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Expectancy Value Theory as an Interpretive Lens to Describe Factors that Influence Computer Science Enrollments and Careers for Korean High School Students

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ABSTRACT

To ensure a robust pipeline of computer scientists worldwide, male and female students must perceive computer science (CS) as a viable field of study and career. Using expectancy-value theory (EVT) as an interpretive framework, this paper reports on a descriptive case study conducted within a CS course in a private, international high school in South Korea to illuminate factors that influenced student (N=10) enrollment in the class and assessments of CS careers. EVT was chosen as a validated model to understand how students' perceptions and choices influence the value and future participation in an activity (like CS). Data was collected from questionnaires, journal entries, essays, and class discussions over a ten-day unit exploring careers in CS. Data was coded using constructs of expectancy-value theory and informed themes for analysis. Factors that influenced sampled students to enroll in the high school CS class included interests in technology and society, perceived difficulty (challenge), interest in math and science, cultural influences, and wanting early exposure to CS content. Career aspirations in CS illustrated both desirable (i.e., broad applications of CS, positive societal impacts, leveraging creativity) and undesirable (i.e., high ability for CS, stifling of creativity) aspects of CS careers. Gender differences showed that only males (n=7) held negative views of creativity and females (n=3) made connections between CS content and other career fields. The difference shows that attracting more gender diversity means focusing on different interventions for males and females. Half of the students (n=5) reported that learning about CS careers changed prior negative perceptions, suggesting CS career information is important for students to develop accurate value judgments of CS.

Keywords: computer science education; expectancy-value theory; secondary education; STEM careers

Introduction

According to the Bureau of Labor and Statistics (2014) projections for 2014 to 2024, computing jobs or jobs that require knowledge in computer programming, software, and/or hardware, will make up 66% of all Science, Technology, Engineering and Mathematics (STEM) based jobs in the United States. Despite this, only 10% of college STEM majors are in the Computer Science (CS) field (Code.org, 2018). While much attention has been given to STEM in the research arena (Georgiou & Ioannou, 2019; Honey, Pearson, & Schweingruber, 2014; National Academies of Sciences, 2018; 2019) a dearth of literature remains on K-12 CS research, despite its growing need in the United States STEM workforce. Yet, for many students, college is where they have their first experiences with CS and CS careers, which creates a more difficult path for students to persist in CS (Hsu & Mimura, 2017).

In the United States, 27% of STEM employees are foreign-born and 17% are from Asia (National Science Board, 2016). Currently, there is very little research on what factors influence this sector toward CS careers in the K-12 setting. The purpose of this paper is to investigate what influences Korean high school students in choosing CS courses and how participation in CS courses plays a role in decisions made towards CS as a career goal. Prior research suggests that K-12 schooling experiences largely guide students' decisions towards STEM as a major and/or career (Andersen & Ward, 2014; Aschbacher, Li, & Roth, 2010; Gottlieb, 2015; Maltese & Tai, 2011; Wang, 2013), and it stands to reason that CS would mirror this trend. The research questions to be addressed in this study are:

1. What factors influence a high school student to enroll in an elective CS course?
2. What factors influence a K-12 student to choose CS as a future career goal?

Theoretical Framework: Expectancy-Value Theory

Attempts to explain enrollment and persistence in STEM courses is fairly common in current research, with studies focusing on why some students choose to take advanced or elective STEM courses (DeJarnette, 2012; Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Maltese & Tai, 2011; Wang & Degol, 2013); why students chose to enter and persist in STEM career pathways (Andersen, 2013; Maltese & Tai, 2011; X. Wang, 2013), or differential aspirations and motivation based on race and/or gender (Andersen & Ward, 2014; Aschbacher et al., 2010; Gottlieb, 2015). Most commonly, these studies use Expectancy-Value Theory or EVT (Atkinson, 1957; Eccles et al., 1983) as their theoretical framework to model students' academic choices in STEM. This study too uses an expectancy-value theory lens to categorize the factors that influence students wanting to enroll (specifically in) CS in high school and from that experience, pursue CS in college and/or career.

Theoretical Basis

Attempting to explain the choices individuals make when given a selection of options has been the focus of achievement-motivation theorists for decades. Beginning with Atkinson (1957) who attempted to address two forms of behavior: why an individual chooses a certain path among others and what accounts for the vigor or persistence the individual applies to the task. Atkinson (1957) postulated that there are three variables that affect motivation: *motive, expectancy,* and *incentive.* Expanding on the groundwork of Atkinson, the EVT posits that *choice, persistence,* and *performance* all link to how well an individual believes they will perform and how they value the activity (Eccles & Wigfield, 2002; Wigfield, 1994; Wigfield & Eccles, 1992; Wigfield & Eccles, 2000). Choices made by students, then, are directly impacted by expectations of success and a subjective task value, both of which relate to a student's personal identity (Eccles, 2009; Wigfield & Eccles, 2000).

Expectancy Construct

Expectations for success can be categorized as ability beliefs and expectancy beliefs (Wigfield & Eccles, 2000). Although the ability and expectancy constructs are conceptually different, the two are shown to be highly related (Eccles & Wigfield, 1995; Wigfield & Eccles, 2000). Ability beliefs differ from expectancy in that ability focuses on the present (i.e. I am good at this task now) and expectancies focus on the future (i.e. I will do good on that task). Both of these highly related concepts are constructs of the social cognitive theory and self-efficacy (Wang, 2013; Wigfield, 1994; Wigfield &

Eccles, 2000) which is the belief by an individual that they can accomplish a certain task (Bandura, 1977; 1986). In EVT, ability beliefs are domain-specific beliefs about an individual's competency in a broad domain area, as opposed to specific beliefs about a single, particular task (Wigfield, 1994). In this study, the domain in question will be CS, but potentially open links to other domains such as math and science.

Subjective Task Value Construct

Value is the second part of EVT and can itself be broken into four components: attainment value, utility value, intrinsic value, and cost. The value an individual gives a task is subjective since the constructs differ from individual to individual depending on their own affective memories, self-concept of abilities, perceived difficulty, and personal goals (Wigfield & Eccles, 2000). The values, in a sense, are one of the manifestations of an individuals' identity construct. Attainment value is the importance an individual places on completing and doing well on a task based on their personal beliefs or values. For example, a student who views helping those in need as an important life goal would place more value on careers that involve helping others. Intrinsic (or sometimes interest) value is the amount of pleasure and individual receives from participating in a task. As an example, a student who loves reading may have a relatively high intrinsic value for their literature courses. Utility value relates to the importance of a task on a student's future or immediate goals. A student who wants to make the basketball team would put a high utility value on playing basketball during their physical education course, and would, therefore, approach the task with more rigor than one who does not have the save value utility value. Finally, cost is a negative construct in that a high value can serve to discourage them from participating in a task, particularly if the other constructs are low. Cost might be that a task reduces time to hang out with friends, participate in a hobby, or a general decrease of free time (Eccles, 2005; Eccles, 2009; Eccles, Vida, & Barber, 2004; Eccles & Wigfield, 1995).

Atkinson (1957) initially started discussions about task value but viewed it as merely a function of efficacy, or the inverse of difficulty, rather than as an individual construct or constructs. However, Eccles et al. (1983) later described value as the ability to fulfill a person's needs, help them reach personal goals, and to affirm their identity. Feather (1992) followed up by postulating that an individual's likelihood to participate in a task was impacted, both positively and negatively, by the amount that they valued the task. Since then, EVT literature has focused on both expectancy and value as two equally important constructs that contribute to individual achievement-related choices.

Identity

Unlike expectancy and task value, identity is not a separate construct that directly impacts achievement-related choices, but rather a piece that generates the feelings of adequacy or value within an individual. In other words, it is the part that explains why task values are subjective and vary from individual to individual. As can be seen in Figure 1, an individual's identity is formed over time and is affected by their cultural and life experiences. In turn, their identity motivates their expectancy and values which then drives their decision to choose certain achievement-related tasks. According to Eccles (2009), students view a particular task as being associated with certain characteristics and they will select tasks that align with the characteristics they see in themselves, e.g., their *identity*. More directly, individuals will select tasks that will allow them to demonstrate their identity, such as masculinity or femininity (Eccles & Wigfield, 2002). These identities can also be personal or collective. Personal identities are characteristics that a person associates with themselves and can be associated with certain socializers, like feedback from parents, teachers, and/or peers and from previous experiences. For example, a student who does poorly in a science class in middle school and receives poor feedback from a teacher will associate their identity as 'not a science person.' Eccles described that collective identities, on the other hand, are characteristics associated with a certain group. These can be gender roles, stereotypes, or certain cultural or ethnic norms. Further, Eccles stated that in this way, identity is closely related to the attainment value construct as it functions to create a sense of importance for one task over another.

In most EVT literature (Andersen, 2013; Andersen & Ward, 2014; Else-Quest, Mineo, & Higgins, 2013; Gottlieb, 2015; Wang, 2012; Wang & Degol, 2013), identity is often only addressed through the constructs that it influences (expectancy and value) and not as its own construct.

However, for this study, looking at the factors that motivate students to enroll in CS and select a CS career, the researchers decided that identity would be important to look at independently. Treating identity separately will allow for a better understanding of what parts of identity (i.e., gender roles, parental or teacher pressure, childhood experiences) play the biggest role in selecting a CS course and/or career track. This study addresses several questions directly impacted by identity (such as *who or what influenced you to enroll in CS* and *would you feel comfortable in this job*) so that understanding about personal and cultural factors could be addressed in the analysis and conclusions as well.

