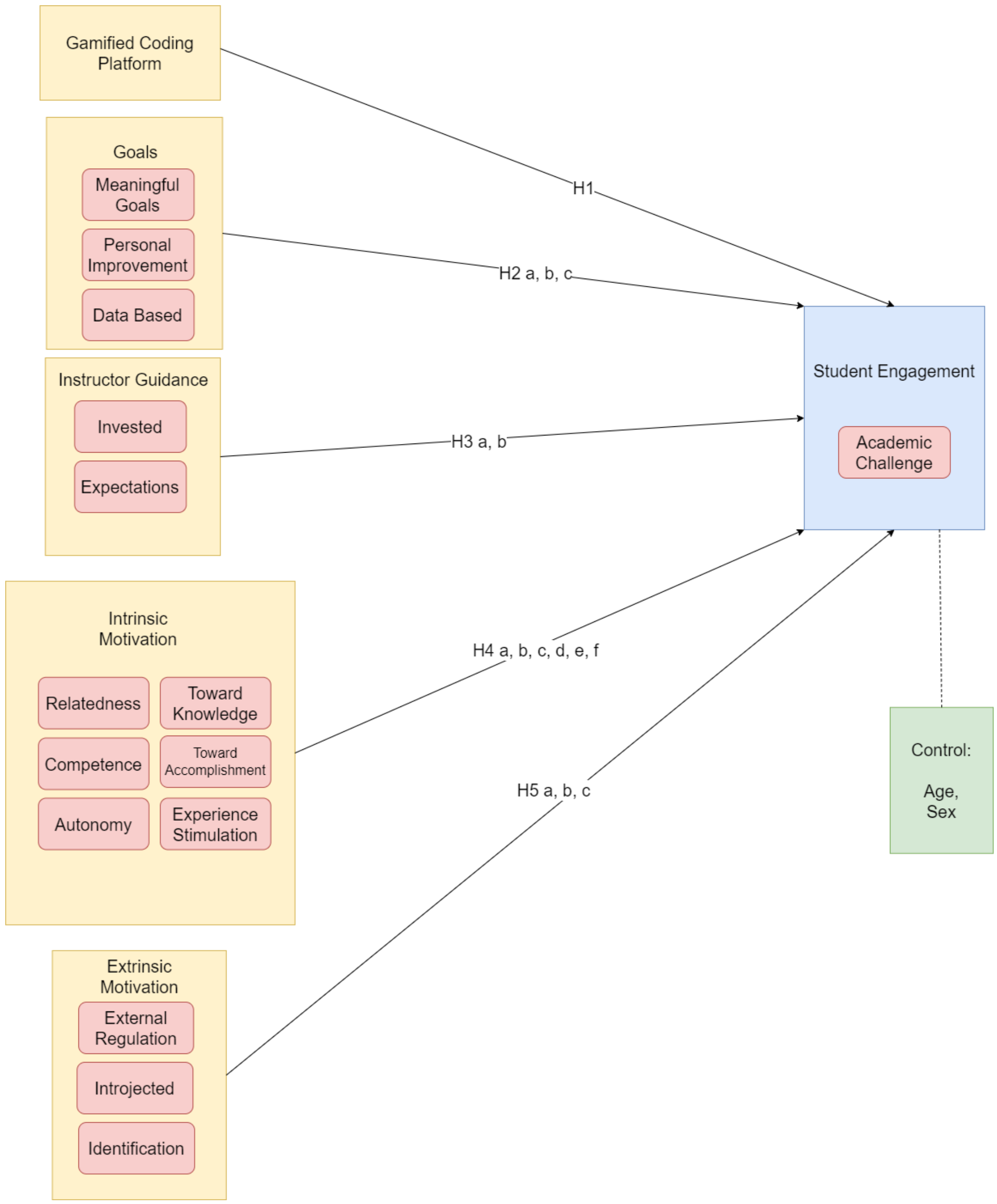


Figure 4 Proposed research model.

3.2 Hypotheses

Students assigned to the gamified coding platform, Codewars, are hypothesized to be more fully engaged during the class. Gamified systems assist users by utilizing clear goals and feedback As a many-small program approach has been shown to engage students, Codewars is likely to increase engagement (Allen et al., 2018). In a review of literature from 2014-2019, gamification used in computer programming courses had a positive impact on student engagement six times and only no impact one time (M. Venter, 2020).

One of the recent studies involved half of the students using Codecademy, that utilizes badges and points and half of the students using a non-gamified platform. Engagement was measured simply as the number of optional activities completed (Ortiz et al., 2017). Thus, it is hypothesized that students using Codewars will have increased engagement. ***H1: The gamified coding platform will positively impact student engagement.***

Goals. Goals direct attention, goals energize individuals, goals encourage planning, and goal setting is impacted by other constructs such as self-efficacy (Locke & Latham, 2002). As mentioned previously, the questions related to goals will be taken from the Goal Setting Formative Questionnaire (Gaumer et al., 2018). Indigent students in Mumbai were surveyed using the Goal Setting Formative Questionnaire along with their fear of failure in school (Dr. Vandana Jain, 2020). As students were more afraid of failure, they had lower levels of goal setting. Students with more confidence and less fear of failure will be more likely to set attainable goals.

The psychological profile of a goal-setting student would seem to be one of a more confident learner. Though the Goal Setting Formative Questionnaire (GSFQ) is not as highly cited as the other surveys used this research, it has been utilized in published educational research. Other recent studies utilizing the survey include measuring goal setting and academic procrastination (van Valderen, 2021) along with goal setting within an outcomes-based paradigm for middle school students (E. O. Simon, 2022).

Within the GSFQ there are questions relating to three types of goals: meaningful goals, personal improvement goals, and data-based goals. Students who have greater meaning associated with their short-term and long-term goals are hypothesized to impact their engagement. In consideration of this published research and the logical belief that goals can drive behavior, the following hypothesis is proposed, ***H2a: Students with higher levels of meaningful goals will exhibit higher levels of student engagement.***

Personal improvement goals are related to the ability to set small goals to guide the individual's self-development. Students in environments that promote performance goals and performance-oriented classrooms have been found to endure through difficulties and use more successful learning strategies (Maehr & Fyans, 1990). Performance goals have the ability to focus students' attention and keep them concentrating on where they wish to go within a class. As students enrolling in college classes are often immensely concerned with their growth, the possibility of personal improvement goals impacting their behavior seems likely. Within this stream of literature and line of reasoning, it is hypothesized that ***H2b: Students with higher levels of goals related to personal improvement will demonstrate higher levels of student engagement.***

Data-based questions include setting goals based on prior life experiences and focusing on the outcomes of planning the goals. Students have a greater commitment to goals when they are specific and achievable (Locke, 1996). By quantifying goals and thinking about barriers that may occur, students are more likely to regulate their behavior and increase their performance on the task. Additionally, questions from this construct include the past performance students have achieved when setting similar goals. Thus, ***H2c: Students with higher levels of data-based goal setting will demonstrate higher levels of student engagement.***

Instructor Guidance. As previously observed in academic literature, instructor and learner interaction leads to higher student engagement in school (Dixson, 2010). Students who feel more connected to their instructor's assistance and supervision will be more engaged. Some instructors are perceived by students to be more focused on their own interests while others are seen as caring more about their students.

Many students are looking for their teacher to metaphorically "hold their hand" as they are learning a challenging subject. When students are stuck on a challenging problem or concept, they are expecting a sympathetic ear who can listen and offer advice. While some instructors will prioritize their own research and grant-writing, others may be more responsive to student concerns. ***H3a: Higher perceived instructor guidance will be associated with higher student engagement.***

High expectations from the instructors are one of the constructs surveyed in the Teacher Support Scale. Students who have instructors who are perceived as having high expectations for their students is most strongly associated with outcome expectations (Metheny et al., 2008). As students look to their instructors to set the standards for the class, those instructors are perceived as demanding higher educational standards may influence the depth of engagement students undertake. Thus, the following hypothesis is proposed, ***H3b: Higher instructor expectations will be associated with higher student engagement.***

Intrinsic Motivation. Students who are more intrinsically motivated to study computer programming will exhibit increased engagement. Elementary school students have been shown that relatedness predicts engagement (Furrer & Skinner, 2003). Research among college students has also shown the importance of a sense of belonging and positive academic results (Freeman et al., 2007).

While some students will be entering classrooms with no avenues for connecting with their classmates others will be entering a space filled with the opportunity to create meaningful connections. Different tools used in course management systems have the opportunity to improve relatedness outside of a physical classroom. During class, students who have the opportunity to offer follow-ups to previous student comments are more likely increase feelings of relatedness with each other, versus quietly watching an instructor solve a problem with no feedback from students.

Students enter these different class environments with their own level of comfort when it comes time to speak out and make connections. Some students are consumed by shyness and others are eagerly looking for new social opportunities. With the differences in student dispostions and classrooms in mind, the following hypothesis is proposed.

H4a: Students exhibiting higher levels of relatedness will be associated with higher student engagement.

The core of an intrinsically motivated student is a student who identifies themselves as proficient to meet a challenge. Two years ago, it was found that students studying statistics in college with higher perceived competence at at mathematics were associated with increased student engagement (Lavidas et al., 2020). As proficiency in mathematics has been found to have a high correlation with proficiency in computer programming courses, there is likely to be an underlying construct between the two.

Students with greater confidence in their ability to master the material in a computer programming class are more likely invest the time to actual learn the material. A student with no belief in their ability to do well in the class (whether this belief is correctly or incorrectly held), is less likely to engage with the course material. With the knowledge that perceived competence has been shown to have a positive effect on student engagement in previously published research, the following hypothesis is proposed. ***H4b: Students with higher levels of perceived competence will have higher levels of student engagement.***

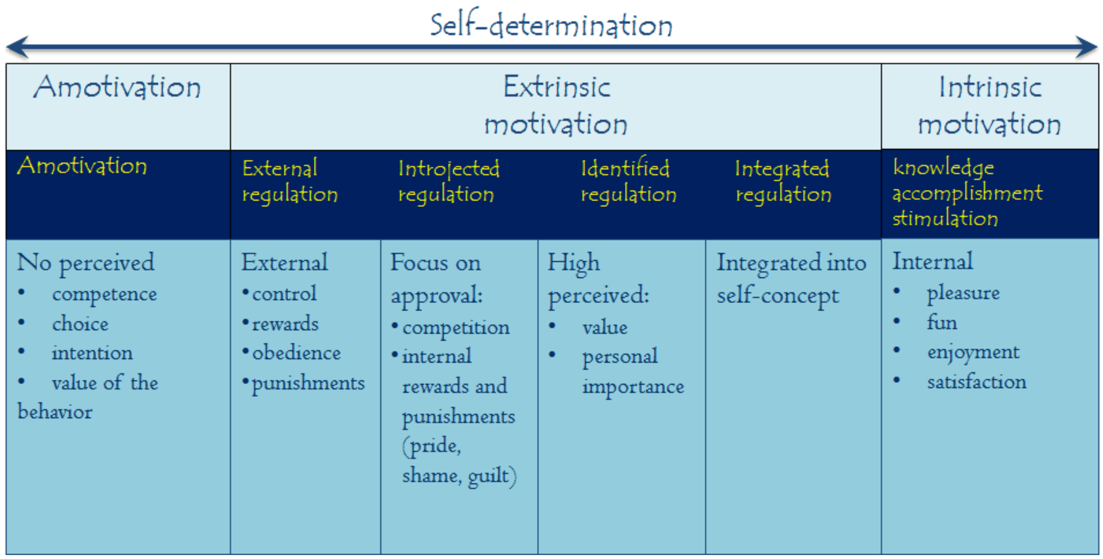
Autonomy has been shown to have a positive effect on engagement in higher education two decades ago (Fazey & Fazey, 2001). As referenced earlier in this text, *A Theory-Driven Model of Community College Student Engagement* (Schuetz, 2008) has found empirical support to show the relatedness, competence, and autonomy are all related to student engagement. In 2004, teachers who used more autonomy support during class were found to have more engaged students (Reeve et al., 2004). Across multiple published research studies, students who are given more choices, more autonomy, in their education have been found to remain more engaged as students. People prefer to have choices in their educational decisions and the freedom translates into a greater engagement with the course. ***H4c: Students with higher levels of autonomy will have higher levels of student engagement.***

Students' engagement can be distilled to motivation (Barkley & Major, 2020). Are the students indicating personality traits that they experience pleasure when they new things? Is the student curious about the world around them? Focusing on the enjoyment of learning new things as a separate factor can be traced back to research in 1985 with elementary and junior high students (Gottfried, 1985). With the idea that learning new things can be the source of pleasure, students who are rate themselves as desiring knowledge will be more eager to participate in activities and behaviors which have a greater chance of absorbing new knowledge. Thus, the following hypothesis is proposed. ***H4d: Students with higher levels of a desire toward knowledge will have higher levels of student engagement.***

Students who enjoy difficult, challenging work have been identified as having an intrinsic drive towards accomplishing something that is not comfortable. Work with elementary through middle school aged students identified this trait. This attraction some of us have towards a major challenge has been the source of research into a scale to identify surveys the trait (Harter, S, 1981). As the coursework challenges students to spend time rehearsing the material for mastery, those students with the intrinsic drive towards accomplishment are likely to engage with the material to gain that great feeling of success.

