

Applying the Model of Interest Development to Understand Why Non-CS Majors Decide to Persist in or Leave Computing

Jinyoung Hur

University of Illinois Urbana-Champaign
Urbana, IL, USA
jhur10@illinois.edu

Junmee Park

University of Illinois Urbana-Champaign
Urbana, IL, USA
emilyp8@illinois.edu

Michael M. Kang

University of Illinois Urbana-Champaign
Urbana, IL, USA
mmkang@illinois.edu

Kathryn Cunningham

University of Illinois Urbana-Champaign
Urbana, IL, USA
katcun@illinois.edu

Abstract

A growing number of non-CS major students are enrolling in CS courses, alongside increased recognition that computing is critical to many fields. However, despite their perception of computing's importance, many of these students lose interest in CS and stop taking additional CS courses. In this study, we examine non-CS major students' CS learning experiences using the Model of Interest Development, a framework that models how learners' interest in academic domains progresses through phases of increasing engagement. Through semi-structured interviews with 19 non-CS major students, we identify key factors common among students who develop the most sustained interest in CS and those who do not. We find that non-CS majors' initial interest is often triggered by external advice and hazy perceptions of computing's importance, even when their understanding of the field is limited. Continued interest depends heavily on the perceived relevance of course content, the presence of a supportive learning environment, self-efficacy in learning computing and pursuing CS-related careers, and the extent to which courses address or reinforce generalizations and biases about computing. For those who develop the strongest interest, key factors include beliefs about the level of CS knowledge needed for their career goals and whether their stereotypes about CS are effectively challenged. Our findings provide insight into why previous efforts to improve the persistence of non-CS major students may have fallen short and highlight implications for course design, interventions, and institutional policies to better support students' interest development.

CCS Concepts

• **Social and professional topics** → **Computing education**.

Keywords

Interest Development, Non-CS Majors, Persistence

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1 Introduction

In computing education, interest has been highlighted as a key factor in student engagement and persistence. Many courses targeted at non-CS majors have made increasing students' interest in computing a primary goal, using approaches such as contextualized computing [11, 19] or projects that allow learners to explore their own interests [10]. Despite this focus on interest, computing education research has not considered the construct of interest with the same level of depth as the psychology literature. In particular, interest is usually depicted as a static trait in computing education, which overlooks its fluid and dynamic relationship with motivation over time. Consequently, existing computing education research lacks the theoretical depth needed to fully explain how interest develops or fades over time for individuals studying computing.

In contrast, an increasingly influential body of psychological research on motivation highlights the changing nature of interest. Represented by the Model of Interest Development, this literature posits that interest evolves through phases marked by the nature and amount of engagement, affect, value, and knowledge [26, 27, 49]. According to these models, early phases of interest involve brief engagement and are dependent on environment, whereas later phases are characterized by sustained, self-regulated involvement with content and are driven by personal value and content knowledge. This framework implies that interventions intended to increase persistence should be designed differently at different phases of interest to more effectively support learners [25].

This lens of the dynamic, developmental nature of interest could help explain why interventions that spark early interest do not always lead to sustained engagement. For example, Media Computation, the contextualized introductory computing course (CS1) which introduces programming through image and sound manipulation, did not encourage learners to persist to CS2 [18]. Although students had interest in the topic at the time, without seeing the



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personal value, students' interest may not develop into a more enduring form, leading to a drop in further participation. Similarly, the launch of Advanced Placement Computer Science Principles (AP CSP) in 2016 has led to an increase in course enrollments among underrepresented students, yet evidence remains conflicted regarding its effect on subsequent enrollment in computing majors, and further persistence in computing or technology careers [54]. These examples highlight that interest at the point of re-engagement is qualitatively different from initial curiosity [49]. Understanding this transition requires more nuanced investigation.

In this paper, we apply the interest development framework to better understand how non-CS majors' interest in computing develops over time. Through semi-structured interviews of 19 non-CS majors, we explored their learning experiences, identified each participant's phase of interest, and analyzed the characteristics and patterns of interest at each phase. The primary contribution of our study is the close examination of how non-CS majors' interest in computing evolves and what factors support or inhibit the transition across phases of interest over time. We obtained detailed accounts on what initially enticed these students to study computing, what experiences led to their decisions to continue to or stop studying computing, and how their perception of computing as a field changed throughout these experiences. Furthermore, our participant pool reflects a wide range of computing coursework experiences, providing a broader perspective of non-CS major students compared to many existing studies [8, 10, 54]. Ultimately, this work aims to inform how we might increase persistence among non-CS majors through support that inspires sustained interest.

2 Background

2.1 Non-CS majors

Non-CS majors are a substantial part of the recent boom in computer science enrollment, across not only courses designed for them, but also in introductory, mid-level, and upper-level electives [5]. However, non-CS majors differ in several ways from CS majors.

2.1.1 Diversity in background and desired endpoints. Non-CS major students enrolled in introductory computing courses differ demographically from CS majors. Non-CS majors in introductory [53, 54] or interdisciplinary [11, 60] computing courses are more likely to be women or students from underrepresented racial groups. In addition, at PhD-granting institutions, the growth rate of students from underrepresented racial backgrounds in introductory non-major computing courses has outpaced that of for-major CS1 courses [6].

Non-CS major students also vary in their goals with computing. Their desired computing endpoints have been categorized into a few stereotypical groups: professional programmers, end-user programmers (who use programming to support needs other than software development) [33], conversational programmers (who learn computing to be able to communicate about technical concepts with colleagues but not to program) [8], and non-programmers. A survey of non-CS majors who took CS courses at a large public research university found that the majority identified as end-user programmers or conversational programmers [30]. Moreover, non-CS majors typically enter college with less exposure to computing [54] and report

lower self-efficacy in computing compared to CS majors [43]. These factors also vary by desired endpoint [30].

2.1.2 Differences in learning needs. Several characteristics of non-CS majors suggest they would benefit from different instructional approaches. Many non-CS majors in computing courses are "late-comers" to computing, often taking their first college-level computing course in the latter half of their undergraduate studies [36, 54]. This limits the time they have to learn computing, especially as they also have to balance the coursework in their primary field of study. Moreover, the learning goals of non-CS majors and their expectations for the courses may shift over time. A study of an introductory programming course in biology found that earlier-stage non-CS majors expressed more exploratory goals while those in later-stages described clearer, career-driven motivations [61].

