Shift in Mid-Year Engineering Students' Perceptions of Their Future Careers Over Time

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***Abstract*— This full research paper presents a pilot study exploring how mid-year engineering students' perceptions of their future careers shift over one academic year. Perceptions of future careers determine many academic decisions students make, affecting student recruitment, persistence, and performance in engineering. Understanding how students' perceptions of their future careers change will give researchers, practitioners, and academic advisors insight into what influences students' choice of engineering major and what they choose to focus on in their courses.**

Students in sophomore engineering courses (n=71) took a survey measuring the clarity of and attitude towards their future career goals at two timepoints, 2-3 semesters apart. Participants' perceptions shifted between four distinct ways of thinking about the future. Most participants shifted to either a well-defined and positive perception of their future possible career or an ill-defined less positive perception of their future possible career.

Keywords—mid-year, motivations, career goals, future time perspective

I. Introduction

Students' perceptions of their future and career goals influence their behaviors and decisions in the present, such as how much effort to put into tasks for the classes they are taking in their major. In turn, those decisions and experiences influence their future perceptions and career goals. This reciprocal dynamic describes a way of thinking about the future that varies even among students who are in the same class or for an individual student at different points in their academic career [1], [2].

Describing these different ways of thinking about the future for engineering students can help researchers and instructors understand the variety of ways engineering students are perceiving the future and improve the educational experiences for these students by taking into account students' motivation for pursuing engineering. Further, exploring how those different perceptions shift at crucial points during a student's academic career, such as the sophomore and junior years when engineering students are most likely to leave engineering [3], will inform researchers, practitioners, and advisors working towards retaining those students whose career goals align with engineering, and help students who truly do not want to remain in engineering discover this mismatch between their goals and their major earlier [4].

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A. Purpose Statement

This study is part of larger multi-phase mixed methods research project which seeks to identify the different ways students think about their future careers. The purpose of this phase of the study is to observe longitudinal shifts in those different ways of thinking about the future. This phase begins to explore how engineering students' perceptions of their future careers shift between sophomore and junior year. The research question addressed in this paper is: "How do engineering students' perceptions of their future careers change over one year for students in sophomore level engineering classes?"

II. Background

This study draws on the theoretical frameworks of future time perspective [1], future possible selves [5] and contingent goal paths [6], and previous work within a larger multi-phase mixed methods study exploring the different ways that mid-year engineering students think about their future careers. This larger study has qualitatively identified three different ways of thinking about future careers and how those perceptions of their future relate to their current academic decisions and behaviors [7], [8] and quantitatively characterized those different ways of thinking [9].

The qualitative work identified three different ways of perceiving future possible careers, distinguished by characteristics drawn from future time perspective [1], future possible selves [5], and contingent goal paths [6] literature. These three characteristic ways of thinking are 1) students who have one well-defined career goal deep into the future, that is both their ideal and attainable career, 2) students who describe having a well-defined ideal career after graduation that they do not believe is realistic, (e.g., a student may want to work at an aerospace company, but because of grades or lack of experience that goal is not realistic and they believe they must settle for work in a field they are less interested in), and 3) students who describe the future in broad, open-ended terms, but believe that whatever they end up doing as a career, they will enjoy [10].

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A survey instrument that measures engineering students' perceptions of the future was refined through the addition and revision of items relevant to the key characteristics of these three different ways of thinking [11]. These different ways of thinking have been quantitatively distinguished through two constructs: alignment of ideal and realistic future possible careers and clarity of future possible careers. These constructs are based on and described in terms of the theoretical frameworks of future time perspective [1] and future possible selves [5].

A. Alignment of Ideal and Realistic Future Possible Careers

The construct of a student's alignment between multiple future possible careers draws heavily from the theoretical framework of future possible selves. Future possible selves describe a person's cognitive manifestations of who they believe they can become and who they do or do not want to become [5]. A person's ideal future possible self is who they ideally want to become in the future; a realistic future possible self describes who a person believes they can be in the future. An avoided future possible self describes who a person does not want to be in the future [1], [5]. A person's future possible career is an aspect of one's future possible selves that describes a persons' cognitive manifestations of who they can become, want to become, and do not want to become in terms of their careers [11].

A student may have conflicting ideal and realistic future possible careers in that they do not believe they will be able to achieve their ideal future possible career. These students often describe their realistic future possible career to also be their avoided future possible career; in other words, a student may describe the career they will have as one they do not want to have [7], [8], [12]. This belief would be considered a low alignment or misalignment of ideal and realistic future possible careers.