In fact, the survey measuring the Intrinsic Motivation Towards Accomplishment, that provided the questions for this study provides information about the construct. In fact, students who work hard on midterms to surpass themselves are exhibiting an Intrinsic Motivation Towards Accomplishment (R. Vallerand et al., 1992). The drive towards accomplishment can be thought of as a competitive drive a student may test their own capabilities to achieve their goals. Within the stream of research, the following hypothesis is proposed. ***H4e: Students with higher levels of a desire toward accomplishment will have higher levels of student engagement.***

Though the IM *to know*, IM *toward accomplishment*, and the IM *to experience stimulation* all contain “common roots”, they are still distinct enough to measure (Carbonneau et al., 2012). The desire to experience stimulation would be associated with the desire for feelings of sensory pleasure or the aesthetic enjoyment of an activity. Although the route many software developers take to their career is through a major known as Computer Science, there is the widespread belief that code can be an art and contain beauty. The search for beauty in the code, the aesthetic appeal of the activity seems to fit together with this drive towards stimulation. Thus, it is theorized that ***H4f: Students with higher levels of a desire to experience stimulation will have higher levels of student engagement.***



[5]

Figure 5 Self-determination

Extrinsic Motivation. Students may also be motivated by the desire for more money, parental approval, or other external sources of support. External motivation and intrinsic motivation are not necessarily at cross-purposes. As long as rewards are being offered, there is an increase in the likelihood the desired behavior will continue (Deci et al., 1999). Intrinsic and extrinsic motivations do not necessarily work at cross-purposes (Scott Rigby et al., 1992). As students are constrained by their instructors and the requirements of the class, their choices are not fully driven by intrinsic motivations. Students who are coerced into an activity and not following an intrinsic motivation, may still engage with the activity. With respect to constrained behavior "all forms of motivation (except amotivation) are expected to influence subsequent behavior (R. J. Vallerand & Bissonnette, 1992)."

---

[5] https://academy.sportlyzer.com/wiki/motivation/self-determination-theory-intrinsic-and-extrinsic-motivation/

As students with higher levels of external regulation are more focused on compliance, they are likely to be more engaged because they are motivated by external rewards. The prospect of an attractive salary and 'good life' will be associated with individuals to stay engaged in their coursework. As SDT explains, extrinsic motivation to gain rewards, such as grades, may increase the activities necessary to achieve their goals (Meyer & Gagnè, 2008). ***H5a: Higher levels of external regulation will be associated with greater student engagement.***

Introjection is when an individual internalizes the attitudes and comparisons with others. Students who wish to prove how smart they are will be more likely to stay engaged with their coursework to prove themselves. Introjection involves boosting one's ego or avoiding feelings of shame (Meyer & Gagnè, 2008). Higher levels of introjected regulation has been positively correlated with self-reports of trying hard and parents' reports of children's motivation (Ryan & Connell, 1989). As many students are trying to prove to themselves they are capable of completing a college degree, they are driven by pride. This pride will likely increase their attention on the course and the following hypothesis is proposed. ***H5b: A student with higher levels of introjection will be more likely to remain engaged in the course.***

A student who has adopted extrinsic motivations in a personal and inner belief is said to be regulating their behavior through identification (R. Vallerand et al., 1992). Students exhibiting self-determined types of extrinsic motivation such as identification were found to be positively related to behavioral perseverance (R. J. Vallerand & Bissonnette, 1992). A student who identifies personally with the decision to study in college and improve their competence to likely employers will likely spend more time engaged during class. A student driven by the belief that their class is training for the competitive job market is more likely to remain an engaged student. ***H5c: A student with higher levels of identification with goals will have higher levels of engagement.***

4. Methodology.

4.1 Construct Measures

This study builds on existing studies by combining multiple existing surveys relating to (1) intrinsic motivation, (2) extrinsic motivation, (3) goal setting, (4) instructor guidance using the Perceived Teacher Support scale. The questions from the National Survey of Student Engagement were re-worded to focus student attention on their current programming class rather than all their classes. Questions about activities not commonly assigned in computer programming classes were removed from the survey. As far as my investigation can tell, I can find no other study attempting to combine these existing surveys into a single study.

The dependent variable will be student engagement. As data about engagement has been analyzed since the first "Involvement in Learning" report in 1984, "virtually every report…emphasized to varying degrees the important link between student engagement and desired outcomes of college (Kuh, 2009)." Students, instructors, and administrators all have a responsibility to increase engagement; there are many stakeholders on the road to an engaged classroom. By examining the role those different variables play in enhancing engagement, stakeholders can better decide how to make hiring decisions or select platforms to use.

Initially, an informed pilot was conducted where I sent out copies of the survey to my colleagues at the college where I am employed. I listened to their feedback about the choice of questions and topics. Based on their feedback I adjusted the order and position of the questions. Furthermore, I interviewed former students to discuss their ideas about the Codewars platform. Their points about how confident they felt using the site and their insights into their motivations provided useful as I started this process. It is particularly noteworthy that a former student remarked that the gamified coding platform central to this study, was "overwhelming" and "too difficult." The student had never reached out to me with such feedback, it was only in a private Zoom call where enough comfort allowed for the honesty.

Aside from the qualitative feedback, the survey questions for the quantitative study were finalized. In order to establish validity for the main construct measures in the survey, a pilot study was conducted.

The questionnaire design consisted of questions about the respondents' demographic information as well as questions pertaining to psychological processes. The survey is the first item in the appendices. A five-point Likert scale measures Intrinsic Motivation: Relatedness, Autonomy, and Competence based on the Intrinsic Motivation Inventory. Questions using five-point Likert scale asks students to evaluate questions relating to their ability to set goals from the Goal Setting Formative Questionnaire. A five-point Likert scale was also used to evaluate the elements of Extrinsic Motivation and additional Intrinsic Motivations from the Academic Motivation Scale. Students self-reported their GPA and hours studied. Questions relating to student engagement used a four-point Likert scale, sometimes known as a forced Likert scale, which does not allow for a neutral position. Additional questions about the hours spent in different academic, family, and work tasks made up the questions relating to student engagement adapted from the National Survey of Student Engagement.

4.2 Pilot Study

A quantitative research methodology was adopted for the pilot study. The study was conducted using a web-based survey through the Qualtrics survey web platform and distributed via email to students studying computer programming classes in Java, C++, and Python at a Southeastern community college. 102 students started the survey with 78 completing the survey demographics information. Once the survey results were in, the data was examined for outliers and distributional assumptions.

Descriptive statistics, correlational analyses, and a principal axis factor analysis (FA) was conducted on the items pertaining to the constructs. The initial FA showed eighteen (18) factors with eigenvalues over Kaiser's criterion of 1. After removing items with significant cross-loadings, a structure which resembled the model emerged. KMO measures were used to check sampling adequacy and Cronbach's Alpha was used to measure scale reliability.

Table 2. Descriptive Statistics of Pilot Data (N=74).

Construct (Reference)	Item Code	Model Item	Mean	SD	α
Questions from the Teacher Academic Support Scale ("Teacher Academic Support Scale," 2020)	II_1	Instructor Invested	4.3378	.76350	.888
	II_2		4.4324	.72303	
	II_3		4.5676	.62111	
	II_4		4.3649	.71336	
	II_5		*N/A*	*N/A*	*N/A*

Goal Setting Formative Questionnaire (Gaumer et al., 2018)	MG_1	Meaningful Goals	4.5769	.93308	.836
	MG_2		4.6883	.78237	
	MG_3		4.6026	.93057	
	MG_4		4.7692	.64311	
	MG_5		*N/A*	*N/A*	*N/A*
	MG_6		*N/A*	*N/A*	*N/A*
	MG_7		*N/A*	*N/A*	*N/A*
Intrinsic Motivation Inventory (McAuley et al., 1989)	R_1	Relatedness	4.86	1.577	.735
	R_2		4.41	1.678	
	R_3		5.06	1.809	
	R_4		4.483	1.584	
	R_5		*N/A*	*N/A*	
	R_6		*N/A*	*N/A*	
	R_7		*N/A*	*N/A*	
	R_8		*N/A*	*N/A*	
	R_9		*N/A*	*N/A*	
Academic Motivation Scale (R. Vallerand et al., 1992)	ER_1	External Regulation	4.4462	.88443	.881
	ER_2		4.5846	.88198	
	ER_3		4.5231	.88579	
	ER_4		4.4	.99687	
National Survey of Student Engagement (Kuh, 2001b)	LE_1	Learning Engagement	4.1034	.93075	.843
	LE_2		4.3276	.80324	
	LE_3		4.0862	1.01367	
	LE_4		*N/A*	*N/A*	*N/A*
	LE_5		*N/A*	*N/A*	*N/A*

a. Note. Items italicized with N/A are subscale items that did not load well in the presence of other items in the factor analysis and are not factored in α of the scale.

Table 3 Exploratory Factor Analysis from the Pilot Questionnaire.

	Factor				
Item Code	Instructor Support	Meaningful Goals	External Regulation	Relatedness	Learning Engagement
II_1	**0.721**	0.142	0.030	0.257	0.191

II_2	**0.973**	0.032	0.039	0.143	0.066
II_3	**0.652**	0.313	0.068	0.094	0.130
II_4	**0.661**	0.203	-0.011	0.235	0.287
MG_1	0.220	**0.583**	0.038	0.244	0.276
MG_2	0.080	**0.822**	0.116	0.094	-0.019
MG_3	0.095	**0.782**	0.273	0.161	0.037
MG_4	0.238	**0.876**	0.121	-0.104	-0.008
R_1	0.205	0.031	0.102	**0.801**	0.160
R_2	0.050	0.305	0.071	**0.660**	0.035
R_3	0.145	-0.033	-0.048	**0.703**	0.318
R_4	0.333	0.049	-0.036	**0.542**	0.120
ER_1	0.192	0.188	**0.861**	-0.012	0.027
ER_2	-0.138	0.215	**0.854**	0.138	-0.039
ER_3	0.196	0.255	**0.834**	-0.089	0.061
ER_4	-0.097	-0.072	**0.682**	0.056	0.196
LE_1	0.197	0.013	0.130	0.074	**0.943**
LE_2	0.278	0.112	-0.030	0.200	**0.724**
LE_3	0.067	0.033	0.165	0.300	**0.637**

a. Note. N = 58. The extraction method was principal axis factoring with an oblique (Varimax with Kaiser Normalization) rotation. Factor loadings above .4 are in bold.

The pilot study indicated that many questions related to intrinsic motivation, specifically relatedness, and instructor guidance failed to load separately. On further reflection, it makes sense, for instance, that the relationship between an instructor and a student is subsumed under the concept of relatedness. Autonomy was unable to load clearly as a separate construct. The pilot study resulted in a Kaiser-Meyer-Olkin KMO store of .710.

After analyzing the pilot data, engagement was measured as the result of the following questions which loaded together: LE_1, LE_2, LE_3. The pilot structure indicated instructor support, meaningful goal setting, external regulation, and relatedness loaded as separate constructs. As the pilot data indicated the questions load into separate constructs, the final study was ready to be run.

5. Data Analysis and Results.

For hypothesis testing, the main study survey employed was web-based using the Qualtrics survey web platform. Different students across the same southeastern college in the United States as the pilot study were surveyed. Instructors to distribute the survey to their students and students who had enrolled in computer programming classes during the previous three semesters were emailed. 219 students began the survey with 159 completed responses. Table 4 outlines the main study sample demographics.

Table 4 Demographic information from the full study.

Baseline characteristic	n	Percentage
Race		
White	115	60.2%
Black or African American	19	9.9%
Asian	8	4.2%
Native Hawaiian or Pacific Islander	0	0.0%
Other	49	25.7%
Gender		
Male	132	79.5%
Female	34	20.5%

Table 5 Ages of participants.

Age	
Minimum Birth Year	1969
Maximum Birth Year	2004
Mean Birth Year	1997
Standard Deviation	7.08

Students ranged in age from their teens to their early fifties with the average student being in their mid-twenties (Table 5). Students were divided in the programming languages they were taking during the semester with C++ being the most common studied (Table 6). Students averaged studying eight hours of programming per week, with a sizeable range (Table 7).

Table 6 Programming language currently studying.

Programming Language Currently Studying		
C++	73	44.5%
Java	61	37.2%
Python	28	17.1%
Other	2	1.2%

Table 7 Hours of Studying Programming Per Week.

Hours Per Week Studying Programming Overall	
Mean	8.03
Std. Deviation	9.66

Interestingly, forty-two students have previously studied a programming language other than Java, C++, JavaScript or C# (Table 8). Sixty-two percent of students taking the survey, have studied computer programming before (Table 9). All 37% of the students enrolled in Java had studied computer programming before because C++ is a requirement for entry into the Java class at this institution.

Table 8 Programming Languages Studied Before.

Programming Languages Studied Before	n
Java	47
C++	86
JavaScript	14
C#	14
Other languages	42

Table 9 Studied Programming Before.

Studied Programming Before		
	N	*%*
Yes	103	62.0%
No	63	38.0%

The students were evenly divided between using the gamified coding platform, Codewars, and those who did not use the platform (Table 9). Students enrolled in computer programming have an average GPA of B+ (Table 10).

Table 10 Codewars usage.

Used Codewars during class?	n	Percentage
Yes	77	49.7%
No	78	50.3%

Table 11 Student GPA.

Student GPA	
Mean	3.319
Std. Deviation	.553

Table 12 GPA, Codewars and Programming

		N	Mean	Std. Deviation	Std. Error Mean
GPA	Males	131	3.26	0.59	0.05
	Females	34	3.51	0.43	0.07
Enjoyed Codewars	Males	65	3.57	1.22	0.15
	Females	14	3.43	1.22	0.33
Studied programming	Males	130	1.33	0.47	0.04
	Females	34	1.56	0.50	0.09

Women reported a higher GPA than men. Contrary to much of the established literature, more women have tried programming before the class started. The enjoyment of Codewars was nearly identical between men and women (Table 12). As students moved along the progression from the Introductory C++ class to their Java class, the average GPA went up considerably. Stronger academic students were able to continue with their studies with many students unable to meet the challenges of the introductory course.