Various studies of end-user programmers and conversational programmers suggest that they have different values for various aspects of computing compared to CS majors. Studies involving end-user programmers [12] and conversational programmers [57] found they do not value learning of low-level programming knowledge, such as syntax, describing such content as irrelevant to their more conceptual and application-focused learning goals. Similar preferences were observed among non-CS majors in computing courses [24]. Also, conversational and end-user programmers favor computing knowledge that aligns closely with their primary domain. Studies have found that end-user programmers most valued computing knowledge that was relevant to their task at hand [13, 33].

2.1.3 Efforts to meet non-CS majors' needs. Recognizing the challenges non-CS majors face in courses designed for CS majors, a growing body of work has developed alternative instructional approaches and curricula tailored to this population. These efforts have been central not only in addressing non-CS majors' needs but also broader goals of broadening participation in computing.

A common approach in these redesigned courses has been contextualization or integrating computing into disciplinary contexts, with the goal of making computing more relevant. One notable example is the Media Computation (MediaComp) curriculum, which uses the context of image and sound manipulation to engage students in programming tasks that yield immediately tangible results [17]. MediaComp was intentionally built around an application context that students from multiple fields could find meaningful. Another example is the BioComp course, which teaches programming in the context of biology, helping undergraduate biology majors acquire computing skills relevant to their domain [38].

Other characteristics of courses for non-CS majors are highly scaffolded programming environments and more manageable workloads. For instance, the Beauty and Joy of Computing (BJC) curriculum uses Snap!, a block-based language [16], while MediaComp employs JES, a simplified Python IDE with built-in media functions [17]. While such tools do not reflect the day-to-day programming practices of real-world end-user developers [22], they serve an important pedagogical function by allowing students to focus on logic, structure, and creativity without being overwhelmed by syntax. In an effort to lower the barrier to entry for non-CS majors, CS 0.5 courses were designed to cover fewer learning outcomes than CS-major courses, with material delivered at a slower pace [10].

2.2 Persistence in Computing

Motivated by high attrition, persistence in computing at the post-secondary level has long been a central focus in computing education research. A considerable proportion of students, especially women and those from underrepresented groups, drop out while transitioning to [7] and during [50] postsecondary computing education. These groups of students are consequently underrepresented in computing, and extensive literature is dedicated to identifying the reasons, namely sense of belonging, self-efficacy, and interest.

2.2.1 Sense of belonging and self-efficacy. One indicator of persistence is the affective experiences of students in computing. These factors, namely sense of belonging and self-efficacy, shape students' perception of their abilities and fit in computing and ultimately influence their academic and professional trajectories. Although sense of belonging began to gain attention relatively recently in post-secondary education [55], its concepts and implications have long been recognized as a research interest in computing education. Empirical studies have consistently demonstrated the link between low sense of belonging to negative outcomes, namely lower academic performance and satisfaction [35], and overall persistence [52].

Similarly, extensive research has shown that low self-efficacy is related to lower persistence. Some studies suggest self-efficacy is the most significant predictor for academic outcomes and persistence in computing [41]. Furthermore, students who tend to negatively self-assess their computing ability during their learning experience have lower self-efficacy, and this tendency has been more pronounced among women [3], contributing to their higher attrition.

2.2.2 Interest in computing. The persistence literature frequently links interest in computing to persistence in computing. For instance, many studies controversially claimed that women's inherent lower level of interest in computing led to their underrepresentation [44]. Kanny et al. associated differences in interest with factors such as early exposure or classroom experience [32]. In their longitudinal study, Holmegaard et al. explored types of resources that affect the formation and transition of interest in computing and highlighted the importance of family influence in creating and stabilizing students' interest in computing [29]. A study has also shown that interest in CS careers led to greater interest in computing in general as well as more active participation in curricular and extracurricular activities among middle and high school girls [15].

However, many studies concerning interest in computing define interest rather broadly or conflate it with other constructs. For instance, survey instruments in Weston et al. [58], the Computer Science Attitude Survey [59], and the Computing Attitudes Survey [14] do not differentiate interest from other constructs such as enjoyment. Friend also deliberately defined interest broadly in the survey [15]. As interest is a construct with a distinct definition, this practice severely limits the instruments' capability to measure students' interest, and may lead to the misunderstanding of interest and its role in students' decision revolving studying computing.

Moreover, these studies often do not consider the complexity of interest as a construct. This practice diverges from contemporary theory on motivation and interest, which positions interest as a dynamic, developmental construct that can fluctuate from moment to moment and evolve over months or years [27].

3 Theoretical Framework

3.1 Model of Interest Development

Within educational psychology, interest has long been recognized as a motivational variable with significant influence on students' attention, depth of learning, goals, and persistence [27]. For some time, research in psychology differentiated between two distinct types of interest: interest as a predisposition and interest as a momentary phenomenon triggered by contextual or environmental factors (e.g., reading a text) [34]. Recognizing the link between these two types of interest, Hidi and Renninger developed the Four-Phase Model of Interest Development describing their relationship [27]. The model distinguishes between two main types of interest, *situational interest* and *individual interest*, each of which has two subtypes. Individuals may progress through these phases of interest as they engage with a topic across time.

The first type of interest, *situational interest*, is defined as a fleeting interest caused by external factors. The model decomposes situational interest into *triggered situational interest* and *maintained situational interest*. Triggered situational interest refers to momentary interest sparked by external factors, primarily affect and experience, while maintained situational interest occurs when learners develop positive affect and personal value through sustained engagement with external support [27]. Maintained situational interest may develop into the second type of interest, *individual interest*, which represents a more enduring predisposition that leads to self-regulated re-engagement with the content and intrinsic motivation to pursue knowledge of particular content. Individual interest is divided into *emerging individual interest* and *well-developed individual interest*. Well-developed individual interest reflects deeper personal value as well as more feedback-seeking behavior [27, 49].