B. Clarity of Future Possible Careers

Clarity describes one's perceptions of their future careers in terms of both extension and density. Extension refers to how far into the future a person is setting goals. One's extension can be short, where only the very near future is considered; or extension can be long, where psychological time extends into the distant future [1], [13]. Density refers to the number of future goals one plans to achieve in the future [1], [14]. Both extension and density describe a student's future time perspective, which includes perceptions of the future, future goals, how those goals are integrated into the present, and how they affect actions in the present [2]. High clarity of future possible careers is defined here as a well-defined perceived future possible career, deep into the future. Clarity is the extent to which one has narrowed down the number of future possible careers and is able to describe those future careers in depth.

C. Survey Instrument

This study focuses on two of the factors from a larger study, Clarity (of Future Possible Careers) and Alignment (of Ideal and Realistic Future Possible Careers). For additional information on the full survey instrument, refer to McGough & Benson [7].

A student with a high score in the Alignment (of Ideal and Realistic Future Possible Careers) factor believes that their ideal future career is realistically achievable. The items in this factor (shown below) are scored on an anchored Likert-scale from 1=Strongly Disagree to 7=Strongly Agree.

- The career path I would find most rewarding is not realistic for me. (reverse coded)
- My ideal career is different from my realistic career. (reverse coded)
- The career I would ideally want is different from a career I could realistically get. (reverse coded)
- I believe I can obtain the career I want.
- I do not think I will enjoy the job I will have immediately after graduation. (reverse coded)
- I think I will be satisfied with the career I will be able to achieve.

A student with a high score in the Clarity factor has a high extension into the future and has narrowed their number of future career goals so that they can define their future career after graduation and beyond. Items in this factor (listed below) are scored on a scale of 1 to 7 ("Strongly Disagree" to "Strongly Agree").

- I am unsure what I want my future career to be. (reverse coded)
- I have a clear idea of what my first job after graduation will be.
- I have a clear idea of what my future career will be in 10 years.
- I'm not exactly sure what I want to do after college. (reverse coded)
- I don't really have a set career goal. (reverse coded)

A combination of these factors can be used to distinguish between different ways engineering students perceive their future possible careers: "Aligned and Clear" (high Alignment and high Clarity), "Unaligned and Clear" (low Alignment and high Clarity), and "Aligned and Unclear" (low Alignment and low Clarity)—shown in Fig. 1.

Theoretically there is a fourth possible group not represented in previous work—"Unaligned and Unclear"—which has a lower Alignment of Ideal and Realistic Future Possible Careers and a lower Clarity of Future Possible Careers. This group has emerged in preliminary work conducted as part of our larger mixed methods project and our future work focuses on describing this group in more depth.

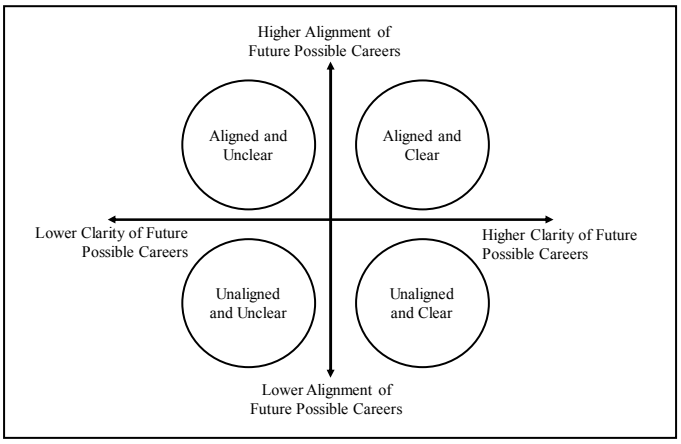

Fig. 1. Engineering students fall into one of four ways of thinking about the future, identifiable by the clarity of and their alignment of their ideal and realistic future possible careers.

III. Methods

The methods described in this paper are a continuation of the project described in the previous work, where longitudinal data was collected from a subset of participants whose characteristic way of perceiving their future possible careers was identified. This longitudinal data was then used to measure and describe the shifts of those ways of percieving the future over one academic year for those participants.

A. Participants

The target population of the larger study are students in large, introductory engineering classrooms. This population of students was targeted for the purposes of the larger study, which seeks to inform instructors and practitioners of students' motivations and career goals. Participant recruitment and target class identification is detailed in our previous work [9].

