Intention to Remain in a Computing Program: Exploring the Role of Passion and Grit

Full Paper

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Abstract

While there are many educational initiatives to promote computer programming (or coding)—the core of an IT major—to the masses of incoming students, we lack pedagogical strategies to retain IT students. This study explores how harmonious passion, obsessive passion, and grit influence computer programming attitude (i.e., coding affect, cognition and behavior), which can lead to student retention. Based on data collected from 109 undergraduate IT students enrolled in a programming course, our exploratory study reveals that harmonious passion leads to positive coding affect and cognition. Obsessive passion has a negative effect on coding affect but contributes significantly to coding behavior. The finding also shows that students who in a variety of coding behaviors are fueled by harmonious and obsessive passion, and grit. Coding affect and behaviors, therefore influence the intention to stay an IT major, suggesting that educators can change students' computer programming attitude by fostering harmonious passion and grit as they engage in programming activities.

Keywords

Attitude, Grit, Computer Programming, Passion, Retention

Introduction

Computer programming is typically required for students in Information Technology (IT). IT or computing degree programs include Computer Engineering, Computer Science, Information Systems, Information Technology, and Software Engineering (Shackelford et al., 2005). These computing programs are experiencing an upswing in enrollments (Gordon, 2016), a phenomenon that was observed in the mid 1980's and also in the late 1990's, but for different reasons—required course and personal interests—compared to the current upswing (Camp and Stout, 2016). One common denominator between these high and low enrollment cycles, however, is the low retention rate from computing programs. Freshman classes are usually large, and attrition rates between the freshman and sophomore years are as high as 30 to 40% (Beaubouef and Mason, 2005). Educators have attempted to understand the problem and have suggested ways to improve retention of minorities in computing programs (Varol and Varol, 2014).

Computer programs that emphasize introductory to intermediate (or advanced) programming courses generally fall under the Accreditation Board for Engineering and Technology (ABET)'s Computing

Accreditation Commission (CAC). With emphasis on programming, there is a strong correlation between successful completion of introductory computer programming course(s) and successful completion of the program (Brown, 2013). Unfortunately, in some programs, introductory programming courses are seen as "weed out" classes for those who want to major in an IT area.

While the role of the learners' intelligence, motivation and time management skills can determine one's success in a computing program, the role of personality traits, i.e., passion and grit in computer programing, remains unexplored. The purpose of our study is to understand what role the learners' characteristics and personalities play in their intention to stay in a computing program after taking a computer programming course. We examine the role of learners' harmonious passion, obsessive passion, and grit in their computer programming attitude, which can lead to their intention to stay within the IT discipline.

Our exploratory study proposed three constructs drawn from the psychology discipline. We believe our findings have both theoretical and practical value. Aside from a new proposed model for predicting retention rates in computing programs, educators can use the understanding of grit and passion to recruit potential students and help them make informed career decisions.

In the section that follows, we look at computer programming courses taught in an ABET-accredited school, i.e., computer science (CS) and information systems (IS), how programming is taught, the challenges of learning computer programming, and suggestions for how to improve the learning process in order to improve retention rates. This section is followed by sections on the theoretical development of our study, the research methodology, the findings, and a discussion of the results. The discussion concludes by suggesting future research possibilities.

Background

Programming is one of the courses that students encounter first in the computing curriculum at their university. Programming is a very useful skill and can lead to a rewarding career. However, learning to write computer programs can be difficult. It is generally accepted that it takes about 10 years of experience to turn a novice into an expert programmer (Winslow, 1996). In general, introductory programming courses focus on teaching several major high-level programming languages such as C, C++, C#, Java, Python and Visual Basic. Generally, students are required to pass these core courses in order to continue in the program.

A number of teaching approaches are used in computer programming courses. The traditional teaching approach is primarily instructor-led and instructor centered. Generally, the instructor explains the contents of the topic in class, assigns a programming exercise, and after the students complete the assignment, the instructor gives them feedback. The active learning approach involves activities such as mini-lectures, active exercises, and peer learning (Zhang and Zhang, 2011). It may include what is called a flipped class, in which students watch instructional videos before coming to class and then apply the concepts with the help of their instructor.