This model has allowed researchers to examine the developmental process of interest through observable features, and has provided a foundation for empirical work on interest-based motivation across various domains [39, 56]. Recently, Michaelis and Weintrop used the Four-Phase Model of Interest Development as inspiration for a framework of interest development specific to computing education [46]. Their framework specifies belonging, knowledge, and value as key drivers of individual interest. Computing education researchers seem to be increasingly recognizing the distinction between situational and individual interest (e.g., [2, 42]), however, the application of the model of interest development in computing education remains limited.

3.2 Our Application of the Model

In this study, we aim to understand the factors associated with the development of students' interest in computing during their attendance at a post-secondary institution. We apply a modified version of the Four-phase Model of Interest Development where we do not differentiate between emerging and well-maintained individual interest, resulting in a three-phase model. In our interview data, it was not possible to identify the features that distinguish these two phases, specifically greater depth in personal value and increased feedback-seeking behavior. Others have noted the unclear distinction between these two types of individual interest [51]. Further, some empirical studies (e.g., [39, 40]) do not differentiate between these two phases of individual interest.

4 Methods

4.1 Participant Recruitment

We recruited non-CS major students who had enrolled in at least one course offered by the Computer Science department at a North American public research university. This department offers three introductory courses specifically designed for non-CS majors, and has majority non-CS major enrollment in multiple other introductory courses. We emailed 370 students who had previously expressed interest in being interviewed for this study during their participation in an earlier study on non-CS majors and invited them to complete a pre-screening survey. To ensure a diverse range of perspectives, we purposively sampled 39 of the 106 students who completed the pre-screening survey, based primarily on academic background (major, number of computing courses taken, desired computing endpoint) and secondarily on demographics (race, gender). In total, 19 students participated in the study (see Table 1). Each participant received \$30 as compensation for their time.

4.2 Semi-structured Interview

We conducted semi-structured interviews remotely via video conferencing. Each interview lasted between 40 and 60 minutes. All interviews were recorded, transcribed verbatim, and anonymized. This study was approved by the university's IRB.

The interview protocol was designed to explore students' computing course experiences, focusing on the following key areas:

- Initial motivations and expectations upon first enrolling in introductory computing courses
- Interests, values, and feelings toward CS across different phases of academic, professional, and personal experiences
- Reasons for persisting (or not) in learning computing

In addition to these topics, our interview guide was tailored for each participant using information gathered from their pre-screening questionnaire. This allowed us to focus on areas most relevant to their individual experiences, with targeted follow-up questions used to encourage elaboration and clarify specific points. During the interviews, interviewers actively encouraged participants to further elaborate, clarify, or provide specific examples of their experiences.

The interview team observed that few new themes were emerging in the later interviews. This observation was confirmed during the coding process, which revealed no new themes beyond the 15th interview. We determined that we had reached saturation and stopped soliciting new interviewees.

4.3 Interviewers

The first three authors performed the interviews. The first author and lead interviewer has learned programming as a non-CS major and has prior experience teaching non-CS majors and conducting research in computing education. The second interviewer was also a non-CS major and has experience as an end-user programmer and education researcher focusing on students from historically under-represented backgrounds. The third author is a combined CS and education major with experience designing curricula for non-CS majors. All interviewers are committed to broadening participation and fostering inclusion in computing education.

4.4 Data Analysis

We used *deductive coding* to identify participants' phases of interest development and then *inductive coding* to identify themes. This hybrid approach created alignment with the established Model of Interest Development while allowing for discovery of novel themes specific to factors contributing to computing interest development.

4.4.1 Coding. We applied theory-driven deductive coding to categorize participant responses into predefined phases of interest (i.e., *triggered interest*, *maintained situational interest*, and *individual interest*), ensuring alignment with the established framework. To guide this process, we first created a coding protocol that included definitions and a list of indicators for identifying each phase, based on the theoretical definitions of each phase of interest development [27, 49]. We coded excerpts from interview transcripts according to their alignment with these indicators, allowing us to classify the phases of interest reflected in participants' experiences. In the preliminary round of coding, the primary coder and the secondary coder coded the first ten out of 19 transcripts and then all coders discussed unclear portions of the initial protocol and further refined it. Using the revised protocol, the primary coder and the tertiary coder coded all 19 transcripts. Inter-rater reliability for phases of interest, calculated using Cohen's kappa, was 0.81, indicating strong agreement [23]. Lastly, all coders reviewed, discussed and harmonized any disagreements that arose from deductive analyses.

Then, we analyzed interview transcripts to generate themes using Braun and Clarke's approach [4]. All coders familiarized themselves with the data, independently generated initial inductive codes, and searched for themes. Then all authors collaboratively reviewed, defined, and finalized themes through an iterative process.

4.4.2 Definition of interest in computing. Throughout this paper, we define *computing* broadly, including computer science, data science, and human-computer interaction. When students referred to specific domains (e.g., data science), we identified and analyzed their phases of interest and contributing factors within each domain separately. For the purposes of reporting in Table 1, we recorded each student's *computing* phase of interest based on the highest level of interest across any domain at the time of the interview.

5 Phase 1: Triggering Situational Interest

Non-CS majors began learning computing for varied reasons, often motivated by its perceived importance, its relevance to daily life, and interpersonal encouragement. Despite entering with a limited initial understanding of what the subject actually entails, many approached computing with an openness, signaling both the fragility and potential of early situational interest.

5.1 Perception of the Prevalence of CS

Despite differing academic and career paths, many students were drawn to computing because they perceived its growing presence across fields and potential connections to their career or primary area of study (P1, P2, P6, P7, P8, P12 P14, P15, P18). P1, for example, said: "*With computer science and coding growing, especially in so many different industries...it would also be useful to have some of that background.*" For some, this perception was strong enough to motivate them to consider a CS minor even before gaining any exposure

Table 1: Participant characteristics, phase of computing-related interest, and prior computing coursework