The participants in this study are the 71 students for whom there is longitudinal data. These participants were students in sophomore-level CE, EE, and ME courses in Fall 2016 or Spring 2017. Of these participants, 65% identified as Male, 34% as Female, 72% as White, 8% as Asian, 1% as Black or African American, and 1% as Hispanic. Women are overrepresented in this sample compared to the national average for undergraduate engineering (19%) [15].

B. Data Collection

The survey instrument was distributed to a total of five institutions and n=748 participants in sophomore-level engineering classes in Fall 2016 and Spring 2017. The participants were asked to complete the survey up to one academic year later, Fall 2017, resulting in n=71 longitudinal records, which were analyzed to describe shifts in the survey results over time. The data collection timeline is shown in Fig. 2.

An electronic version of the survey instrument was used to comply with the IRB of participating institutions. In the first survey distribution, instructors of large-enrollment courses were asked to provide a link to the electronic survey to their students in the course. Depending on the IRB at the institution, some instructors were able to provide extra credit for completing the survey, provide class time to complete the survey, introduce the survey in class, or only provide a link to the survey [9]. The students were given one week to complete the survey and were sent two reminder emails.

Students who provided their email in the first distribution, were sent an invitation to complete the survey a second time. The participants were, again, given one week to complete the survey, were sent two reminder emails, and were offered a chance to win a $20 gift card.

C. Data Analysis

Participants were binned into one of the four groups for both the first and second distribution of the survey. The n=71 data points were "binned" into one of four groups described in Fig. 1 ("Aligned and Clear," "Unaligned and Clear," "Aligned and Unclear," and "Unaligned and Unclear") based on their scores on the two factors, Clarity and Alignment. Qualitative work identified three of those four groups and how students in these groups describe their future possible careers with more or less clarity and their alignment their ideal and realistic future possible careers [8], [10].

The mean of each the Clarity and Alignment factor scores across all participants at the first timepoint (n=71) was used as a cutoff value to bin participants, shown in Table III. For example, if a participant has a score on the Alignment factor above the mean for all participants and a Clarity score less than the mean, they were binned in "Aligned and Unclear".

The shifts were then identified using the differences in the two distributions. For example, one participant may have been binned as "Aligned and Unclear" in the first distribution and "Aligned and Clear" in the second distribution; this shift would be identified as a shift from "Aligned and Unclear" to "Aligned and Clear."

D. Quality Considerations

The survey instrument used in this study was tested for validity and reliability on this sample of students in the first distribution [9], [11]. Pearson's chi-squared goodness-of-fit test

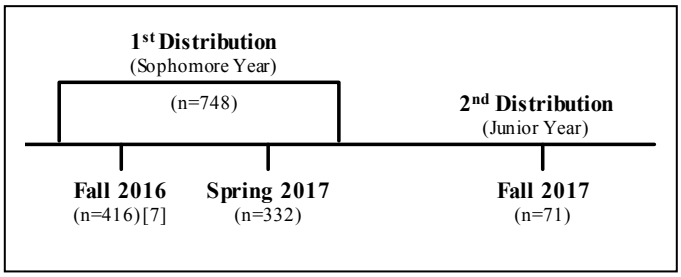

Fig. 2. The survey was completed by n=748 students in sophomore-level courses (1st Distribution); the survey was completed by n=71 of these same students 1 academic year, or 2-3 semesters, later (2nd Distribution).

was used to determine how representative the distribution of demographics of the longitudinal sample was to the larger sample [16], and Welch's two-sample *t*-test for equal means was used to determine how representative the means of the two factor scores were.

The chi-squared goodness-of-fit test determines whether there is a relationship between participating in the second distribution of the survey (n=71) and the demographic variable. The expected frequencies for the demographic variables were calculated from the independent sample from the first distribution (n=677). A chi-squared goodness of fit was run to compare the distributions for four different demographics: year in school, university, race and ethnicity, and gender. A *p*-value less than 0.05 would indicate that the proportions of the samples are significantly different with a 95% confidence level.

Next, Welch's two-sample t-test for equal means was used to determine if the means of the two factor scores (Clarity and Alignment) were unequal for the participants who did (*n*=71) and did not (*n*=677) complete the survey in the second distribution. A *p*-value higher than 0.05 would indicate that the means of the two samples are similar [17].