Other studies that looked at female student retention have made a number of teaching recommendations, several of which are mentioned by Varol and Varol (2014). First, students who do not feel like they are part of the larger academic community can be encouraged through a suite of mobile and internet games which aim to facilitate social networking between members of a group. The second recommendation is to decrease the "computer guru" culture and make programming courses less intimidating by using teaching methods that make programming fun instead of a big challenge. Third is to introduce students to research in new media and computer graphics, complementing computer programming, and fourth is to use pair programming, or Peer Led Team Learning (PLTL) approaches (Varol and Varol 2014). These four suggestions for computer programming teaching interventions have been recommended to improve student retention in computing courses.

In addition, this study explores the effect of personality on learners' attitudes towards computer programming, and ultimately their decision to stay or leave the Information Technology program. Experience from teaching computer programming courses has shown us that struggling students who do not give up, but keep on working hard, succeed in passing the course. This type of student communicates with the instructor on regular basis with questions and regularly comes to see the instructor's office. Such

students show a determination and dedication towards succeeding. We therefore argue that the learners' personality influences whether they succeed in the course. Specifically, our study examines the effects of the learners' personality type in terms of the "harmonious passion," "obsessive passion," and "grit" on their computer programming attitude (i.e., "affect," "cognition," and "behavior") affects their decision to stay in or leave the program. This study seeks to clarify the following research questions:

a. *Does the learners' personality have an effect on their computer programming attitude?*

b. *Does the learners' computer programming attitude have an effect on their intention to remain in an IT major?*

Theoretical Development

Our study focuses on the learners' characteristics and personality as the predictors of computer programming attitude, which in turn influences their intention to stay within their chosen major. Our research model shows that the two types of passion and grit are the antecedents leading to computer programming attitude, which in turn determines the likelihood of remaining in a computing program.
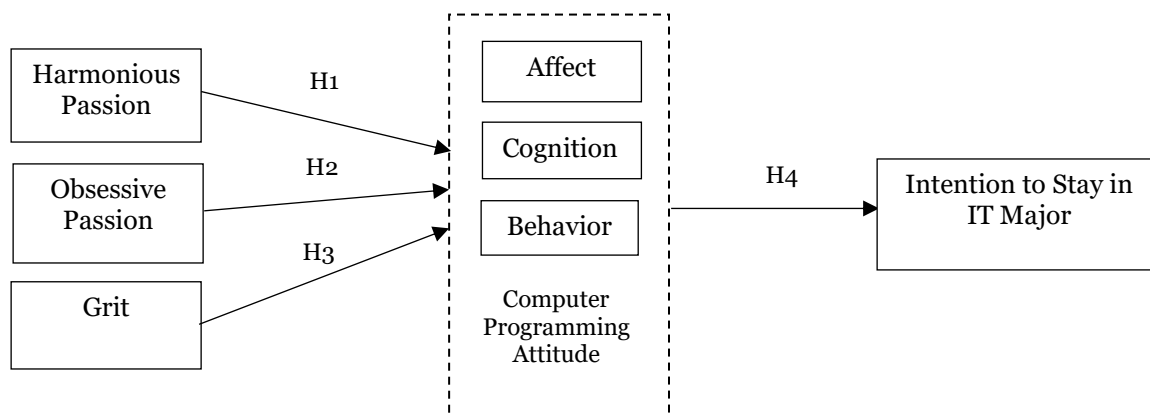

Figure 1. shows our proposed research model

Harmonious passion

Research on passion has been linked to work performance. Organizational studies show that when we are passionate about something, we are internally motivated and seek to associate our identity with it (Vallerand et al., 2003). Passionate employees are focused, driven, enthusiastic, persistent and dedicated; they will spend more time and energy on activities that are important to them (Perrewé et al., 2014). The object of one's passion helps define one's persona and becomes the person's identity (Vallerand et al., 2003). This study follows the dualistic model of passion proposed by Vallerand et al. (2003)—harmonious and obsessive passion. Recent meta-analyses of the constructs show that harmonious passion is positively related to affective, cognitive, and motivational outcomes while obsessive passion exhibits negative relationships to those outcomes (Curran et al., 2015).