Participant	Major	Phase of Interest	Computing Courses Taken	Desired Endpoint ¹	Gender	Race
P1	Accountancy	Triggered	2	CP	Woman	White
P2	Chemical Engineering	Maintained	3	NP	Woman	Asian
P3	Civil Engineering	Triggered	1	CP	Man	White
P4	Statistics	Maintained	3	CP	Woman	White
P5	Statistics	Individual	5	EUP	Man	Asian
P6	Mathematics	Individual	5+	EUP	Man	Asian
P7	Physics	Individual	2	EUP	Woman	Asian
P8	Chemical Engineering	Individual	5	CP	Woman	Asian
P9	Undeclared	Individual	3	EUP	Woman	Asian
P10	Music: Instrumental Performance	Maintained	2	EUP	Woman	Prefer not to disclose
P11	Learning and Education	Maintained	2	EUP	Woman	White
P12	Physics	Individual	4	EUP	Man	Asian
P13	Industrial Engineering	Maintained	1	CP	Man	Hispanic or Latina/o/e
P14	Accounting	Triggered	1	CP	Woman	Asian
P15	Accountancy & Economics	Triggered	1	CP	Woman	Asian
P16	Agricultural Consumer Economics	Triggered	1	NP	Woman	Asian
P17	Information Science	Individual	5+	EUP	Woman	Asian
P18	Information Science	Individual	4	CP	Woman	Asian
P19	Mechanical Engineering	Maintained	1	NP	Man	Asian

¹Non-programmers (NP), Conversational programmers (CP), and end-user programmers (EUP).

to the subject: “CS is really big. So I thought it’d be important to get a CS minor” (P2). These accounts show how broad societal narratives about computing’s prevalence can trigger initial interest.

5.2 Interpersonal Encouragement

Direct advice and encouragement from others were significant factors in triggering non-CS majors’ interest in computing (P2, P3, P4, P5, P7, P8, P9, P11, P19). Several students chose to study computing based on strong recommendations from family members, academic advisors, and teachers. P11 shared that “I did not know about [CS courses]” until her father suggested “You should take [CS] class.” Likewise, P5 enrolled in a computing course based on his advisor’s advice: “I had no background [in] computing, so I had no idea what was any of it. He said it’s a good course and I should try it out, so I did, and I found that I liked it.” In some cases (e.g., P7), such advice even motivated students to enroll directly in the CS1 course for CS majors rather than the version intended for non-CS majors. Further, teachers’ encouragement sometimes transformed mandatory course-taking into triggered interest, with the potential to foster more sustained engagement: “The teacher thought I had potential to do more CS, so I took CS again....then I know I liked CS” (P8).

Peer encouragement also mattered. Several students described how having friends who were CS majors or interested in CS sparked their initial interest, often through casual conversation or informal invitations to explore together. For example, P8 explained how exposure to her peers’ interests piqued her curiosity about a new domain: “I have a lot of friends that are CS majors, so they just talk about [AI] all the time. I guess I want to see what it is really like.” P4 described enrolling in a CS course despite a previous negative experience, because of a friend’s encouragement: “I’m taking this class. You take it with me. I don’t want to do it alone. I promise you’ll like it better this time.” These examples illustrate how interpersonal encouragement can trigger interest, drawing students into computing before they have developed intrinsic motivation.

5.3 Relevance to Daily Life

Computing’s relevance to daily life also helped trigger situational interest for some (P5, P17). Alongside his advisor’s recommendation, P5 was personally motivated by his interest in gaming: “I also had in the back of my mind I enjoyed gaming. So game development was something that I did consider. So I was like, ‘I’ll give it a shot.’” P17 was drawn to computing through its relevance to everyday digital life: “I took [intro computing course] because I was like, ‘Oh, this could be interesting because I’ve always been a little interested in digitalized spaces’....because everything is being digitalized and a lot of information is being stored, including our information.”

Notably, regardless of what triggered their interest, many non-CS majors’ initial interest with computing was characterized by limited understanding alongside a willingness to explore. Their perceptions of CS often lacked depth and were not grounded in personal experience. As P17 put it, “I didn’t really understand CS at first. Well, that was before I had any knowledge of it.” Despite this uncertainty, many expressed a willingness to explore computing with an open mind. P11 described their mindset as simply, “All right, sure, why not.” P7 saw it as an opportunity to explore: “I’d be able to figure out if I enjoyed CS and if I wanted to continue with it.” This openness suggests that while initial interest may be situational and loosely formed, students are receptive to engaging further. Indeed, several students noted that they had not made a firm decision about how many computing courses they would take at the outset, suggesting that their commitment could evolve over time depending on how their interest developed.

6 Phase 2: Maintaining Situational Interest

According to the Model of Interest Development, triggered situational interest transitions into maintained situational interest when learners repeatedly engage with the content in a meaningful way, often facilitated by contextual support. In our analysis, we identified three forms of contextual support that were critical in helping

non-CS majors maintain their interest in computing: 1) relevance of course material; 2) support from peers, instructors, and course staff; and 3) counteracting negative stereotypes about computing.

6.1 Relevance to Academics and Career

6.1.1 Maintaining interest can be influenced by relevance to academics and career. Non-CS majors' situational interest in computing was more likely to be maintained when they perceived its clear relevance to their future careers or academic coursework. Interestingly, only one interviewee (P18) mentioned the relevance of computing learning to daily life (*"how new technology works"*) as something that triggered maintained situational interest. Even then, this was cited alongside career motivations, implying that while personally meaningful, everyday relevance alone may not be a strong driver of sustained interest. Instead, it appears to play a complementary role in supporting interest already grounded in other forms of relevance.

Academic Relevance. Several non-CS majors sustained their interest in computing by recognizing its relevance to their primary disciplines and coursework (P6, P7, P10, P12, P18, P19). P19 explained that seeing how artificial intelligence (AI) and coding applied to his senior project helped him recognize the value of computing. P6 sustained his interest through the meaningful intersections between CS and mathematics: *"CS theory has so many...intersections to graph theory....Anything related to counting...has very heavy CS influence. So that's interesting to me."* P12 similarly said computing courses *"actually helped me in a lot of other physics classes."*

This alignment was more apparent among students in majors with clearer conceptual or methodological overlaps with computing, such as mathematics, physics, or certain areas of engineering, compared to those in fields like business or the social sciences, where connections may be harder to recognize early on.

While less common, one student sustained their interest even without immediate evidence of relevance to their major as long as they believed the relevance would become apparent eventually. P10 described: *"I didn't learn [the relevance between my major and CS] as much in these beginning courses."* However, she anticipated that such connections would emerge later, explaining that *"I knew that CS and music had some applications....electronic instruments is where it really gets into the CS stuff. So that's a little bit later down the line for me."* This forward-looking perspective suggests that for some students, the anticipation of future value can support sustained interest, even in the absence of current understanding of relevance.

