



Future Time Perspective and Self-Regulated Learning: Multiple Case Studies in Industrial Engineering

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Abstract

This research paper is a pilot of a larger, mixed methods study that aims to capture the experience of sophomore engineering students' self-regulated learning (SRL) strategy use and the connections with the student's motivation with respect to the future. The overarching goal of the project is to understand the motivations and attitudes of undergraduate students in engineering, which is vital to answering the call for increasing the number of engineering graduates. Our project aim is to study engineering students' future time perspective (FTP) and how their FTP affects their use of SRL strategies. The quantitative portion of this study describes a cluster analysis of data from a motivation survey that characterizes students' FTP (n=118). The qualitative portion consists of case studies (n=4) which assess connections between students' FTP and SRL use. The cluster analysis showed three clusters of student FTP's. Interviews showed that clustering matched the FTP interview results, a variety of SRL strategy use among FTP's, and connections between FTP and SRL including perceived instrumentality and a timeline of short and/or long term goals. Future work will focus on the connection between FTP and SRL with the intent that practitioners may use this work to create programming related to these themes to increase SRL use among undergraduate engineering students.

Introduction

The U.S. workforce is in need of a large number of well-educated science, technology, engineering and mathematics (STEM) graduates¹, and education and psychology research has shown that motivation has an effect on student success in STEM fields²⁻⁴. As described by the Future Time Perspective (FTP) theory, motivational attributes have been shown to positively affect student achievement and persistence⁵. Additionally, Self-Regulated Learning (SRL) has been positively linked with increased self-efficacy of undergraduates⁶. FTP and SRL have often been researched separately, but previous literature has reported that there is a link between these two areas^{2,7-11}. We seek to observe the student experience in terms of FTP and how FTP affects student task-specific behavior in terms of SRL, thus investigating this link for engineering students. This paper describes a pilot project aiming to study Industrial Engineering (IE) students' FTPs and how these views of the future affect how they regulate their learning in the present.

Background

In the engineering education and education psychology realms, FTP has been defined as "the present anticipation of future goals"¹². Quantitative work studying FTPs of engineering students featured the Motivation and Attitudes in Engineering (MAE) survey, which includes Likert-type FTP items focused on students' perceptions of the future, perceived instrumentality (PI), and effects of the future on present tasks (Appendix A). Perceptions of the future involve time orientation (how people generally focus on the past, present, or future¹²), perception of time (an

individuals' positive or negative perception of the future¹²), and other characteristics. PI has begun to appear as a connection between SRL and FTP and can be defined as how important students view present tasks for their future/goals^{10,11,13,14}. Effect of the future on present tasks (future on present) refers to how a student's future goals are influencing what they do in the present. Characteristic categories of FTP have been identified in previous quantitative and qualitative work of engineering undergraduates^{15,16}. Within these categories of student FTPs, characteristics that distinguish between different student FTPs have emerged^{15,17,18} including: steps to future goals, depth of future goals, number and type (avoided, ideal, and realistic) future possible selves, effects of future on the present, and characteristics of future careers. These FTP characteristic differences can be used to distinguish between students in terms of their temporal motivations, particularly when conducting qualitative analysis of interview data.

Students who practice SRL use metacognition, motivation, and behaviors to regulate their own learning and utilize methods, such as evaluating (metacognitive) and organizing (behavioral), to reach their learning goals^{19,20}. Additionally, students who are self-regulated "perceive themselves as self-efficacious, autonomous, and intrinsically motivated" (motivational)¹⁹. While the literature defines SRL in many ways, one underlying theme connects all SRL research: students achieve at a higher level academically when they regulate their learning¹⁹⁻²². SRL has been operationalized to measure aspects of students' metacognition, motivation, and behaviors related to their academic self-regulation, such as the Self-Regulated Learning Interview Scale (SRLIS) developed by Zimmerman and Martinez-Pons¹⁹. SRLIS, a semi-structured interview protocol focused on "hypothetical learning contexts"²³ based on research with K-12 students comprises 14 themes^{19,20}, including *self-evaluation*, *organizing and transforming*, *goal-setting and planning*, *seeking information*, *keeping records and monitoring*, *environmental structuring*, *self-consequences*, *rehearsing and memorizing*, *seeking social assistance* (peers, teachers, adults), and *reviewing records* (notes, books, tests).

Prior research has explored connections between SRL and FTP at length, such as the findings that suggest a student's FTP can be motivational for adopting SRL strategies^{8,10,11,24}. The model created by Miller and Brickman⁸ focuses on the fact that a distal future goal in turn motivates the creation of distal sub-goals, which are motivational for proximal self-regulation. Another model by Deci and Ryan²⁵ shows that FTP is linked with self-regulation, with a focus on the fact that the "journey" is more important than the future end result. This suggests that a connection exists between SRL and FTP, rather than FTP serving as simply general motivation for students. More recently, Simons, Dewitte, and Lens²⁶ discussed that PI may be a key aspect of student motivation, and the connection between SRL, PI, and FTP has been described in previous literature²⁷. While theory and literature has shown connections exist between SRL and FTP, including quantitative studies of engineering students^{10,28}, research is lacking to describe the nature of these connections. This pilot study will begin looking qualitatively at why and how engineering students connect their views of the future to the self-regulation of their learning in the present.

Research Purpose

This research is a pilot of a piece of a larger, mixed methods project which seeks to understand the connection between engineering students' FTP and their SRL strategy use through investigating the sub-questions as outlined below:

- 1) What SRL strategies do IE undergraduates use?
- 2) How do students' FTP attributes relate to their use of SRL strategies?
- 3) How do the SRL strategies among different FTP types compare?
- 4) What are the connections between SRL and FTP?

Methods

This project is a pilot of a multi-phase mixed methods sequential explanatory study. In Phase I (quantitative), a survey was implemented in an IE course and a cluster analysis was run on the survey responses to select the participants for the second, qualitative phase. In Phase II (qualitative), we piloted the use of a semi-structured protocol to interview four students, with the goal of selecting at least one from each FTP type as determined through the cluster analysis in Phase I, and analyzed SRL strategy use and the connections between SRL and FTP. While we analyzed interviews in this pilot for these four participants, we collected other pieces of qualitative data, which will be utilized for triangulation in future case study and related work.