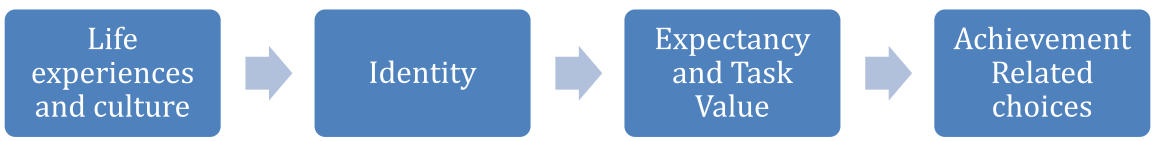

Figure 1. Condensed version of the expectancy-value model of achievement. Adapted from "Motivational beliefs, values, and goals," by J. S. Eccles & A. Wigfield, 2002, *Annual Review of Psychology*, *53*(1), p.119.

Previous studies have only been concerned directly with motivation and not necessarily the experiences that lead up to expectancy and value. This is not a limitation for these studies, but this one is set apart in that the goal of this research is to provide insight for a K-12 system that can better prepare and motivate students for CS careers. As other research has shown, early exposure in education plays a vital role in the development of expectancy and task value by shaping the identity of students (DeJarnette, 2012; Wang 2012; Wang, 2013). Understanding what aspects of identity, both personal and collective, play the largest role in the constructs related to CS seems to be of importance for the purposes of this study.

Existing Research

Relevant existing research can largely be divided into two groups: STEM research and CS research. Although the STEM research rarely discussed CS directly, it still considered part of the STEM umbrella and the findings are likely relevant to the CS field.

STEM Research

As was mentioned previously, previous research has focused on students' motivation for STEM through their choices of high school elective courses, such as advanced math and science, and careers. Among the more interesting findings from STEM education research are links between early exposure to science and math and its later effects on STEM-related achievement tasks. Wang (2012) in his study found that students' seventh-grade math classroom experience predicted 10th-grade math efficacy, value perception, and interest. As a result, Wang noted that students with high levels of these characteristics were more likely to take math courses in the 12th grade and maintain their math career interests. Further, by middle school, students were less likely to change how they feel about math and science (their expectancy and value perceptions), and if they have formed a low opinion of their abilities or the value of STEM at that point, they are very unlikely to change their perceptions after that point. DeJarnette (2012) looked even earlier and reported that exposure to STEM in the elementary grades motivated students to enroll in more advanced science and math courses when they were in middle and high school. Likewise, a study by Maltese and Tai (2011) found that students with an early interest in science and math were more likely to enroll in science and math classes later in their schooling and chose a STEM-related career. These studies all indicate how crucial early exposure to STEM coursework can be in leading students to take STEM courses during their secondary schooling, especially when students enter middle and high school with high levels of efficacy and task value related to STEM.

Instead of looking at decisions to enroll in secondary STEM courses, Andersen (2013) examined factors that predicted why students would choose a STEM occupation for their career goals while in high school. In their findings, Andersen found that high expectancy values for math and science and high math and science utility values were predictors of STEM occupational choice (Andersen, 2013). The study by Wang (2013) had similar results, which revealed that exposure to math and science has a strong positive impact on a student's future STEM entrance also with science having the greater impact. The results imply that earlier exposure to math and science course work could be an effective way to bring more students to careers in the STEM field by developing those higher expectancy and task value motivations. Andersen and Ward (2014) examined STEM persistence among students and found that of ninth-graders who listed the STEM field as their chosen careers those with the highest utility values for science were more likely to maintain those plans through high school.

Computer Science Research

Despite the current push for more CS in K-12 schools, there is only a small amount of recent research with a specific focus on CS enrollment, retention, and career aspirations in the secondary setting, especially from the perspective of CS students. A large number of studies and articles deal with curriculum models (Fouh, Akbar, & Shaffer, 2012; Hubwieser, Armoni, Giannakos, & Mittermeir, 2014; Papastergiou, 2009; Webb, Repenning, & Koh, 2012), computational thinking (Barr & Stephenson, 2011), or university-level populations (Barker, McDowell, & Kalahar, 2009; Cooper & Dierker, 2017; Hoegh & Moskal, 2009; Tsai, Li, Elston, & Chen, 2011).

The perspectives of females in CS is a popular topic at the moment with the idea of increasing female enrollment in CS as a means to increase students entering the CS field (Beyer, Rynes, Perrault, Hay, & Haller, 2003; Carter, 2006; Master, Cheryan, & Meltzoff, 2016). The low number of females in computer science is a persistent problem in many countries that is heightened by the stereotypes held by females about the CS field (Master et al., 2016). Master et al. (2016) found that the lack of females in the field makes the problem even worse when females develop a sense of not belonging to a field dominated by men. Beyer et al. (2003) found that there was no difference between the male and female university CS majors' quantitative ability and CS interest to explain help explain the dearth of women in the CS field. However, Beyer et al. did show that negative perceptions of CS as a major for *nerds*, the perceived obsessive and antisocial nature of CS majors, and the belief that it is a masculine trade did discourage the enrollment of non-CS majors. One study by the Google CS Ed Research Group (2014) found that high school was the most influential time for a woman to enter into a future CS major; 60.5% of this influence stemmed from her pre-college years. In the same study, they found that during that pre-college period, academic exposure (CS coursework) alone counted as 22.4% and those with the opportunity to take AP CS were 46% more likely to indicate interest in a CS major and 38% more likely to pursue a CS major. Wang, Hong, Ravitz, and Ivory (2015) compared the factors influencing males and females to enroll in CS in university and found that previous academic exposure influenced both genders, but females significantly more so than males. Wang et al. (2015) also found that a high efficacy and interest in math was influential to males, but again more so to females.

Wang, Hong, Ravitz, and Moghadam (2016) found that parents, students, and administrators all had positive image of CS, but lacked an understanding of what CS was or what would be done by an employee in that field. Wang and colleagues also found that over 75% of schools surveyed had no CS classes offered to their students. This is important since Barker et al. (2009) showed that previous programming experience as having a positive impact on success in introductory CS courses in college as well as an influence on retention rates. In a similar vein, Schulte and Knobelsdorf (2007) found that a barrier for students to enter the CS field was a low sense of efficacy and the perception that CS cannot be learned like other subjects, something that was verified by Biggers, Brauer, and Yilmaz (2008). Carter (2006) added that students needed to see the multidisciplinary nature of CS and how it is used in other fields and how it is more than just sitting in front of a computer all day.

Korean Education Research

The sample used in this study was largely composed of Korean students, so a look into attitudes around education in Korea is important to frame the discussion. The Korean approach to education, like other East Asian countries, is largely influenced by Confucianism and has been so for the past thousand years. The influence of Confucianism has provided Korea with strong social capital and frugality, hard work, and a high value for education (Kim, 2005; Robertson, 2002; Sorensen, 1994). While lately Confucianism has been named as the reason for economic and educational success in Hong Kong, Japan, Singapore, Korea, and Taiwan (Kim, 2005), it has also been listed as a reason for China's failure to modernize (Sorensen, 1994). The influence of Confucianism has created a strong focus on family and family well-being in Korea (Robertson, 2002; Shin & Koh, 2005) and a very high regard for education and educators, especially when compared to the support given in the United States (Kim, 2005).

In Korean society (and East Asia as a whole), a child's grades in school, rather than their cognitive growth, are seen as the most important indicator of a child's success and as such, parents closely monitor their children's grades and hold high expectations (Kim, 2005; Shin & Koh, 2005). This is at least partly due to the national education system that seeks to sort children and citizens by academic achievement: the top jobs go only to the graduates from the top universities, and the top universities only admit students scoring the highest on the national exam (Sorensen, 1994). Since prestigious education is the only means of upward mobility in Korea, Koreans tend to view education itself as a marker of social status, even more so than income or job title. As such, Korean parents intensely pressure their children to study (Sorensen, 1994). While parental control is not unique to Korean or Asian society, its ubiquity and fervor is fairly unique to the culture (Kim & Bang, 2017; Kim, et al., 2005; Shin & Koh, 2005).

College in Korea is viewed as one of the only means of advancement in Korea; not attending university or attending a trade school are seen as both a dishonor and as a step down in social status (Kim, Lee, & Lee, 2005; Shin & Koh, 2005; Sorensen, 1994). However, the universities in Korea have only a limited number of spots every year, thus leading to intense competition for entrance. The connection between the educational pressure and Confucianism comes from the corporate nature of families and the filial piety it promotes; Korean children are expected to provide for their parents socially and economically in old age, so the perception of comfort in retirement becomes directly related to the success of their children in school (Sorensen, 1994). The corporate nature of the family also means that status is a family matter and not an individual one. In other words, a family member who does not reach what Korean's deem as successful brings the entire family's status down, not just their own (Sorensen, 1994). Perhaps for both of those reasons, studies have shown that most of the fervor for education does not come from the students, but rather from the parents whose future and status hinge on their children (Kim et al., 2005). Another concern for Korean students is the effects of their structured and organized culture on creativity (Kim, 2005; Lee & Seo, 2006). Kim (2005) further discussed the focus on rote learning, the devaluing of play, and rigid social structures and norms are all reported as components of Confucianism that drive down creativity in Korean students. Likewise, the intense focus on standardized testing for university admittance forces teachers and administrators to focus on traditional rote learning and memorization over independent thought and creativity (Kim, 2002; Kim et al., 2005; Kim, 2005). However, this is a problem and a need that is recognized in Korea and educators are calling for and focusing on bringing creativity to the classroom (Kim, 2005; Lee & Seo, 2006). For this to happen, though, it will require a shift in the structure of education to move away from the focus on standards and standardized testing and a shift in the cultural views of education (Kim, 2005).