Table 13 Student GPA by programming language course currently taken.

Language	N	GPA Mean	Std. Deviation	Std. Error Mean
C++	73	3.19	0.67	0.08
Java	60	3.41	0.48	0.06
Python	28	3.38	0.39	0.07
VB.NET	2	3.75	0.35	0.25

Next, the descriptive statistics of the items remaining in the study can be examined individually and by construct.

Table 14 Descriptive Statistics of Main Study Data (N=152)

Construct / α	**Item Code**	**Item**	**Mean**	**SD**
Instructor Invested	II_1	My instructor is interested in my future	4.03	1.03
α = 0.88	II_2	My instructor takes the time to help me get better grades	4.15	1.05
	II_3	My instructor is helpful when I have questions about the course	4.43	0.92
	II_4	My instructor pushes me to succeed	4.09	1.04
		Why do you go to college?		
External Regulation α = 0.75	ER_1	Because with only a high-school degree I would not find a high-paying job later on.	4.06	1.21
	ER_2	In order to obtain a more prestigious job later on.	4.44	0.90
	ER_3	Because I want to have the 'good life' later on.	4.40	0.89
Meaningful Goals	MG_4	My goals are meaningful to me.	4.60	0.72
α = 0.78	MG_5	My goals are based on my own interests and plans for the future.	4.66	0.63
	MG_6	I set goals to achieve what I think is important.	4.63	0.63
Relatedness α = 0.78	IM_R_1	At school, I feel part of a group.	3.49	1.27
	IM_R_2	At school, people involve me in social activities.	3.14	1.35
	IM_R_2_3	I often meet classmates I can communicate with during a class.	3.40	1.32

Student Engagement from NSSE α = 0.81	SE_7	During the current class, how often have you analyzed an idea or line of reasoning in depth by examining its parts?	2.75	0.90
	SE_8	During the current class have you formed a new idea or understanding from various pieces of information?	2.82	0.91
	SE_9	During the current class, about how often have you evaluated what others have concluded from numerical information?	2.54	1.02
		How much has your experience in this class contributed to your knowledge, skills, and personal development in the following areas?		
Student Engagement II from NSSE α = 0.86	SE_2_1	Thinking critically and analytically	3.22	0.84
	SE_2_2	Analyzing numerical and statistical information	3.01	0.92
	SE_2_3	Solving complex real-world problems	2.91	0.97
Personal Improvement α = 0.80	Goals_PI_2	I set goals to help me be more successful in school.	4.38	0.93
	Goals_PI_3	I set goals to help me do my personal best.	4.47	0.87
	Goals_PI_4	When I want to learn something, I make small goals to track my progress.	4.09	1.14
	Goals_PI_5	I focus on my own improvement instead of worrying about whether other people are doing better than me.	4.11	1.21
	Goals_PI_6	Even if I lose a competition, I'm pleased	4.24	1.00

		if I have improved.		
Competence α = 0.84	IM_C_1	I am able to achieve my goals in this course.	4.24	1.00
	IM_C_2	I am capable of learning the material in this class.	4.47	0.82
	IM_C_3	I expect to do very well in this class.	4.14	1.01
		Why do you go to college?		
Experience Stimulation α = 0.88	IM_ES_1	For the intense feelings I experience when I am communicating my own ideas to others.	3.43	1.29
	IM_ES_2	For the pleasure that I experience when I read interesting authors.	3.42	1.25
	IM_ES_3	For the pleasure that I experience when I feel completely absorbed by what certain authors have written.	3.54	1.31
	IM_ES_4	For the "high" feeling that I experience while reading about various interesting subjects.	3.81	1.19
		Why do you go to college?		
Introjected α = 0.89	EM_IJ_1	To prove to myself that I am capable of completing my college degree.	4.19	1.21
	EM_IJ_2	Because of the fact that when I succeed in college I feel important.	3.75	1.43
	EM_IJ_3	To show myself that I am an intelligent person.	3.54	1.49
	EM_IJ_4	Because I want to show myself that I can succeed in my studies.	4.13	1.27

As seen in the descriptive statistics, the Cronbach alpha values for each of the constructs is above .75 which indicates internal consistency and validity. When measuring for multi-collinearity when two or more predictors in the model are correlated and provide unnecessary information about the answer. All VIF values were less than 2 indicating low multicollinearity. After running several iterations, ten factors were retained and the best EFA model was generated after removing items. To test the model, a hierarchical linear regression was then performed with the constructs remaining after factor using SPSS Version 27.0.0.0.

Table 15 Regression to predict Student Engagement.

	Unstandardized Coefficients			
Parameter	Beta	Std. Error	T	Sig.
Intercept	-0.176	0.431	-0.407	0.685
[GamifiedCodingPlatform=1]	-0.149	0.084	-1.767	0.079
Age	0.003	0.006	0.571	0.569
Instructor Invested	0.207	0.057	3.630	p < .001
External Regulation	-0.044	0.055	-0.800	0.425
Meaningful Goals	0.123	0.078	1.568	0.119
Relatedness	0.060	0.038	1.569	0.119
Competence	0.247	0.054	4.614	p < .001
Experience Stimulation	0.100	0.038	2.620	0.010
Introjected	0.047	0.037	1.277	0.204
[Sex=1]	0.012	0.098	0.124	0.902

R Squared = .485, Adjusted R square = .449

Using the model, the regression accounted for 44.9% of the variation in student engagement.

5.1 Hypothesis 1

Despite the promising literature presented earlier in the literature review regarding gamification, when examining the full regression model (Table 14), Codewars did not impact student engagement. The results of this study can offer no further confirmation to research suggesting gamified coding platforms having a positive impact on student engagement. Students may not be as eager to solve problems on the Codewars platform as the other gamified platforms previously cited in the literature review. Perhaps, the site is as “confusing” as the student described during the initial informed pilot study and the platform does not hold any great advantage of the other tools used. Based on the results of the regression model, it must be concluded that **Hypothesis 1: The gamified coding platform was not statistically significant for the student engagement.**

In 2019, a study utilizing gamification within an introductory computer programming class found intrinsic motivation scores were not improved (Facey-Shaw et al., 2020). The current results are thus consistent with published literature that a gamified approach to teaching computer programming would not have conclusive results. Despite the appealing nature of gamification, and the considerable attention it has received in the research community, this study can offer no conclusive answer yet to the role it plays in promoting student engagement.

Because the survey administered to students merely asked if they used Codewars or not, there is the possibility they were assigned a similar gamified coding platform like Hacker Rank or CodinGame.

5.2.1 Hypothesis 2a

According to the model, the ability to set meaningful goals did not translate into increased student engagement. Students who had improved meaningful goal setting, were not more likely to analyze numerical information, form new ideas, or the other components of an engaged student as defined in this study. The responses to “My goals are meaningful to me”, “My goals are based on my own interests and plans for the future”, and “I set goals to achieve what I think is important” in retrospect were not specific enough to measure student engagement within a computer programming class.

The meaningful goals that students are planning for themselves and are important to their lives did not transfer to a deeper understanding of the material through higher cognition.

Hypothesis 2a: Meaningful goals were not an accurate indicator of engagement.

5.2.2 Hypothesis 2b

Students who identified they were more likely to set goals related to short term and long-term college and career goals were not more likely to report increased engagement, as defined by the research study. Questions related to “I set goals to help me be more successful in school”, “I set goals to help me do my personal best”, “When I want to learn something, I make small goals to track my progress”, “I focus on my own improvement instead of worrying about whether other people are doing better than me” and “Even if I lose a competition, I’m please if I have improved” *did* load together as expected from the literature from the survey. However, as with the H2a, the goals were of such a general nature that they did not impact student engagement during the course.

During the literature review, the Goal Setting Formative Questionnaire has been used in evaluating multiple areas of education including learning communities and self-efficacy (Bawdon, 2019), teacher empathy and school discipline referrals (Leggiadro, 2018), and foreign students and their English language speaking anxiety (Tahsildar & KABİRİ, 2019) to name a few. However, there is no indication of a researcher utilizing the survey as a predictor for student engagement with the NSSE as the dependent variable. Thus, the results of this study indicating that Personal Improvement goals as not impacting student engagement does not contradict any published research.

Hypothesis 2b: Personal Improvement goals were not statistically significant to student engagement.

5.2.3 Hypothesis 2c

Data-based goals did not clearly load when considering the number of questions relating to student motivation. “Based on everything I know about myself, I believe I can achieve my goals” and “When I set a goal, I am confident that I can meet it” seem close enough to questions surrounding competence within the Intrinsic Motivation Inventory that they did not load separately.

Students with a “motivational orientation” will be asking themselves what their reasons are for doing the task (Paul Pintrich, & De Groot, 1990). The students who believe the task is exciting and based on their own sense of curiosity, are said to be more intrinsically motivated. Because of the connection recognized by published literature between intrinsic motivation and the different types of goals, it is understandable that the mixed concepts did not load separately. **Hypothesis 2c: Data Based goals did not load separately as a unique factor and thus were not included in the model.**

5.3.1 Hypothesis 3a

As instructors were perceived to be more invested in their students, a clear connection between instructor involvement and student engagement has been found (Wiggins et al., 2017). This study reinforces that finding where students perceived greater instructor involvement, student engagement was improved. As this construct predicted the dependent variable, it can be reported that **Hypothesis 3a Instructor Invested is statistically significant to student engagement, as defined.**

5.3.2 Hypothesis 3b

Despite the fact that Instructor Invested responses were a predictor of student engagement, the other responses to the other construct Instructor Expectations did not load separately. “My instructor expects me to work hard in school”, “My instructor tries to answer my questions”, and “My instructor wants me to do well in school” were too similar to the questions from the NSSE about instructor involvement. For instance, one of the questions from the NSSE was, “During the current school year, about how often have you done the following? Talked about career plans with a faculty member.” Additionally, questions from the relatedness section of the Intrinsic Motivation like “People in my life care about me” seem to be close enough to overlap with the more specific questions about instructor relations. Due to the theoretical overlap among the constructs, the hypothesis must be rejected. **Hypothesis 3b: Questions relating to Instructor Expectations did not load separately as a factor and were not included in the model.**

5.4.1 Hypothesis 4a

Relatedness is one of the three major components of intrinsic motivation, along with autonomy and competence. Despite the importance to the importance to the extant literature, the questions which made up student engagement about learning challenges were not affected by the degree of relatedness from the student. Although the NSSE does contain questions relating to the social cohesion of the classroom among students and professors, as mentioned earlier those questions had theoretical overlap. Questions from the NSSE such as, “During the current school year, about how often have you done the following? Asked another student to help you understand course material?” and “How much has your experience in this class contributed to your knowledge, skills, and personal development in the following areas? Working effectively with others” did not load into the dependent variable because of theoretical overlap.

As relatedness was not statistically significant within the full model, it must be concluded that: **Hypothesis 4a: Relatedness does not contribute to student engagement.**

5.4.2 Hypothesis 4b

Competence is one of the most studied aspects of Self-Determination Theory, and very clearly related to engagement. Logically, it follows those students who have a feeling of understanding and proficiency will continue to chase this positive feeling. The work the students with positive levels of competence are putting into their studies is likely to lead to the students describing the course as having improved their ability to, say, “solve complex real-world problems.” Student engagement as before was predicted by levels of competence, according to the model; therefore, **Hypothesis 4b: Competence is statistically significant to student engagement.**

5.4.3 Hypothesis 4c

Some sample questions about autonomy from the Intrinsic Motivation Inventory are “I go to school because I experience pleasure and satisfaction while learning new things” and “My actions are consistent with who I really am.” When reading through the questions from the Academic Motivation Scale questions from Experience Stimulation questions such as “Why did you go to college? For the pleasure that I experience when I read interesting authors”, one can logically reason how the responses were not differentiated. Including both sets of questions in the survey seems to have resulted in, again, a theoretical overlap and the inability to include autonomy in the regression. Thus, **Hypothesis 4c: Autonomy did not load as a separate construct and was not included in the regression; this hypothesis is rejected.**

5.4.4 Hypothesis 4d

Questions from the Academic Motivation Scale focusing on the students’ drive toward knowledge embody the pleasure inherent in learning something novel. However, questions like: “Why do you go to college? Because I experience pleasure and satisfaction while learning new things” and “Why do you go to college? Because my studies allow me to continue to learn about many things that interest me” were not subtle enough, or the sample size was too small, to load separately from the questions examining Autonomy.

Again, combining questions and constructs from the two surveys the Intrinsic Motivation Inventory and the Academic Motivation Scale resulted in results where questions did not load separately. Because there was overlap between the concepts in the two surveys with the current sample size tested it is not possible to differentiate between the responses. **Hypothesis 4d: Intrinsic Motivation Toward Knowledge did not load as a separate construct as was not included in the regression; this hypothesis is rejected.**

5.4.5 Hypothesis 4e

Questions about students' intrinsic drive towards accomplishment and achievement were included from the Academic Motivation Scale. Questions such as: "Why do you go to college? For the pleasure I experience while surpassing myself in my studies" and "Why do you go to college? For the satisfaction I feel when I am in the process of accomplishing difficult academic activities" were similar enough to the questions related to the questions from the competence construct that the responses were not distinct. Because of the lack of clarity among these concepts and the other aspects of the survey there was theoretical overlap. **Hypothesis 4e: Intrinsic Motivation Toward Accomplishment did not load as a separate construct as was not included in the regression; this hypothesis is rejected.**

5.4.6 Hypothesis 4f

Students participating in an activity because it is exciting or aesthetically pleasing are said to be intrinsically motivated to experience stimulation (Carbonneau et al., 2012). The students who were more motivated by the excitement and beauty involved in solving a computer programming problem reported higher levels of engagement, as defined for the model. There is great joy and beauty in solving problems and students who pick up on that joy, do respond that they are more engaged in the class. **Hypothesis 4f: Experience stimulation is statistically significant to student engagement, as defined.**

5.5.1 Hypothesis 5a

An extrinsic motivator may cause conflict with intrinsic motivation. Enticements to encourage extrinsic motivation may lessen intrinsic motivation (Hanus & Fox, 2015). Students who have higher motivation to study programming because they want a higher salary or other outside stimuli were not more engaged. The founders of SDT, Edward Deci and Richard Ryan, along with Richard Koestner, have conducted a meta-analysis of the interplay between extrinsic and intrinsic rewards (Deci et al., 2001). Tangible rewards harmed the intrinsic motivation of young children more than college students; however, the effect was still noticeable. In the conclusion, Deci, Ryan, and Koestner call the promotion of rewards as a "significant issue" to the detriment of intrinsic motivation.