Phase I

A quantitative survey was distributed to students enrolled in a sophomore level IE seminar course in Fall 2014 at a southeastern land grant, four-year university at the end of the semester (n=118). Students were a mix of sophomores and juniors. Students received course credit for completing the survey in phase I, and a final letter grade was assigned for this course. These students participated in a larger study as outlined in another paper²⁹, which included attendance at an intervention focused on using SRL strategies and writing reflections about their SRL strategy use. While the intervention may have impacted student self-report of their SRL strategy use, two benefits occurred: improved rapport with the researcher, who provided the intervention, and a greater fluency of SRL strategies in the reflections and interviews³⁰.

The survey distributed at the end of semester included four sections with 86 items. Some items were adapted to be applicable to an engineering course from the Motivated Strategies for Learning Questionnaire (MSLQ)^{31,32}. Other survey items were written in three sections¹⁶: a 13 item goal orientation section, a 28 item FTP section, and 16 items on task and course specific problem-solving self-efficacy³³. The MSLQ^{31,34,35} has been well-documented, and the MSLQ and MAE survey³⁶ have both been tested for validity and reliability. Only the 28 items from the FTP section of the end of semester survey were included in a cluster analysis (see Appendix A) due to the research questions for this pilot study. The items in Appendix A are labeled by factor: future on present (items that describe how future goals of the student influences present actions), PI (items that describe relevance of a task), and perceptions of the future (items that describe views of the future).

We conducted a k-means cluster analysis³⁷ utilizing a statistical software environment³⁸ in R³⁹. When running a cluster analysis on a survey, the k-means variety utilizes scores of survey factors to form homogeneous subgroups from the data by maximizing variance between clusters and also minimizing variance within the clusters. Promax rotation was utilized to adjust for the fact that some of the factors in our survey were correlated; more details about correlation among factors and utilizing rotation in a cluster analysis may be found in the literature^{40,41}.

Phase II

In Spring 2015, students enrolled in the same sophomore level IE course in Fall 2014 were recruited to participate in semi-structured interviews (see Appendix B) addressing their views of the future and how they regulate their learning. Four students volunteered for the interviews, and each student was given a \$20 Amazon card as incentive for participating. Interviews were transcribed, and the text was analyzed with RQDA using directed content analysis⁴², with both *a priori* coding and emergent themes. *A priori* themes used in the analysis are from previous uses of this protocol in regards to the FTP sections¹⁸, as well as the Zimmerman and Martinez-Pons^{19,20} framework in regards to SRL in previous work²⁹. Themes about the connections between these students' FTP and SRL were allowed to emerge from the data.

The Q³ quality assurance framework by Walther, Sochacka, and Kellam⁴³ was utilized to examine the validity and reliability of the qualitative methods in phase II. Previous work on FTP and SRL were referenced, and experts in the field were contacted to ensure *theoretical and procedural validity* of this project. A thorough description of the data collection procedures was collected, and descriptive memos were taken throughout the research process during data analysis, supporting *pragmatic and procedural validity*. Multiple researchers, including an engineering undergraduate, conducted the data analysis in Phase II to ensure *reliability* and *communicative* and *pragmatic validity*. The interview protocol has been reviewed by undergraduate engineering students to check for the correct interpretation of the questions and to ensure that the answers aligned with our research objectives, supporting *communicative validity* of the questions. Additional support of *communicative validity* includes selection of representative quotes from each interview.

Results and Discussion

Phase I

In order to select students for the qualitative phase, a cluster analysis around the FTP variables was completed. The items and factors (perceptions of the future, future on present, and PI) of each item are listed in Appendix A. Three clusters were expected due to previous research from a k-means cluster analysis and follow-up qualitative work^{15,17}. These clusters are described below:

- 1) low future scores, low future on present scores, and high PI scores
- 2) medium future scores, high future on present scores, and low PI scores
- 3) high future scores, high future on present scores, and high PI scores

A dataset was created with the averages of these three factors, and the number of clusters appropriate was determined utilizing a plot of the variance, which is included in Appendix C.

From the plot of variance, three, four, or five clusters appear to be a good fit. Due to the pilot nature of this work and as the purpose of the cluster analysis was for participant selection, rather than analysis of the participants' FTP, we selected $k=3$ as our final clustering as three clusters (see Appendix D) of FTP characteristics were found in our prior research¹⁵. The average scores noted for each cluster by FTP factor appear to match this previous work: Cluster 1 has low future perceptions and low future on present scores, Cluster 2 has medium scores, and Cluster 3 has high scores for all three factors. This is shown in Table 1. Scores of the interview participants in Phase II are included in Table 2.

Table 1: Average scores for each of the three clusters according to FTP factor				
Cluster	N	Perceptions of the Future	Perceived Instrumentality	Future on Present
1	28	3.90	3.61	2.04
2	52	3.52	3.50	3.30
3	38	4.09	4.36	4.26

Table 2: Scores for participants in phase II according to FTP factor				
Participant	Cluster	Perceptions of the Future	Perceived Instrumentality	Future on Present
Amy	1	3.29	4.50	2.0
Blake	3	4.43	4.33	4.0
Claire	1	4.57	3.17	2.5
Daisy	2	4.00	3.67	3.5

Phase II

The following section details the FTP, SRL strategy use, and connections between FTP and SRL of four engineering students enrolled in a sophomore level IE course based on the interview protocol attached in Appendix B. A codebook for analyzing FTP is included in Appendix E, with sample quotes from study participants for each code. Similarly, the SRL categories described by each participant are listed in Appendix F. Below we describe the FTP, SRL, and the connections between the two for each individual case study participant. All names shown for the four individuals are pseudonyms.

Case 1: Amy

Amy is a Caucasian, female second year engineering student in her third year at the institution. She declared her engineering discipline in Fall 2014. Unlike the other participants, she originally declared biology as her major but switched to engineering due to the high value she placed on the work of engineers after seeing what her friends were doing in their courses and seeing what types of jobs she could have after graduation. She chose her engineering discipline in a “pragmatic” way—IE would allow her to graduate in a timely manner, and she did not like other disciplines such as electrical engineering.