Career Relevance. For many students, recognizing computing's relevance to their future careers was a key factor in maintaining their interest (P2, P4, P5, P7, P8, P9, P10, P11, P12, P13, P18, P19). For example, P5 maintained his interest in computing by viewing the content of his CS courses as *"adjacent"* to his career path in *"data science."* P4 found *"learning Python was super relevant"* because *"having an understanding of CS made [using tools like Excel] easier"* in workplace contexts. P16 also noted the usefulness of computing for *"Excel skills"* but wished for more *"similar applications"* and *"soft skills that I could utilize after college"* to maintain her interest.

Importantly, career relevance is not limited to coding expertise; rather, students frequently pointed to broader competencies, such as interdisciplinary collaboration, technical literacy, and communication, as drivers of continued engagement. For instance, P18, who

aspired to a consulting or product management career, highlighted computing's career relevance in maintaining her interest: *"I wanted to definitely have those technical skills because it really stands out to employers and careers....[I could be] discussing with teammates on a project and you wanna understand what they're doing."*

6.1.2 Introductory computing curricula often fail to help non-CS majors see the relevance of the material. While non-CS majors expressed mixed views about their introductory computing courses, many failed to see how the content was meaningfully relevant to them, despite initially believing it would be (P1, P2, P3, P14, P15, P16). For example, P3 shared: *"a lot of [content in CS1] is abstract and so I don't know exactly how well it would transfer into an office."* Business students, in particular, appeared to face greater difficulty in seeing the relevance of computing to their field, which may have contributed to their decision not to persist beyond introductory courses. P1 reflected: *"I don't know if [computing] plays a big enough role [in my field]... In terms of jobs, I wouldn't really say that it's used that much."* She emphasized that for her to pursue more computing coursework, the course *"would have to be really specific in terms of the topic and how you could actually apply it to certain roles and jobs within business rather than something more general."*

Many students, regardless of their level of interest in computing, felt that introductory courses were not designed to maintain non-CS majors' interest. As a concluding remark in our interview, P7 said, *"I know a lot of people who end up not enjoying their CS minor or end up giving up on it. I think there should be an emphasis placed on intro-level classes that you don't have to use CS to be a software engineer. There are other things that you can do with it."* This student added that such framing could help non-CS majors think, *"Okay, I might be stuck doing this for now, but I don't have to do this forever. I can use programming for other applications in the future."* These findings suggest that many non-CS majors do not fully recognize the relevance of computing until after their introductory courses, if at all, highlighting a critical gap in early curriculum design.

6.1.3 Students often have clarity of relevance after or outside of introductory courses. Interestingly, many students realized the relevance of CS *after* introductory courses, typically in later academic or professional settings (P2, P4, P9, P15, P16). For example, P16 came to appreciate the value of computing when it became useful during a senior-year course in her major: *"My perception of usefulness definitely increased because I saw how applicable it could be to coursework....there is some delayed satisfaction."* More commonly, students grasped the relevance of computing in career settings, such as internships or conversations with professionals in the field. For example, P2 had once lost interest in computing after her introductory course and dropped the CS minor. However, she later regained interest and began pursuing a data science minor after realizing computing's value during an internship: *"CS was like coding those models and software, but I didn't understand how it relates to chemistry at all. But now I'm working and reaching out to people at [a pharmaceutical company], and they're [saying] the AI space is going really strong, especially in R&D."* She also noted that she had been unaware of computing-related roles in her field, such as applied data scientists or project managers, until speaking with professionals and wished such possibilities had been made more visible earlier: *"[Computing-related roles] should have been highlighted a*

lot more because a lot of people don't know it... so then not that many people will go into it."

6.2 Supportive CS Learning Environment

6.2.1 Struggling without adequate support can lead to a loss of interest in computing. Struggling was a common theme among many students who did not maintain their interest in computing. While challenges often stemmed from the difficulty and workload of course content, they were frequently exacerbated by the lack of accessible support within CS courses (P1, P2, P11, P14, P15, P16).

One common source of struggle was the lack of meaningful interaction with instructors and course staff, often due to large course sizes and the absence of in-person components. P14, whose *"interest in taking any CS course plummeted to zero,"* felt that CS courses would be much more helpful if not held in a *"big lecture hall"* but in *"smaller learning environments"* that *"promote people to ask more questions."* Similarly, P2 contrasted a data science course she *"really liked"* for its *"feedback"* and *"in-person"* elements with a negative CS1 experience that led her to lose interest in CS domain: *"[CS1] was not in-person. You didn't have an in-person lab. It was just very lonely if you didn't know what you were doing."* Her only option was to attend *"online office hours"* that disliked because *"you just wait there until someone else finishes their problem"* and emphasized the need for *"more in-person, like teachings or anything."*

In contrast, non-CS majors who maintained interest in computing often attributed it to positive course experiences with timely support or meaningful interaction. P17 found having ways to ask questions and collaborate *"nice"* and *"very helpful"* despite online lectures: *"the discussions were in-person so you could ask the TA for help...connect with peers...labs in groups."* P19 also valued immediate support: *"I got help from the office hour....when you are stopped you can always ask a TA."* P11 added that meaningful interaction *"doesn't necessarily have to be humans"* but could come from tools, pointing to the importance of engaging course design.

Support from CS majors or peers skilled in computing was critical in shaping non-CS majors' experiences. Many students shared having CS-major peers helped ease their struggles or concerns. P7 said: *"I have a lot of friends who are CS majors...would support me in my learning and helped me understand things if I ever did feel like this course was too much for me."* Conversely, P15 described the difficulty of navigating computing courses without strong peer support. Even when professor office hours were available, she *"wouldn't be able to attend"* due to schedule conflicts with major courses. Relying on equally inexperienced friends *"was difficult for me"* because it felt like *"blind leading the blind like we would both not know anything."* P1 suggested expanding opportunities for non-CS majors to connect with CS majors for academic support: *"I think there [should] be a way for non-CS majors to kind of connect more with CS majors, for like tutors and help."* Our interviews suggest that peer support, whether through friendships or structured tutoring, can influence non-CS majors' persistence in computing.