IV. Findings

A. Representativeness of the Longitudinal Sample

The chi-square test statistic, χ^2, and p-value, were used to assess the representativeness of the longitudinal sample (*n*=71) with respect to the first distribution sample (*n*=677). Table I shows the chi-square test statistic, degrees of freedom, and p-values for each of the demographic variables. The sample is representative of the population in terms of race and ethnicity, gender, and the distribution of the four groups. Year in school and university are not well represented in the longitudinal sample. Most notably, a higher proportion of participants who were sophomores in Fall 2016 and Spring 2017 responded in the second distribution (65%) than in the first distribution (44%).

Additionally, Welch's two-sample *t*-test for equal means showed that Alignment and Clarity scores were not statistically different for the participants who did (*n*=71) and did not (*n*=677) complete the survey in the second distribution, as shown in Table II.

TABLE I. Results of the Pearson's Chi-Squared Goodness-of-Fit Test

	Table Column Head		
	χ2	***Degrees of Freedom***	***p-value***
Year	13.111	3	0.0044
University	19.319	4	0.0006
Race	2.4323	4	0.6568
Gender	4.8952	2	0.0865
Group	3.6733	3	0.2990

TABLE II. Results of the Welch's Two Sample T-Test

	Mean Clarity Score *p*-value	**Mean Alignment Score *p*-value**
Aligned and Clear	0.5761	0.3228
Aligned and Unclear	0.9636	0.3776
Unaligned and Clear	0.0757	0.3743
Unaligned and Unclear	0.3113	0.8222
All	0.2340	0.7129

Overall, there were no significant differences in participation by race or gender, but participants who were sophomores at the first distribution were more likely to respond to the second distribution, and thus are overrepresented in the longitudinal sample. With this limitation noted, the longitudinal sample (N=71) is used for the remainder of the paper.

B. Group Frequencies

The participants were binned into either "Aligned and Clear", "Aligned and Unclear", Waffle, or "Unaligned and Unclear" using cutoffs based on the mean scores of the Clarity (4.0 out of 7) and Alignment (5.2 out of 7) factors for the *n*=71 participants. The cutoff scores and classifications for binning is shown in Table III.

There were a higher proportion of participants in "Aligned and Clear" in the first (42%) and second (45%) distributions, as well as a higher proportion in "Unaligned and Unclear" in both the first distribution (28%) and particularly in the second distribution (35%). A majority of participants (80%) were in either "Aligned and Clear" or "Unaligned and Unclear" in the second distribution. The distribution of participants in these four groups for the first and second distribution is shown in Table IV.

TABLE III. Cuttoff Scores Based on Average Factors for All Participants (n=71) Used to Bin Students into One of Four Groups

	Clarity Factor Score		**Alignment Factor Score**	
	Above Average (≥ 4.0)	***Below Average (< 4.0)***	***Above Average (≥ 5.2)***	***Below Average (<5.20)***
Aligned and Clear	X		X	
Aligned and Unclear		X	X	
Unaligned and Clear	X			X
Unaligned and Unclear		X		X

TABLE IV. Number and Proportion of Participants (n=71) Assigned to Each Group

	Proportion of Participants		**Number of Participants**	
	1st Distribution	***2nd Distribution***	***1st Distribution***	***2nd Distribution***
Aligned and Clear	42%	45%	30	32
Aligned and Unclear	21%	17%	15	12
Unaligned and Clear	9%	3%	6	2
Unaligned and Unclear	28%	35%	20	25

C. Shifts in Perceptions of Future Careers

The shifts in participants perceptions of their future careers from the time of the first distribution of the survey to the second were identified and are represented below in Fig. 3. These shifts demonstrate the temporal and contextual dependency of students' perceptions of their future careers, meaning that some of the participants perceptions shifted from the time and context of their sophomore year courses to their junior year courses [1].

From these shifts it can be seen that participants who were in "Aligned and Clear" and "Unaligned and Unclear" in the first distribution, tended to remain in those groups, while "Aligned and Unclear" and "Unaligned and Clear" were more transitional states. More participants shifted out of "Aligned and Unclear" (n=10) than shifted into "Aligned and Unclear" from another group (n=7). "Unaligned and Clear" demonstrates this further, with only one participant shifting in to this group. Participants who started in "Aligned and Clear" or "Unaligned and Unclear" tended to remain there.