FTP

Amy's core attributes follow: an ill-defined and open view of the future, high PI for her IE and all other coursework, and an overall positive time attitude. Amy's description of the distant future was vague and ill-structured. She mentioned many desired futures, such as earning an MBA, acting as a lead engineer, working in industry, and engineering in a startup company. She described her desired future best as "happy" and "well-off." While her possible future appeared open, Amy was able to articulate in detail short-term goals, such as playing every intramural sport at the university in a single school year, and how she planned to obtain them. Amy fits into cluster 1, as her goals do not extend far into the future.

While Amy was not clear about the job she definitely wants, she was very clear about characteristics, such as no manual labor and "use hands and brains," again, common for students in cluster 1. She also mentioned many feared possible selves in her career, which is common among cluster 1 students; for example, she fears being overly involved and "not feel[ing] like I'm continually going everywhere." These details again support that Amy may be transitioning between clusters.

Amy has a high PI but low future on present, which match her survey scores and is consistent with cluster 1. She sees many things she is doing now as relevant and instrumental to the future (i.e. her Public Speaking course), but she does not have future goals that help her decide what is important in the present; she believes everything she is learning may be useful: "...the whole world is your oyster when you're an engineer. They give you all the tools and then you just get to do stuff."

SRL

Amy described a strong use of SRL strategies (Appendix F). Some of her SRL strategies overlapped with her goal of succeeding during finals week: managing her time, being organized with notes, and getting plenty of sleep. Amy frequently mentioned getting enough sleep and attending class (*study environment*), and she explained how she utilizes a summary sheet to study (*organizing and transforming*). Finally, Amy mentions that in studying, it is important to "know yourself," including using focus and perseverance (*self-evaluation*). Meanwhile, Amy explained that studying is the same in engineering and non-engineering but was able to articulate the differences in particular courses, such as coding versus memorization-based engineering content.

FTP and SRL Connections

Amy's connections between her FTP and SRL appear within her PI of her current tasks and within her goal setting for her courses and her short term life and career goals. She spoke of how many courses are important to her future. In particular, she mentioned that she adopted her study skill set after attending workshops through the learning center on campus due to how valuable she thought the new skills could be on her success in her coursework. Her short term goals, such as working at an internship related to engineering, influenced a much shorter term goal of achieving a high GPA. In this case, her longer, short-term goal influenced her adoption of a more proximal short-term goal.

Her self-regulation was also influenced by her goals, primarily her distal goal of happiness. Her proximal goal of succeeding during finals week influenced her self-regulation while studying for her finals. Additionally, her drive to experience so many things during her time at the university, such as playing all intramural sports, caused her to utilize time management and other SRL techniques to best maximize the use of her time. Her strong use of SRL strategies connects to her high PI of all coursework, including engineering and non-engineering courses, and her goals of having a good GPA and graduating. Overall, Amy mentioned that "success is what you want it to be." Her SRL habits are a means to an end: "...me studying gets me good grades which will get me into either a good grad school or a good job. They're pushing me along" and her set of goals are mapped out in Figure 2.

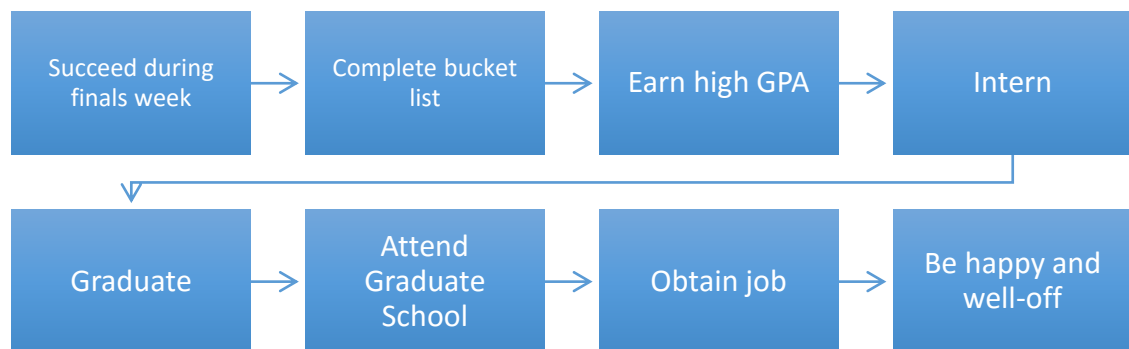


Figure 2: Amy's timeline of her proximal sub-goals and distal future goal relating her FTP and SRL

Case 2: Blake

Blake is an undergraduate Caucasian, male who spent a few years in the military before returning to the university. He enrolled in general engineering and selected IE due to the "efficiency" focus of the courses. He felt that the military lacked many aspects of efficiency and disclosed wanting to be able to improve processes in a company. Blake is not a typical male sophomore due to his past work experience and age.

FTP

Blake fits into cluster 3 with a long FTP, well-defined distal goal, explicit path of sub-goals, detailed desired future career characteristics, high PI in courses he feels are relevant to his future, and a positive time axis. During the interview with Blake, he clearly described a well-defined, long-term future goal: becoming chief operating officer (COO), a proximal sub-goal which was created due to his distal future goal of being financially stable. Figure 3 depicts his outline of sub-goals leading to this distal future goal with an end point of retirement, which Blake also described as a time when he hopes to be financially stable.

Blake described a very high PI for engineering, mathematics, physics, and other related courses to his future career goals: "When as in IE, you can do whatever you want, really. There are just so many applicable areas that you can use for a process improvement." Blake said that general education courses are irrelevant, but he showed a high level of PI when describing his work in daily life, such as efficiency while driving.

A key aspect about Blake was the impact of his past on his current state and future goals, and he described several ways his future goals are impacting his present. His previous military experience has helped him create a well-defined career path and he described an example of a job characteristic he values due to his past experiences: "I had my time wasted by inefficient management for years. It really gave me appreciation of efficient management. It's kind of what industrial engineering is all about."

SRL

Blake's self-regulatory study behaviors stemmed primarily from his experience in the military and due to his future goals. Specifically, Blake mentioned on multiple occasions that repetition is important in learning information (*rehearsing and memorizing, organizing and transforming*), and he discussed attending and engaging in class (*keeping records, seeking information*). Overall, Blake is a perseverant and reflective learner (*self-evaluating*); he described differences in studying between classes, and in particular that the memorization in IE is the same as other classes. While Blake self-regulated in his current courses, especially if he felt the material will be necessary in the future, he was clear that he felt you must be motivated to learn in order to figure out how to appropriately study and learn the material in a course.