Methods

This study was intended to describe factors (related to EVT constructs) that mediated sampled Korean students' decisions to enroll in a CS course and their thoughts regarding CS as a career. For this reason, a qualitative approach was chosen to understanding the meaning of students' experiences, context and influences to understand their choices and actions (Maxwell, 2013). This study was designed to describe such factors that may warrant more in-depth or larger-scale future research.

Case Selection

This particular study used a descriptive case study methodology that sought to explain how students' longitudinal experiences led to them enrolling in a CS course and for a better understanding of why they are (or are not) considering a career in CS. To set the stage for the study, a week-long unit (440 minutes total) was developed around CS careers. The study took the form of a single case, a holistic approach that elicited responses during a single unit of instruction about CS careers (the time-bound case) in a high school CS course. The single case designed to both prompt responses related to affective memories and to provide insight into a program that provides students with a chance to explore CS careers.

Assumptions

To design this study and answer the described research questions, certain assumptions were made by the researchers. First, it was assumed that the unit used as the case would be treated by students as any other unit in the course and not as a separate activity or as a study. Second, students were asked about peers who were not in the class and why they were not enrolled as well. It was therefore assumed that students communicate with each other about the classes they are taking and why they are taking ones and not others. Finally, it was assumed that students would willingly share their own thoughts and opinions during both written and oral prompts. Students in the course were experienced with writing and class discussions and were familiar with the expectations around those.

Participants and Context of the Case

This study was conducted with 10 high school student volunteers enrolled in Advanced Placement computer science principles (AP CSP) at a private, international school in Seoul, South Korea. Using the pseudonyms provided for the study, sampled students included three females (Jiyoung, Jia, and Minseo) and seven males (Jejoon, Junyoung, Doyoon, Jiho, Minjoon, Dongsoo and

Enyu) ranging from grade 10 to grade 12 (approximately 15 to 18 years old). Students all identified as Asian, with eight being Korean (two of whom also held dual citizenship with the United States), one identifying as Chinese and one as Japanese. All of the students, per entrance requirements of the school, are fluent in the English language. This group was selected to participate because their enrollment in a non-required CS course would allow the researchers to understand their motivations for enrolling in CS and how they perceived CS as a career. AP CSP is also referred to as a *CS 0* course in that it is not necessarily designed for only those who see CS as a career goal. A CS 0 course, like AP CSP, means that the participants will have varying levels of interest in pursuing CS at the beginning of the course and will have differing identity constructs, as related to CS.

Data Collection

The study and data collection took place during a routine classroom unit so while students were given the option of participating in the study, they were required to complete all items in the study regardless of their participation status. Before the study began, all prompts and questions used during the study were aligned with particular EVT constructs to ensure that each construct received proper data saturation and collection from multiple sources (see Appendix E). The unit was intentionally organized to ask items after particular milestones in order to gain insight into how students perceived the CS field. For example, most of the reflective questions about CS careers were saved until after students had learned more information about the field. By doing this, the researchers were able to glean insight into what aspects of the lessons and discussions were most impactful to the students. Data was collected document analysis through five written journal prompts and a final reflective essay (see Appendix A), two questionnaires (see Appendix B and C), two topical class discussions (see Appendix D). All collection prompts were organized used a coding system for easier analysis. The coding started with an abbreviation that represents the collection instrument, *RW* for reflexive writing, *CD* for class discussion, *CIS* for career interest questionnaire, *CES* for course enrollment questionnaire, and *CPR* for career project reflection. After the abbreviation a number was given to distinguish the different prompts. For example, RW1 referenced the first reflexive writing prompt. These codes were used both for the analysis and the write up and will be referred to in the results section. The referring prompt can then be found in Appendix A – D. For trustworthiness, the line number or cell from the data spreadsheet was also included in the results to allow other researchers to find the data in the source material.

Data Analysis: EVT

The researchers approached this case study using an embedded analysis approach (Creswell, 2017) to look for student utterances or writing (data) related to the EVT model within a CS careers unit. Rather than a holistic approach with constant data collection, data was only analyzed from certain points in the unit that elicited responses related to CS and EVT. EVT is generally used as a framework for quantitative studies. However, with the goal of discerning what factors led students to choose to enroll in CS and choose CS as a career goal, EVT has proven to be a robust and reliable model. For this reason, it was used to guide the coding in order to give the researchers a theoretical lens with which to develop and analyze the data collection.

Once the unit was completed, all data was transcribed and de-identified. The data was then coded a priori for utterances that aligned to one (or more) of the six EVT constructs: expectancy, attainment value, intrinsic value, utility value, cost, and identity. The utterances were placed into a spreadsheet parsed by construct-based coding. The frequency of each construct was tabulated for the whole population and each gender based on the data collection type: journal entries, class discussions, and reflection questions. Data from the two questionnaires were also compiled into a table according to question type: binary and Likert. Additional open coding was conducted to identify emergent themes not captured by EVT. Commonalities were found between the EVT constructs and the themes were grouped, counted, and reported. The link between the data sources and the EVT constructs can be found in Appendix E.

Additional Analyses

While this study was done through an EVT lens for concurrent validity and credibility (Andersen, 2013; Andersen & Ward, 2014; Eccles, 2009; Gottlieb, 2015; Wang & Degol, 2013), open coding was leveraged to capture ideas note well described by EVT. During initial coding, themes that emerged but did not fit within the six constructs were placed in a seventh category, *items of interest*. Like the EVT constructs, these items were analyzed again and grouped into different themes to be analyzed in the discussion section. The topics included *constrained performance*, *gender bias*, and *personal and perceived views*. Constrained performance (Atkinson, 1957), whether or not the course was taken out of free choice from where the pressure to take the class (if constrained to take it) came from. Gender bias was analyzed for by first analyzing the data as a whole and then looking for differences between the genders. Finally, personal and perceived views were analyzed by asking both personal questions and about personal experience and also asking questions about why students perceived their peers where not inclined to take a CS course.

Trustworthiness

To ensure trustworthiness, a number of steps were taken both in the design of the study and carrying out of the research. During the design process, instruments informed (and analyzed) by EVT constructs and data sources were diversified (e.g., class discussions, journal entries, and reflections) with similar wording to ensure consistency. Both oral (class discussion) and written (journal entries and reflection questions) data sources helped to ensure that all students had the opportunity to share their thoughts and provided avenues for students to report their thoughts without being influenced by more vocal peers. Prior to commencement of the research, a third-party researcher, an experienced qualitative methodologist examined, evaluated, and made recommendations on study design and execution.

During data collection, the main contact for students was their regular classroom teacher also researcher, with whom the students were comfortable with through prolonged engagement. This helped to ensure that students were willing to share their thoughts with someone they recognized; this provided a sense of rapport and trust between the data collector and the sampled population. The collected data was deidentified with nationality- and gender-appropriate pseudonyms. During analysis, an audit trail was established to ensure that identified codes came from multiple mediums and students. The audit trail identifies quotes or contributions cited to a student's name (pseudonym), the location of the utterance in the data source (e.g. Class Discussion is CD, reflective writing journal entries is RW) and the analysis cell or line number (from culled utterances from the respective data sources in excel).

Results

Once data collection of the career unit was complete, audio recordings were transcribed and all data was de-identified with pseudonyms. In total, 385 utterances were identified from class discussions, journal entries, and reflection questions that were coded a priori according to the six constructs of EVT and parsed by gender. Once coding was completed, the frequency for each construct was calculated as well as the percentage of that construct within the total. Data from the questionnaires was also de-identified and descriptive analyses were completed.

Overall Class Discussion Results

Table 1 shows the frequencies of 135 pieces of data, sourced from 79 utterances made in class discussions. The identity construct was most commonly mentioned during class discussions (*n*=33, 24%) followed by attainment value (*n*=30, 22%). For males, identity was likewise the most mentioned (*n*=23, 27%) followed by attainment value (*n*=19, 22%). For females, attainment was mentioned equally to males (*n*=11, 22%; *n*=19, 22%) followed by identity (*n*=10, 20%). For both genders, the cost construct had the fewest number of coded utterances (*n*=8, 6%).

Table 1. *Observations Frequencies of Expectancy Value Theory Constructs in Class Discussions (N=135)*

Expectancy Value Theory (*N*=135)	**Sampled Population (*N*=10)**	
Constructs	Males (*n*=86)	Females (*n*=49)
Identity (*n*=33, 24% of Construct)	23 (27%)	10 (20%)
Attainment Value (n=30, 22% of Construct)	19 (22%)	11 (22%)
Expectancy (*n*=23, 29% of Construct)	16 (19%)	7 (14%)
Utility Value (*n*=22, 16% of Construct)	13 (15%)	9 (18%)
Intrinsic Value (*n*=19, 14% of Construct)	11 (13%)	8 (16%)
Cost (*n*=8, 6% of Construct)	4 (5%)	4 (8%)

Journal Entry Results

Frequency counts for 175 pieces of data were coded from 106 utterances sourced from journal entries and are shown on Table 2. The most mentioned construct was attainment value (*n*=44, 25%) followed by utility value (*n*=40, 23%). For males, utility was the most common (*n*=26, 22%) with attainment (*n*=25, 21%) and intrinsic (*n*=25, 21%) being next. For females, attainment was the highest (*n*=19, 34%) followed by utility (*n*=14, 25%). Like class discussions, the cost construct was the least mentioned (*n*=9, 5%).

