A Preliminary Factor Analysis on the Success of Computing Major Transfer Students

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Abstract

In STEM education, many 4-year colleges and universities now get most of their students from community colleges. Students who transfer from community colleges, especially those who are underrepresented, often face problems, such as deciding whether or not to transfer, getting academic and non-academic support during the transfer, and finding a job. Also, program advisors at both 2-year and 4-year colleges and universities face problems because they need to know how their students make transfer decisions and how to help them be successful post-transfer. A data-driven and survey-based study will help establish a solid understanding of the underlying elements contributing to these challenges. In this paper, the researchers first conduct a literature review to identify the critical personal and academic factors that influence the transfer decision, particularly for students from traditionally disadvantaged groups. Secondly, an exploratory analysis of these factors was performed by inviting a small group of computing major students from both community colleges and universities to participate in a survey that includes a wide range of questions, from demographics and pre-transfer decisions to post-transfer performance. The preliminary findings indicated that financial challenges, university reputation, university location, job prospects, and family expectations are the primary factors influencing student transfer decisions. The findings of the study can be beneficial to underrepresented transfer students, their advisors, and other stakeholders in higher education.

1 Introduction

Student success is a critical objective of higher education. Numerous community colleges and universities have challenges co-advising transfer students due to the uncertainty surrounding the path from their decision to transfer to post-transfer graduation [1], particularly those who are from disadvantaged minority or underrepresented groups in STEM majors [2], [3]. Such groups, also referred to as underrepresented minority students (URMs), include "women, persons with disabilities, and some minority groups — Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives" [4]. According to a statistical report on college enrollment [5], 32.56% of the enrolled students were URMs in 2021. Statistics show that only 17% of workers in STEM fields were Black and Hispanic [6]. On the other hand, women accounted for only 15% of engineering jobs and 25% of computer jobs. There is a dire need to improve the diversity of the workforce in these fields.

A variety of approaches were proposed to foster a diverse workforce. In [7], Kulkarni et al. presented a pilot program at San Francisco State University to promote inclusivity in computing. The program enrolled undergraduate students from disciplines that traditionally have a diverse stu-

dent population, e.g., biology. Pedagogical methods such as cohort-based learning and near-peer mentorship were leveraged in the pilot program. It is worth noting that employees with Master's or Doctoral degrees contribute to the computing workforce as well. It is equally imperative to diversify the graduate student body at higher education institutions. Gilbert et al. [8] explored the status of African American representations at Ph.D.-granting computing departments. They proposed several measures to broaden the participation of African Americans (and other URMs) through a National Science Foundation-funded project – Institute for African-American Mentoring in Computing Sciences. Some of the measures include distributed research experiences for undergraduates (to help URM students in preparation for graduate school), K-12 outreach (to provide middle and high school URM kids with opportunities in computing awareness and exposure) as well as academic year undergraduate research (to increase African American Ph.D. pipeline), etc.

As an essential source of incoming students at many universities, transfer students from community colleges became a non-negligible contributor to the highly diversified student body [9]. A large percentage of such students are underrepresented minorities and from low-income families. They choose to begin with community colleges because the tuition is cheaper than 4-year universities. Understanding how they make transfer decisions is critical in designing comprehensive and systematic measures to ensure their academic and career success.

In this paper, a literature review is conducted to identify the key personal and academic factors that influence the transfer decision, particularly for students from traditionally disadvantaged groups. We also perform an exploratory analysis of these factors by inviting students from both community colleges and 4-year universities to a survey that includes a wide range of questions, from demographics, pre-transfer decisions, post-transfer performance, etc.

The remainder of this paper is organized as follows. Section 2 gives the summary of the related work, and Section 3 outlines the methodology of the study. Section 4 presents the data analysis on the datasets collected via surveys and interviews. Some concluding remarks and future research directions are given in 5.

2 Literature review on individual factors

The transfer student population at 4-year universities has been increasing, however, the success of transfer students has been a concern at the majority of the institutions [10]. Past research in the area of transfer student success attempted to answer important questions such as: "Why is the success rate of transfer students low?" and "Why do some transfer students persist to graduation, whereas many others do not?" According to the literature, transfer students fall into two categories that need different kinds of guidance to succeed in a new institution [11], [12]. The first category of transfer students includes those who pre-plan the transfer before getting admission into a community college [13], [14], [15], [16]. This category often includes students who choose to take general education courses or earn an associate degree at a community college before transferring to a 4-year institution (often because of the lower cost of tuition). The second category includes students who do not have a definite academic plan [14], [15], [17]. The 4-year institutions need to offer different kinds of assistance for these two categories of transfer students. Table 1 lists the expected individual factors, both personal and academic, and those that may affect the transfer

decision and success of students.