P11's experience showed the struggles the learning environment can cause. Despite having a genuine desire to continue learning CS, lack of accessible support ultimately led her to decide against taking any more CS courses at the university: *"I just needed a little bit more help. And it just didn't seem like there were those resources. So that*

was kind of the top [reason for dropping out]." Across interviews, it became clear that a lack of responsive instructional support and limited opportunities for connection can significantly undermine non-CS majors' interest and persistence in computing. A more supportive, approachable, and collaborative learning environment could be key to sustaining their interest over time.

6.3 Generalization and Bias about Computing

6.3.1 Maintaining interest is influenced by how well generalized perceptions of computing fit students' traits or values. Some non-CS majors formed generalized perceptions of computing based on early coursework and evaluated its fit through the lens of their personal traits or identities. These early perceptions often influenced both their interest and their decision about whether to continue learning CS (P2, P3, P17). For example, P2, who described herself as a *"very hands-on person"* explained why she struggled to find personal value in CS: *"I did enjoy [coding]. It just never seemed like something physical that I wanted to do... you're doing something, but it's on a computer."* Though satisfied with his CS1 experience, P3 similarly decided not to continue. One contributing factor was his perception that computing *"is kind of the opposite of"* of his chosen field of civil engineering, which he described as more *"physical," "down-to-earth,"* and *"tangible."* Even when students acknowledge the utility of computing, they may not see it as personally meaningful or aligned with their preferred ways of learning and working.

6.3.2 Generalized perceptions can evolve with experience, impacting interest. Non-CS majors often enter computing courses with generalized perceptions about what computing is and what it entails. These perceptions—whether positive or negative—can shift significantly through experience, ultimately influencing their interest (P15, P16, P18). P18, for example, initially saw coding as *"boring...sitting behind a computer all day,"* but a hands-on HTML project that gave her instant, visible outcomes of her work changed her view. Witnessing her website *"comes to life"* made her think coding was *"really cool"* and *"wasn't just a bunch of numbers and texts."* This experience also made her *"respect computer scientists a lot more,"* realizing that they *"are making such a big output and impact"* behind the scenes. In contrast, P15's interest in learning more CS faded in part due to her evolving perception of programming following the advent of generative AI tools: *"if you just go and ChatGPT and be like, 'OK, write me a code to do this' and it would just give you the answer."* She felt the *"meticulous part of CS,"* a quality she had previously believed was essential and worth developing, was no longer important. Instead, she believed that only *"a basic understanding of coding"* would be enough to modify AI-generated code to suit one's needs. These examples show how students' interest in computing responds to their evolving perceptions and experiences. Therefore, providing educational experiences that addresses negative or inaccurate perceptions of computing through diverse and meaningful exposure is essential for sustaining interest.

6.4 Expectation of Success

6.4.1 Self-efficacy drives non-CS majors' decisions to re-engage with computing. Students' expectations of success in learning computing and pursuing CS careers, especially relative to CS majors, were critical in their decisions to continue with the field (P3, P6, P9, P16,

P17). P3 perceived a gap between his own capabilities and those of CS majors: *"I feel like there's a large leap...a lot of the people I know in deep CS have kind of been doing it their whole lives."* His low self-efficacy was reinforced by limited hands-on experience in his introductory computing course, where he recalled writing *"20 lines [of code] at most,"* compared to the *"massive pages and huge projects of code"* he associated with CS. P16 similarly did not take more CS courses, partly due to anticipated failure or belief that *"it would negatively impact my GPA."* External perceptions of credibility also influenced students' expectations of success, especially in the context of career prospects. P17 expressed concern over employer bias against non-CS majors in traditional CS roles: *"when [companies] see that I'm applying to CS roles like as a non-CS major. They don't really like that and my application will get auto rejected."* This perceived lack of credibility reduced her confidence in pursuing a career in software engineering and discouraged her from learning more in that domain. By contrast, P6 described high self-efficacy grounded in disciplinary overlap. He explained how this background helped him *"like that course a lot"* and feel *"interest[ed]"* in further engagement: *"A lot of people find [the first theory course] quite difficult, but I didn't find it the most difficult since I have a math background."* These examples illustrate when students anticipate low expectation of success, whether due to limited prior experience, comparisons to peers, or systemic barriers, they are more likely to disengage. Conversely, experiences that affirm readiness or align with prior knowledge can strengthen self-efficacy and interest in computing.

7 Phase 3: Developing Individual Interest

According to the Model of Interest Development, individual interest is marked by continued self-directed engagement, a clear understanding of its value, and the demonstration of deeper knowledge. In our analysis, the development of individual interest among non-CS majors was shaped by career relevance and stereotypes of computing as solitary and competitive.

7.1 Negative Stereotypes about CS

7.1.1 *Certain stereotypes limit the development of individual interest in traditional CS, even after multiple courses.* Even after multiple CS courses, some non-CS majors held narrow views of computing (P5, P8, P9, P17, P18, P19). While they nonetheless pursued computing areas, they were discouraged from seeking traditional CS roles.

One common perception was that CS work is solitary and individualistic, often shaped by classroom experiences. For example, P8 was not interested in code-writing jobs, due to her group project experience: *"sitting at a table, and then for like hours. Oh My God. I did not like that at all... There wasn't communication."* Even though she had not experienced a CS job firsthand, the classroom environment shaped her assumptions, as she said *"that's how I imagine it."* P18 shared a similar view, specifically about programming, describing coding as *"very individual based"* and saying collaboration often felt like *"copying code."* These examples suggest that unsupported collaboration in class may reinforce isolating views of CS, discouraging non-CS majors from developing further interest or seeing themselves as fitting within the field.

Assumptions about the nature of working in large tech companies further contributed to students' disinterest in traditional CS

career paths. P9 expressed hesitation about joining big tech companies, recalling how others had warned her about feeling like *"a little leaf or a tiny node of a giant tree."* She stated *"I do not want to work for someone that will basically use me like a tool for the company, won't see me as a human being,"* implying that she associates CS jobs with corporate bureaucracy and a lack of autonomy.