Table 2. *Observations Frequencies of Constructs of Expectancy Value Theory in Journal Entries (N=175)*

Expectancy Value Theory (*N*=175)	**Sampled Population (*N*=10)**	
Constructs	Males (*n*=119)	Females (*n*=56)
Attainment Value (*n*=44, 25% of Construct)	25 (21%)	19 (34%)
Utility Value (*n*=40, 23% of Construct)	26 (22%)	14 (25%)
Identity (*n*=35, 20% of Construct)	24 (20%)	11 (20%)
Intrinsic Value (*n*=31, 18% of Construct)	25 (21%)	6 (11%)
Expectancy (*n*=16, 9% of Construct)	11 (9%)	5 (9%)
Cost (*n*=9, 5% of Construct)	8 (7%)	1 (2%)

Project Reflection Question Results

For this data set, 75 data were coded to EVT constructs regarding the CS careers students chose to study. Notably, these results do not speak to CS as a whole, but rather to a specific job that they researched. Responses, however, were useful for the discussion of what factors made a CS job desirable or undesirable. Frequency counts for the project reflection questions are shown on Table 3. The most mentioned construct, like students' journal entries, was attainment value (*n*=12, 24% for males and *n*=8, 33% for females). Like class discussions and journal entries, the cost construct was the least mentioned for males (*n*=3, 6%) and next to last for females (*n*=3, 13%). For males, utility was the most common (*n*=26, 22%) with attainment (*n*=25, 21%) and intrinsic (*n*=25, 21%) being next. For females, attainment was the highest (*n*=19, 34%) followed by utility (*n*=14, 25%).

Table 3. *Observations Frequencies of Constructs of Expectancy Value Theory in Project Reflection Questions (N=75)*

Expectancy Value Theory (*N*=75)	**Sampled Population (*N*=10)**	
Constructs	Males (*n*=51)	Females (*n*=24)
Attainment Value (*n*=20, 27% of Construct)	12 (24%)	8 (33%)
Utility Value (*n*=10, 13% of Construct)	6 (12%)	4 (17%)
Intrinsic Value (*n*=13, 17% of Construct)	11 (22%)	2 (8%)
Expectancy (*n*=14, 19% of Construct)	11 (22%)	3 (13%)
Identity (*n*=12, 16% of Construct)	8 (16%)	4 (17%)
Cost (*n*=6, 8% of Construct)	3 (6%)	3 (13%)

Survey Results

Both the CS Enrollment and CS Career questionnaire results were tabulated on Tables 4 and 5, respectively. For the CS enrollment questionnaire, which took place before the careers unit, no students strongly agreed with the questions aimed at efficacy, although a majority did say they agreed. However, none of the ten students said they enrolled in the course because they were 'good' at CS. Also, most disagreed with the questions dealing with the cost construct. All students reported that they were enjoying the course, with one student strongly agreeing at the other nine agreeing. Only one student reported that he perceived CS as boring. Students largely reported the class to be useful for life, college, and career. All ten students reported the class would be useful in college.

Table 4. *Students'4-Point Likert Responses to the Computer Science Enrollment Survey (N=10)*

Computer Science Enrollment Items	**Strongly Agree**	**Somewhat Agree**	**Somewhat Disagree**	**Strongly Disagree**
I see myself as a CS person.	1 (10%)	4 (40%)	4 (40%)	1 (10%)
Others see me as a CS person.	2 (20%)	2 (20%)	6 (60%)	0 (0%)
I am confident I will do an excellent job on tests in this course.	0 (0%)	6 (60%)	3 (30%)	1 (10%)
I am certain I can understand the most difficult material presented in this course.	0 (0%)	7 (70%)	2 (20%)	1 (10%)
I am certain I can master the skills being taught in this course.	0 (0%)	6 (60%)	3 (30%)	1 (10%)
I am confident that I can do an excellent job on assignments in this course.	0 (0%)	7 (70%)	3 (30%)	0 (0%)

I am confident that I can do an excellent job on projects in this course.	0 (0%)	7 (70%)	3 (30%)	0 (0%)
My time and effort in CS means not enough time with friends.	0 (0%)	1 (10%)	6 (60%)	3 (30%)
My time and effort in CS means not enough time for extracurriculars.	0 (0%)	2 (20%)	5 (50%)	3 (30%)
My time and effort in CS means I won't be popular.	0 (0%)	1 (10%)	5 (50%)	4 (40%)
My time and effort in CS means people will make fun of me.	0 (0%)	1 (10%)	3 (30%)	6 (60%)
I am enjoying this course very much.	1 (10%)	9 (90%)	0 (0%)	0 (0%)
I think this class is a waste of time.	0 (0%)	0 (0%)	4 (40%)	6 (60%)
I think this class is boring.	0 (0%)	1 (10%)	6 (60%)	3 (30%)
What we learn in this class is useful for everyday life.	2 (20%)	6 (60%)	2 (20%)	0 (0%)
What we learn in this class will be useful for college.	2 (20%)	8 (80%)	0 (0%)	0 (0%)
What we learn in this class will be useful for a future career.	3 (30%)	7 (70%)	0 (0%)	0 (0%)

Note. This was taken as a pre-assessment.

Table 5 shows that the majority of students believed CS would help them get into college (80%), and CS would be useful in college (100%). Students also reported enjoying CS (80%) and being their choice to enroll in CS (90%), despite all students feeling they were not good at CS (100%) at the time they were questioned (i.e. prior to CS career unit).

Table 5. *Students' Binary (Yes/No) Responses to Taking Computer Science in High School (N=10)*

Why are you taking Computer Science in High School?	Yes	No
Because it will help get into college.	8 (80%)	2 (20%)
Because it will be useful in college.	10 (100%)	0 (0%)
Because I enjoy CS.	8 (80%)	2 (20%)
Because I am good at CS.	0 (0%)	10 (100%)
I had no choice, it is a requirement.	1 (10%)	9 (90%)

Note. This was taken as a pre-assessment.

For the CS career questionnaire, which took place after the CS career unit, students reported positive thoughts regarding CS careers, efficacy, and interest. Three students (30%) strongly agreed and four (40%) agreed that they had good CS skills. Two (20%) students strongly agreed and 5 (50%) agreed that CS careers were suited to their abilities. And while one student (10%) strongly agreed and six students agreed (60%) that they were interested in being a computer scientist, only four students (40%) expressed that they have always wanted to enter the field. A majority of the students attributed positive characteristics to the CS career field. For example, eight students (80%) agreed and one (10%) strongly agreed that CS would provide a reliable income and would allow them to provide a service to society. Likewise, seven students (70%) agreed and one (10%) strongly agreed that CS would be a secure job and that computer scientists make worthwhile contributions to society.

Table 6. *Students' 4-Point Likert Responses to the Computer Science Career Survey (N=10)*

Computer Science Career Items	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
I have the qualities of a good computer scientist.	1 (10%)	5 (50%)	4 (40%)	0 (0%)
I have good computer science skills.	3 (30%)	4 (40%)	3 (30%)	0 (0%)
Computer science is a career suited to my abilities.	2 (20%)	5 (50%)	3 (30%)	0 (0%)
I am interested in being a computer scientist.	1 (10%)	6 (60%)	3 (30%)	1 (10%)
I have always wanted to be a computer scientist.	1 (10%)	3 (30%)	5 (50%)	1 (10%)
My friends think I should become a computer scientist.	1 (10%)	4 (40%)	4 (40%)	1 (10%)
My family thinks I should become a computer scientist.	1 (10%)	5 (50%)	3 (30%)	1 (10%)
I like computer science work.	1 (10%)	8 (80%)	1 (10%)	0 (0%)
Computer science will offer a steady career path.	1 (10%)	6 (60%)	3 (30%)	0 (0%)
Computer science will provide a reliable income.	1 (10%)	8 (80%)	0 (0%)	1 (10%)
Computer science will be a secure job.	1 (10%)	7 (70%)	2 (20%)	0 (0%)
Computer science will allow me to provide a service to society.	1 (10%)	8 (80%)	1 (10%)	0 (0%)
Computer scientists make a worthwhile contribution.	1 (10%)	7 (70%)	1 (10%)	1 (10%)
The time and effort required for a CS career means I won't have enough time for my own activities.	0 (0%)	3 (30%)	7 (70%)	0 (0%)
The time and effort required for a CS career means I won't have enough time with my friends.	0 (0%)	4 (40%)	5 (50%)	1 (10%)

Note. This was taken as a post-assessment.

Case Analysis

The analysis that follows is organized first by summary data, followed by research questions regarding factors influencing students' CS enrollment and factors influencing students' CS career aspirations. A fourth topic not directly related to the three research questions, that will be discussed is the impact of a CS careers unit on student perceptions.