The questions focusing on extrinsic regulation were about rewards years in the future. One question was "Why did you go to college? Because with only a high-school degree I would not find a high-paying job later on." Such an external reward will only come to fruition long after the student's current class. A student motivated primarily by extrinsic rewards, does not seem as likely to keep that thought going to keep analyzing the new ideas and staying engaged with the course. **Hypothesis 5a: External regulation is not statistically significant to student engagement.**

5.5.2 Hypothesis 5b

The learner who is biased towards an introjected extrinsic motivation is driven by their ego. Students with a high score in this construct answered agreed strongly with questions like the following: “Why do you go to college? To show myself that I am an intelligent person.” Although the feelings associated with proving oneself as a successful and intelligent person were hypothesized to be enough to stay engaged in the course, the data did not show this to be the case. An investigation into students’ engagement in a religious class found introjection to show a negative relationship with student engagement (Maryama et al., 2020). An investigation into the psychological needs and engagement in a math class also indicated a negative relationship between introjection and student engagement (Hofverberg et al., 2022). Thus, there is recent published literature confirming the relationship this study determined. Students with higher introjected extrinsic motivation were not more likely report higher levels of engagement.

An examination of the introjected style of motivation in the context of one of the questions comprising the student engagement dependent construct will prove edifying. Consider the question: “During the current class, how often have you analyzed an idea or line of reasoning in depth by examining its parts?” Assuming the class is being run by a competent instructor who is providing materials for the student to explore computer programming, will the student driven by ego be as likely to analyze an idea by deconstructing it into sections as the student driven by an intrinsic enjoyment of the material? The data indicates this is not to be and a momentary reflection into the question provides reassurance that the data is accurate. There is published research among school age children which shows extrinsic motivation to be negatively correlated with academic outcomes (Lepper et al., 2005), thus placing this result within an established research stream. **Hypothesis 5b: The introjected extrinsic motivation construct is not statistically significant to student engagement.**

5.5.3 Hypothesis 5c

Questions related to identification focused about job skills from their current programming class and possible future earnings in the field. A sample, "Why did you go to college? Because I think that a college education will help me better prepare for the career I have chosen." Outside of the identification section, there were questions about acquiring job or work-related skills from the NSSE survey as well as career questions within the meaningful goals construct. Because of the overlap, the results were not able to load separately. **Hypothesis 5c: Identification did not load as a separate construct as was not included in the regression; this hypothesis is rejected.**

Neither control for sex nor age were statistically significant when examining engagement in the full model.

Table 16 Summary of findings.

Hypothesis	Results
H1: Students using the gamified coding platform has a positive effect on engagement.	Not supported
H2a: Meaningful goals have a positive effect on student engagement.	Not supported

H2b: Personal improvement goals have a positive effect on student engagement.	Not supported.
H2c: Data-based goals have a positive effect on student engagement.	Not supported.
H3a: Instructor guidance through investment will have a positive effect on student engagement.	Supported
H3b: Instructor expectations will have a positive effect on student engagement.	Not supported.
H4a: Relatedness has a positive effect on student engagement.	Not supported
H4b: Perceived competence has a positive effect on student engagement.	Supported
H4c: Autonomy has a positive effect on student engagement.	Not supported.
H4d: Intrinsic motivation toward knowledge has a positive effect on student engagement.	Not supported.
H4e: Intrinsic motivation toward accomplishment will have a positive effect on student engagement.	Not supported.
H4f: A greater desire to experience stimulation has a positive effect on student engagement.	Supported
H5a: External regulation has a positive effect on student engagement.	Not supported

H5b: Introjection has a positive effect on student engagement.	Not supported
H5c: Identification has a positive effect on student engagement.	Not supported.

5.6 Post Hoc Analysis

Further attention ought to be paid to the two groups, students using Codewars and students not using the site, beyond the model analyzed previously. The two groups in question (Codewars vs. no Codewars) differ on responses such as “Spending significant amounts of time studying and on academic work” and “During the current class have you formed a new idea or understanding from various pieces of information?” Thus, there is a suggestion that the gamified coding platform affected aspects of student engagement, outside of the questions which loaded together and averaged into the dependent variable student engagement.

Table 17 Individual measures of engagement between Codewars students and non-Codewars.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Spending significant amounts of time studying and on academic work	Between Groups	4.130	1	4.130	6.237	0.014
	Within Groups	99.988	151	0.662		
	Total	104.118	152			
During the current class have you formed a new idea or understanding from various	Between Groups	3.405	1	3.405	4.186	0.043
	Within Groups	122.830	151	0.813		
	Total	126.235	152			

pieces of information?

Table 18 ANOVA of constructs between courses using Codewars and those not.

		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Instructor Invested	Between Groups	11.485	1	11.485	19.235	0.000
	Within Groups	95.533	160	0.597		
	Total	107.017	161			
External Regulation	Between Groups	2.443	1	2.443	3.951	0.049
	Within Groups	98.946	160	0.618		
	Total	101.389	161			
Meaningful Goals	Between Groups	0.073	1	0.073	0.247	0.620
	Within Groups	47.570	160	0.297		
	Total	47.643	161			
Relatedness	Between Groups	0.003	1	0.003	0.003	0.958
	Within Groups	195.064	160	1.219		
	Total	195.067	161			
Student Engagement	Between Groups	1.752	1	1.752	2.738	0.100
	Within Groups	96.594	151	0.640		
	Total	98.346	152			
Learning Engagement	Between Groups	2.803	1	2.803	4.499	0.035
	Within Groups	99.702	160	0.623		
	Total	102.505	161			
Competence	Between Groups	0.316	1	0.316	0.462	0.498
	Within Groups	109.352	160	0.683		
	Total	109.668	161			
Experience	Between	3.796	1	3.796	3.018	0.084

Stimulation	Groups					
	Within Groups	193.665	154	1.258		
	Total	197.461	155			
Introjected	Between Groups	0.811	1	0.811	0.586	0.445
	Within Groups	213.260	154	1.385		
	Total	214.072	155			

When comparing gamified coding platform vs. non-gamified coding platform groups there is a clear difference between every question related to the instructor invested constructs.

Table 19 Construct measurements by Codewars usage.

Gamified Coding Platform		N	Minimum	Maximum	Mean	Std. Deviation
No	Instructor Invested	83	1.00	5.00	3.9578	0.89615
	External Regulation	83	1.00	5.00	4.2691	0.84817
	Valid N (listwise)	83				
Yes	Instructor Invested	79	2.50	5.00	4.4905	0.61686
	External Regulation	79	2.00	5.00	4.5148	0.71571
	Valid N (listwise)	79				

Students using Codewars have higher levels for the constructs Instructor Invested, and External Regulation.

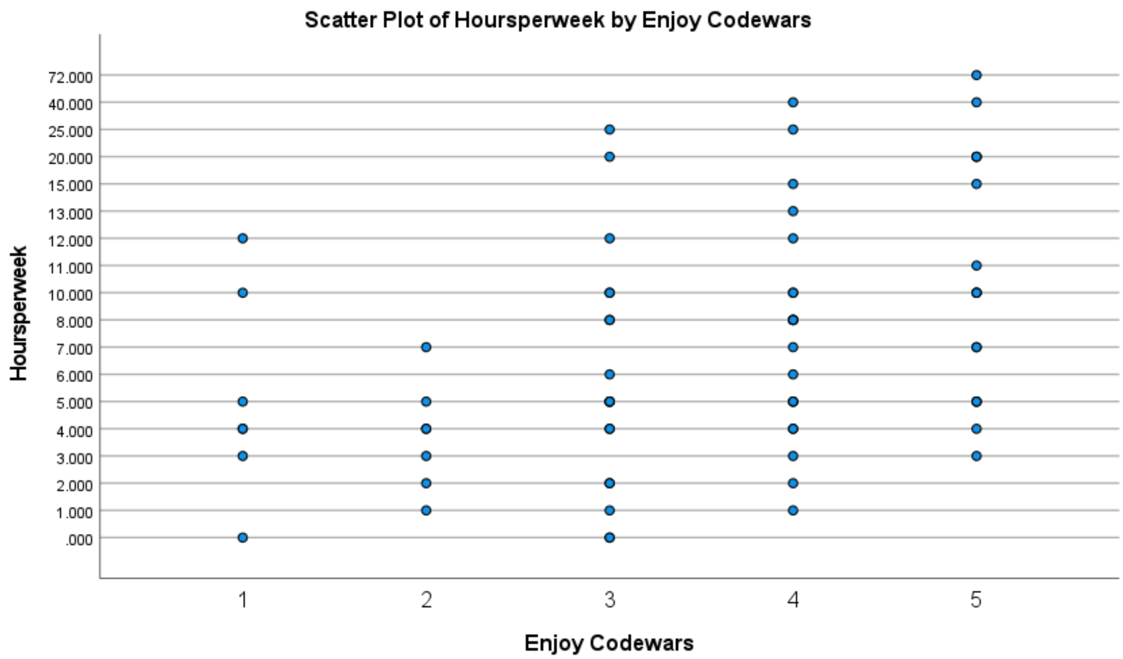


Figure 6 Hours/week studying programming and Codewars enjoyment.

Students who reported enjoying using the website Codewars were more likely to report spending more time studying computer programming. Could the gamification on Codewars be encouraging greater time studying programming? As students feel more competent, they may be spending more time in a virtuous cycle and find greater enjoyment while using Codewars. Seeing a clear relationship between time spent and the enjoyment of the site illustrates the importance of practice and the benefits of increasing feelings of competence.

6. Discussion and Implications.

The purpose of this study was to investigate the role intrinsic and extrinsic motivation, student goal setting, perceived instructor support and the use of Codewars as a predictor of student engagement. Correlational research, such as this study, attempts to determine whether, and to what degree, a relationship exists between two or more quantifiable variables (Gay et al., 2011). This section will interpret the results of the study, discuss implications for future computer programming courses, and discuss limitations of the study. Suggestions for further research will also be presented.

6.1 Theoretical Implications

At the academic level, my aim has been largely driven by the tremendous personal allure of the Self-Determination Theory and its simplicity. This attraction to the theory comes after an almost twenty year career in education. Isaac Asimov, as only he can, sums up one of the most profound revelations when he wrote, “Self-education is the only possible education; the rest is mere veneer laid on the surface of a child’s nature.”[6] An opportunity to investigate the concept with students at a Southeastern College seemed like a thrilling opportunity. Because of the findings within this study that competence and an intrinsic drive towards greater stimulation, this study can offer evermore incremental support of the Self-Determination Theory.

The research aimed to integrate extant surveys to determine which constructs were measured and which questions were theoretically overlapping. The cross-loadings from the main research study can be found in Table 19 after removing the questions which needed to be removed from consideration. This finding may be of use to a future researcher attempting to embark on a similar study.

Intrinsic motivation has been empirically found to be a much bigger driver of tenacity, accomplishment, and fulfillment than extrinsic motivation (which failed to

---

[6] https://www.goodreads.com/quotes/131363-self-education-is-i-firmly-believe-the-only-kind-of-education

predict student engagement in this study) across many different studies. Managers who supported their employees' intrinsic needs compared with extrinsic rewards predicted better evaluations (Baard et al., 2004). In education, there too have been many studies explaining the role intrinsic motivation has in performance. Instructors who were seen as more autonomy supportive were found to predict greater enjoyment in their organic chemistry classes (Black & Deci, 2000). In line with the previous research, this study also found support for increased levels of perceived competence predicted increased engagement during the course.

Despite the title of this dissertation and focus on gamification, H1 had to be rejected as Codewars did not predict greater student engagement. However, the causes and implications of this finding are worth examining in further detail. Individuals respond to gamification differently depending on the individual's own "personal and demographic characteristics (Koivisto & Hamari, 2019)." Thus, the result that Codewars was not statistically significant is dependent on multiple factors. Is the lack of a clear statistical significance in the model caused by some characteristic of the site itself and another gamified platform would be more appropriate for students? Could it be the students find the Codewars interface confusing? Would a competitor such as Hacker Rank provide a better experience for students? Are the introductory students more intimidated by the site and less likely to use it than students taking their second or third programming class? Students surveyed during this study were at an open access college, which does not require any entrance requirements other than a high school degree or an equivalency exam such as the GED.

Although the author personally greatly enjoys the site[7], students may obviously not appreciate Codewars with the same passion, and they may prefer to use other platforms. After years of using the site in class and revisiting the top 10 students by points solved on the site, nearly all of them have turned their computer programming class into a career as evidenced by their LinkedIn profiles and emails through the years.

You are automatically given an allegiance with anyone who is in the same clan as you. You can also become allies with other warriors by following each other or inviting new warriors to join.