Harmonious passion refers to "a strong desire to freely engage in the activity and results from an *autonomous* internalization of the passion into the person's identity (Marsh et al., 2013). According to the researchers, people with harmonious passion do not feel pressured to perform the activity in question, as it aligns with their lives. Lavigne et al. (2014) reveal that harmonious passion for teaching is related to positive perceptions at work—higher levels of job control and supervisor support and lower levels of work load; obsessive passion, on the other hand, leads to perceptions of a higher level of work load. Start-up entrepreneurs with harmonious passion are significantly satisfied with their work (Thorgren et al., 2013).

Harmonious passion is positively related to activity engagement, positive emotions, autonomy, and voluntary behaviors (Mageau et al., 2009; Marsh et al., 2013; Zhang et al., 2014). We argue that students who exhibit harmonious passion for coding engage in coding voluntarily, for the fun of it; they are internally driven. Therefore, we propose that harmonious passion for coding has a positive influence on all three-subscales of computer programming attitude.

> *H1a: Harmonious passion has a positive influence on coding affect.*
>
> *H1b: Harmonious passion has a positive influence on coding cognition.*
>
> *H1c: Harmonious passion has a positive influence on coding behavior.*

Obsessive passion

Obsessive passion is often in conflict with other aspects of one's life. It occurs in "controlled" situations; that is, it is motivated by external intrapersonal and/or personal pressure to be accepted by peers or society (Marsh et al., 2013). Obsessive passion is associated with the process of building self-worth or of obligation to engage in an activity. Donahue et al. (2012) find that professional coaches and nurses with obsessive passion have an increased level of rumination and emotional exhaustion from work. Addictive online gaming behaviors are related to obsessive passion (Chu and Wang, 2007). Obsessive passion, therefore, reflects involuntary control as one pursues the IT major, computer programming being one of the core requirements. Therefore, we propose that increased obsessive passion for coding has a negative influence on all three-subscales of computer programming attitude.

> *H2a: Obsessive passion has a negative influence on coding affect.*
>
> *H2b: Obsessive passion has a negative influence on coding cognition.*
>
> *H2c: Obsessive passion has a negative influence on coding behavior.*

Grit

"Grit," which has recently become an educational buzzword, is one's ability to sustain long-term interest in an effort to complete an ongoing task; it is a combination of "perseverance of effort" and "consistency of interests" (Duckworth and Quinn, 2009). To be successful in an introductory programming class, students must engage in a semester-long practice of coding. One cannot cram a coding assignment prior to the deadline; learning a programming language for the first time is similar to learning a verbal language, which required continual practice. Duckworth and Quinn (2009) reveal that grit is related educational achievement. Since grit is one's ability to sustain long-term interest in an effort to complete an ongoing task, "grittier" students should have a tendency to work hard toward completing their programming assignments. IT students must maintain a positive computer programming attitude by working diligently and focusing unceasingly on completing their coding assignments. By fixating on their long-term graduation goal, gritty students are less likely to divert their attention to other distractions, make fewer career changes, and study for longer hours (Duckworth et al., 2007). Wolters and Hussain (2015) find that grittier students have a tendency to be self-motivated and are less likely to procrastinate. Hence, we reason that grit has a positive influence on affect, cognition, and behavior related to computer programming.