Table 7. *Summary Table of Combined Qualitative Data from Class Discussions, Journal Entries, and Project Reflection Questions*

Expectancy Value Theory Constructs (*N*=385)	Class Discussions (*N*=135) From Table 1		Journal Entries (*N*=175) From Table 2		Project Reflection Questions (*N*=75) From Table 3	
	Males (*n*=86)	Females (*n*=49)	Males (*n*=119)	Females (*n*=56)	Males (*n*=51)	Females (*n*=24)
Attainment Value (*n*=94, 24% of Construct)	19 (22%)	11 (22%)	25 (21%)	19 (34%)	12 (24%)	8 (33%)
Identity (*n*=80, 21% of Construct)	23 (27%)	10 (20%)	24 (20%)	11 (20%)	8 (16%)	4 (17%)
Utility Value (*n*=72, 19% of Construct)	13 (15%)	9 (18%)	26 (22%)	14 (25%)	6 (12%)	4 (17%)
Intrinsic Value (*n*=63, 16% of Construct)	11 (13%)	8 (16%)	25 (21%)	6 (11%)	11 (22%)	2 (8%)
Expectancy (*n*=53, 14% of Construct)	16 (19%)	7 (14%)	11 (9%)	5 (9%)	11 (22%)	3 (13%)
Cost (*n*=23, 6% of Construct)	4 (5%)	4 (8%)	8 (7%)	1 (2%)	3 (6%)	3 (13%)

Qualitative Data Summary

Table 7 is a summary of *Q*ualitative data from each coded data source (i.e. class discussions, journal entries, and project reflection questions) to illustrate the strength of the EVT constructs within the case, where attainment (*n*=94, 24%) and identity (*n*=80, 21%) were the most salient attributes of students' reported expectancy-value.

Table 8 provides a deeper examination of gender as it relates to reported EVT constructs from qualitative data using percentages of each gender's coded data. This indicates that although attainment was primary for both genders (22% and 30%, respectively), females diverged from the males in identifying utility values (21%) more than males (17.5%). Otherwise, both genders followed a similar pattern regarding intrinsic value, expectancy, and cost.

Table 8. *Summary Table of Combined Qualitative Data by EVT Constructs Disaggregated by Gender*

Expectancy Value Theory Constructs (*N*=385)	Males (*n*=256, 66.5%)	Females (*n*=129, 33.5%)
Attainment Value (*n*=94)	56 (22%)	38 (30%)
Identity (*n*=80)	55 (21.5%)	25 (19%)
Utility Value (*n*=72)	45 (17.5%)	27 (21%)
Intrinsic Value (*n*=63)	47 (18%)	16 (12%)
Expectancy (*n*=53)	38 (15%)	15 (12%)
Cost (*n*=23)	15 (6%)	8 (6%)

Computer Science Enrollment Results

Further, utterances from class discussions (*N*=38) and journal prompts (*N*=40) that dealt with CS enrollment yielded 133 coded pieces of data that were tabulated according to construct as shown in Table 9. The identity construct (*n*= 41, 31%) was the most frequently mentioned construct for CS enrollment, followed by attainment value (*n*=34, 26%). For males, identity was still the highest (*n*=33, 34%), but for females, attainment was higher (*n*=13, 37%). Cost was the lowest for both genders and overall, with zero utterances from males and only one mention (3%) from females.

Table 9. *Observation Frequencies of Expectancy Value Theory Constructs Related to Computer Science Enrollment (N=133)*

Expectancy Value Theory (*N*=133)	**Sampled Population (*N*=10)**	
Constructs	Males (*n*=98)	Females (*n*=35)
Identity (*n*=41, 31% of Construct)	33 (34%)	8 (23%)
Attainment Value (*n*=34, 26% of Construct)	21 (21%)	13 (37%)
Utility Value (*n*=28, 21% of Construct)	20 (20%)	8 (23%)
Intrinsic Value (*n*=19, 14% of Construct)	17 (17%)	2 (6%)
Expectancy (*n*=10, 8% of Construct)	7 (7%)	3 (9%)
Cost (*n*=1, 1% of Construct)	0 (0%)	1 (3%)

Computer Science Career Aspiration Results

Utterances from class discussions (*N*=42) and journal prompts (*N*=101) that related to CS career aspirations yielded 177 pieces of data that were tabulated in Table 10. Attainment value was the highest construct when discussing CS careers (*n*=40, 23%) followed by utility value (*n*=34, 19%). The same rankings hold true for both genders. Again, cost was the lowest mentioned construct for both genders and overall (*n*=16, 9%).

Table 10. *Observations Frequencies of Constructs of Expectancy Value Theory in Computer Science Career Aspiration (N=177)*

Expectancy Value Theory (*N*=177)	**Sampled Population (*N*=10)**	
Constructs	Males (*n*=107)	Females (*n*=70)
Attainment Value (*n*=40, 23% of Construct)	23 (21%)	17 (24%)
Utility Value (*n*=34, 19% of Construct)	19 (18%)	15 (21%)
Intrinsic Value (*n*=31, 18% of Construct)	19 (18%)	12 (17%)
Expectancy (*n*=29, 16% of Construct)	20 (19%)	9 (13%)
Identity (*n*=27, 15% of Construct)	14 (13%)	13 (19%)
Cost (*n*=16, 9% of Construct)	12 (11%)	4 (6%)

Research Question #1, Factors Influencing CS Enrollment

Students in the course shared their reasons for enrolling in CS as well as their thoughts as to why their high school-aged peers did not enroll in the same course. The themes related to enrollment in CS courses that emerged were: (1) technology and society, (2) difficulty, (3) math and science interest, (4) cultural influence, (5) poor impression, and (6) early exposure to CS content.

Technology and Society

When asked about their reason for enrolling in an elective CS course, the topic of technology and its impact on modern society came up several times. The topic largely fell under the attainment value construct, as students saw it as something important and worth pursuing. Jiho said he is taking CS because "we call our time period as [*sic*] informational technical age" (RW 2, Cell 7) and Jejoon remarked that CS is all around the world and will continue to be needed (RW 2, Cell 3). Jiyoung stated that technology seems to be one of the biggest parts of society (RW 1, Cell 10) and she chose to take the class partly out of interest after her social media account once got hacked, wanting to learn more about the Internet and Internet security (CD 2.2, Line 147-149). Jia discussed the electronic ordering machines that were starting to be placed in the local fast food restaurant and her desire to learn more about the current technology development (RW 1, Cell 8). Minjoon related his interest to computer gaming (RW 1, Cell 13). All of these show that students were exposed to something in their daily lives and saw CS as a potential to learn more about something they saw as important.

Several students also shared that they likely would not go into a CS career specifically but saw the importance of computers in their chosen field and decided to enroll in CS because of the benefit it may provide, an example of the utility construct. An example came from Minseo who shared:

> In this era, I think computer science fits into most career goals due to its prevalence in today's society. For example, almost every single career uses computers and technology to some degree. More specifically, in my case as an aspiring physician, electronic medical records are now commonly used around the world. With a computer science background, I will be able to more easily understand the privacy issues regarding health records, but also how to use the technology to my advantage in surgeries and research. (RW 2, Cell 5)

Difficulty

Relating to efficacy, the difficulty theme emerged when students were asked about why their peers, despite the high-demand and high-pay associated with CS careers, do not enroll in CS courses.

What proved interesting was that students did not express an actual *inherent* difficulty with CS, but merely a *perceived* difficulty among their peers. In other words, the students enrolled in the course did not share the view that CS was difficult but understood that others who had never taken a CS course did. Jiho said, "I felt there are few students taking CS classes and pursuing CS degrees because most of the students think that computer science is difficult, and there are a lot of things to do" (RW 4, Cell 7). Similar quotes were captured, but students consistently used the term *think* to designate the idea as a perception rather than a reality, such as Jejoon who said: "it's mostly that people think it's too hard" (CD 2.3, Line 55). Correspondingly, Jia shared her change in perception when she discussed why she enrolled in CS saying, "I thought the CS courses require a lot of CS knowledge. But I heard [from a friend who took the class] that they're actually some courses that aren't require a lot of knowledge [*sic*]" (CD 1.2, Line 107-108). Jejoon concurred in stating that "many students think that computer science is very difficult and has a lot to learn. This does not mean that computer science is difficult but has the feeling of new and developed" (RW 4, Cell 3).

Students also expressed the perception of CS students and majors as having some ability not achievable by everyone, like athleticism. Per Minseo, "personally, I was initially reluctant to take computer science because it was such a technical subject, a subject that only experts choose to do...didn't seem approachable, I think because of how specific it looks…like a subject for geniuses." (RW 5, Cell 5). Again, Minseo expressed these sentiments as a *perception* rather than a *reality*. Her and her peers' exposure to the course and CS made them recognize this to be false.

Math and Science Interest

Perhaps not surprising, since CS generally is considered part of STEM, several students related their decision to enroll in CS to their interest in math and science. Jia (CPR 1, Line 9-11) and Minseo (RW 1, Cell 5) talked about how they had already taken several math and science courses and saw CS as the next step in their pursuit of more STEM credits. Doyoon (RW 1, Cell 6) and Jiyoung (CD 1.2, Line 131-132) saw the utility of CS helping them in future math or science careers. Doyoon also shared that he is "more of a math person someone who likes doing math more than reading the writing" (RW 1, Cell 6), a sentiment shared by Jejoon (CD 1.2, 139-140) and Minseo, who said, "I am towards the scientist and like not the humanities" (CD 1.2, Line 98).