FTP and SRL Connections

Blake stressed the importance of reiterating material to learn it and the relevance of the material and his motivation in the course played a huge part in whether he self-regulated in a course. His perception about the importance of material to his future and if he felt the future depended on knowing the material altered how he studied for courses, as shown in this quote:

"...I would say that using study skills is important but... it's just hard for me to look at... some of these questions ...and say, 'This, this is definitely going to decide my future. Memorizing is going to be something that makes or breaks my career.' I can never get myself to be motivated enough to learn with that mindset because I just know that it's not true." -Blake

Blake described self-regulating differently in relevant versus general education courses: "I don't use the same study skills because the classes [non-engineering] are stupid. That's really how I felt about it the entire time." However, his past experiences appeared to have a large impact on his SRL, and the goals he set for himself created the motivation for him to self-regulate in his courses in order to achieve the path of proximal sub-goals set up to reach his distal future goal of financial stability. His future goals are impacting how he regulates his studying now and have helped him create a path of sub-goals, which additionally motivate him to be successful.

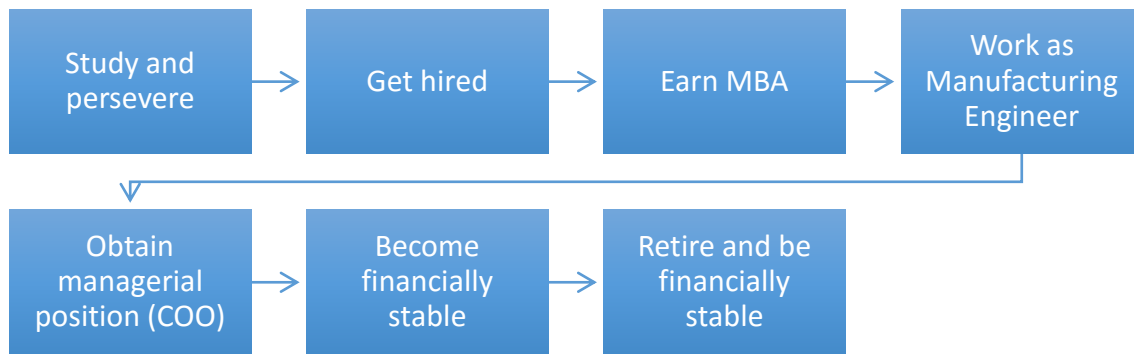


Figure 3: Blake’s well-defined set of goals that reach 10+ years into the future, relating his FTP and SRL. His well-defined distal goal supports his path of proximal sub-goals, which reinforce his SRL.

Case 3: Claire

Claire is a second year, Caucasian, female IE major at the university who started in general engineering and selected IE after a year classified as a chemical engineering (ChemE) major.

FTP

Claire has a positive outlook of the future, a high PI, and an extremely ill-defined view of the future: “I just want to be able to know all my different options that industrial engineering offers, to see exactly what I want to do in two years.” Claire’s main goals are to obtain a good job that allows her to travel and be happy. Her mother had a large impact on her work goals and she mentioned working as a professor as an avoided future due to her mom’s experience as a teacher. She aims to “always improv[e]” her position and knowledge, just like her mom.

Claire has a high PI for all of her courses except general education courses, in which her motivation was lowered. She said “I learned so much worse because I’m just like not interested in the class, so I don’t really want to learn the material...,” but that she was lucky to have a [language] minor so that the majority of her general education requirements were filled by more relevant courses. Additionally, one key reason for her switch in engineering discipline was she found IE material more relevant than ChemE. Besides course material, she described relationship building, along with problem-solving, leading, networking, and communication as important, which she is learning in school: “You’re going to be working with different engineers, you’re going to be working with chemical engineers, mechanical, anything electrical, and you need to be able to, like, express your views.”

Claire fits in cluster 1; her experience with the major limited the characteristics she could describe for her future job. The goals she described were primarily short-term and ill-defined. Figure 4 shows Claire’s goal timeline, along with her distal future goals of being happy and progressing in her career. Her positive, but ill-defined, view of the future is captured in this quote:

“I guess just [actively striving for] experience right now. I’m looking to shadow some process or some field engineers in manufacturing through different companies this summer, as well as working at [company]. I’m just trying to get as much experience as

possible, because I just want to be able to know all my different options that industrial engineering offers, to see exactly what I want to do in two years.”

SRL

Claire described typical student study habits (Appendix F) of taking notes in class, reviewing slides, and rewriting material (*record keeping and monitoring, reviewing records, rehearsing and memorizing*), and the other self-regulatory habits she mentioned include *seeking social assistance*, such as studying in groups, and adapting her study environment (*structuring environment*). When talking about working with professors, she focused on the future impact, something she learned from her mother, a variation not commonly seen with *seeking social assistance*. She explained that the better you know your professors, the better you are able to determine what information in class is important.

Claire mentioned selecting the main ideas of material, *organizing and transforming material*, as “efficient” because students “don’t have to study as much material because you know exactly ... and you can study the main points more.” However, Claire described studying as “personal” and different between people rather than courses. She also viewed success as meeting her own expectations, including success in studying. Overall, Claire described studying as putting in time, and she did not describe major differences between how to prepare for engineering and non-engineering courses. She described studying for dissimilar courses as different, such as memorizing versus learning a process, and that studying depends on the material and not the subject: “I think engineering is mostly ... problem solving. Whereas [language] has no problems, it’s just knowing the material.”

FTP and SRL Connections

Claire described the short-term future, specifically job interviews, when asked how she developed the ideas of what was important that she is learning. She viewed studying and study skills as instrumental for her future, and her view of wanting success in the future impacts her study habits in the present: “I think just the fact that I find it interesting and that I want to retain that information, I might study a lot differently from someone who doesn’t really care.... I’m hoping to use it in the future so I’m studying differently because of that.”



Figure 4: Claire’s timeline of her ill-defined distal goal and her short-term sub-goals. Claire has an extremely open view of the future but an ill-defined set of proximal sub-goals that do not reach far into the future.