Position	User		Clan	Honor
1	2 kyu	mrfreer	Miami Dade College	5,035
2	5 kyu	sergiohg93	Miami Dade College	382
3	5 kyu	cesarRuiz786	HL7 FHIR Integration & Interop	357
4	5 kyu	life_of_baka	Miami Dade College	312
5	5 kyu	1fn0t	Miami Dade College	307
6	5 kyu	gio101046	Miami Dade College	305
7	5 kyu	castorvelasquez	Miami Dade College	285
8	5 kyu	MiguelAmaro	Miami Dade College	277
9	6 kyu	eduardo.jimenez	Miami Dade College	250
10	6 kyu	JosePujol21	Miami Dade College	216

Figure 7 Top 9 students on Codewars, the author is #1.

However, these were the top students out of hundreds and hundreds of others who did not solve so many extra problems beyond the requirements. Perhaps there is a dichotomy where higher performing students may greatly prefer the site and they competitively engage with other top students in a drive to reach the top. Those students are generally computer science majors and looking to work as software engineers. As there are many students enrolled in the computer programming classes because they are required to take the classes for Information Technology and Data Analytics, they are generally not interested in working as software engineers or a similarly named position.

[7] https://www.codewars.com/users/mrfreer

The finding that the gamified platform did not predict student engagement would be consistent with published literature showing educational tools have mixed results with students based on their academic level (Pieterse & Liebenberg, 2017).

6.2 Practical Implications

Motivation is often used as a mediating or dependent variable to explain a wide range of behaviors (Buckley & Doyle, 2016). Practically, educators will want to increase motivation which results in more time spent on task and better performance. Motivation is a means to an end and there a great many practical suggestions that can be made after this study.

Students may find the following simplified points of the findings to be of value as they begin their computer programming classes:

- Programming is a challenging subject that requires deep contemplation and analysis. Prospective programmers will need to examine a line of reasoning in depth.
- As a programming student you will be expected to evaluate numerical inputs and conduct calculations. You will be thinking critically and analytically. Basically, you may be solving complex real-world problems during class activities.
- With a partial definition of an engaged student from the previous two points, the best way to ensure that you will be an engaged student will be to take an honest assessment of your abilities and interests as you embark on your study of computer programming.

- Do you experience a rush when you learn something new? Do you find learning new things pleasurable? This study found those students who were more stimulated by learning new things to be more engaged in their computer programming class.
- Lastly, you cannot guarantee an instructor will be as good or bad as their online reputation, but you should know that students who perceived their instructor to be invested in their education were more engaged students. Try to choose your instructor carefully!

Instructors and administrators may find the study of value as well. Practically, students with low perceived competence can be improved through interventions; their perceived competence score is not fixed. For instance, informing students before starting a task that they have an outstanding chance of learning the material can provide an ‘expectancy boost’ (Durik et al., 2015). As the current research replicates the many other studies which have shown perceived competence to be positively related with engagement, a practical implication would be to encourage instructors to offer encouragement to students. Instructors are not merely purveyors of information, but to a certain extent cheerleaders, guiding their students to a goal.

Based on the results from the study, the following is a list of additional strategies that may assist educators use these findings:

- Instructors can encourage students’ competence development by giving timely feedback to students on work that has already been submitted. Instructors should model the necessary skills required for success for their students; an environment where work is not graded quickly sets the wrong precedent about the effort needed for a challenging course. Additionally, positive reinforcement and respect for students can increase students' competence (Orsini et al., 2016).

- The connection between competence and an instructor's investment in student success is clear. When an instructor provides meaningful instruction and a caring attitude to their students, student engagement increases.
- The desire to experience stimulation, as a goal of intrinsic motivation, is all about the state of flow and getting lost in an interesting subject. Students who were highly intrinsically motivated using an incremental learning system showed more persistence than students who were similarly intrinsically motivated using an entity learning condition (W. Li et al., 2008). An incremental approach to teaching a complicated topic is more effective to increasing intrinsic motivation.

6.3 Limitations and Future Research

Codewars is a platform geared towards computer programmers with at least a modicum of computer programming skills. As mentioned earlier, to even create an account on the site a computer programming puzzle must be solved. Students who are unsure about themselves may be overwhelmed by the process and less eager to use the platform. This study surveyed students at the beginning their academic programming journey, along with students who have studied computer programming previously. The site may not be as welcoming for struggling students as it is for the students who have taken to computer programming. Perhaps future research could utilize school data to corroborate academic measures like standardized test scores to build a model of who really likes and benefits from the gamified platform.

Another limitation to address is the usage of the NSSE for a specific subject rather than as a measure of student engagement across multiple subjects. There is criticism of using the NSSE for specific subject groups instead of as a tool for the entire college experience (Sinclair et al., 2015). The full NSSE survey asks general questions about academic behaviors which are not emphasized by Computer Science / Computer Programming classes, such as asking the student to reflect on how many research papers they wrote during the semester. As students in computer programming classes do not regularly write research papers, those questions would not hold much relevance for the subject area. For the purposes of this study, those questions were not administered to the programming students in the survey. A promising possible future study may be to validate a survey that asks about specific computer programming skills, instead of the more general academic questions on the NSSE.

This was a convenience survey taken at a public college in the Southeastern region of the United States. Email invitations to complete the survey were sent to students who have taken computer programming classes at the institution over the past two years. Six instructors directly asked their current students to complete the survey. After the requests, 219 students started the survey with 151 fully completed surveys. Despite the multiple attempts to encourage greater participation through email reminders, a limitation of the study would be the lower participation rate in the survey.

This current study was not an experiment which required students to be randomly assigned to use Codewars or another non-gamified platform, but rather a self-reported snapshot of computer programming students enrolled during Fall 2021 (previous students were emailed going back three semesters). During the study, instructors simply used the tools they felt were most appropriate for their classes; if an instructor was using Codewars, the students would check that off on their survey. If not, there was no manipulation of the courses. A possibility for future research may be to measure intrinsic motivation at the beginning of the semester and then the intrinsic motivation at the end of the semester, to see how the use of Codewars influenced the students' intrinsic motivation. On a much larger scale, perhaps it would also be interesting to have one college fully adopt Codewars for all their programming classes then ask another to specifically *not* utilize the site. Such a study would give much better evidence to determine the usefulness of Codewars in a computer programming class.

During this study using self-reported results did not permit the same level of internal validity as a pretest-posttest design would have offered (Pascarella, 2001). A future study utilizing a pretest-posttest would provide greater validity and a clearer answer to the effects, if any, a gamified coding platform offer to student engagement.

Questions related to gender and the study of computer programming are a popular further area for research. Male students have previously shown more positive interest in computer programming than female students (Baser, 2013). Students were asked to self-report their sex for this survey and the demographics of this study clearly indicate males were more represented in the results. According to the model, however, sex was not a significant predictor of engagement. Do male and female students use Codewars equally across a semester? By requiring students to submit their Codewars username, data could be gathered as to the number of problems attempted but not completed, problems completed, and number of comments written on the site. Such data would be valuable to determine whether Codewars usage differed by sex.

Future research perhaps should focus on fewer aspects of human motivation and classroom structure to avoid theoretical overlap. However, some questions which should have been included in this survey were not due to an oversight from the researcher. For instance, students were asked the following question with a binary answer: Did you use Codewars? This study does not examine the tools used by the students NOT using Codewars. Perhaps there were students using a platform that has similar features to Codewars? Because of this limitation, the possibility of other platforms that utilize gamification were influencing the students' engagement. Furthermore, a question asking the student to indicate their current major would have been useful for analysis. Referring back to the end of the theoretical discussion of the lack of support for Codewars driving student engagement, clearly the lack of data on the students' majors was also an oversight in the survey design.

This omission brings about the possibility of a new research opportunity; a noteworthy area for future research would be to compare non-Computer Science students using of a gamified coding platform with those who are majoring in Computer Science. Are students studying other aspects of information technology as intrinsically motivated to study the required computer programming classes? Are there clear differences between students studying more traditional paths like Computer Science versus the Data Analytics program? Are the students who are not looking to work as professional programmers less eager to work with a site like Codewars?

7. Conclusion.

The NSSE measures the level of academic challenge, time on task, and participation in educational activities (Kuh, 2001a). Using some historical data from the survey, we can get a better feel for the students and how they spend their time. For instance, in 2000, 63% of students reported doing some sort of community service project. However, in 2022, at the institution surveyed, 69% reported doing no community service during the week. During the survey more than 2/3 reported engaging in paid work with over a quarter working more than 30 hours per week. In 2000, 10% of students surveyed reported spending five or fewer hours preparing for class. By 2018, 11% of students reported spending five or fewer hours preparing for class. However, during this survey in 2022 36% of students reported spending five or fewer hours preparing for class. Such a glaring discrepancy should give pause. Students devoting so little time to classroom preparation is certainly not enough, especially for students studying computer programming.

Both students and institutions have a role to play in student engagement. Intrinsic factors like perceived competence and the desire to experience stimulation were found to be predictors of student engagement. As previous research has shown, intrinsic motivation can be impacted by educational practices. The other significant predictor of engagement was instructor involvement, which would have an institutional responsibility. Faculty up for tenure may have students surveyed and the data tabulated about their involvement in promoting student success. Does the student believe the instructor pushes them to succeed? Are they helpful when they have questions? Are the instructors interested in their future?

Aside from the pedagogical and psychological theories covered in depth up to this point, what follows is a straightforward description of an engaged student:

> They have a psychological investment in learning. They try hard to learn what school offers. They take pride not simply in earning the formal indicators of success (grades), but in understanding the material and incorporating or internalizing it in their lives (Voke, 2002).

The study corroborates these points. Students who had a higher perceived competence in relation to their computer programming classes did report greater engagement. Students who had a greater desire to experience stimulation also reported greater engagement. Additionally, those who felt a greater connection with their instructor’s investment in their class and their personal success reported a higher level of student engagement.

Instructors and administrators at my institution will receive a copy of the dissertation to evaluate the student responses and to better understand a picture of programming students at our institution. The understanding that Codewars is not an excellent predictor of engagement for students beginning their computer programming education also will open the possibility of adopting other systems. As there was no clear negative effect by Codewars, its usage should not be seen as a detrimental activity when considering the results of the study.

REFERENCES

Allen, J. M., Vahid, F., Downey, K., & Edgcomb, A. D. (2018). *Weekly programs in a CS1 class: Experiences with auto-graded many-small programs (MSP)*. 2018 ASEE Annual Conference & Exposition.

Aparicio, A. F., Vela, F. L. G., Sánchez, J. L. G., & Montes, J. L. I. (2012). Analysis and Application of Gamification. *Proceedings of the 13th International Conference on Interacción Persona-Ordenador*. https://doi.org/10.1145/2379636.2379653

Astin, A. (1984). Student Involvement: A Development Theory for Higher Education. *Journal of College Student Development*, *40*, 518–529.

Baard, P. P., Deci, E. L., & Ryan, R. M. (2004). Intrinsic Need Satisfaction: A Motivational Basis of Performance and Weil-Being in Two Work Settings1. *Journal of Applied Social Psychology*, *34*(10), 2045–2068. https://doi.org/10.1111/j.1559-1816.2004.tb02690.x

Bandura, A. (1989). Regulation of Cognitive Processes through Perceived Self-Efficacy. *Developmental Psychology*, *25*(5), 729–735. MLA International Bibliography. https://doi.org/10.1037/0012-1649.25.5.729

Barkley, E. F., & Major, C. H. (2020). *Student Engagement Techniques: A Handbook for College Faculty*. Wiley. https://books.google.com/books?id=6kfZDwAAQBAJ

Baser, M. (2013). Attitude, gender and achievement in computer programming. *Online Submission*, *14*(2), 248–255.

Bawdon, J. (2019). *Academic Confidence: A Quantitative Study of Living Learning Communities and Self-Efficacy*.

Begel, A., & Simon, B. (2008). *Struggles of new college graduates in their first software development job*. 226–230.

Bennedsen, J., & Caspersen, M. E. (2019). Failure rates in introductory programming: 12 years later. *ACM Inroads*, *10*(2), 30–36.

Bergin, S., Reilly, R., & Traynor, D. (2005). Examining the Role of Self-Regulated Learning on Introductory Programming Performance. *Proceedings of the First International Workshop on Computing Education Research*, 81–86. https://doi.org/10.1145/1089786.1089794

Black, A. E., & Deci, E. L. (2000). The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: A self-determination theory perspective. *Science Education*, *84*(6), 740–756. https://doi.org/10.1002/1098-237X(200011)84:6<740::AID-SCE4>3.0.CO;2-3

BLOOM, B. S. (1984). The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. *Educational Researcher*, *13*(6), 4–16. https://doi.org/10.3102/0013189X013006004

Buckley, P., & Doyle, E. (2016). Gamification and student motivation. *Interactive Learning Environments*, *24*(6), 1162–1175. Academic Search Complete.

Carbonneau, N., Vallerand, R. J., & Lafrenière, M. K. (2012). Toward a tripartite model of intrinsic motivation. *Journal of Personality*, *80*(5), 1147–1178.

Chen, K.-C., & Jang, S.-J. (2010). Motivation in online learning: Testing a model of self-determination theory. *Emerging and Scripted Roles in Computer-Supported Collaborative Learning*, *26*(4), 741–752. https://doi.org/10.1016/j.chb.2010.01.011

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin*, *143*(1), 1.

Computer and Information Technology Occupations. (n.d.). https://www.bls.gov/ooh/computer-and-information-technology/home.htm

Cook, D. A., & Artino Jr, A. R. (2016). Motivation to learn: An overview of contemporary theories. *Medical Education*, *50*(10), 997–1014. https://doi.org/10.1111/medu.13074

Coughlan-Mainard, K. (2002). *Why Go to School? Why Do Homework? Motivational Correlates for School and Homework in High School Students.*

Daly, C. (1999). RoboProf and an Introductory Computer Programming Course. *SIGCSE Bull.*, *31*(3), 155–158. https://doi.org/10.1145/384267.305904

Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivation. *Journal of Personality and Social Psychology*, *18*(1), 105–115. https://doi.org/10.1037/h0030644

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, *125*(6), 627.

Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. *Review of Educational Research*, *71*(1), 1–27. https://doi.org/10.3102/00346543071001001

Deci, E. L., & Ryan, R. M. (1990). *Intrinsic motivation and self-determination in human behavior.* (FIU Hubert Library (BBC) General Collection - 3rd Fl. BF503 .D43 1985). Plenum; FIU Library Catalog.

http://ezproxy.fiu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat06026a&AN=fiu.020973400&site=eds-live

Deci, E. L., Ryan, R. M., Lewis, M. A., & Neighbors, C. (2005). General Causality Orientations Scale. *Self-Determination and the Use of Self-Presentation Strategies*, *145*, 469–489. Health and Psychosocial Instruments.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From Game Design Elements to Gamefulness: Defining Gamification. *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, MindTrek 2011*, *11*, 9–15. https://doi.org/10.1145/2181037.2181040

Dicheva, D., dichevad@wssu. edu, Dichev, C., dichevc@wssu. edu, Agre, G., agre@iinf. bas. bg, & Angelova, G., galia@lml. bas. bg. (2015). Gamification in Education: A Systematic Mapping Study. *Journal of Educational Technology & Society*, *18*(3), 75–88. eue.

Dixson, M. D. (2010). Creating effective student engagement in online courses: What do students find engaging? *Journal of the Scholarship of Teaching and Learning*, 1–13.

Dotsenko, N. A. (2021). Technology of application of competence-based educational simulators in the informational and educational environment for learning general technical disciplines. *Journal of Physics: Conference Series*, *1946*(1), 012014. https://doi.org/10.1088/1742-6596/1946/1/012014

Dr. Vandana Jain, A. J. A. (2020). Goal Setting and Fear of Failure among Indigent Adolescents. *PalArch's Journal of Archaeology of Egypt / Egyptology*, *17*(9), 6069–6080.

Durik, A. M., Shechter, O. G., Noh, M., Rozek, C. S., & Harackiewicz, J. M. (2015). What if I can't? Success expectancies moderate the effects of utility value information on situational interest and performance. *Motivation and Emotion, 39*(1), 104–118.

Dweck, C. S. (2006). *Mindset: The New Psychology of Success: Vol. 1st ed*. Random House; eBook Collection (EBSCOhost). http://ezproxy.fiu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=737546&site=eds-live

E. O. Simon. (2022). T.A.L.A Goal Setting Life Skills Learning Approach on the Meta-Empirical Competence and Academic Performance of Diverse Learners. *2022 11th International Conference on Educational and Information Technology (ICEIT)*, 175–179. https://doi.org/10.1109/ICEIT54416.2022.9690748

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology*, *54*(1), 5–12. https://doi.org/10.1037/0022-3514.54.1.5

English, J. (2004). Automated Assessment of GUI Programs Using JEWL. *SIGCSE Bull.*, *36*(3), 137–141. https://doi.org/10.1145/1026487.1008033

Evertson, C. M., Sanford, J. P., & Emmer, E. T. (1981). Effects of class heterogeneity in junior high school. *American Educational Research Journal*, *18*(2), 219–232. https://doi.org/10.2307/1162383

Facey-Shaw, L., Specht, M., van Rosmalen, P., & Bartley-Bryan, J. (2020). Do Badges Affect Intrinsic Motivation in Introductory Programming Students? *Simulation & Gaming*, *51*(1), 33–54. https://doi.org/10.1177/1046878119884996

Fazey, D. M., & Fazey, J. A. (2001). The potential for autonomy in learning: Perceptions of competence, motivation and locus of control in first-year undergraduate students. *Studies in Higher Education*, *26*(3), 345–361.

Fischer, K., Vaupel, S., Heller, N., Mader, S., & Bry, F. (2020). *Effects of Competitive Coding Games on Novice Programmers*. 464–475.

Fotaris, P., Mastoras, T., Leinfellner, R., & Rosunally, Y. (2016). Climbing up the Leaderboard: An Empirical Study of Applying Gamification Techniques to a Computer Programming Class. *Electronic Journal of E-Learning*, *14*(2), 94–110. ERIC.

Freeman, T. M., Anderman, L. H., & Jensen, J. M. (2007). Sense of Belonging in College Freshmen at the Classroom and Campus Levels. *The Journal of Experimental Education*, *75*(3), 203–220. https://doi.org/10.3200/JEXE.75.3.203-220

Fu, X., Peltsverger, B., Qian, K., Tao, L., & Liu, J. (2008). APOGEE: automated project grading and instant feedback system for web based computing. *ACM SIGCSE Bulletin*, *40*(1), 77–81.

Furrer, C., & Skinner, E. (2003). Sense of relatedness as a factor in children's academic engagement and performance. *Journal of Educational Psychology*, *95*(1), 148–162. https://doi.org/10.1037/0022-0663.95.1.148

Gaumer, E., Soukup, J. H., Noonan, P. M., & McGurn, L. (2018). *Goal setting formative questionnaire*. http://www.researchcollaboration.org/uploads/GoalSettingQuestionnaireInfo.pdf

Gawel, J. E. (1996). Herzberg's theory of motivation and Maslow's hierarchy of needs. *Practical Assessment, Research, and Evaluation*, *5*(1), 11.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and applications*. Pearson Higher Ed.

Gonyea, R. M. (2005). Self-reported data in institutional research: Review and recommendations. *New Directions for Institutional Research*, *2005*(127), 73–89. https://doi.org/10.1002/ir.156

Gottfried, A. E. (1985). Academic intrinsic motivation in elementary and junior high school students. *Journal of Educational Psychology*, *77*(6), 631–645. https://doi.org/10.1037/0022-0663.77.6.631

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A.-B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. *Science*, *341*(6153), 1455–1456. https://doi.org/10.1126/science.1240487

Grow, G. O. (1991). Teaching Learners To Be Self-Directed. *Adult Education Quarterly*, *41*(3), 125–149. https://doi.org/10.1177/0001848191041003001

Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, *80*, 152–161.

Harter, S. (1981). A new self-report scale of intrinsic versus extrinsic orientation in the classroom: Motivational and informational components. *Developmental Psychology*, *17*(3), 300–312. https://doi-org.ezproxy.fiu.edu/10.1037/0012-1649.17.3.300

Hofverberg, A., Winberg, M. T., Palmberg, B., Andersson, C., & Palm, T. (2022). Relationships Between Basic Psychological Need Satisfaction, Regulations, and

Behavioral Engagement in Mathematics. *Frontiers in Psychology*, *13*. DiVA. https://doi.org/10.3389/fpsyg.2022.829958

Hollingsworth, J. (1960). Automatic Graders for Programming Classes. *Commun. ACM*, *3*(10), 528–529. https://doi.org/10.1145/367415.367422

Horváth, G. (2018). A web-based programming environment for introductory programming courses in higher education. *Annales Mathematicae et Informaticae*, *48*, 23. Complementary Index.

Jang, H. (2008). Supporting students' motivation, engagement, and learning during an uninteresting activity. *Journal of Educational Psychology*, *4*, 798. Gale Academic OneFile.

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education*, *38*(5), 758–773. https://doi.org/10.1080/03075079.2011.598505

Kearsley, G., & Shneiderman, B. (1998). Engagement theory: A framework for technology-based teaching and learning. *Educational Technology*, *38*(5), 20–23.

Knowles, M. S. (1975). *Self-directed learning: A guide for learners and teachers.*

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management*, *45*, 191–210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Kuh, G. D. (2001a). Assessing what really matters to student learning inside the national survey of student engagement. *Change: The Magazine of Higher Learning*, *33*(3), 10–17.

Kuh, G. D. (2001b). *National survey of student engagement: The college student report: NSSE technical and norms report*. Indiana University Center for Postsecondary Research and Planning.

Kuh, G. D. (2009). The national survey of student engagement: Conceptual and empirical foundations. *New Directions for Institutional Research*, *141*, 5–20.

Kuh, G. D., Kinzie, J. L., Buckley, J. A., Bridges, B. K., & Hayek, J. C. (2006). *What matters to student success: A review of the literature* (Vol. 8). National Postsecondary Education Cooperative Washington, DC.

Landers, R. N. (2014). Developing a Theory of Gamified Learning: Linking Serious Games and Gamification of Learning. *Simulation & Gaming*, *45*(6), 752–768. https://doi.org/10.1177/1046878114563660

Lavidas, K., Barkatsas, T., Manesis, D., & Gialamas, V. (2020). A STRUCTURAL EQUATION MODEL INVESTIGATING THE IMPACT OF TERTIARY STUDENTS'ATTITUDES TOWARD STATISTICS, PERCEIVED COMPETENCE AT MATHEMATICS, AND ENGAGEMENT ON STATISTICS PERFORMANCE. *Statistics Education Research Journal*, *19*(2), 27–41.

Law, K. M., Lee, V. C., & Yu, Y.-T. (2010). Learning motivation in e-learning facilitated computer programming courses. *Computers & Education*, *55*(1), 218–228.

Lee, J., & Hammer, J. (2011). Gamification in Education: What, How, Why Bother? *Academic Exchange Quarterly*, *15*, 1–5.

Leggiadro, E. (2018). *The Relationship Between Teacher Empathy and School Discipline Referral Rates*.

Lei, S. A. (2010). Intrinsic and Extrinsic Motivation: Evaluating Benefits and Drawbacks from College Instructors' Perspectives. *Journal of Instructional Psychology*, *37*(2), 153–160. Academic Search Complete.

Lepper, M. R., Corpus, J. H., & Iyengar, S. S. (2005). Intrinsic and extrinsic motivational orientations in the classroom: Age differences and academic correlates. *Journal of Educational Psychology*, *97*(2), 184.

Li, Q., McCoach, D. B., Swaminathan, H., & Tang, J. (2008). Development of an Instrument to Measure Perspectives of Engineering Education Among College Students. *Journal of Engineering Education (Washington, D.C.)*, *97*(1), 47–56. https://doi.org/10.1002/j.2168-9830.2008.tb00953.x

Li, W., Lee, A. M., & Solmon, M. (2008). Effects of Dispositional Ability Conceptions, Manipulated Learning Environments, and Intrinsic Motivation on Persistence and Performance. *Research Quarterly for Exercise and Sport*, *79*(1), 51–61. https://doi.org/10.1080/02701367.2008.10599460

Locke, E. A. (1996). Motivation through conscious goal setting. *Applied and Preventive Psychology*, *5*(2), 117–124.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist*, *57*(9), 705–717. https://doi.org/10.1037/0003-066X.57.9.705

Locke, E. A., Shaw, K. N., Saari, L. M., & Latham, G. P. (1981). Goal setting and task performance: 1969–1980. *Psychological Bulletin*, *90*(1), 125–152. https://doi.org/10.1037/0033-2909.90.1.125

M. Venter. (2020). Gamification in STEM programming courses: State of the art. *2020 IEEE Global Engineering Education Conference (EDUCON)*, 859–866. https://doi.org/10.1109/EDUCON45650.2020.9125395

Machanick, P. (2007). A Social Construction Approach to Computer Science Education. *Computer Science Education*, *17*(1), 1–20. ERIC.

Maehr, M. L., & Fyans, L. J. (1990). *School culture, motivation, and achievement*. US Department of Education, Office of Educational Research and Improvement ….

Maryama, H., Nisa, Y. F., Suralaga, F., & Latifa, R. (2020). *Students Engagement in Memorizing Al-Qur'an*.

McAuley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: A confirmatory factor analysis. *Research Quarterly for Exercise and Sport*, *60*(1), 48–58.

Medeiros, R. P., Ramalho, G. L., & Falcão, T. P. (2019). A Systematic Literature Review on Teaching and Learning Introductory Programming in Higher Education. *IEEE Transactions on Education*, *62*(2), 77–90. https://doi.org/10.1109/TE.2018.2864133

Metheny, J., McWhirter, E. H., & O'Neil, M. E. (2008). Measuring perceived teacher support and its influence on adolescent career development. *Journal of Career Assessment*, *16*(2), 218–237.

Meyer, J. P., & Gagnè, M. (2008). Employee Engagement From a Self-Determination Theory Perspective. *Industrial and Organizational Psychology*, *1*(1), 60–62. Cambridge Core. https://doi.org/10.1111/j.1754-9434.2007.00010.x

Moore, M. E., Vega, D. M., Wiens, K. M., & Caporale, N. (2020). Connecting theory to practice: Using self-determination theory to better understand inclusion in STEM. *Journal of Microbiology & Biology Education*, *21*(1), 05.

Norman, V. T., & Adams, J. C. (2015). Improving Non-CS Major Performance in CS1. *Proceedings of the 46th ACM Technical Symposium on Computer Science Education*, 558–562. https://doi.org/10.1145/2676723.2677214

NSSE. (2021). https://nsse.indiana.edu/nsse/survey-instruments/index.html

Orsini, C., Evans, P., Binnie, V., Ledezma, P., & Fuentes, F. (2016). Encouraging intrinsic motivation in the clinical setting: Teachers' perspectives from the self-determination theory. *European Journal of Dental Education*, *20*(2), 102–111.

Ortiz, M., Chiluiza, K., & Valcke, M. (2017). *Gamification in Computer Programming: Effects on learning, engagement, self-efficacy and intrinsic motivation*.

Pascarella, E. T. (2001). Using student self-reported gains to estimate college impact: A cautionary tale. *Journal of College Student Development*, *42*(5), 488–492.

