

Engineering Student Motivation and Attitudes Towards Self-Regulated Learning

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Introduction and Background

This research seeks to understand the connections between aspects of time-oriented motivation and Self-Regulated Learning (SRL) strategies of students. The Future Time Perspective (FTP) of a student includes the future goals of that student and how those goals relate to his or her current learning behaviors, such as SRL or the ability to think motivationally, metacognitively, and behaviorally¹. This project will enhance completed and ongoing work to study attitudes and motivations of engineering students and their effect on student learning; our understanding of student learning will be extended to include SRL strategies. The goals of this project are to 1) qualitatively describe and document engineering students' SRL strategy use, 2) examine interactions between students' motivations, specifically their FTPs and SRL strategy use, and 3) study goal setting as a connection between FTP and SRL for the engineering undergraduate population.

The uniqueness and value of the project lies in its ability to provide evidence of connections between motivation and engineering students' SRL strategies, which up to this point have only been theorized or demonstrated through limited quantitative measures. This study is part of a larger project that focuses on identifying factors that contribute to students' motivation to pursue engineering, how motivational attributes correlate to learning and cognition in engineering, how motivational attributes change over time as knowledge, experience, and skills in one's field develop, and how attributes and their relationships to learning compare between the different engineering disciplines.

The focus of this paper is a sub-study within the larger, multi-phase mixed methods study² to specifically investigate the connections between Future Time Perspectives (FTP) and Self-Regulated Learning (SRL) strategies of second year engineering students with the following research questions guiding our work:

- RQ1: What SRL strategies do engineering students develop and utilize, specifically related to sub-goaling, at the task level?
- RQ2: What are the connections between students' motivational attributes and their adoption and use of SRL strategies, in particular sub-goaling, at the task level?
- RQ2.1: How do students' FTP attributes affect their adoption and use of SRL strategies?
- RQ2.2: How do the SRL strategies among different FTP types compare?

Executive Summary

Protocols for participant selection, data collection methods, and analysis were developed based on prior work³⁻⁵ and through consultation with experts in the field. The reflection questions to assess SRL strategy use throughout the semester was altered from a previous study assessing the SRL strategies in an Industrial Engineering course³. The interview protocol to examine students'

FTP was modified from a previous protocol used to analyze the connection between FTP and problem-solving, as well as other task-specific, current actions⁵. This protocol was first tested for validity, including a pilot study with four undergraduate engineering students⁴. A second interview protocol was developed to explore the connection between FTP and SRL, as a follow-up to the first interview. Underlying theory and the advice of experts were used to develop the questions, and the protocol was piloted with an engineering undergraduate for validity.

Students in one section of a Materials Science and Engineering (MSE) course were required to complete a survey about their motivation and attitudes (Motivation and Attitudes in Engineering (MAE)⁶⁻⁷) and to journal about their studying for three exams. Seven students from this population volunteered the following semester to retake the MAE survey and be interviewed using the first protocol. The new MAE survey results were used to analyze the current FTP of the students and compare them to the FTP revealed through the interview. This helped support validity of the MAE and to show quantitative changes of the FTP of the students in relation to time, semester, and course enrollment. Three of these seven students were selected for case analysis after analysis of their responses to the two MAE surveys and interview results for each student. These three case study students participated in a second interview.

The results of the MAE survey from the students in the MSE course (n=97) were combined with survey results from another IE course and were analyzed using two cluster analysis methods: k-means cluster analysis (partitional) and multiple hierarchical cluster analyses. Cluster analyses assisted in case study/participant selection as well as characterized the FTPs of the students enrolled in the MSE course. Students' FTPs were classified based on previous findings⁷ that conceptually represent three FTP types as different shapes of ice cream cones: Sugar, Waffle, and Cake. The Sugar category represents students with both a well-defined ideal and matching realistic future career. Sugar students are able to connect the future to present tasks and present tasks back to their future. Waffle students had conflicting ideal and realistic future careers. The Waffle FTP differs from the Sugar FTP in that the Waffle FTP does not have expressed outcomes from these desired future careers. Cake students had limited expressions of the future, either lacking a well-defined desired future career or with ideas about possible future careers but lacking a sense of which one they desire.

Analysis of the three case study students was conducted in Spring 2016. This included *a priori* coding of the journals from the Fall using an SRL framework⁸ and *a priori* and emergent coding of interview data using an adapted version of the FTP codebook from previous work by our group^{4,6}. New and adapted emergent codes related to FTP and connections between FTP and SRL were identified. These emergent codes pertained mainly to paths from the present to the future, for example contingent paths (adapted code; perceptions that success in the future depends on successfully completing intermediate steps)⁹⁻¹⁰, divergent paths (new code; multiple branches in a path to the future), and convergent paths (new code; paths to goals that were once split eventually converge to a single path towards a goal).

Summary of Major Findings

Our quantitative results (analysis of MAE survey data) revealed that survey constructs were heavily course dependent, in particular, perceived instrumentality items. We also found that the composite FTP survey scores for the three case study participants did not necessarily match the qualitative FTP the following semester. A clear shift had occurred for two of the three students from Fall to Spring semesters: one from Cake to Sugar, and the other from Waffle to Sugar. However, when analyzing the qualitative data and quantitative scores, it appeared that the Perceived Instrumentality of the MSE course, or how useful the students believed their MSE course to be for their future, in the Fall had a strong influence on the characterization of the students' FTP types. In the future we will develop more theoretical and FTP-type focused items, including depth of the FTP, time orientation of the FTP, etc. with less focus on the context. When context-specific items such as those related to perceived instrumentality are removed, a more accurate characterization of students' FTP type may be realized from quantitative data.

An additional outcome of the work is a novel research method for the study of how FTP is connected to SRL for engineering students. In particular, during the second interview, a card sort method was used to elicit a list of the student's goals, the order of these goals, goals related to SRL, and other aspects of FTP. Students and/or the interviewer(s) wrote on index cards all the goals that the student mentioned. The student was then instructed to organize the goals into a path. Additionally, the interview elicited strategies, often self-regulated, that the student used to obtain a goal based on the importance (on a scale of 1-10) of it to their distal future goal. These strategies, scores, and an estimates of time to obtain the goals were written on the cards. The cards and paths provided a rich data set for analysis of how student FTP type relates to strategies the student uses to reach goals.

Research to Practice: SRL Intervention

One key outcome from this project is the development of a SRL-focused workshop, which can be used for future student learning, faculty development, in-class SRL strategy development, or support for SRL data collection. This workshop mapped SRL strategies onto an existing and heavily-used strategy called the "Study Cycle"¹¹. To thoroughly understand the SRL use of engineering students, an intervention³ was created which enhanced the "Study Cycle" by introducing key pieces of SRL into a five step process: previewing before class, engaging in class, reviewing after class, holding study sessions, and supplementing their learning with resources. The "Study Cycle" was selected for the basis of the intervention as it is commonly utilized as a model for study strategies at through the university learning center, several other engineering-focused institutions,¹² and previous literature¹³. Additionally, it was a strong base of commonly used study skills, but was lacking in respect to SRL strategies. The "Study Cycle" was adapted to include all SRL themes from the SRLIS framework⁸ into a workshop-style intervention in order to increase the fluency of the students in regards to SRL for data collection.

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