Individual Factors	
Personal	**Academic**
Gender, Age	GPA, SAT or ACT Score
Race, Ethnicity	Current Classification, Math Proficiency
First Generation, Work	Associate Degree, Credits earned at CC
Socioeconomic Status	Credits transferred
...	...

Table 1: List of personal and academic factors

2.1 Personal factors

Past research has examined the role of demographics such as socioeconomic status, gender, race, and ethnicity on the retention of transfer students [18], [19], [20], [21]. Research has also examined transfer student persistence through the lenses of attitude and motivation, previous community college attendance, and academic performance prior to transfer [18], [22], [23], [24], [25]. In addition, past research attempted to study the effect of belonging uncertainty, uncertainty about social relationships and connections on student success [26].

Researchers identified the following factors that can negatively impact the persistence, retention, and completion rates of transfer students:

- Social isolation and lack of belongingness to the new institution hinders the development of a social support system that helps students with their academic journey [14], [27], [28], [29], [30], [31].
- Finances [32], [14], [28]: Lack of financial support may have caused students to attend a cheaper institution (e.g., a community college) before they could transfer to a 4-year institution where they can complete their desired program.
- Distance between old and new institutions [15], [12]: The greater the distance, the more students seem to struggle. If the institutions are physically closer, it is easier for them to cooperate and transfer equivalent course credits. Close proximity also reduces the hassle and cost of relocation.
- Students who have declared a major are more likely to succeed at the new institution [14], [15].
- Academic preparedness [27], [29]: If the new institution is tougher than the old one, some students tend to struggle.
- Work/life/school balance, specifically for working students [27], [31]: The struggle to maintain a balance between work and personal life compels some students to drop out or change their career path [33]. Adversities to life expectancy like COVID-19 disrupt the educational plans of students [10]. Students who did not have a balanced life found that it made them more tired and feel lower self-esteem, which gave them the intention to drop out [11].

2.2 Academic factors

There are several academic factors that impact underrepresented STEM transfer students. While there are some factors that are relevant to all transfer students, there is variation in the level of impact these factors have and some can be noted as specific to underrepresented students. This variation is noted by [34], "Our study's finding that there are substantial differences in factors associated with transfer for White and URM students implies that the norms, behaviors, and supports involved in 'transfer culture' may not mean the same thing for students from different racial/ethnic backgrounds." It is also important to note that URM students enroll in community colleges at a disproportionally higher rate, therefore identifying the factors which have an impact on their success can play a large role in properly supporting these students. Although a significant amount of research has been conducted in identifying these factors for the Latinx community, more research needs to be done for black and LGBTQ+ students. Some of the factors that have been found to have a direct impact on student success include:

- Number of credits earned by the student before transferring [12], [14], [29]: The more credits a student can transfer, the more likely they are to persist.
- GPA at the community college (CC): Much literature discusses the impact known as "transfer shock" where students have a sudden and temporary drop in grades upon transfer to a four-year university. This supposes that while students may be successful at community college, they may struggle to adjust academically to the new environment or not have had appropriate preparation for the rigor at a 4-year university [14], [15], [34], [35], [36]. Despite that, students with higher GPAs tend to persist and complete their degrees [12], [14], [28], [37].
- The majors started at the community college: There has been some documentation that mathematics, science, and business majors experienced a more severe drop in GPA after transfer than other majors [14], [15], [38].
- Pre-transfer advising at the community college: Having access to focused advising where students are encouraged and can plan their path toward vertical transfer has been shown to have an impact on student success. It has also been suggested that for URM students, it is important that their advisor has high academic expectations [35], [36], [39], [40], [41].
- Articulation agreements at the 4-year institution: Articulation agreements can serve to mitigate the loss of credits due to vertical transfer for transfer students through the presence of a formalized transfer agreement between colleges. For example, [25] notes "the widespread loss of credits that occurs after undergraduates transfer from a community college to a 4-year institution". The research team observed a few cases where students would enroll in extra courses which would not be transferable unless notified by an academic advisor. While taking extra courses may allow the student to increase their skill set, it can be counterargued that for underrepresented transfer students, an extra course or two can add unnecessary financial burden as well as delay graduation by an extra semester [35], [36], [41].
- Relationships with institutional agents: Institutional agents are defined as "People who have the access, status, and willingness to help other person access opportunities that previously seemed unattainable…" This has been identified as a factor impacting the success of all STEM transfer students. However, we see that it plays a significant role in the likelihood and intention to persist specifically in the Latinx community and for black women in STEM.