Case 4: Daisy

Daisy is an international student who came to the United States to study engineering at our institution. While she is a second year student in IE, her international roots may have an impact

on her FTP and SRL habits. However, her interview provided insight into an international perspective and fourth view of the possible connections between FTP and SRL.

FTP

Daisy fits in cluster 2, with a conflicting ideal and realistic view of the future and low PI. She discussed becoming an engineer and obtaining an MS degree in America. However, on multiple occasions, Daisy wistfully spoke of her goals of opening a bakery in her home country. While these goals may appear long term, she was very clear that she plans only over the short term, which may be caused by her home culture but also could be caused by characteristics of her cluster type: “Like how I will think of a plan too much, it doesn't really help me, so I will just try to have a plan for the near future, and make that plan be safe, but don't get fixed on something and then realize I didn't want to do that.”

While she is conflicted about these two goals and which to pursue, she is clear that she does have one distal goal: to be “happy.” When she spoke of being happy, she discussed a certain lifestyle, which may have caused her to be open in her career planning. This distal future goal motivated her to form the proximal sub-goals of pursuing higher degrees, as she believes that a higher degree will allow for a better job which will translate into a higher level of happiness. Additionally, she has a low PI for her coursework, and she labeled herself as “lazy” in her courses. Daisy’s timeline of her future goals is in Figure 5. Of the four students, she has the least amount of goals and the lowest PI, but her goals are well-defined, though conflicting, all characteristics of a cluster 2 student.

SRL

Daisy self-reported using SRL strategies listed in Appendix F. In particular, she mentioned multiple times working problems, as many undergraduate engineering students do, but most interestingly making sure to knowing the “why,” a very self-evaluative feature of self-regulation. Daisy mentioned that study skills are context and person dependent by saying, “I mean it will change from math to literature, and stuff like that. It's like industrial engineering, there's a lot of different classes, so I think it doesn't really, it's specific.” Daisy dislikes general education courses and spoke of being “lazy” in classes she does not like. She self-reported her studying as very limited but mentioned that she earns good grades. While “lazy,” Daisy is particularly self-aware and is clear about how she does and does not study, so she was able to explain her SRL strategy use. She even went as far as to say “I don't like study skills.”

FTP and SRL Connections

Though Daisy self-labeled herself as “lazy,” she did describe a connection between her future goals, such as a high GPA and being happy, and the regulation of her learning. However the goals she connects this regulation to are very short term: “If I have a goal to get a graduate degree, it affects that I work to get good grades besides understanding, so I try to do what I have to do, even if that would not help me to get better understanding, just because it gets me better grades, and I want to get that.”

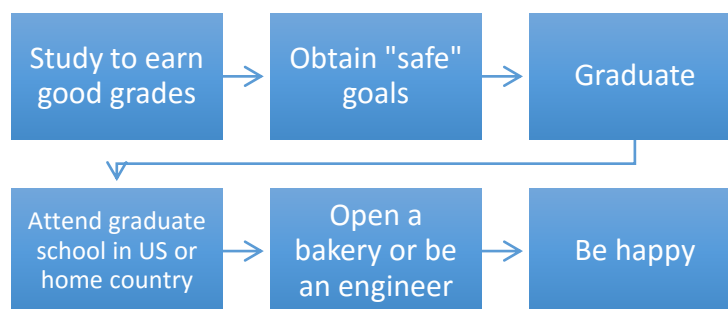


Figure 5: Daisy's timeline of her proximal future and distal sub-goals relating her FTP and SRL. Daisy sets very short-term goals and has two conflicting future goals: an ideal goal of being a baker in her home country and a realistic goal of becoming an engineer.

Conclusions, Limitations, and Future Work

The goal of piloting the FTP and SRL interview protocol was met and the methodology was shown to be effective for collecting and analyzing data on FTP, SRL, and their connections. The cluster analysis accounted for a high level of variance (81%); however, while the interview data triangulated with the survey data, the FTP survey items may not completely measure the clusters. The qualitative piece was useful in observing and analyzing a more complete picture of the FTP of each student to compliment the quantitative piece of the study. In addition, this also yielded an overview of the SRL use in engineering and non-engineering courses, and helped to begin building connections between FTP and SRL. However, there are still some questions left unanswered and more questions about the connections have been generated. Other qualitative work may be useful in guiding the building our knowledge of FTP, SRL, and the connections between the two for the engineering undergraduate population.

Some themes persisted between cases and may highlight FTP and SRL connections in future work. Both students in cluster 1, Amy and Claire, defined success as meeting their own expectations, a theme which may persist among students in this cluster; additionally, both of these students felt material outside of their major coursework may be relevant to their future and saw a difference between studying for different kinds of coursework, specifically in and out of major. Additionally, the four students self-reported using a variety of SRL strategies, which can also be seen in a previous study²⁹. Finally, when a participant reported a high level of PI in a course, they also reported a high variety of self-regulatory strategies.

For future SRL and FTP work, more sources of data should be collected for a multiple case study for triangulation. A cross-case analysis would be useful in the future, for which more sources of data will be needed. While the data showed SRL strategies, FTP, and some connections between the two, more data should be collected and analyzed about how these students are regulating their learning, especially in their engineering courses. One such source could be periodic reflections during the course on their study strategies. Also, more interviews should be conducted to connect the pieces between how and why students are self-regulating and the views of their futures. A future survey addressing the cluster types may highlight common themes between student FTPs and how they regulate their learning in the present.

Overall, this study is limited by the nature of self-reported data. While this is common, future work should aim to triangulate the quantitative and qualitative data with additional information on actual student SRL strategies. This project helped to validate the motivation survey our research group has developed by triangulating the self-reported FTP items on the survey with the qualitative FTP interview. Bias was a concern since the researcher who hosted the workshop about SRL strategies was also the interviewer; therefore, a second researcher was present at each interview to corroborate the data, review the notes and transcript, and to read the analysis and results. The familiarity with the researcher helped with rapport during the interview. The attendance at the workshop may have biased the results of the self-report of SRL strategies, but this limitation was offset by the benefit of providing the students with language about SRL with which they could verbalize their strategy use. This is important as prior research showed that students have incomplete or “naïve”⁴⁴ models of what SRL entails³⁰.