Paul Pintrich, & De Groot, E. (1990). Motivational and Self-Regulated Learning Components of Classroom Academic Performance. *Journal of Educational Psychology*, *82*(1), 33–40.

Pieterse, V., & Liebenberg, J. (2017). Automatic vs Manual Assessment of Programming Tasks. *Proceedings of the 17th Koli Calling International Conference on Computing Education Research*, 193–194. https://doi.org/10.1145/3141880.3141912

Reeve, J., Cheon, S. H., & Jang, H. (2020). How and why students make academic progress: Reconceptualizing the student engagement construct to increase its explanatory power. *Contemporary Educational Psychology*, *62*, 101899.

Reeve, J., Jang, H., Carrell, D., Jeon, S., & Barch, J. (2004). Enhancing Students' Engagement by Increasing Teachers' Autonomy Support. *Motivation and Emotion*, *28*(2), 147–169. https://doi.org/10.1023/B:MOEM.0000032312.95499.6f

Rocconi, L. M. (2011). The Impact of Learning Communities on First Year Students' Growth and Development in College. *Research in Higher Education*, *52*(2), 178–193. https://doi.org/10.1007/s11162-010-9190-3

Rodriguez-Keyes, E., Schneider, D. A., & Keenan, E. K. (2013). Being Known in Undergraduate Social Work Education: The Role of Instructors in Fostering Student Engagement and Motivation. *Social Work Education*, *32*(6), 785–799. https://doi.org/10.1080/02615479.2013.765841

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, *5*, 749. Gale Academic OneFile.

Ryan, R. M., & Deci, E. L. (2000). Self-Detfermination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *The American Psychologist*, *1*, 68. Gale Academic OneFile.

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* (FIU Online Electronic Book BF575.A88). Guilford Press; cat06026a.

http://ezproxy.fiu.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat06026a&AN=fiu.035812482&site=eds-live

Schuetz, P. (2008). A Theory-Driven Model of Community College Student Engagement. *Community College Journal of Research and Practice*, *32*(4–6), 305–324. https://doi.org/10.1080/10668920701884349

Scott Rigby, C., Deci, E. L., Patrick, B. C., & Ryan, R. M. (1992). Beyond the intrinsic-extrinsic dichotomy: Self-determination in motivation and learning. *Motivation and Emotion*, *16*(3), 165–185. https://doi.org/10.1007/BF00991650

Senko, C., Hulleman, C. S., & Harackiewicz, J. M. (2011). Achievement goal theory at the crossroads: Old controversies, current challenges, and new directions. *Educational Psychologist*, *46*(1), 26–47.

Sinclair, J., Butler, M., Morgan, M., & Kalvala, S. (2015). *Measures of student engagement in computer science*. 242–247.

Sweet, S. N., Fortier, M. S., Strachan, S. M., & Blanchard, C. M. (2012). Testing and integrating self-determination theory and self-efficacy theory in a physical activity context. *Canadian Psychology/Psychologie Canadienne*, *53*(4), 319.

Tahsildar, N., & KABİRİ, A. (2019). The Relationshıp Between Afghanistan EFL Students' Academic Self-Efficacy and English Language Speaking Anxiety. *Academy Journal of Educational Sciences*, *3*(2), 190–202.

Teacher Academic Support Scale. (2020). *Instruments*. http://stelar.edc.org/instruments/teacher-academic-support-scale

Thébaud, S., & Charles, M. (2018). Segregation, stereotypes, and STEM. *Social Sciences*, *7*(7), 111.

Trowler, V. (2010). Student engagement literature review. *The Higher Education Academy*, *11*(1), 1–15.

Umbach, P. D., & Wawrzynski, M. R. (2005). Faculty do matter: The role of college faculty in student learning and engagement. *Research in Higher Education*, *46*(2), 153–184.

Vallerand, R. J., & Bissonnette, R. (1992). Intrinsic, extrinsic, and amotivational styles as predictors of behavior: A prospective study. *Journal of Personality*, *60*(3), 599–620. https://doi.org/10.1111/j.1467-6494.1992.tb00922.x

Vallerand, R., Pelletier, L., Blais, M., Brière, N., Senécal, C., & Vallieres, E. (1992). The Academic Motivation Scale: A Measure of Intrinsic, Extrinsic, and Amotivation in Education. *Educational and Psychological Measurement*, *52*, 1003–1003. https://doi.org/10.1177/0013164492052004025

van Valderen, R. (n.d.). *Academic Procrastination: The relationship between academic procrastination*.

VanLEHN, K. (2011). The Relative Effectiveness of Human Tutoring, Intelligent Tutoring Systems, and Other Tutoring Systems. *Educational Psychologist*, *46*(4), 197–221. https://doi.org/10.1080/00461520.2011.611369

Voke, H. (2002). Motivating students to learn. *ASCD Infobrief*, *2*(28).

Vroom, V. H. (1964). *Work and motivation.*

Wiggins, B. L., Eddy, S. L., Wener-Fligner, L., Freisem, K., Grunspan, D. Z., Theobald, E. J., Timbrook, J., & Crowe, A. J. (2017). ASPECT: A survey to assess student perspective of engagement in an active-learning classroom. *CBE—Life Sciences Education*, *16*(2), ar32.

Wilson, B. C., & Shrock, S. (2001). Contributing to success in an introductory computer science course: A study of twelve factors. In *SIGCSE Bull.* (Vol. 33, Issue 1, pp. 184–188). Association for Computing Machinery.

Zinovieva, I. S., Artemchuk, V. O., Iatsyshyn, A. V., Popov, O. O., Kovach, V. O., Iatsyshyn, A. V., Romanenko, Y. O., & Radchenko, O. V. (2021). The use of online coding platforms as additional distance tools in programming education. *Journal of Physics: Conference Series*, *1840*(1), 012029.

Appendices

Survey

ADULT ONLINE CONSENT TO PARTICIPATE IN A RESEARCH STUDY *The Role of Gamification in Promoting Student Success in Introductory College Programming Classes*

SUMMARY INFORMATION

Things you should know about this study:

Purpose: *The purpose of the study is to study computer programming tools and student motivation.*

Procedures*: If you choose to participate, you will be asked to answer survey questions about your class.*

Duration: *This will take about 30 minutes.*

Risks*: The main risk or discomfort from this research is the possibility of discomfort associated with answering questions on a survey and reflecting upon some challenging computer programming questions.*

Benefits: *The main benefit to you from this research is to reflect upon your motivations for studying computer programming.*

Alternatives: *There are no known alternatives available to you other than not taking part in this study.*

Participation: *Taking part in this research project is voluntary.*

Please carefully read the entire document before agreeing to participate.

PURPOSE OF THE STUDY *The purpose of this study is to understand more about motivation and platforms used to study computer programming.*

NUMBER OF STUDY PARTICIPANTS *If you decide to be in this study, you will be one of 150-200 people in this research study.*

DURATION OF THE STUDY *Your participation will involve approximately 30 minutes or less.*

PROCEDURES *If you agree to be in the study, we will ask you to do the following things: · Participants will answer survey questions about their study habits. · Participants will answer questions about their motivation. · Participants will be asked about their level of interest in computer programming.*

RISKS AND/OR DISCOMFORTS *The study has the following possible risks to you: the possibility of discomfort in answering computer programming questions. Although you must answer the questions on your own during the survey, following completion of the survey you are free to investigate the topics you were unable to answer.*

BENEFITS *The study has the following possible benefits to you: there are no benefits to you.*

ALTERNATIVES *There are no known alternatives available to you other than not taking part in this study.*

CONFIDENTIALITY *The records of this study will be kept private and will be protected to the fullest extent provided by law. In any sort of report we might publish, we will not include any* *information that will make it possible to identify you. Research records will be stored securely and only the researcher team will have access to the records. However, your records may be inspected by authorized University or other agents who will also keep the information confidential.*

USE OF YOUR INFORMATION *Your information collected as part of the research will not be used or distributed for future research studies even if identifiers are removed.*

COMPENSATION & COSTS *There are no costs to you for participating in this study.*

RIGHT TO DECLINE OR WITHDRAW *Your participation in this study is voluntary. You are free to participate in the study or withdraw your consent at any time during the study. You will not lose any benefits if you decide not to participate or if you quit the study early. The investigator reserves the right to remove you without your consent at such time that he/she feels it is in the best interest.*

RESEARCHER CONTACT INFORMATION *If you have any questions about the purpose, procedures, or any other issues relating to this research study you may contact me at dfree001@fiu.edu.*

IRB CONTACT INFORMATION *If you would like to talk with someone about your rights of being a subject in this research study or about ethical issues with this research study, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.*

PARTICIPANT AGREEMENT *I have read the information in this consent form and agree to participate in this study. I have had a chance to ask any questions I have about this study, and they have been answered for me. By clicking on the "consent to participate" button below I am providing my informed consent.*

- ○ Consent to participate
- ○ Do not consent to participate

The following questions will ask you to consider some feelings you have about school and computer programming. There will be questions related to how much you already know about programming. Answer to the best of your ability.

Please indicate how true each statement is for you, using the scale below.

	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree
At school, I feel part of a group.	○	○	○	○	○
At school, people involve me in social activities.	○	○	○	○	○
One of the most important aspects of school is the feeling of being part of a community.	○	○	○	○	○
I often feel alone at school.	○	○	○	○	○

Please check one response that best describes you. There are no right or wrong answers.

	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree
I set short-term goals for myself (like finishing all my homework or exercising for an hour).	○	○	○	○	○
I set long-term goals for myself such as earning a college degree or entering a career.	○	○	○	○	○
I imagine what life will be like when I reach my goal.	○	○	○	○	○
My goals are meaningful to me.	○	○	○	○	○
My goals are based on my own interests and plans for the future.	○	○	○	○	○
I set goals to achieve what I think is important.	○	○	○	○	○

My instructor...

	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree
Is interested in my future	○	○	○	○	○
Takes the time to help me get better grades	○	○	○	○	○
Is helpful when I have questions about the course	○	○	○	○	○
Pushes me to succeed	○	○	○	○	○

Using the following scale. Answer, why do you go to college?

	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree
Because with only a high-school degree I would not find a high-paying job later on.	○	○	○	○	○
In order to obtain a more prestigious job later on.	○	○	○	○	○
Because I want to have the 'good life' later on.	○	○	○	○	○
In order to have a better salary later on.	○	○	○	○	○

How much has your experience in this class contributed to your knowledge, skills, and personal development in the following areas?

	Very little	Some	Quite a bit	Very much
Thinking critically and analytically	○	○	○	○
Analyzing numerical and statistical information	○	○	○	○
Solving complex real-world problems	○	○	○	○

Please indicate how true each statement is for you, using the scale below.

	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree
I am able to achieve my goals in this course.	○	○	○	○	○
I am capable of learning the material in this class.	○	○	○	○	○
I expect to do very well in this class.	○	○	○	○	○
My study skills are excellent compared with others in this class.	○	○	○	○	○
I prefer problems that are challenging so I can learn new things.	○	○	○	○	○

	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree
I feel like I am free to decide for myself how to live my life.	◯	◯	◯	◯	◯
My actions are consistent with who I really am.	◯	◯	◯	◯	◯
My decisions represent my most important values and feelings.	◯	◯	◯	◯	◯
My whole self stands behind the decision to study computer programming.	◯	◯	◯	◯	◯
I picked this programming class because I wanted to study it not because others are requiring me to sign up for it.	◯	◯	◯	◯	◯
I go to school because I experience pleasure and satisfaction while learning new things.	◯	◯	◯	◯	◯
I think that what I am learning in this programming class will be useful for me to know.	◯	◯	◯	◯	◯
I signed up for the programming class because	◯	◯	◯	◯	◯

others pressured me to do so.

Please indicate how true each statement is for you, using the scale below.

	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree
People are generally pretty friendly towards me.	○	○	○	○	○
I consider the people I regularly interact with to be my friends	○	○	○	○	○
I often meet classmates I can communicate with during a class.	○	○	○	○	○
People in my life care about me.	○	○	○	○	○
The people I interact with regularly do not seem to like me much.	○	○	○	○	○

How many hours per week do you spend reading about programming and or computer science?

____

Have you studied programming before?

- ○ Yes (1)
- ○ No (2)

Select all the programming languages you have worked with before.

- Java (1)
- C++ (2)
- Javascript (3)
- C# (4)
- Other languages (5)

What programming language are you studying in this class?

- ○ C++ (1)
- ○ Java (2)
- ○ Python (3)
- ○ Other (4)

*

What is/was your college GPA?

____

What is your year of birth?

____

Choose one or more races that you consider yourself to be:

White (1)

Black or African American (2)

American Indian or Alaska Native (3)

Asian (4)

Native Hawaiian or Pacific Islander (5)

Other (6) ____

What is your sex?

○ Male (1)

○ Female (2)

End of Block: Default Question Block

Start of Block: Default Question Block

Please check one response that best describes you. There are no right or wrong answers.

	Disagree (1)	Slightly Disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
Based on everything I know about myself, I believe I can achieve my goals. (13)	○	○	○	○	○
When I set goals, I think about barriers that might get in my way. (14)	○	○	○	○	○
When I'm struggling, I set goals to help me improve. (15)	○	○	○	○	○
I set goals that are challenging but achievable. (16)	○	○	○	○	○
I set short-term goals to help me achieve my long-term goals. (17)	○	○	○	○	○
When setting a goal, I think about my past successes and failures. (18)	○	○	○	○	○
When I set a goal, I am confident that I can meet it. (19)	○	○	○	○	○

Please check one response that best describes you. There are no right or wrong answers.