One specific example of the role of institutional agents is access to mentoring which has been identified as a positive factor for URM by the students themselves [38], [40], [42].

- Pre-college preparation and high school mathematics: Taking advanced high school math classes has been identified as a significant factor for URM student success and the likelihood to persist [35], [36], [38], [42], [43].

Other factors with a specific impact on underrepresented transfer students' success include the availability of internships and post-graduate opportunities after completing the degree. According to Zippia [44], internships and post-graduate opportunities are less available to underrepresented students. It reported women as holding 28.6% of all computer science internships compared to 73.2% for men. Among underrepresented ethnicities of computer science interns, 14% are Hispanic or Latino and 10% are black. This compares to White (57.7%) and Asian (14.7%).

The aforementioned statistics highlight the low representation of URM students in computing internships and ultimately the technology labor force. Generally, URMs are also more negatively impacted by both personal and academic factors. Big Tech has also acknowledged the lack of diversity in the workforce and has taken steps to increase participation from minority groups [45]. This study aims to raise awareness of these factors among the underrepresented groups and their stakeholders including advisers so they can make better decisions that facilitate the transfer process, improve their academic performance (GPA), and also reduce the high attrition rate. The next section discusses the methodology used to ascertain the factors impacting transfer students.

3 Methodology

In this paper, we designed a survey and interview to understand the decision-making processes of (potential) transfer students. The survey has two major branches, one for students who are currently enrolled at a community college and plan to transfer to a 4-year university, and the other for students who have already transferred. Both branches have the same set of pre-transfer questions. The post-transfer questions are only visible to those who have completed their transfers. Students had to answer a few demographic questions regardless of their current enrollment status. By doing this, the correlation between student background information and their decision on starting with community colleges can be analyzed, facilitating the research on how to help students, especially underrepresented students improve their decision-making process. The pre-transfer questions primarily focus on when students made their transfer decision and what information they used when making the decision. For example:

- What was your major before your transfer?
- When did you decide about the transfer?
- What are the reasons for you to start with a 2-year community college instead of a 4-year university program?
- What information and information sources did you use while making the decision of joining the community college?

The survey also included questions about their current level (freshman, sophomore, junior, or senior at community colleges or 4-year universities) and their GPA. The latter was also asked in

the post-transfer section to provide the research team with a basis for studying how the transfer affected their academic performance. While the pre-transfer questions focused on students' decision-making process, the post-transfer questions were designed to find out their challenges during transfer and the impact on their career plans. The students provided their informed consent before beginning the survey. The study was approved by the Institutional Review Board at NEIU. The following list shows a few representative questions:

- How many transfers have you made?
- During the transition from your previous institution, what challenges did you encounter?
- How did your expectations/career plan change after transferring to your current institution?
- Any particular experience do you feel is important as a transfer computing major student?

Students all exited the survey with a question regarding their choice of a follow-up interview. Students who agreed to take the interview had to meet with one of the team members via Zoom in the following month.

The interview questions were developed based on the conceptual framework. A pilot of the initial interview protocol was conducted with three students and the protocol was revised accordingly. The final interview protocol included six open-ended questions with several sub-questions. Examples of questions include the following:

- When did you start thinking about transferring and what resources did you use to plan your transfer process?
- How helpful were these resources?
- Did you talk to anyone about transferring, either to get advice or guidance or just to talk about your ideas?

Each interview was approximately 30 minutes long. All interviews were audio-recorded with consent from the participants and transcribed verbatim. All students' names were changed to some randomly generated strings to protect their privacy. The next section presents the preliminary analysis of the data collected via surveys and interviews to provide insights into the decision-making factors involved in transferring from a community college to 4-year university.

4 Exploratory data analysis

4.1 Demographics

In this pilot study, twenty-six students from three institutions were surveyed and fifteen of them participated in a follow-up interview. All respondents were computer science or computing-related majors. The majority of the students were males with a smaller percentage of females. The rest of the participants identified as non-binary or preferred not to say. The vast majority of participants were white with the next largest ethnic groups being Latinos and Asians. Black, African American, American Indian or mixed ethnic identities accounted for less than 10% of all participants. The detailed numbers are listed in Table 2.