V. Discussion

Based on our previous qualitative work, students in the "Aligned and Clear" group have identified a realistic and desirable future possible career and career path and are taking steps to reach that future possible career [7], [8]. It is unsurprising that most participants who started in "Aligned and Clear" remain there (70%), because of their clear perceptions of their future possible careers. The four participants who shifted from "Aligned and Clear" in the first distribution to "Unaligned and Unclear" in the second distribution may have had an influential event or experience occur, such as an undergraduate research experience or co-op; experiences such as these have been shown to influence students' perceptions of their future [12], [18], [19].

Based on qualitative results, it is expected that students would shift out of the "Unaligned and Clear" group. Previous qualitative work has identified that this group of students are conflicted between two future career paths: one that is desirable yet unrealistic and another that is realistic yet not ideal [6], [9]. It is possible that over time students resolve this conflict, shifting them into one of the other groups—either determining that they're not sure what their future possible careers are ("Aligned and Unclear"), deciding on one career path ("Aligned and Clear"), or not finding a future possible career that is desirable ("Unaligned and Unclear").

There is not much qualitative information on the "Unaligned and Unclear" students; participants in this group have been interviewed and qualitative analysis is in progress. From their quantitative scores, it can be seen that these students have less clarity of their future possible careers (2.8 out of 7) and a lower alignment of their ideal and realistic future possible careers (3.9 out of 7). These scores are indicative of students who are not sure what they want to do in the future for their careers but believe that whatever career they do pursue is not likely to be enjoyable. These beliefs are not conducive to academic achievements [20], and it is concerning that a majority of participants who were in the "Unaligned and Unclear" in the first distribution remained there in the second distribution (70%). Participants who remained in the "Unaligned and Unclear" group have not identified a future possible career that is realistic and desirable.

VI. Implications and Conclusions

Participants who completed a survey on their perceptions of their future careers while in a sophomore-level course and completed the survey again in the following fall semester, showed a shift in those perceptions between the two time points. Participants primarily shifted out of the "Aligned and Unclear" and "Unaligned and Clear" groups; in other words, participants with conflicting perceptions of their futures and participants who have very broad perceptions of their future changed their perceptions over time. Participants in the "Aligned and Clear" group, with a very well defined future possible career that is both ideal and obtainable, tend to remain in this group over the two time points. Participants who were unsure of their future possible careers and had a less positive perceptions of those future possible careers ("Unaligned and Unclear"), also tended to have these same perceptions at the second time point.

The trends of these shifts may be informative to persons advising mid-year engineering students on their academic and career paths. Knowing that those students who do not believe as strongly that engineering will provide a satisfying future career tend to remain in this way of thinking could indicate that students may need advising to choose another major that better fits their career goals or to gain experience in jobs related to their field earlier in their academic track.

Implications may extend into high school education and advising. Exposing students prior to choosing a college major may provide students with a more accurate understanding of engineering. Formal engineering programs in high school, helped students form a clearer perception of engineering and their future possible selves as engineers [19]. Creating clearer, more accurate perceptions of their futures in engineering prior to selecting a major may reduce the number of students who do not have a clear perceptions of their future in engineering in their sophomore year. These findings also have implications for research, in informing the direction of future work.

VII. Future Work and Limitations

The limitations of this study included the possible measures of validity and reliability that could be performed on the small sample size in the second distribution. This also, limited the methods by which students' characteristic ways of thinking were identified. Little is known about the "Unaligned and Unclear" group, and an analysis of the larger data set from the first distribution, as well as interviews are needed to better identify and understand this group. The analysis of the larger data set in the first distribution, including a cluster analysis, is being completed, and a qualitative study exploring the "Unaligned and Unclear" group is in progress.