	Disagree (1)	Slightly Disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
I set goals to help me improve myself. (9)	o	o	o	o	o
I set goals to help me be more successful in school. (10)	o	o	o	o	o
I set goals to help me do my personal best. (11)	o	o	o	o	o
When I want to learn something, I make small goals to track my progress. (12)	o	o	o	o	o
I focus on my own improvement instead of worrying about whether other people are doing better than me. (13)	o	o	o	o	o
Even if I lose a competition, I'm pleased if I have improved. (14)	o	o	o	o	o

End of Block: Default Question Block

Start of Block: Default Question Block

My instructor...

	Disagree (1)	Slightly disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
Expects me to work hard in school (1)	○	○	○	○	○
Tries to answer my questions (2)	○	○	○	○	○
Wants me to do well in school (8)	○	○	○	○	○

End of Block: Default Question Block

Start of Block: Default Question Block

Did you use codewars.com during your programming class?

○ No (1)

○ Yes (2)

Usage of codewars...

	1 (Dislike) (1)	2 (2)	3 (3)	4 (4)	5 (Like) (5)
How much did you enjoy using codewars? (1)	○	○	○	○	○

End of Block: Default Question Block

Start of Block: Default Question Block

Using the scale below, indicate to what extent each of the following items presently corresponds to one of the reasons why you go to college. Why do you go to college?

	Disagree (1)	Slightly disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
Because I experience pleasure and satisfaction while learning new things. (1)	○	○	○	○	○
For the pleasure I experience when I discover new things never seen before. (2)	○	○	○	○	○
For the pleasure that I experience in broadening my knowledge about subjects which appeal to me. (3)	○	○	○	○	○
Because my studies allow me to continue to learn about many things that interest me. (4)	○	○	○	○	○

Using the scale below, indicate to what extent each of the following items presently corresponds to one of the reasons why you go to college. Why do you go to college?

	Disagree (1)	Slightly disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
For the pleasure I experience while surpassing myself in my studies. (1)	○	○	○	○	○
For the pleasure that I experience while I am surpassing myself in one of my personal accomplishments. (2)	○	○	○	○	○
For the satisfaction I feel when I am in the process of accomplishing difficult academic activities. (3)	○	○	○	○	○
Because college allows me to experience a personal satisfaction in my quest for excellence in my studies. (4)	○	○	○	○	○

Using the scale below, indicate to what extent each of the following items presently corresponds to one of the reasons why you go to college. Why do you go to college?

	Disagree (1)	Slightly disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
For the intense feelings I experience when I am communicating my own ideas to others. (1)	o	o	o	o	o
For the pleasure that I experience when I read interesting authors. (2)	o	o	o	o	o
For the pleasure that I experience when I feel completely absorbed by what certain authors have written. (3)	o	o	o	o	o
For the "high" feeling that I experience while reading about various interesting subjects. (4)	o	o	o	o	o

Using the scale below, indicate to what extent each of the following items presently corresponds to one of the reasons why you go to college. Why do you go to college?

	Disagree (1)	Slightly disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
Because I think that a college education will help me better prepare for the career I have chosen. (1)	○	○	○	○	○
Because eventually it will enable me to enter the job market in a field that I like. (2)	○	○	○	○	○
Because this will help me make a better choice regarding my career orientation. (3)	○	○	○	○	○
Because I believe that a few additional years of education will improve my competence as a worker. (4)	○	○	○	○	○

Using the scale below, indicate to what extent each of the following items presently corresponds to one of the reasons why you go to college. Why do you go to college?

	Disagree (1)	Slightly disagree (2)	Neither agree nor disagree (3)	Slightly agree (4)	Agree (5)
To prove to myself that I am capable of completing my college degree. (1)	○	○	○	○	○
Because of the fact that when I succeed in college I feel important. (2)	○	○	○	○	○
To show myself that I am an intelligent person. (3)	○	○	○	○	○
Because I want to show myself that I can succeed in my studies. (4)	○	○	○	○	○

End of Block: Default Question Block

Start of Block: Block 5

During the current school year, about how often have you done the following?

	Never (1)	Sometimes (2)	Often (3)	Very often (4)
Asked questions or contributed to course discussions in other ways. (1)	○	○	○	○
Asked another student to help you understand course material. (2)	○	○	○	○
Explained course material to one or more students. (3)	○	○	○	○
Prepared for exams by discussing or working through course materials with other students. (4)	○	○	○	○
Connected ideas from your courses to your prior experiences and knowledge. (5)	○	○	○	○
Talked about career plans with a faculty member. (6)	○	○	○	○
During the current class, how often have you analyzed an idea or line of reasoning in depth by examining its parts? (7)	○	○	○	○
During the current class have you formed a new idea or understanding from various pieces of information? (8)	○	○	○	○
During the current class, about how often have you evaluated what others have concluded from numerical information? (9)	○	○	○	○
During the current class, about how often have you summarized what you learned in class or from course materials? (10)	○	○	○	○

Challenge

	Not at all 1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	Very much 7 (7)
During the current school year, to what extent have your courses challenged you to do your best work? (1)	○	○	○	○	○	○	○

How much did your class emphasize the following?

	Very little (1)	Some (2)	Quite a bit (3)	Very much (4)
Spending significant amounts of time studying and on academic work (1)	○	○	○	○
Providing support to help students succeed academically (2)	○	○	○	○

About how many hours do you spend in a typical 7-day week doing the following?

	0 (1)	1-5 (2)	6-10 (3)	11-15 (4)	16-20 (5)	21-25 (6)	26-30 (7)	More than 30 (8)
Preparing for class (1)	○	○	○	○	○	○	○	○
Participating in hobbies (2)	○	○	○	○	○	○	○	○
Working for pay (3)	○	○	○	○	○	○	○	○
Doing community service or volunteer work (4)	○	○	○	○	○	○	○	○
Relaxing and socializing (5)	○	○	○	○	○	○	○	○
Providing care for family members (6)	○	○	○	○	○	○	○	○

How much has your experience in this class contributed to your knowledge, skills, and personal development in the following areas?

	Very little (1)	Some (2)	Quite a bit (3)	Very much (4)
Acquiring job or work-related skills (3)	○	○	○	○
Working effectively with others (4)	○	○	○	○

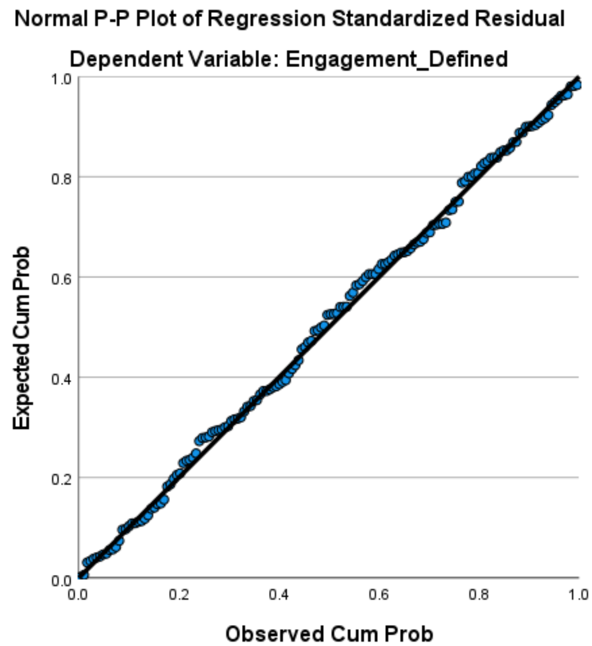
End of Block: Block 5

Table 20 Cross loadings for main study.

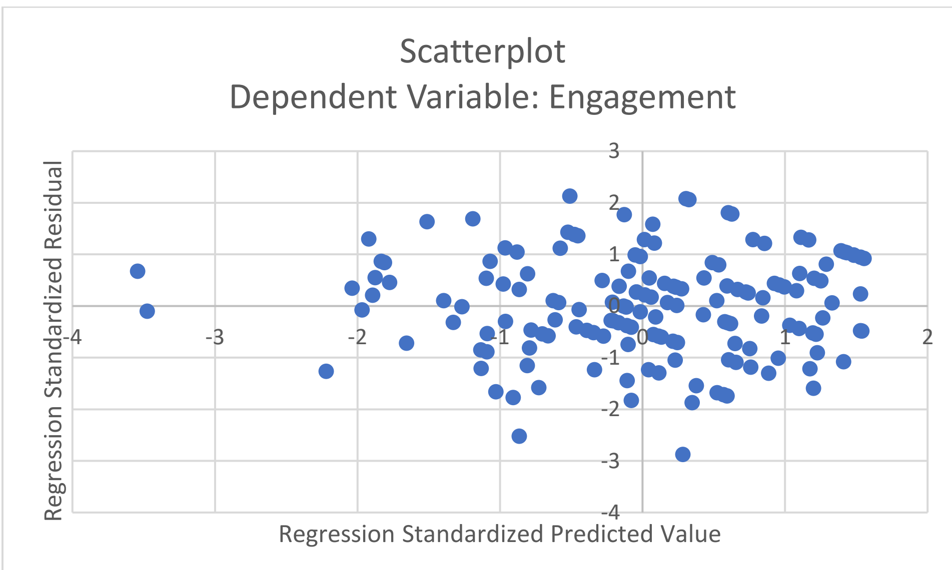
Structure Matrix

	Factor								
	Introjected	Instructor Invested	Experience Stimulation	Learning Engagement	Student Engagement	Competence	Relatedness	Meaningful Goals	External Regulation
EM_IJ_4	0.846		0.306						0.301
EM_IJ_2	0.846		0.317						0.351
EM_IJ_3	0.829								
EM_IJ_1	0.783								0.352
II_4		0.847		0.393	0.365	0.344			
II_2		0.803		0.418		0.328			
II_3		0.803		0.315		0.383			
II_1		0.749		0.487	0.390	0.443			
IM_ES_3	0.336		0.950		0.315		0.308		
IM_ES_2			0.890				0.370		
IM_ES_4	0.316		0.726		0.333		0.380		
LE_3		0.353		0.841		0.495	0.306		
LE_1		0.454		0.836		0.515			
LE_2		0.401		0.819		0.502			
StudentEngagement_8		0.374			0.934	0.345			
StudentEngagement_7		0.309	0.322		0.762				
StudentEngagement_9			0.332		0.641				
IM_C_2		0.399		0.486		0.864			
IM_C_3				0.500	0.312	0.809	0.336	0.407	
IM_C_1		0.467		0.528	0.359	0.776			
IM_R_1							0.829		
IM_R_2			0.354				0.822		
IM_R_2_3			0.356	0.375	0.327		0.680		
MG_4						0.310		0.822	
MG_6				0.334		0.367		0.756	
MG_5								0.678	
ER_2	0.378								0.840
ER_4	0.368								0.724
ER_1									0.678

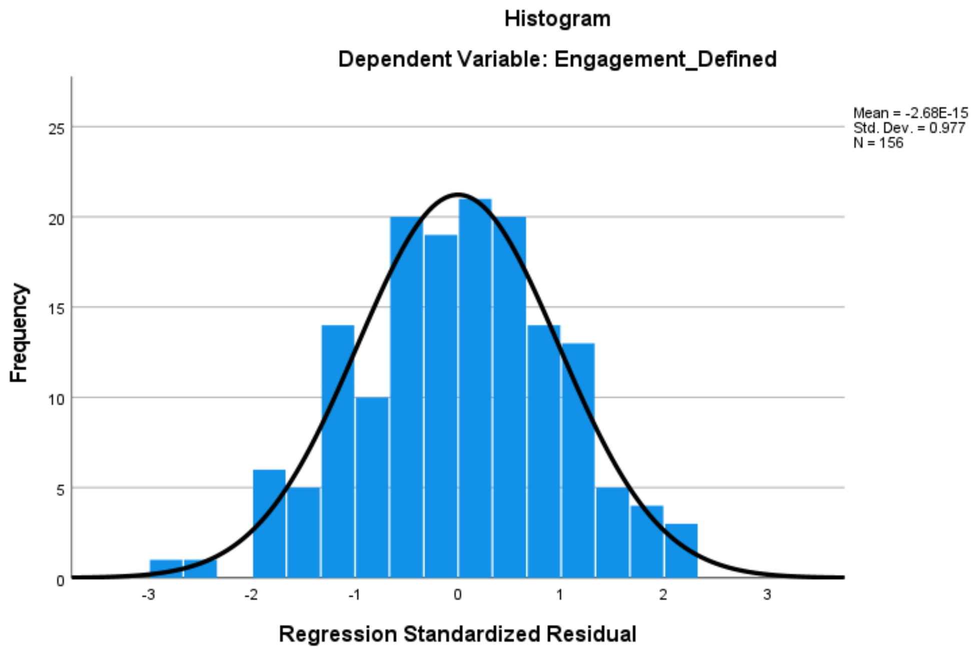
Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.



Normal P-P Plot of Regression Standardized Residual
Dependent Variable: Engagement_Defined
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0



Scatterplot
Dependent Variable: Engagement
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
-1
-2
-3
-4
-3
-2
-1
0
1
2


Histogram
Dependent Variable: Engagement_Defined
Mean = -2.68E-15
Std. Dev. = 0.977
N = 156
Frequency
25
20
15
10
5
0
-3
-2
-1
0
1
2
3
Regression Standardized Residual

VITA

DAVID FREER

1997-2001	Bachelors in Economics, University of Florida Gainesville, Florida
2001-2003	Masters in Decision and Information Science University of Florida Gainesville, Florida
2002-2003	Programmer, General Clinical Research Center Gainesville, Florida
2003-2016	AP Economics Teacher Miami Killian Senior High Miami, Florida
2017-Present	Programming Professor Miami Dade College Miami, Florida