Of the twenty-six participants, eleven reported identifying as URM. The average age of the students was 30, however, there was a high level of standard deviation ($\sim$8.95) suggesting that there was significant variation in this category. Figure 1 shows the histogram distribution of their age, which

Category	Sub-category	Percentage
Gender	Male	69.23%
	Female	23.08%
	Others	7.69%
Race & Ethnicity	White	55.33%
	Hispanic, Latina/o	22.33%
	Asian	13.33%
	Black, Afr. Am.	3.33%
	Other	5.68%

Table 2: Demographics

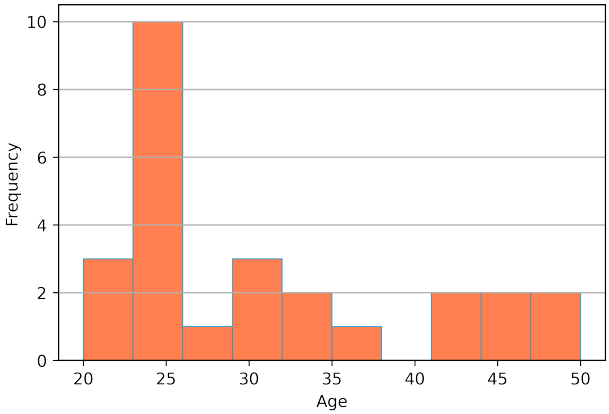

Figure 1: Histogram distribution of student age

indicates that at least 46% of students were above 30 years of age. The majority of participants were in-state residents with 7.7% presenting as undocumented or declining to state.

Over half the students surveyed were low-income with approximately 61% reporting a family income under $50,000. Participants were evenly split between first-generation students (46.15%) and not (53.85%). The vast majority of participants had no other siblings in college. The majority of participants (57.7%) were working in some form alongside attending college. More participants reported working part-time on or outside the campus and a smaller minority worked full-time.

4.2 Decision making

Question 1: What are the factors that influenced students' decision of transferring?
One of the most essential questions in the research is to identify the contributing factors for students to make decisions on starting with a community college and then transferring to a 4-year university. Among the students surveyed, sixteen were of upperclassmen status and had transferred from community college, while ten were currently attending community college. Many of the factors surveyed in the literature were confirmed by both the survey and the interview. For example, more than 90% considered the cost and financial aid options to be the major factors for pursuing community college before university. Figures 2(a) and (b) display the word cloud generated respectively from the two open-ended questions of the survey where we asked them to (1) provide reasons that helped them in deciding between community college and 4-year university, and (2) the most important information affecting their transfer decision. The first-word cloud indicates that the cost is the major factor in choosing community college, and the second word cloud shows that the availability of scholarships, affordability, and the proximity of the institution to their home played a crucial role.

Some students mentioned that after high school when they were preparing for admission into a 4-year university they were denied financial aid as their age was less than 24 years, hence, their family income (both parents' income combined) was higher than the cut-off needed to get the financial aid according to FAFSA. This was the reason for a lot of students to go to community college, which is a cheaper option for them at that age, and when they are above 24 years age they can transfer to a 4-year university after securing some financial aid as their own income is considered to provide financial aid to them. Figure 3 represents the visualization of a topic from

(a) (b)

Figure 2: Word cloud of open-ended question response showing (a) reasons for deciding to start with community college, and (b) most important information for transfer decision.

topic modeling using LDA [46] on the responses from the students on the question where they were asked to provide reasons for choosing community college over a 4-year university. Some of the topic words like "money", "affordability", "financial" and "cost" again depict that the financial aspect played the most important role in their decision-making process.