Cultural Influence

As discussed at the beginning of this paper, Asian students live under the influence of Confucianism as a part of their cultural heritage. This influence contributes to the formation of their identity construct, which in turn impacts the formation of their subjective value constructs. Inherent to Confucianism is the power that parents have in the decisions impacting education and career for their children. Relating to CS enrollment, Jiyoung shared that Korean parents do not encourage computer access because they feel it takes away part of their parental control (CD 2.3, Line 50-52). Dongsoo said that Korean parents want their children to focus on more standard classes, like language and science (CD 2.3, Line 23-25). Enyu stated that many peers do not take CS because they already have a family industry to go into (RW 2, Cell 4; RW 4, Cell 4), referring to students whose parents have a field of work they are in and want their child to pursue as well. As an example, Junyoung discussed his desire to pursue CS in college, but his parents "chose pharmacy and they thought it was a better field than CS" (CD 2.3, Line 58-61). In the case of Junyoung, he wanted to enroll in a more advanced CS course at the school in this study, but his parents would only allow him to take the CS 0 course (RW 1, Cell 12).

Poor Impression

Though not as strong as some of the other themes, with only two utterances related to it, this topic is worth adding to the discussion since it relates to perceived stereotypes and identity. Junyoung talked about how computer science courses at his previous school all took place in the basement of the building. As a result, CS was perceived as closed and always had the same people who would never mingle with other people (CD 2.3, Line 40-43). This created a split between students who took CS and the general population; not showing CS as a general course that anyone can or should take. Enyu also wrote that students "are not interested by the computer science due to the fact that as long as people mention IT and computer science, people feel bored, people generally having the impression that computer science is boring, nobody should like them [*sic*]" (RW 4, Cell 4).

Early Exposure

One theme that emerged the most often, and had implications for both enrollment and career, was that of early exposure to CS. The students in this study who were most interested in CS all had a previous experience that led them to enroll in an elective CS course and to aspire to a CS career. Some of those experiences were with relatives or in-laws who were in the CS field or had CS-related hobbies (Jiho, RW 1, Cell 7; Minjoon, RW 1, Cell 13). Other students were exposed to CS through robotics programs in primary and early secondary schooling (Dongsoo, CD 1.1, Line 34-35 & Junyoung, RW 1, Cell 11) and some through after school coding classes and camps (Jia, RW 1, Cell 8; Jiho, RW 1, Cell 10; Jiyoung, CD 1.3, Line 162).

When discussing why other students are not taking CS, the idea of early exposure was again brought up several times. Junyoung shared this:

> I think that the main problem for people not going into a CS class or a computer science job is the lack of exposure. When I am talking about exposure, I don't mean exposure to technology, I mean exposure to the job field itself. (RW 4, Cell 12)

Jiyoung shared that her first exposure to CS did not come until high school and she believed others likely were not taking CS courses because they did not have chances from young ages (RW 4, Cell 10). Junyoung, who had earlier reflected on the negative stereotypes associated with CS also said that he thought earlier exposure to CS would help to mitigate or prevent those stereotypes from forming (RW 2, Cell 12). Minseo shared that she believed compared to other courses, biology, chemistry, language, and history, CS was relatively unknown and that students fear the unknown and unprecedented (RW 4, Cell 5).

Research Question #2, Factors Influencing CS Career Aspirations

Students in the course shared their level of interest in CS careers and reasons for that interest. As with CS enrollment, they also shared reasons why their peers were not interested in CS careers. The codes related to CS career aspirations were: (1) desired career characteristics (2) ability, (3) broader use, (4) societal impact (5) creativity, and (6) negative factors, and (7) early exposure.

Desired Career Characteristics

Though not all specific to CS careers, students in the case openly shared the characteristics they wanted in their future career and what characteristics were desirable and not desirable. Most students expressed that their career needed to be something they enjoyed and had to do with their talents. Other common factors were a talent in the field, a sense of satisfaction from the career, the societal need, and the ability to earn money. Junyoung summed it up by saying "careers need to be something that a person likes doing, something that people need, something that they get paid for, and something that the person is good at [*sic*]" (RW 2, Cell 2). Only Enyu distinguished himself from the class by saying that "the career doesn't have to be interesting or entertaining" (RW 2, Cell 4) and that income is the most important factor outweighing all others (RW 2, Cell 4). When discussing CS careers specifically at the end of the case study unit, the topic of the high salaries associated with CS careers was the most commonly mentioned reason for aspiring or considering a CS career. However, salary was often mentioned along with other desirable characteristics. One example is Jiho who said, "by having the benefit of flexible remote working, and other benefits of health care system, high average starting wage, but also stable income and future job market status, I would feel comfortable in this job" (RW 2, Cell 7). Minseo added that "the most important factors in choosing a career is the money and my happiness. However, ultimately, I would like to have a job that I am happy at, no matter how much money I receive" (RW 2, Cell 5). The CS career questionnaire showed that many students attributed these characteristics to the CS field as well (see Table 6). The majority of students felt that CS would provide a steady career path, a reliable income, and a secure job. Likewise, a majority said that they liked computer science work and that they were interested in a career in the field.

Ability

This theme aligns with the discussion of the ability versus expectancy beliefs discussed in the framework section of this paper. Expectancy beliefs tend to focus on the future rather than on the present as do ability beliefs (Wigfield & Eccles, 2000). There were six instances where students said they were not interested or capable of a CS career because they lacked the knowledge and skills at the present. For example, Jia said, "I'm not interested in this job because you have to know a lot of like code and computer languages" (CD 2.2, Line 55). Referring to his limited CS experience, Junyoung shared that "I think pursuing the field of pure computer science would be difficult, since I would be only just what I am, adequate" (RW 2, Cell 11). Both of these cases potentially indicate that some students were unable to project their current skills and abilities. For many students in the class, this was their first CS experience, so it is possible their expectancy beliefs have not been developed enough to envision further and continued growth in the field. An example of someone who was correctly able to project her expectancy beliefs into future ability beliefs, Jiyoung said,

> Although I am not at the proficiency level of programming and coding, which are the basic knowledge that web developers should have, once I learn more deeply when I go to college or when I take advanced AP classes related to this field, I would definitely consider of becoming web developer as my career. (CPR 1, Line 8-11)

Broader Use

Another common reason for students selecting or considering CS careers was the realization that it has a broader use beyond just writing code. Doyoon said, "as I was researching through careers, I found out that even though there is a computer science major there is lots of things connected" (CD 2.1, Line 20-21). Jejoon shared:

> I also think that computer science will be helpful for my life and decisions I make in the future. I take this class to make experience and grow knowledge because I think it is useful. At first, it was only for use and to go to college but made me get more interested in computer science.

> More I look into it the more it is related with any other subject I learn such as history, law, lifestyle and more. (RW 1, Cell 3)

Many students who previously were not interested in a computer science career found themselves considering the possibility when they realized there were careers in their desired field that used computer science. For example, Minjoon shared that he wanted to be a designer and found the augmented-reality field of CS as an interesting way to fulfill his dream in a modern, in-demand area (RW 5, Cell 14). Others were intrigued by the career of medical informatician, a career that combined the commonly chosen medical track and computer science.

Societal Impact

Many also expressed a desire to enter a field with such a clear impact on society. Students expressed that they would feel very satisfied with a CS job because they knew that what they created would benefit and be used by others. Enyu shared "I am a gamer, I play games a lot, I was kind of dreaming about to be a computer programmer and make some fun games to let others to play" (RW 1, Cell 4). Similarly, Doyoon said:

> Nowadays, many students and adults like playing video games. And the video games all come from video game developers. By having this job, we will be able to be proud of showing how interesting and fun games that we've made. (CPR 3, Line 26-28)

Discussing the web development career she researched, Jiyoung said:

> The fact that web developers could actually work on the websites that normal people use daily sounds to me that has lots of values because I would be satisfied when I see people using the websites that I have contributed making or building. (CPR 3, Line 35-38)

In her desire for a CS career, Minseo said that "a career should give me the opportunity to contribute to the world. I would like to have a job in which I can help other people, not just myself, live a better life" (RW 2, Cell 5). This sentiment was shared by other students when discussing the reasons for aspiring to CS careers. Other students expressed a desire to be on the modern front of technology. For example, Minseo said "I think this could be a positive aspect—possibly the best aspect—of this job. I would be doing groundbreaking work, which I think would be a lot of fun" (CPR 5, Line 43-45).

Creativity

The impact of creativity as a factor in CS career aspirations had both a positive and negative effect. When researching jobs, two students talked about the imaginative and inventive aspect of coding as a hurdle for them. When discussing the job he had researched, Enyu stated, "I think I might capable with this job, but I think even I will know how to code fast and correctly [*sic*], I'm less of creativity in codings [*sic*]" (CPR 1, Line 8-10). Likewise, Doyoon said "I am not that creative. I like doing things that have the answer to it. For example, math" (CPR1, Line 11-12). These sentiments show a low expectancy for creativity even though they feel they can learn the coding and other technical aspects of CS. "I think I can handle those programming. But I don't think I'm creative with this things [*sic*]" wrote Enyu (CPR 5, Line 24-25).

However, this was met with a larger number of students who saw the creativity and freedom of CS jobs as a positive aspect. Students enjoyed the prospect of being encouraged to "think outside the box" (Dongsoo, CPR2, Line 21) and having "no limits of what you can think and create" (Jiyoung, CD 2.2, Line 33-34). In a class discussion, Dongsoo also stated "since you have like a lot of freedom, you can really be creative. I really like that stuff" (CD 2.1, Line 49-50). The concept of working on their own ideas was appealing to many students impacted the perceived satisfaction they would receive from a CS job. "Since this job obviously requires a lot of dedication in both time and work aspects, I think this value would help me get satisfied from giving all my effort," Jia shared (CPR 3, Line 35-36). When comparing gender differences in positive and negative comments about creativity, the females all indicated that creativity was a positive aspect of the CS career and none shared anything negative about creativity in CS.