Some students also distanced themselves because they viewed CS as highly competitive, sometimes even without firsthand experience. P5 expressed hesitancy to join the field based on perceptions about the CS community gleaned from a CS roommate: *"It seems so competitive."* P17, who participated in CS-related student organizations, described a more personal experience with this competitive culture: *"I didn't feel belongingness within the CS community. I know that it's very competitive and maybe it's also because I'm an organization full of people that are very competitive more than others. I did feel a little inferior compared to them."* Although these students recognized the importance of computing and had positive classroom experiences, the persistent stereotype of CS as overly competitive discouraged them from pursuing a CS career.

Our analysis illustrates how non-CS majors internalize stereotypes about who belongs in CS and what CS work entails, not only through personal experiences but also through broader cultural narratives and peer influences. While some developed individual interest in computing, such interest rarely translated into pursuing a traditional CS career. Instead, it often led to careers in interdisciplinary or applied areas, such as data science, AI, or FinTech, where computing felt purposeful and aligned with their identities.

7.2 Relevance to Career

7.2.1 *Career relevance acts as a highly impactful type of relevance for individual interest development.* Like students with maintained situational interest, we found that career relevance was critical in the development of individual interest compared to other types of relevance (e.g., academic, daily life) (P6, P7, P8, P9, P10, P12, P18). Except for two students who cited both career and academic relevance, career relevance was the sole type of relevance cited as critical for deepening interest and motivating re-engagement from the maintained situational interest stage, implying its greater prominence in later phases of interest development. In addition, students' understanding of computing's career value was more concrete, often expressed through specific, career-aligned use cases. For instance, P7, who was pursuing a CS minor, said: *"My dream job would be the application of physics to aerospace. I'm getting experience working in controls engineering within the aerospace sphere...definitely a lot of coding....seeing how using CS for modeling is really huge in crossover between physics and aerospace, so I would like to keep doing that."*

When learners failed to transition to the individual interest stage, lack of clarity about career relevance was often a factor. For example, P10, who was in the maintained situational interest stage, expressed uncertainty about the long-term career relevance of computing due to a lack of clear interdisciplinary pathways or role models. She noted that students in the CS+Music program ended up pursuing solely CS or music professionally, despite the interdisciplinarity of the program: *"The people that I knew who were in CS+Music went on to either do one or the other, and if they did do a mix of it was just working as a software engineer for a company that puts out*

a music service.” This perceived disconnect between coursework and job opportunities made computing seem less viable as a long-term professional path and hindered the development of individual interest. P18 also valued her prior programming coursework but did not develop individual interest in programming domain. Instead, she focused on CS-adjacent areas like user experience (UX) design and research, believing her current programming knowledge was sufficient for her career goals: *“I think having the knowledge right now is really good....[But] I don’t think I need more...mainly I want to focus on working with like the design process, the UX research, and design thinking.”* These examples show that career relevance can limit interest development, depending on how students perceive alignment between computing and their long-term goals.

7.2.2 Career relevance shapes learning goals and appreciation for practical applications. Many non-CS majors with individual interest translated their recognition of career relevance into concrete learning goals, especially when selecting courses (P5, P6, P7, P8, P9, P12, P18). Unlike those in earlier phases of interest development who took classes without understanding what the course would be about, these students showed greater intentionality and topic familiarity. Many emphasized domains such as data science and AI as aligned with their career goals, and these areas often guided their course planning. For example, P6’s motivations for his course choices of a *“reinforcement learning class...and maybe machine learning theory course”* were closely aligned with his aspiration to become a data scientist and *“apply my skillset that I develop as a mathematics major.”* Some students, like P8, focused less on a specific domain and more on building adaptable skills for their future career: *“I want to be able to understand what the code is doing [and have the] ability to pick up new programming languages if I need to for a job....That’s why I’m going to take the [certain] classes next semester.”*

These career-oriented learning goals also influenced students’ preferences for how computing was taught. Several students described valuing hands-on experiences and practical applications despite the challenges. For example, P7 explained: *“The [application project]...taught me more about how coding actually works and how all these different pieces come together. Even though it was more difficult, I just found it to be more valuable.”* P6 found that content focused solely on foundational concepts without a clear connection to real-world uses felt disengaging: *“delivery of those topics...wasn’t the most interesting since [they] were introduced...as basic topics that a student should learn and understand why they’re using...but the applications [were not] really elaborated on.”* In these ways, career relevance shaped not only students’ intentions to persist in computing but also their preferences for learning experiences that prioritized practical application and skill development over basic concepts.

8 Challenges to Persistence After Developing Individual Interest

8.1 Structural Barriers

8.1.1 Students with individual interest face structural barriers to pursuing their desired computing courses or pathways. Even after developing individual interest in computing, students faced structural barriers that hindered further engagement in academic settings (P5, P6, P9, P12, P17). Common barriers included enrollment restrictions,

limited seats, and prerequisite requirements. P6 shared, *“I sometimes worry that I won’t be able to get a seat in this course...they’re restricting courses because of availability.”* P5 explained the challenge associated with taking prerequisites that are not relevant: *“I wanted to take [game development course] from the beginning. I don’t think that there was very much relevant information from the previous four courses that would’ve changed anything about.”* One student who developed interest later in her academic career stated that she could not take courses that she became interested in as *“it was pretty late and I knew that I couldn’t really add”* due to prerequisites.

To address these barriers, students offered suggestions to make computing pathways more accessible to non-majors. P5 proposed streamlining introductory requirements: *“what I have right now is [four prerequisite courses]. Instead, if there was two courses specifically for non-majors that stepped into that and then just gave them more access to that a lot sooner, I think it’d be great.”* P12 recommended increasing elective availability within non-CS departments: *“more classes available to students....if there’s more of those within department specific, they might be easier to sign up for...sign up restrictions are sometimes a big thing. Elective classes are a little bit harder for non CS majors to sign up for just because of restrictions.”* These insights underscore the need for more flexible, inclusive curricular pathways that allow interested students to meaningfully pursue computing without being blocked by structural constraints.