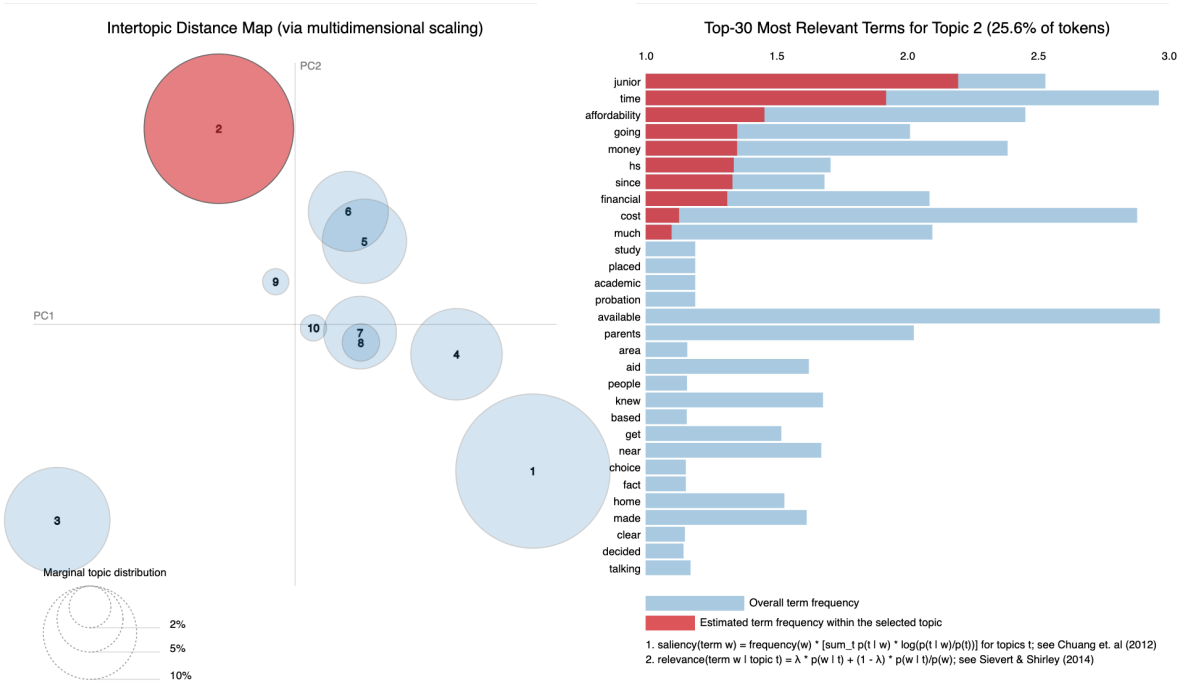

Figure 3: Topic modeling using LDA representing topic 2 most salient words.

A good number of students mentioned that the proximity of the institution to home was an important reason for selecting a local community college for education. One interviewee revealed that the use of the same learning management system (LMS), Brightspace, at both Community college and their 4-year university was instrumental to their success.

It is worth mentioning that, of those in community college there was an even split in intention to transfer. None of the participants reported no intention of transferring, however, half were unsure.

Of those intending to transfer, most planned on moving to a 4-year university after finishing their associate degree. One participant noted that they intended to transfer "after failing for 3 years." Of the participants who had already transferred, most reported that they made their decision to do so after completing their associate degree at community college (43.75%) with the next highest group having decided as early as high school (31.25%). There was much variation in the reasons they chose to attend community college, however, the most prominent reasons were saving money and being uncertain about the major. The average GPA for the last 60 credits attempted by those in community college was 3.25 with a significant amount of standard deviation (0.64). About 90% of the participants were beyond their first year at community college with the highest number of students presenting as seniors (30%) or sophomores (40%).

Question 2: What are the sources of information that students used to make a transfer decision?

In the era of the information explosion, people often experience information overload where too many opinions are presented from all over the place. When making academic decisions, students seek help and advice from various sources. Figure 4 illustrates the most common sources used by the participants to help make their transfer decisions. Students mentioned that one of the primary information sources is their friends and peers with whom they usually spent a considerable amount of time. When participants were asked to list the information that determined their decision to go to community college they stated:

- Finances, cost, or financial aid in some form, which ranged from cost efficiency, saving money, and better financial aid at community college to lacking funds. (66.66%)
- Several participants stated that the ease of transfer or transferability was significant (16.6%).
- There was also some reference to lack of information or poor guidance (16.6%).