Several connections were seen by piloting the interview protocol assessing FTP, SRL, and the connections between the two for undergraduate engineering students. However, while not the focus of this work, future work may want to look at how students define success in their undergraduate engineering programs. A future interview with students should be developed which focuses on goal setting to paint a clearer path of student goals and views of the future. This protocol should also address how and why engineering students set goals and create views of their possible future. Other FTP literature should be incorporated to highlight these paths, such as Raynor’s work on achievement motivation^{45–47}.

Implications for Practice

Based on our participants’ responses regarding how their perceptions of the future affect their SRL strategy use, practitioners should work to build career awareness, general education importance, and goal-setting agendas into their curricula. To see the value in the work in major and non-major courses, students need to be able to map out the relevancy of the material to their futures. If students are more aware of what types of jobs are available in their major, and the nature of those jobs, students may have a higher PI related to their coursework and may be able to connect the current task at hand to their future. Additionally, if students can see how general education courses are important to other current, valued coursework or directly to future valued roles, students may engage in this material in a more regulated manner. Finally, helping students build goals in their field, including a distal future goal and proximal sub-goals mapping to this overarching goal, will help students regulate their learning on current tasks that they see as valuable to this path. Curricula that focus on careers and goal-setting will help students regulate their learning in their coursework as they will see a higher relevancy to their future.

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Appendix A: FTP Items from the MAE survey distributed in Fall 2014 including factor of item utilized in the cluster analysis

FTP Factor	Survey Item
Perceived Instrumentality	I will use the information I learn in this course in the future.
Perceptions of the Future	I am unsure what my future career will be.
Future on Present	My future career determines what is important in this course.
Perceived Instrumentality	I will not use what I learn in this course.
Perceived Instrumentality	I will use the information I learn in my course in other classes I will take in the future.
Perceptions of the Future	My interest in a career in engineering outweighs any disadvantages I can think of.
Perceived Instrumentality	My course work is preparing me for my first job.
Future on Present	My future career influences what I learn in this course.
Perceived Instrumentality	What I learn in my engineering course will be important for my future occupational success.
Perceptions of the Future	I am considering switching majors.
Perceptions of the Future	I am confident about my choice of major.
Perceived Instrumentality	I do not connect my future career to what I am learning in this course.
Perceptions of the Future	Engineering is the most rewarding future career I can imagine for myself.
Perceptions of the Future	I am considering multiple careers.

Appendix B: FTP and SRL Interview Protocol

Long Term Goals (FTP model) Conceptual Replication Study

What are your goals for the future?

What are your personal goals for the future?

What are your career goals for the future?

What would you ideally like to be in the future?

What do you think you can be in the future?

What do you want to be in the future?

Perceived Instrumentality

Why are you pursuing an engineering degree?

What parts of your education do you see as relevant to your future?

What skills do you view as important for your profession?

How did you develop these conceptions of your future?

Present study skill use and perceptions

Define study skill?

Do you use any study skills?

Do you use different study skills in IE?

Describe where you see yourself in 10 years?

Can you think of anything that could make you change your goals?

If you could pick one thing and it could happen, what would it be?

If you could pick a professional goal to attain, what would it be?

What are you actively striving for?

What goals are you currently pursuing to reach this future?

In other words, what jobs, or careers do you know you do not want to pursue?

In what ways do you plan on using what you are learning in your current major as part of your day-to-day work?

For how long after graduation do you plan on using what you are learning in your current major as part of your day-to-day work?

How long do you plan on remaining in an engineering related profession after graduation?

What do you consider an engineering-related profession?

What skills are relevant to your ideal self (who you would ideally like to be)?

What skills are relevant to who you think you could be?

How do you see your education playing into your career?

What kind of profession (If more than one profession mentioned)?

What are they?

Where and how do you use them?

Why or why not?

What is an IE study skill?

Have you used IE study skills effectively?

Have you used any of these study skills while pursuing your IE degree?

If yes, please describe in what context and what you were doing.

If yes, describe a time you used IE study skills effectively?

What did you do?

Why did you use these skills?

What was the outcome?

What worked?

What didn't work?

How do you know if it didn't work?

How do you learn something in your IE classes?

How do you know you've learned it?

How would you tell another student to be successful in your IE classes?

What would you tell other students about what to do when they sit down to study/during study time?

Describe an IE study skill that would be beneficial to you in your IE education.

What makes these study skills beneficial?

Have you utilized any of these study skills while pursuing your IE degree?
(may be a repeat)

If yes, please describe in what context and what it looked like.

If no, please describe where your ideal study skills could fit into your degree.

How do you remember your discipline?

How do you remember aspects of your classes? Topics?

Is it possible to learn IE study skills?

If yes, where do you learn study skills to be used in your IE classes?

Can you give me an example of where/how you used these skills?

Where or in what context do you use these skills (homework, projects, studying for test, etc.)?

What is your goal when you use IE study skills?

What if anything do you *personally* hope to get from using IE study skills?

Do you use study skills in your non-engineering classes?

Why do you use these skills?

Are these skills different than your engineering study skills?

If yes, where do you learn study skills for your non-engineering classes?
Are study skills different between non-engineering classes?

Interconnection of Long- and Short-Term (Goal orientation)

How do the IE study skills you use relate to your future goals?

In engineering courses
In co-op/intern
In research experiences

How do your future goals affect how you approach your IE study skill use?

Will using IE study strategies/skills help you get to where you want to be in the future?

Why?
How?

What do you define failure as?

Have you ever struggled to use IE study skills?

If yes, what do you do when you struggle to use IE study skills?

How do you define success?

What do you consider success in terms of using IE study skills?

How important are grades?

If yes, why?

Demographics and How did you get here (past and future connection):

Which presentation did you view in [IE course]?

Study Cycle in person, Test Anxiety in person, or Test Anxiety online?