> *H3a: Grit has a positive influence on coding affect.*
>
> *H3b: Grit has a positive influence on coding cognition.*
>
> *H3c: Grit has a positive influence on coding behavior.*

Computer programming attitude

Attitude is the predictor of behavioral intention (Ajzen, 1991; Davis et al., 1989). Attitude also is one of the major predictors of retention. Johnson et al. (2008) confirm that attitudes toward jobs in IT significantly

determine intention to pursue a career in IT. Using the Theory of Planned Behavior (Ajzen, 1991), Kaltenecker et al. (2015) investigate the drivers of entrepreneurial intentions among IT students and find that attitude strongly predicts intention. We argue that students who have positive emotions toward coding, who understand the importance of computer programming, and who actually take an effort to code, will have a higher tendency to stay within the IT major. Therefore, we propose:

> *H4a: Coding affect has a positive influence on intention to stay within the IT major.*
>
> *H4b: Coding cognition has a positive influence on intention to stay within the IT major.*
>
> *H4c: Coding behavior has a positive influence on intention to stay within the IT major.*

Methodology

Prior to data collection, a pilot study was conducted with a group of undergraduate IT students (n=30) who had successfully completed the basic Java programming class. All measurable items (Duckworth et al., 2007; Vallerand et al., 2003) were modified to fit the characteristics of computer programming activities and pilot tested, with the exception of the Computer Programing Attitude Scale (Cetin and Ozden, 2015), which was used in its original form. After the pilot test, we modified or rephrased the items that showed cross-loadings or unrelated loadings.

Instrument

We used 5-point Likert scales (1 = *strongly disagree* to 5 = *strongly agree*) to capture harmonious and obsessive passion for coding. Sample items of harmonious passion for coding (HP) statements included, "Computer programming allows me to learn a variety of skills," and "The new things that I learn with computer programming allow me to appreciate the IT major even more." However, we had to eliminate three items from harmonious passion due to significant cross factor loadings with obsessive passion, leaving us with an alpha of .682. Sample items for obsessive passion for coding (OP) were "I have difficulty imagining my career without computer programming," and "I am emotionally dependent on computer programming" (Cronbach's alpha=.749). To measure grit (GR)—the trait-level "perseverance of effort" and "consistency of interest"— we used a 12-Item Grit Scale anchored by 5 = v*ery much like me* to 1 = *not like me at all* (Duckworth, et al., 2007) with some modifications to fit programming activities, such as "I have overcome setbacks to conquer a programming challenge," "Setbacks don't discourage me from doing computer programming," and "I finish a programming assignment (or exercise) whenever I begin." The Computer Programing Attitude Scale has three sub-scales, capturing three sub-dimensions of computer programming attitude: affect (AF), cognition (CG), and behavior (BH) (Cetin and Ozden, 2015). Respondents were asked to indicate, based on a 5-point Likert scale (1=*strongly disagree* to 5 = *strongly agree*), the extent to which (1) they liked programming (AF, Cronbach's alpha=.877), (2) programming was beneficial (CG, Cronbach's alpha=.584), and (3) they engaged in programming (BH, Cronbach's alpha=.723). Intention to stay within the IT major (ISIT) was captured by asking the respondents how likely (1=*very likely* to 5=*very unlikely*) they were to switch to a non-IT major in the next 12 months. All in all, harmonious passion (HP) and cognition (CG) fell on the lower limit of reliability; an alpha value of .60 is found in exploratory research (Robinson et al., 1991).

Sample

We solicited undergraduate students enrolled in their first programming classes at the end of fall 2016. Bonus credits were given to the students who completed the survey; however, from an approximate total of 250 students taking the class, there were only 188 responses. After dropping incomplete responses, the study had 178 completed surveys—a response rate of 71%. We also eliminated non-targeted respondents— three graduate students, sixty-two non-IT majors, and four Telecommunication Management students. The remaining 109 respondents include 56 Computer Science (CS) and 53 Information Systems (IS) majors. The results of chi-square tests indicate no significant differences between the two groups in GPA (χ^2=.688, *p*=.332) and academic levels (χ^2=.915, *p*=.822). Approximately 94 percent of the respondents are male.