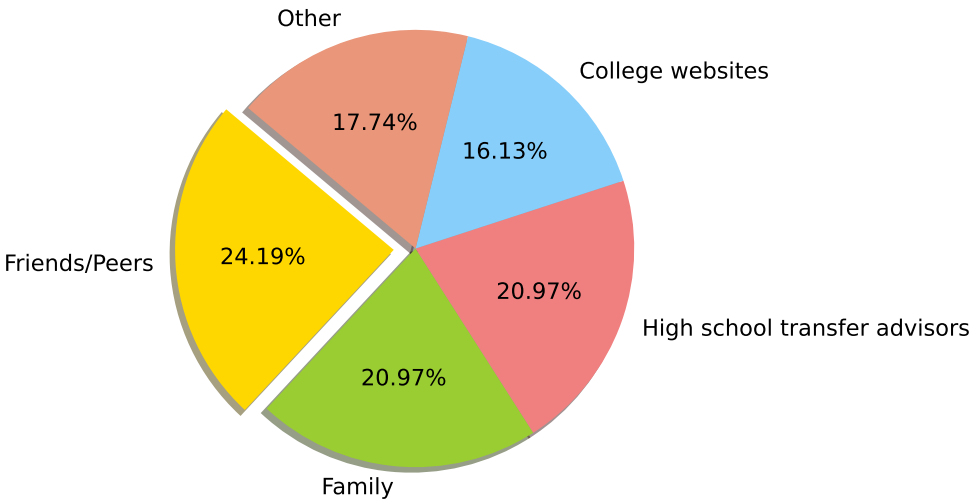

Figure 4: Source of information

Question 3: How does the transfer to a 4-year university impact students' overall success?

Most students choose to transfer to a 4-year university because they want to achieve more academic and career success. We expected to investigate the impact of the transfer on students' overall success with several survey questions. As the background information, 81.25% of those who have already transferred from community college to a 4-year university declared computer science majors. The rest were evenly split between information systems, cybersecurity, and data science majors. Of these participants, most students reported only transferring from an institution once while 30.25% reported having transferred twice or more in their academic career. The average GPA of these participants before transferring was 2.98 which increased significantly with a mean of 3.39 post-transfer GPA. However, only 43.75% of participants reported their GPA increasing after transfer with 25% saying they were uncertain about any change. All participants were seniors (75%) or juniors (25%). Most participants (43.75%) reported that their overall career plan was not reshaped after transferring and attending their current institution. That said, some participants did report that they had changed their major or area of study within their current field. Some challenges that were frequently reported by participants who had gone through the process of transferring institutions were:

- Course articulation/ Units transferring (37.25%)
- Transfer advisement or lack of information about the process (12.5%)
- Finances (25%)
- Degree uncertainty (12.5%)

When students were asked to explain any experiences that are important when transferring into a computing major, the responses include

- Talk to advisor/staff to get academic guidance (31.25%)
- Research the place you are going to (31.25%)
- Make friends and create a supportive environment (25%)
- Imitation is normal, but do not let it stop your education (6.25%)
- Try different experiences (6.25%)

Despite the small sample size and a higher percentage of males in the study, the age distribution of the respondents is highly varied. In summary, affordability, and location were the most dominant factors impacting students' decision to start at a community college and ultimately which 4-year institution to transfer to. Over 65% of students relied on friends, high school transfer advisors, peers, or family for information to help make their transfer decisions. Only 16% relied on college websites as their main source of information for their decision-making process.

5 Conclusion and future work

Community colleges have become a primary source of enrollment for many 4-year universities. Students, especially underrepresented students who transfer from community colleges often experience challenges in various aspects, including but not limited to transfer decision-making, academic and non-academic support during the transfer, and job placement. Meanwhile, program

advisors at community colleges and 4-year universities are facing challenges as well due to the uncertainty surrounding the path from their decision to transfer to post-transfer graduation. A data-driven and survey-based study will help establish a solid understanding of the underlying elements that contribute to these challenges. This paper first reported a literature review conducted to identify the key personal and academic factors that influence the transfer decision, particularly for students from traditionally disadvantaged groups. Secondly, an exploratory analysis was performed on these factors cited in the literature, by inviting a small group of students from both community colleges and universities to a survey that includes a wide range of questions, from demographics, pre-transfer decisions, to post-transfer performance, etc. The results revealed that cost (including scholarships and affordability) and location as the most important factors impacting students' decision to transfer. Yet, social factors were the dominant source of information used by students to help make transfer decisions, with only 16% relying on college websites. There is work for advisers and institutions for better outreach to students and software tools to improve the smoothness of the transfer process.

Based on the preliminary factor analysis, the research team intends to expand the survey to a larger group of students across multiple states and use the combined results from factors ascertained to design an AI-driven advising system for transfer students, particularly those who are from underrepresented groups. The researchers anticipate that additional factor analysis and future studies will be beneficial to transfer students, their advisors, and stakeholders of higher education.

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