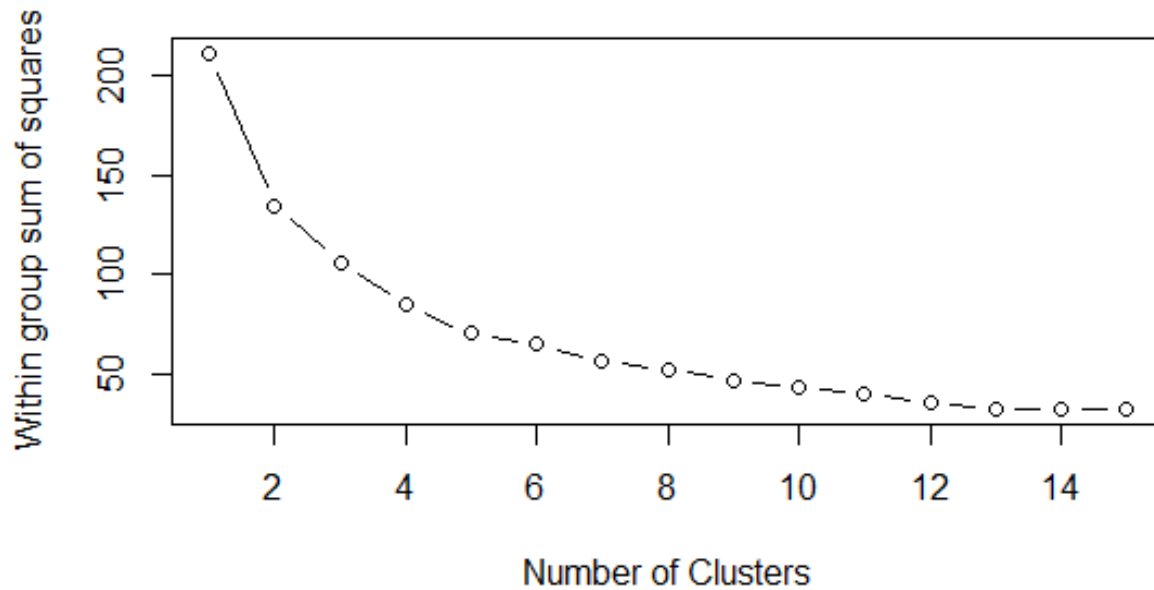
Did you change your study strategies after attending the workshop?

How did you benefit from any changes?

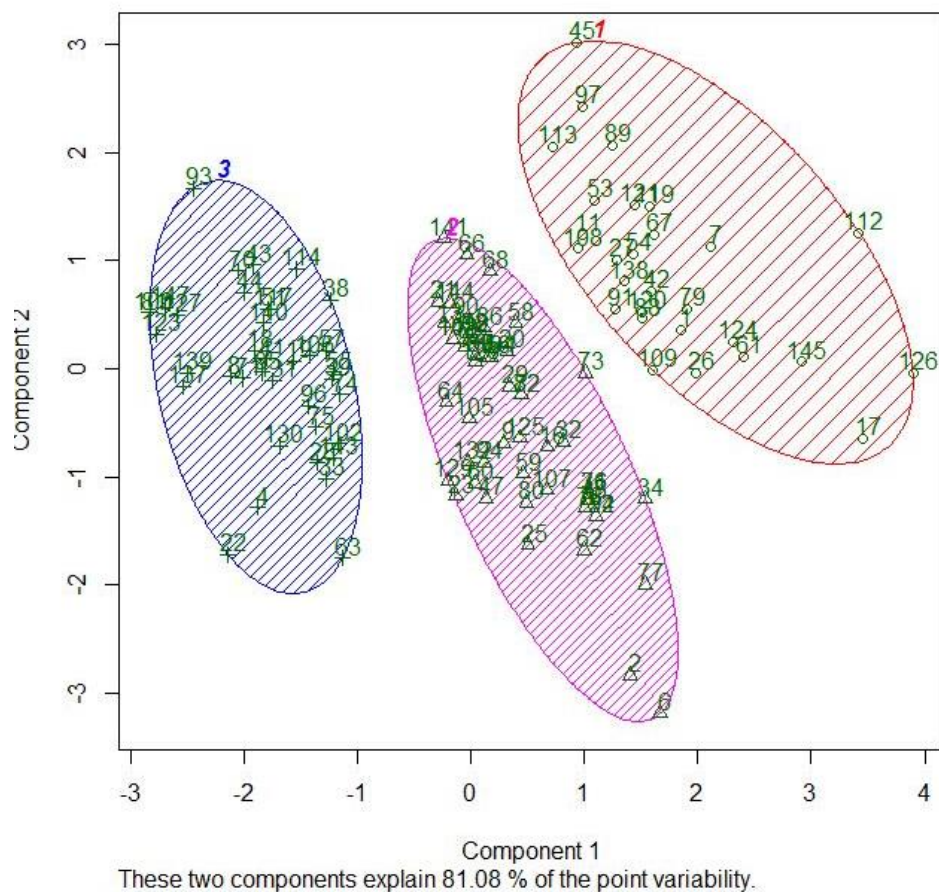
What level of engineering are you in?

How long have you been enrolled at [university]?

Appendix C: Plot of variance used to select the number of clusters for cluster analysis for IE student data through the MAE survey distribution in Fall 2014



Appendix D: Plot of three clusters for IE student data through the FTP section of the MAE survey distribution in Fall 2014



Appendix E: FTP Codebook for IE Fall 2014 interviews, including descriptions of FTP categories found in the literature and representative quotes from study participants.