Procedure and Hypothesis Testing

The study addressed multicollinearity through principle component analysis (PCA), which identified any significant cross-loadings among questionnaire items. To verify the computer programing attitude, we used on oblique rotation technique, allowing its subscales to correlate as parts of the Computer Programming Attitude Scale (Cetin & Ozden, 2015). The results confirmed that the Computer Programming Attitude Scale is a multi-dimensional scale composed of affect, cognition, and behavior, as shown in Appendix A. Then, using an orthogonal rotation technique, we performed another PCA on the predictor variables and each of the computer programming attitude sub-scale. Through the process of eliminating cross-factor loadings (>.55), the final PCA revealed three distinct constructs. The "grit" measurement follows the calculation procedure suggested by Duckworth et al. (2007), while "intention to switch major" is based on a single 5-point Likert-scale. Appendix A shows the final survey items used in this study.

We tested the proposed hypotheses by performing multiple regression analyses: (a) regressing each sub-set of the computer programing attitude, i.e., AF, CG, and BH, on the predictor variables, i.e., HP, OP, and GR; and (b) regressing intention to stay in an IT major (ISIT) on the sub-scales of the computer programming attitude.

Results

The results from the first set of regression runs show that approximately 29 percent of the variance in affect (AF) can be explained by grit (GR) (t=5.06, p<.001), harmonious passion (t=2.14, p=.018), and obsessive passion (OP) (t=-2.03, p=.045); thereby supporting H1a, H2a and H3a (F= 14.21; p<0.001). Harmonious passion (HP) (t=4.43, p<.001) explains about 23 percent of the variance in cognition (CG), supporting H1b (F=8.19, p<.001) and rejecting H2b and H3b.

Nearly 45 percent of the variance in behavior (BH) can be predicted by the model (F=28.29, p<.001), demonstrating the significant contribution of obsessive passion (OP) (t=4.99, p<.000) and grit (GR) (t=4.19, p<.001) on computer programing behavior (BH); therefore, we accept H2c and H3c and reject H1c. The second regression analysis shows that approximately 38 percent of the variance in intention to stay (ISIT) can explained by affect (AF) (t=6.35, p<.001) and behavior (BH) (t= 2.30, p=.023), which confirms H4a and H4c (F=21.58; p<.001) and rejects H4b. Table 1 summarizes the results. Figure 2 illustrates the results of our hypothesis testing (only significant paths are shown) with standardized coefficients and significance.

Proposed Hypotheses	Hypothesis Tests	Result
H1: Harmonious Passion (HP) → Attitude	H1a: HP → AF	Accept
	H1b: HP → CG	Accept
	H1c: HP → BH	***Reject***
H2: Obsessive Passion (OP) → Attitude	H2a: OP → AF	Accept
	H2b: OP → CG	***Reject***
	H2c: OP → BH	Accept (+)
H3: Grit (GR) → Attitude	H3a: GR → AF	Accept
	H3b: GR → CG	***Reject***
	H3c: GR → BH	Accept
H4: Attitude → Intention to Stay	H4a: AF → ISIT	Accept
	H4b: CG → ISIT	***Reject***
	H4c: BH → ISIT	Accept