Negative Aspects of CS Jobs

Although some of the undesirable characteristics of CS and CS careers, whether true or perceived, have already been mentioned, other roadblocks were presented by the students in the case study that did not fit into another code. One of those was what students classified as long and tedious work. About the software development career, Minseo stated that "staring at codes for hours a day seems boring and stressful. I would want to do something more interactive and fun" (RW 5, Cell 5). On the job he researched, a programmer, Dongsoo said "one downside of this job is working for 8 hours straight. This is really hard because you just have to see words and numbers for the whole 8 hours" (CPR 5, Line 41-43). However, most of these perceptions came before the *broader use* discussions written about earlier. Many of these points were made about careers that seemed to involve mostly coding, as described in the quotes above. For example, the quote above is from Minseo when she is discussing software development, a career she saw as only coding, but when discussing database administration, she had something different to share:

> Because it involves working with other people… [the job has] interpersonal relationships and like we discussed before sometimes like you would be like sitting at your desk coding and that's a very like a solo task. Whereas this you have to work with other people, and I think that would be like fun and refreshing and I like this kind of environment. (CD 2.2, Line 95-98)

Another aspect that discouraged students from selecting CS as a career was the perceived saturation of the field. During the unit, statistics regarding the need for more employees in the CS field surprised many students who were under the impression that CS had limited jobs and high competition. Jia shared that:

> Though we know that this huge development in the computer science field is creating tons of new jobs and opportunities, I think people tend to think there are too many people who are wanting a major in computer science and, therefore, would actually make it hard to find a job in the future. (RW 4, Cell 8)

Similarly, Jiho shared that many peers do not choose CS careers because they assume that technology has already fully developed and therefore will not have a need for new workers in the future (CD 2.3, Line 108-112).

The final concept that had a negative impact on students' aspirations for a CS career was the relative newness of the field. Minseo shared that "I think the biggest downside to this job is the lack of history; this fosters some uncertainty for the future" (CPR 5, Line 40-41). Without a lot of role models in the CS field, students cannot see that success is possible like they can in more familiar jobs. "They might just want to follow, other people's footsteps rather than taking the initiative" said Minseo (CD 2.3, Line 130-132). Both Dongsoo (RW 4, Cell 9) and Junyoung (CD 2.3, Line 58-61) shared that the older generation in Korea also prefer that their children select jobs that are popular and with a proven record.

Early Exposure

Early exposure was discussed in the enrollment section, but its implications also reached to career aspirations. As discussed in the enrollment analysis, early exposure was a strong theme for why students felt that CS was a course not pursued by many of their peers. Their common sentiment was that students feared CS because it was unknown to many of them and false assumptions were made about the course and the career. Students felt that early exposure would mitigate the lack of efficacy and stereotypes. With regards to careers, Minseo shared that people chose careers based on interests they formed while in school and "if you don't have that like fundamental interest in computer science, you never end up doing it again in college as well" (CD 2.3, Line 63-65). Jia, likewise shared that CS is a field that seems to require some experience before entering, and without that exposure, they will instead pick a field where they can show their strengths (CD 2.3, Line 118-119).

Other Findings, Impact of Careers Unit

Although this study was initially designed to only look at the three research questions discussed above, a new topic of interest emerged during coding that seemed relevant to the study. To create the case in which the study took place and to make it fit within the structure of a normal classroom, a unit was created that gave students the opportunity to discuss and explore CS careers. Pedagogically speaking, one of the interesting aspects of this study was the impact the careers unit had on students' interest in CS careers. At the end of the unit, during the final class discussion, students were asked if their thoughts about CS had changed (see Appendix D, CD4). Minseo, for example, said, "I think it broke a lot of my generalization about the career and before I am kind of apathetic, Okay, someone will do it. Now I am consider going into CS career" (CD 2.1, Line 52-53). During one of the last class discussions (CD 2.1) three students, Jejoon, Junyoung, and Jiho, were already interested in a CS career prior to the unit and their aspirations did not change. Another two, Jiyoung and Dongsoo, stated they were already interested by felt more motivated after the unit. Another five students, Minseo, Jia, Doyoon, Minjoon, and Enyu said their previously negative opinion changed significantly after the end of the unit. As discussed in the *broader use* analysis, students were motivated when they saw the use of CS in more areas than just computers. Two of those students, Jia and Minseo, cited seeing the connection of CS to other fields, such as business, biology, and the medical field, as their reason for finding themselves more interest in CS. Doyoon had similar sentiments when they said they realized a CS career was more than just coding (CD 2.1, Line 19-20. Minjoon said he probably would not pursue a CS career, despite interest, because he felt it was still too hard, an example of the expectancy construct (CD 2.1, Line 39-41). No students expressed *less* interest in CS as a result of participating in the CS unit.

Discussion

In this case study, students provided insight into what factors influenced them to enroll in an elective CS course, choose CS as a future career goal, and to what extent (if any) early exposure to CS coursework play in their decisions regarding enrollment and future career goals. Previous research has shown that decisions to enroll in elective courses and aspire to certain careers are influenced by expectancy and value constructs a student associates with that domain (Andersen & Ward, 2014; Eccles, 2005, 2009; Eccles et al., 1983). Likewise, there is literature to indicate the Confucian principals of East Asia the educational culture in South Korea and how students are motivated to pursue their coursework (Hyun, 2001; Kim, 2002; Kim et al., 2005; Lee & Seo, 2006; Robertson, 2002; Shin & Koh, 2005; Sorensen, 1994). The results of this case study situated in South Korea highlight the importance of early exposure to CS, student exposure to a variety of CS careers, and the cultural influence on CS in the Korean setting.

Early exposure to content has been shown to be valuable in other studies because of the role it plays in developing student identity and their expectancy and task value (DeJarnette, 2012; Wang 2012, 2013). This was reiterated by the students who discussed a fear and low expectancy about CS course work among themselves and peers, with many expressing the need for early experiences to help motivate others. This has been shown in previous research that shows its positive impact on CS success in college (Barker et al., 2009; Biggers et al., 2008; Schulte & Knobelsdorf, 2007) and on students decisions to select a CS major (Google CS Ed Research Group, 2014; Wang et al., 2015). Students shared that they feel more comfortable with traditional courses, like math and science because those are ones to which they, their peers, but more importantly their parents, had all been exposed to during their education.

Likewise, exposure to details about the CS career field was valuable to students in the course and would likely help other students to break down misconceptions they had about CS professionals and careers. Eccles (2009) showed that students pursue careers that they associate with the characteristics they see in themselves, including gender. Misconceptions of the CS field as nerdy or masculine has a negative impact on females who already consist of a smaller percentage of the CS field (Beyer et al., 2003; Master et al., 2016; Wang et al., 2015). In this study, females saw the creativity of CS as a positive aspect since it made the career sound more interesting and fun. Students also shared that they largely assumed CS was a stand-alone trade that just involved typing code, indicative of Wang et al. (2016) who showed a strong misunderstanding among students about what the CS career entails. While coding is a big part of the job description, students were surprised and pleased to find that CS is part of a much broader workforce and that it could be used within the fields that they were already interested in, like medicine, business, and biology. This fits with Carter (2006) who said that the multidisciplinary nature of CS is influential in students' selection of a CS major.

Finally, this study took place in a population composed of students all from an East Asian heritage. While the findings addressed above fit with previous students completed among populations in the Western world, the filial piety and urge to conform driven by Confucianism may have a unique impact on students from Korea. A student's identity includes their cultural component, mediating how their subjective task values are formed (Eccles, 2009; Eccles et al., 1983; Eccles & Wigfield, 2002). This was indicated by students who referred to parents as their reason to either cautiously pursue or outright avoid a career in CS. With so much riding on academic success in Korean culture (Kim et al., 2005; Shin & Koh, 2005; Sorensen, 1994), the uncertain nature of CS (due to its relative newness) makes it risky for students and parents to pursue. Likewise, the fear among students about the creative aspect of CS was influenced by their feelings of inadequacy in being imaginative and inventive. As shown by Kim et al. (2005) and Lee and Seo (2006), the focus on rote memorization and the tightly organized nature of Confucian culture could have a negative influence on students' abilities and efficacy regarding creativity. However, as noted earlier, the negative utterances about creativity were all made by males, and not by any female.

Limitations

Being a case study confined to a normally operating classroom, this study was also limited in the breadth of information it could obtain. In order to maintain the natural setting of the classroom, no one-on-one interviews or smaller focus groups took place. Instead, the study was designed to focus on specific questions, which were asked through a variety of means in order to find commonalities and consistencies Hence, the study was limited in the sense that it focused only on a single group.

However, being a qualitative study, the goal is to explore the factors associated with CS enrollment and career aspirations, not to generate or refine theory. As such, the data gathered in this study is meant to open dialogue about future studies in the field. Thus, one of the central limitations of this study is the context of the school. Students enrolled in this particular private international school were taught using a Western-style curriculum. As such, it may be argued that the students were not representative of typical Asian pupils. However, all students still reside in Asia and are living within the context of the Korean culture. It is the view of the researchers that, though slight differences may be present, the students in this sample will provide insight into the motives and motivations affecting their respective population. Another limitation was the limited number of students in the course and therefore the sample. However, by using multiple forms of data collection, the information gleaned in this study is able to be validated through triangulation.