9 Discussion

9.1 Model of Interest Development as a Lens for Understanding Interest and Persistence

We provide empirical evidence that the Model of Interest Development offers a valuable lens for understanding the dynamic nature of interest among non-CS majors and for gaining insights into their persistence. According to the model, positive affect, personal value, and knowledge are essential for progressing from one phase of interest to the next [27]. Our findings confirm that non-CS majors who did not persist often lacked support in one or more of these areas. Notably, some described their courses as “interesting” or expressed enjoyment when instruction was well-scaffolded, responses that might be misinterpreted as signs of sustained interest. However, we found that without a clear sense of personal value or relevance, such enjoyment rarely led to continued engagement. These findings help explain why initial interest or sentiments that seem to indicate interest may not always lead to persistence in computing [18] and underscore the importance of designing curricula that intentionally support multiple dimensions of interest development.

9.2 Reimagining Instruction for Non-CS majors

Our findings highlight the influential role computing courses play in shaping non-CS majors’ evolving interest. Unlike past [36, 54], we find that many students enter their first computing course with openness, despite limited prior knowledge, sometimes even early in college. This openness offers a valuable opportunity to support persistence. However, these students face an uphill battle in developing deeper interest due to a range of challenges: 1) difficulty seeing the relevance of early courses, 2) limited access to the support needed to learn, and 3) uncertainty about fitting into the culture of computing, often shaped by stereotypes and generalizations. Importantly, loss

of interest was rarely about computing itself. Rather, disengagement stemmed from how courses failed to address these challenges. Some students later regained interest after recognizing computing's relevance to their career or encountering positive learning experiences. These shifting trajectories underscore the dynamic nature of interest and the potential of computing courses to foster, disrupt, or rekindle engagement. In this section, we draw on these insights to reimagine how introductory courses can better support non-CS majors across different phases of interest development.

9.2.1 Improving relevance. While many institutions offer computing courses for non-CS majors, these courses often still adhere to traditional CS curricula [10, 16, 20]. Our analysis suggests a need to reimagine these courses around students' evolving sense of relevance. For many participants, situational interest was initially triggered by computing's relevance to daily life or its growing presence across fields, signaling potential academic or career value. However, sustaining that interest often required stronger ties to their academic fields or career paths. For those who developed individual interest, this relevance tended to be more directly career-aligned. This trajectory suggests that perceptions of relevance among non-CS majors are not static but may become increasingly discipline- and career-specific over time. Yet, many existing courses do not account for this shift, making it harder for students to sustain or build interest. Drawing on interview insights, we argue for computing instruction that responds to these evolving needs. Collaborations with non-CS faculty or industry professionals can help identify computing topics, activities, and methods of inquiry that align with students' intended communities of practice. This would support the relevance of what they are learning and therefore may boost persistence. For instance, researchers at the University of Michigan are creating non-major computing courses grounded in the values and computational practices of liberal arts and sciences faculty, without direct ties to CS major curriculum or software development careers [21]. This model can be expanded through co-design with industry professionals, especially in disciplines where the connections between computing and disciplinary practices are less clear.

9.2.2 Addressing unsupportive course environments. Struggles related to physical learning environments and lack of support in courses are well-documented in the CS education literature [1, 31]. Our findings suggest that many of these barriers are relevant to non-CS majors, but perhaps more acutely. Lacking peers with computing expertise, non-CS majors often have fewer avenues for help, making formal support structures, such as office hours and tutoring, especially critical for sustaining non-CS majors' interest and persistence. Based on our findings, we suggest creating structured opportunities for non-CS majors to connect with CS peers for academic support and incorporating in-person components, such as lab sessions or office hours, to facilitate small-group interaction and provide space for questions and feedback. Such designs need not rely on small classes or fully in-person instruction but can be intentionally integrated into large or hybrid courses.

9.2.3 Addressing stereotypes and generalizations. Research shows that internalizing stereotypes discourages students from pursuing computing [37, 45]. Our findings suggest that similar stereotypes (e.g., competitive, solitary) affect non-CS majors as they develop

individual interest, underscoring the need to address them in non-major computing courses. We also identify stereotypes (e.g., "not physical", "not tangible") that appear specific to non-CS majors and may hinder sustained interest. One way to counter this type of stereotype is through physical computing, which prior work has shown to support tangible, motivating learning experiences [9, 28, 47, 48]. More importantly, these findings raise questions about other stereotypes that may inhibit sustained interest and suggest that introductory CS1 should proactively challenge them early on.

Another emerging factor is how non-CS majors perceive computing in the age of generative AI. As these tools become more accessible, some believe that "meticulous" nature of coding is no longer needed and question the value of deeper CS learning. Instructors should consider how to contextualize the use of generative AI within computing curricula, helping non-CS majors understand both the affordances and limitations of these tools and engage meaningfully with computing in this new landscape.

10 Limitations

While this study offers insights into factors that support or inhibit interest development in computing among non-CS majors, we recognize several limitations of our analysis. First, we acknowledge a critique of the Four-Phase Model of Interest Development. Some studies have pointed out that the definitions and indicators of each phase of interest are defined ambiguously and therefore lead to difficulties in its measurement [51]. Acknowledging this challenge, we created data analysis guidelines by synthesizing literature that discusses the theoretical definitions and empirical applications of the model to support a more systematic approach. However, the model's conceptual ambiguity is a potential limitation of our study.

Another limitation is the inherent subjectivity in interpretive process of qualitative research. To enhance the trustworthiness of our findings, we independently coded transcripts and refined themes through iterative discussions. Our data also heavily relies on participant recollection. Participant memories are known to be subject to bias based on their current perceptions, such as students' recollection of affective experiences [62]. Since we asked participants to reflect on experiences from several years ago, their reports may be mediated by their current biases.

The generalizability of our findings should be viewed with caution. This study was conducted at a single, large institution known for its strong computing programs and relatively inclusive opportunities for non-CS majors. In different institutional or cultural contexts, the conclusions of this study may not be valid.

11 Conclusion

Despite general acknowledgment of its importance in persistence, interest has not been thoroughly examined in computing education research. In this paper, we demonstrate the empirical value of applying the Model of Interest Development to understand the dynamic process of non-CS major students' interest in computing by identifying factors that affect students in earlier and later phases of interest. We also highlight the importance of addressing non-CS majors' stereotypes about computing, providing structured support for questions and feedback, and introducing career-relevant computing topics early in the interest development process.

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