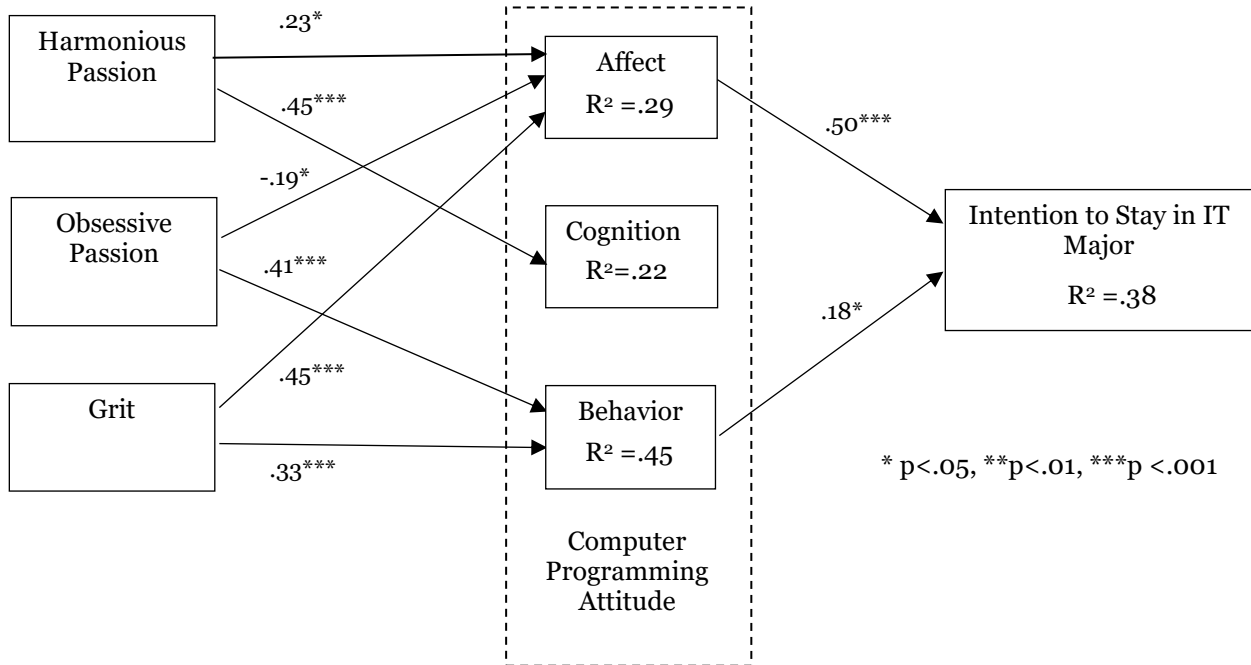**Table 1. Results from Hypothesis Testing**

Figure 2. Standardized Coefficients of Significance Paths and R²

Findings

Harmonious passion leads to coding affect and cognition. Obsessive passion negatively predicts affect; and contrary to our proposed H2C, it *positively* influences coding behavior. The findings echo previous studies, showing that the two types of passion have different outcomes. Thorgren et al. (2013) show similar findings; that is, harmonious passion is positively related to off-task thoughts at work but obsessive passion is negatively related to it. Grit leads coding affect and behavior. Intention to stay in the IT major can be predicted by coding affect and behavior. Passion and grit provide sufficient predictability for computer programming attitude and retention.

Discussion and Implications

There are several insightful implications from this study. First, the findings support the dualistic model of passion (Vallerand et al., 2003). Although we can say that harmonious passion leads to positive outcomes, each type of passion influences computer programming attitude in its own way. The findings show that harmonious and obsessive passion work in tandem to sustain students' attitude towards computer programming; harmonious passion or obsessive passion alone may not help a student to become a successful programmer. Harmonious passion, as well as cognition, builds a positive feeling but obsessive passion reduces it. However, the reduction in coding affect caused by obsessive passion is not so detrimental to attitude since obsessive passion strongly reinforces the coding behavior (see Figure 2). And since coding affect and behavior clearly predict intention to stay in the major, educators can foster or increase harmonious passion by fostering learner-centered assignments or projects that students are passionate about.

Second, as shown in Figure 2, grit, which fervently predicts coding affect and behavior, can compensate for the negative effect of obsessive passion on coding affect. Other than passion, persevering in a semester-long practice of coding, with the ability to remain focused until a coding project (or a set of coding assignments) is completed, characterizes a gritty student. For less gritty students, educators can provide "scaffolding" support for difficult assignments. Moreover, dividing large, complex coding assignments into manageable chunks can motivate students to complete the assignments, resulting in an increased level of coding affect. In other words, for less gritty students, building both types of passion could be an alternative motivational strategy to increase student retention.