Delimitations

As a case study, data was collected using a variety of sources. Data was collected through questionnaires, document analysis, and class discussions in order to create a triangulation that would allow the researchers to draw conclusions about the student's motives and outlook. The questions and prompts that composed the study were all linked to particular constructs from EVT (i.e., expectancy, identity, attainment value, intrinsic value, utility value, and cost) and each construct was addressed multiple times through multiple collection types. This focus could then prevent the emergence of alternative theories or ideas. This study was not intended to develop and causal relationships or to provide quantitative data about CS enrollment and aspirations. As addressed in the literature review, the CS research in the secondary field, and in Korea, is limited so the purpose of this study was to probe on potential factors that could be studied more in-depth with larger samples and more directive data collection.

Conclusion

Globally, CS education is of especially high concern, as is demonstrated by the demand for trained workers in the field. The promise of high-paying, in-demand jobs, however, is not enough to attract students without interventions across the K-12 spectrum; both for students and parents. This study has demonstrated that students need to develop a sense of efficacy in CS, or a least a familiarity with it, in order to feel motivated to take CS courses in high school and possibly university. Likewise, students need to understand what the career entails and what someone in that field would do on a daily basis. This includes understanding the different careers that are available in the field, more than just coding, with a special focus on the impact CS can have on improving society.

For the Korean population, where education and academic success are so highly valued and monitored by parents, the study indicates that extra effort needs to be made not only addressing the perceptions and concerns of students but parents as well. Students indicated that their parents tended to see proven careers, those held by family members, as the best choices and shied away from or discouraged pursuing ones to which they had no familial comparison. Entering the CS field itself does not contradict Korean culture, it has high-demand, high-paying, and highly regarded careers, so informing and assuring Korean parents about the needs and benefits of CS may help to ease the burden of the unknown and encourage more of them to help their children to pursue degrees in the field.

Implications

This study clearly helped to reiterate the need for early exposure, although it is indicative of exposing students to CS at even younger ages. Previous studies have looked at factors that influence enrollment and success in CS in the college years and found that previous high school experience is a positive factor on both accounts. However, encouraging high schoolers to take a CS course may itself needs additional information and education prior to entry. Students shared that the lack of early experiences with CS discouraged them and their peers from taking CS and made them perceive the content as too advanced for them. This indicates that in order to increase CS interest and success in college, exposure to CS needs to happen in lower grades, perhaps as low as elementary school. By exposing students earlier, there is an increase in their perceptions of their own abilities and thus a higher level of expectancy when they enter high school and college. Future research is warranted regarding the influence CS information may have on younger learners in CS interest and perceptions of CS as a viable career.

The study also shows the value in exposing students to information about careers in CS. The realization that CS is a multidisciplinary subject that entails a vast array of other fields was enlightening to students and helped encourage many to consider the field. As previous researchers have noted, the perception of CS as a secluded subject that involves sitting alone typing code only serves to discourage students, especially females. Yet, females also saw the creativity within CS, which should be researched further and expounded upon, such to attract more women to the field. Since the students in this case study had been enrolled in CS for half a year and did not make this connection to CS in other careers until this unit was presented, it is clear that merely enrolling in and learning CS is not enough to point out the broader impact of CS. The unit in this study was only seven instructional days; if such a small unit can have such a large impact on student perceptions, it may be well worth it to consider including a careers unit in more K-12 CS courses.

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Appendix A

Data Collection Written Items and Reference Codes

Source	*Item*	Reference Code
Reflective Writing (RW)	*Why are you in this class?*	RW1
	When you think about a career, what is most important to you? How does CS fit into your goals?	RW2
	Would you consider yourself "good" at CS? Even if this is your first CS class, do you see this as something you could do well in in the future? What qualities and skills make you good at CS? If you don't	RW3
	This statement was shared in class: "CS jobs are the fastest growing, highest-paying, and most in-demand jobs in America." Why do you think there are so few students taking CS classes and pursuing CS degrees?	RW4
	Which CS career(s) were most appealing to you and why? Which were least appealing and why?	RW5
Career Project Reflection (CPR)	*Could you do this job? What skills do you posses or lack that you think would help you?*	CPR1
	Would you feel comfortable in this job? Are the people in this job similar to you or different? How?	CPR2
	What value do you see in this job? Would you be satisfied from completing the accomplishments?	CPR3
	What benefits does this job bring to society?	CPR4
	What are the downsides to this job? Does that affect your decision? How?	CPR5

Appendix B

Data Collection Computer Science Enrollment Survey (CES) Items and Reference Codes

Item	Item Type	Reference Code
Why are you taking computer science in high school?	Yes/No	
Because it will help me get into college.		CES1a
Because it will be useful in college.		CES1b
Because I enjoy CS.		CES1c
Because I am good at CS.		CES1d
I had no choice, it is a requirement.		CES1e
Compared to other activities, how useful is what you learn in computer science? Explain.	Short Answer	CES2
If you were to order all of the students in your CS class from worst to best, where would you put yourself?	Ranking (1-10)	CES3
How much do you agree or disagree with the following statements?	Likert (4-point)	
I see myself as a CS person.		CES4a
Others see me as a CS person.		CES4b
I am confident I will do an excellent job on tests in this course.		CES4c
I am certain I can understand the most difficult presented the material in this course.		CES4d
I am certain I can master the skills being taught in this course.		CES4e
I am confident that I can do an excellent job on assignments in this course.		CES4f
I am confident that I can do an excellent job on projects in this course.		CES4g
My time and effort in CS means not enough time with friends.		CES4h
My time and effort in CS means not enough time for extracurricular activities.		CES4i
My time and effort in CS means I won't be popular.		CES4j
My time and effort in CS means people will make fun of me.		CES4k
I am enjoying this course very much.		CES4l
I think this class is a waste of time.		CES4m
I think this class is boring.		CES4n
What we learn in this class is useful for everyday life.		CES4o
What we learn in this class will be useful for college.		CES4p
What we learn in this class will be useful for a future career		CES4q

Appendix C

Data Collection Computer Science Career Survey (CIS) Items and Reference Codes

Item	**Item Type**	**Reference Code**
Are you planning to pursue a career in computer science in college?	Likert (5-point)	CIS1
What is your planned career field? If computer science, what are of computer science?	Short Answer	CIS2
How much do you agree or disagree with the following statements?	Likert (4-point)	
I have the qualities of a good computer scientist.		CIS3a
I have good computer science skills.		CIS3b
Computer science is a career suited to my abilities.		CIS1c
I am interested in being a computer scientist.		CIS3d
I have always wanted to be a computer scientist.		CIS3e
My friends think I should become a computer scientist.		CIS3f
My family thinks I should become a computer scientist.		CIS3g
I like computer science work.		CIS3h
Computer science will offer a steady career path.		CIS3i
Computer science will provide a reliable income.		CIS3j
Computer science will be a secure job.		CIS3k
Computer science will allow me to provide a service to society.		CIS3l
Computer scientists make a worthwhile contribution.		CIS3m
The time and effort for a CS career means I won't have enough time for my own activities.		CIS3n
The time and effort for a CS career means I won't have enough time with my friends.		CIS3o

Appendix D

Class Discussion (CD) Items and Reference Codes

Source	*Item*	Reference Code
Discussion 1 (Pre-Career Lesson)	*What (or who) influenced you to enroll in an elective CS course?*	CD1
	Do you think you will take future CS coursework in high school or college?	CD2
	What (or who) influences you to choose CS as a future career goal?	CD3a
	If CS is not your career goal, what is your career goal? How do you think CS will help you in your goal?	CD3b
Discussion 2 (Post-Career Lesson)	*Have your thoughts about CS changed after learning more about CS careers? If so, how? What changed your mind? If no, why?*	CD4
	Does anyone have interest in the following careers? (list given in class)	CD5
	If yes, what makes each career interesting to you? If no, what is unappealing about this career in CS?	CD6
	If CS is in high demand and pays well why do you think so few students take CS classes or pursue CS degrees? In K-12? In college? In career?	CD7

Appendix E

Theory Constructs Linked to Methods

Variables	Reference Codes
Expectancy	*RW1, RW3, CD2, CD6, CIS3a, CIS3b, CIS3c, CES1d, CES3, CES4c, CES4d, CES4e, CES4f, CES4g, CPR1*
Identity	*RW1, RW2, RW3, RW4, RW5, CD1, CD3a, CD3b, CD4, CD5, CIS1, CIS2, CIS3l, CIS3m, CES4a, CES4b, CPR1, CPR2*
Attainment Value	*RW1, RW2, CD2, CD3b, CD4, CD6 CIS3d, CIS3e, CPR3*
Intrinsic Value	*RW1, RW4, RW5, CD2, CD6, CIS3f, CIS3g, CES1c, CES1e, CES4l, CES4m, CES4n, CPR3*
Utility Value	*RW1, RW2, CD2, CD3b, CD4, CIS3h, CIS3i, CIS3j, CIS3k, CES1a, CES1b, CES2, CES4o, CES4p, CES4q, CPR3, CPR4*
Cost	*RW4, CD2, CD4, CD6, CD7, CIS3n, CIS3o, CES4h, CES4i, CES4j, CES4k, CPR5*