Category	Code Name	Description	Example Quotes	Example Interview Prompt
Future	Future Career	The student describes attributes or characteristics of their future career.	"I just want to do all the operations. I like operations research. I enjoy efficiency." -Blake	"Where do you see yourself in 10 years?"
Future	Outcomes of Future Career	The student describes outcomes of their future career	"I wanted to be able to use my hands and my brain to make something that could benefit me or benefit the world." -Amy	"What are your career goals for the future?"
Future	Steps to Reach Future Goals	The student describes a series of steps or paths needed to reach a distant future goal.	"If I was going to go to grad school I would maybe want to get an MBA and become a manager." -Amy	"How long do you plan on remaining in said career?"
Future	Desired Future	The student describes what they do want to be in the future.	"Anything like system designs or process engineering." -Claire	"What do you want to be in the future?"
Future	Undesired Future	The student describes what they do not want to be in the future	"I don't really have any desire to teach. My mom's a professor right now... I'd rather just work for a company and work with products and systems than teach the material." -Claire	"Is there anything you do definitely don't want to do?"
Future	Realistic Future	The student describes what they can realistically do in the future.	"I like engineering, so if I find a nice job I will stick with it if I have some nice research or something." -Daisy	"What do you think you can be in the future?"
Future	Ideal Future	The student describes what they ideally want to do in the future.	"My dream before, I wanted to be a pharmacist, but I don't think I want to be that anymore and then I wanted to open a bakery [laugh] and now I don't really know." -Daisy	"What would you ideally like to be in the future?"
Future	Well-Defined Future	Having a defined future goal that one wants to attain. The goal should be clearly defined by the student. The sources of these future goals are coded separately.	"Realistically in the future..an eventual goal.. COO, chief of operations." -Blake	"What are your goals for the future?"
Future	Ill-Defined Future	The student describes a future goal using ambiguous terms. The goal is not clearly defined by the student. The sources of these future goals are coded separately.	"Just honestly, I would go wherever the breeze took me. I would want to take as many opportunities to try out interesting things, and hopefully 10 years down	"Describe where you see yourself in 10 years."

			the road I would be in a job that I would like or I would know that I was good at.” -Amy	
Future to Past/Present Connection	Future on Present	The student describes how their future goals are influencing what they do in the present.	"In high school I knew that I wanted to go into engineering just because it's a good field to go in. I've always heard that you get good jobs... so I came to college and I was like, "I'm going to be a chemical engineer." - Claire	"What skills do you consider relevant to your ideal self?...who you could be?"
Future to Past/Present Connection	Past/Present Actions Influence on Future	The student describes how what they do in the present or what they have influences what they will do in the future or what their future goals are.	"I'm an IE, so right now I am... I have an internship for the summer so I'm going to see if I like manufacturing, because that's usually what people think of IE's naturally." - Amy	"Why are you pursuing such a degree?"
Perceived Instrumentality	Perceived Instrumentality	The student describes how relevant they view certain tasks	"Some stuff we learn I can just apply to my life, and I can see how people are very difficult, and they could do it much easier." -Daisy	"How do you see your education playing a role in your career?"
PAST	Past Experience and Perceptions	The student describes an experience that occurred in the past or a perception of the present or future that was formed in the past.	"By sitting really angrily wasting a lot of time in the Marine Corps, by thinking about "Why is this so poorly done? What could be done better about this?" -Blake	"What do you think you can be in the future?"

Appendix F: SRL Strategies utilized by each case study participant, including their FTP cluster

Participant	Cluster	SRL Category	Example Quote
Amy	1	Goal setting and planning	"Preparing ahead of time. Not cramming the night before. It's nice to hear that preached over and over because you finally start doing it."
		Keeping records and monitoring	"Effective note taking. Being... not writing down everything you hear but writing down the main points and listening in class."
		Organizing and transforming	"I made myself a note sheet, the cheat sheet that I need for my exam tomorrow. I went through all my notes and consolidated it and circled

			and highlighted things that were really important.”
		Reviewing records	“...my human factors class is learning laws and learning what works and what doesn't work. That's essentially kind of memorization. You have to see the examples and then know what they are.”
		Seeking social assistance	“I'm not afraid to ask the professor because they were in my shoes too.”
		Self-evaluating	“For me, I have to write it down because that's how I learned how to take notes and that's how I remember better.”
		Structuring environment	“I go to class, whether it's an 8AM or a 4PM class. I'm going to get there. I mean, college isn't cheap so I'm going to go because I'm paying for this. I'll try to be a little pragmatic. Then, I sit down. I try to actively listen. I ask questions.”
Blake	3	Keeping records and monitoring	“Transcribing, writing a lot. Any class that I struggle in, which is basically any non-math class or incredibly heavy math class like statics and dynamics which I thought is great ... I write it.”
		Organizing and transforming	“Look at it as this is maybe something that I see as being kind of esoteric but how can I take this and apply it to other situations because we may actually have an entire field of study related to this.”
		Rehearsing and memorizing	“I was studying for an exam and I was going back through. I was transcribing. I read one of the lines out of the book that I could've sworn I read previously but it didn't click. You know, it's like the 3rd or 4th repetition through reading the book and just writing down or just annotating anything else.”
		Seeking information	For me, it's important to know where the answer is located or where I might find an answer to any question that might be asked ...”
		Seeking social assistance	I'll email teachers a lot and ask them questions...”
		Self-evaluating	“If I do fail, I feel like the easily most important thing for me is just learning why it happened because there may be ways that I can apply, you know ... A no gives you almost as much information as a yes in a lot of situations. You can take the same

			knowledge that you learned from a no and apply it in the future.”
Claire	1	Keeping records and monitoring	That's mostly what I do in lectures, just like listen and hear it from their way, write down anything that's important that's not on the slides and make sure that I'm not writing down the extra stuff that's just the fluff, I guess, of the lecture.
		Organizing and transforming	“Sometimes that’s not always an option and you need ot be able to teach yourself, just pick out what’s important from material.”
		Rehearsing and memorizing	“To remember a character, I'll just write it down like 20 times, and then you use it a lot in class or in the homework, it focuses on the new characters you're supposed to learn. So it's just repetition, basically.”
		Reviewing records	“Do all the homework, because the homework is only going to help you learn it. It’s basically a study tool to help you study for when you actually need to recall it.”
		Seeking social assistance	“I think always seek help. If not from a professor, but another student, just try and figure out how they're studying and see if you can mimic that.”
		Structuring environment	“I feel like the best way to learn at first is through the explanation of your professor... I think just through him lecturing is probably the best way to learn it.”
Daisy	2	Keeping records and monitoring	“I go to class and listen to lecture and write it down, and I think it gives me more than some people get from studying and not going to class...”
		Organizing and transforming	“I try to make a sheet...”
		Rehearsing and memorizing	“I like doing the problems, maybe over...”
		Reviewing records	“I want to have the sheet which looks really pretty and nice. You to look over it and understand it, have it written down”
		Seeking information	“...if I try to understand I will Google it and look at interesting sites of it.”
		Self-evaluating	“I use [a method] for homework or class or something. It it’s something very complex, you should do it, and then, yeah. For me, when I understand something, when I know

			how and why it works, I know that it works.”
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