Third, obsessive passion occurs under involuntary control and is motivated by social factors (Curran et al. 2015). However, fueling obsessive passion for the sake of learning is a double-edged sword: obsessive passion increases the level of coding behavior but also reduces the level of coding affect (see Figure 2). And since coding affect has a much higher magnitude than behavior in predicting intention to stay, we can use grit along with harmonious passion to change computer programming attitude. Another way to increase the level of obsessive passion without creating too undesirable an impact on computer programming attitude is through establishment of IT student clubs or online social communities, allowing optimistic social pressure to exert its influence.

Lastly, for instructors and administrators in computing departments, other psychological factors, e.g., cognitive and analytical abilities, self-efficacy, locus of control, mindset, as well as other social and pedagogical strategies can influence computer programing attitude and retention (Varol and Varol, 2014; Zhang and Zhang, 2011). The findings from our modest research model can be used to recruit and assess the students' personality a few weeks into the semester and adjustments made accordingly. Such adjustments may include communication of the benefits of learning computer programming and career prospects, and modifications in the style of teaching.

Conclusion

Retaining IT students within their chosen major is a challenge. Computer programming can be difficult for some students. This study points out that a better understanding of passion and grit can help change students' computer programming attitude leading to the intention to remain in the IT major. The study also reveals that emerging psychological constructs—harmonious passion, obsessive passion, and grit—play an intricate role in teaching and learning, especially when students are exposed to new and difficult learning concepts such as computer programming.

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APPENDIX - Final Survey Items

Computer Programming Attitude Scale *(taken from Cetin & Ozden, 2015)*
Affect (alpha=.877)
> Aff1: I find programming frustrating (R)
> Aff2: I think program-writing is unnecessary (R) (dropped)
> Aff3: Program-writing is boring (R)
> Aff4: Programming-related activities make me nervous (R)
> Aff5: I get really bored when I start writing a program (R)
> Aff6: The very idea of code-writing makes me nervous (R)

Cognition (alpha=.584)
> Cog1: Programming is a distinguish skills (dropped)
> Cog2: Programming has no significant in daily life (R) (dropped)
> Cog3: Programming makes human life easier
> Cog4: I feel nervous while writing programs (dropped)
> Cog5: Programming improves your problem-solving skills
> Cog6: I think that many problems that remain unsolved in our age will be solved thanks to the advances in programming

Behavior (alpha=.723)
> Beh1: I always strive to write a better program
> Beh2: If I encounter a program that I cannot solve in the short term while writing a program, I do not give up until I solve it
> Beh3: I take part in programming projects if I get the chance
> Beh4: I do research in order to be a good programmer (dropped)
> Beh5: Once I start working on a computer program, I try to finish it before anything else
> Beh6: I follow the developments in programming

Grit *(adapted from Duckworth et al., 2007)*
> 12-Item Grit Scale with all items added and divided by 12. See reference

Intention to Stay in IT Major*
> It is likely that I will switch to a non-IT major in the next 12 months (R).
> * *ABET-accredited Computer Science (CS) and Information Systems (IS) programs.*

Passion *(adapted from Vallerand et al., 2003)*
Harmonious Passion (alpha=.682)
> Hp1: Computer programming allows me to learn a variety of skills
> Hp2: The new things that I learn with computer programming allow me to appreciate IT major even more
> Hp3: Computer programming reflects the qualities I like about myself (dropped)
> Hp4: Computer programming is in harmony with my other activities in the IT major (dropped)
> Hp5: Computer programming is a passion that I still manage to control (dropped)

Obsessive Passion (alpha=.749)
> Op1: The urge is so strong. I cannot help myself from engaging in computer programming (dropped)
> Op2: I have difficulty imagining my career without computer programming
> Op3: I am emotionally dependent on computer programming
> Op4: An IT major cannot exist without computer programming (dropped)
> Op5: I cannot help myself from engaging in computer programming