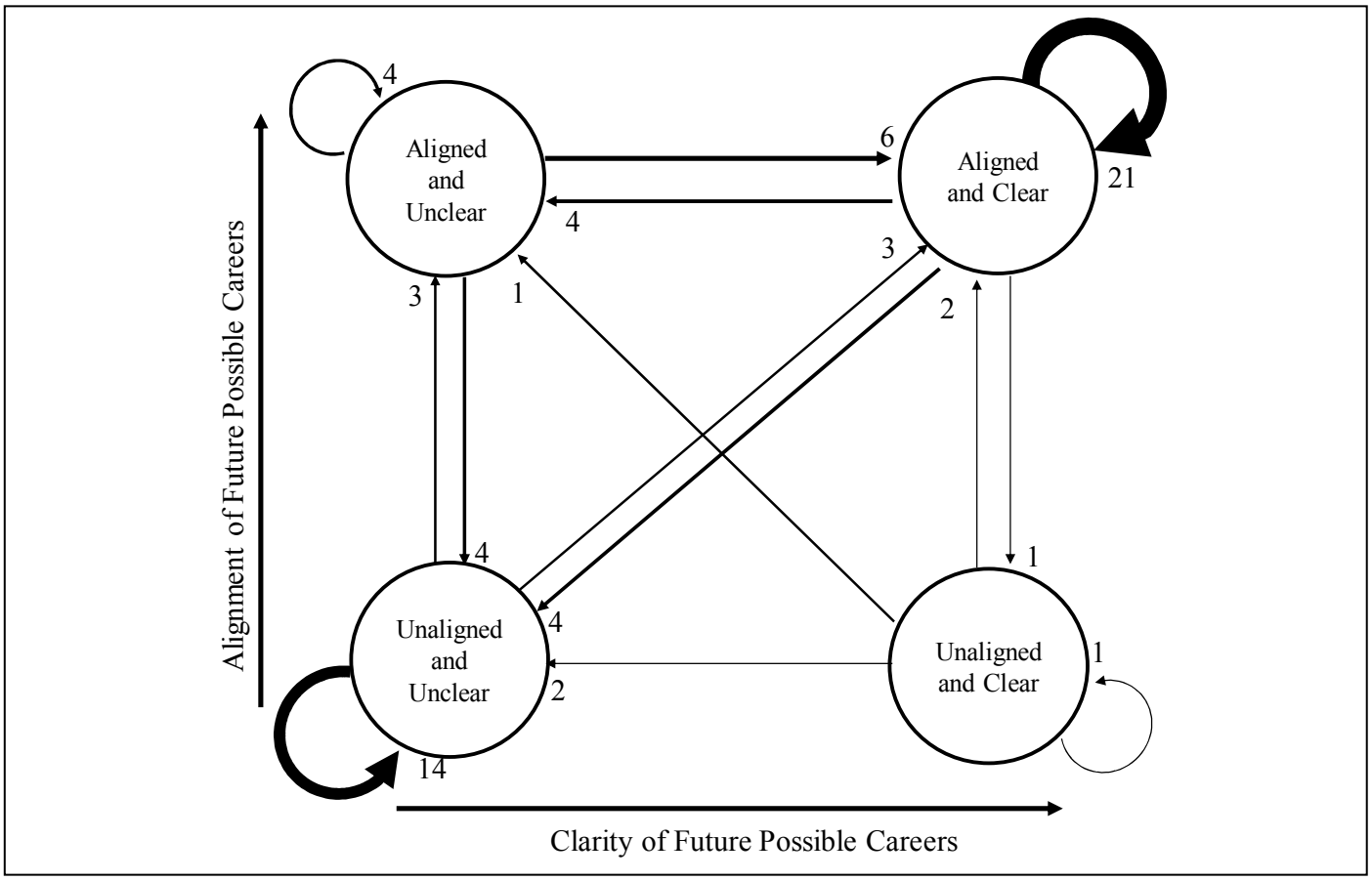

Fig. 3. Students' perceptions of their future possible career shifted over time. The arrows indicate the shifts between the two survey distributions, and the numbers beside and width of the arrows indicate the number of students who shifted.

The time between the first and second distribution was not consistent for all participants. However, in the case of this study, this discrepancy may not be as influential to the results. All participants were in a similar context during the first distribution (students in sophomore-level engineering course), and all participants had a summer semester between the first and second distributions. Additionally, the first distribution in the Spring was two weeks into the semester, which is a 6-8 month time gap between the first and second distribution. The limitations of sample size and data collection methods provide context for which the results and implications should be considered, and provide opportunities for expanding this study in future work.

The findings in this study provide promising preliminary results for future longitudinal studies in engineering students' perceptions of their futures. A larger scale longitudinal study with a sample that is more representative of the engineering student population would contribute to the validity of this work and may help identify more significant patterns in these shifts.

Future qualitative studies would be useful for identifying why these shifts may be occurring. Now that "Unaligned and Unclear" has been identified as a group which students tend to remain in, particularly in their crucial middle years in engineering, studying why students shift in to the "Unaligned and Unclear" could help advisors improve the educational experience of these students by helping them find a good fit in their education for their career goals prior to them reaching the point of feeling "stuck" in engineering.

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