AC 2011-1852: THE DIALECTICS OF GOAL SETTING AND MONITORING: TWO STUDENTS' EXPERIENCES WITH PORTFOLIO CONSTRUCTION

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The Dialectics of Goal Setting & Monitoring:
Two Students' Experiences with Portfolio Construction

Abstract

Goal theory explains the relationship between setting specific goals and the increased likelihood of achieving those goals, along with a mutually beneficial relationship with self-efficacy. When students enter an engineering program, they are often asked to declare a major; however, after this initial, long-term goal-setting experience, there is little room for students to engage in continual goal monitoring and refining. During a series of portfolio construction studios, it was determined that engineering students participated in the dynamic process of goal setting and monitoring as a result of portfolio construction.

While portfolios are often used as an assessment tool in educational practice, there are several learning outcomes that have been associated with portfolio construction that are less studied, such as goal setting and monitoring, intellectual development, and self-authorship. This paper presents two case studies that highlight goal setting and monitoring as an outcome of portfolio construction by engineering students in the context of a studio environment.

Introduction

In comparing what you have with what you want to have, whether it is something learned or a material product acquired, there is a mutually informative relationship between your reflections and actions taken toward achieving goals and the continued definition and re-definition of goals over time.[1-3] In this paper, we describe the relationship between goal setting and goal monitoring in its various instantiations as a dialectic; that is, an exchange of arguments and counter-arguments about students' goals and their progress toward achieving them.

Goal setting and monitoring are activities that can lead to increased levels of achievement, persistence, direction, and self-efficacy[2-4]; all are important in the field of engineering education as many students, especially underrepresented minorities, leave before reaching their goal of graduating with an engineering degree.[5] Because goal setting and monitoring involve reflection, both introspective and prospective, they can be difficult for engineering students to engage in since students are often uncomfortable with, and even resistant to, reflective activities. [6-8] However, we observed that students began to engage in goal setting and monitoring as natural by-products of the development of a professional portfolio. The professional portfolio is a demonstration of students' preparation for an engineering career, and thus requires students to reflect carefully on their professional goals in order to support their claim of progress toward those goals. In this paper, we will describe how the mutually informing processes of goal setting and monitoring unfolded in the experiences of two students—Jessica and Nolan—who developed professional portfolios over the course of three academic quarters.

This paper discusses how portfolio construction, as discussed by these students in qualitative interviews, facilitates a dialectic process of goal setting and monitoring in which the students were continually reflecting on their preparation level (i.e., what I have) in light of their professional goals (i.e., what I want). By studying these students' experiences as case studies, a

more in depth analysis of the complexities and dynamics of goal setting and monitoring was explored, leading to a deeper understanding of the processes. Through close inspection of these nuanced dynamics, the potential to better inform and support students in this difficult and often vague process was established.[9]

As these students' experiences were studied, the following questions emerged:

1. What was the nature of these engineering students' goals?
2. What was the process by which these goals evolve through portfolio construction?

In the following sections we provide a brief overview of goal theory as it relates to portfolio construction. We then describe our methods of gathering and analyzing data to elucidate the dialectical activities of goal setting and monitoring. The results highlight two students' experiences, as they described goal setting and monitoring in the context of portfolio construction. In the discussion and conclusion we offer explanations for the findings and discuss their implications as they answer the above two questions.

Background

Much research exists about how portfolios support assessment; however, little has been studied about the potential use of portfolio construction as a feedback mechanism for students, themselves, particularly as it relates to goal setting and monitoring. [10] In order to understand better the role of goal setting and monitoring within the portfolio studios, it is important to understand the context within which this study evolved. In the following sections, we describe common understandings and uses of portfolios; describe our own approach to portfolio construction (via portfolio studio); situate this approach within the backdrop of goal theory to provide a theoretical framework for our findings; explain the positive relationship between setting goals and self-efficacy; and conclude with issues related to goal setting and monitoring within engineering education.

Portfolios and their use in education

Historically in education, portfolios are used for various activities: assessment, learning, and preparedness to engage in a profession, and are often characterized as a purposeful compilation of one's work, typically in service of an implicit argument. [10-12] Another way of defining portfolios is as "an electronic collection of evidence that shows your learning journey over time." [11] In this work, students create an online portfolio in which they articulate their engineering preparedness.

While there is much room to categorize the uses and types of portfolios, a significant outcome of portfolio construction is the allowance for students to explore their previous experiences and engage in self-regulation and feedback. [10] As students examine and select work to be included in their portfolios, they can document non-traditional elements of learning, such as identity – a component of goal setting, in addition to more traditional elements, such as internships. [13] In the context of the portfolio studios, students are given the opportunity to develop and monitor their goals as they articulate their engineering preparedness in relation to their experiences.

The Portfolio Studios

Over the course of three sequential quarters, third and fourth year students from a range of engineering disciplines at a large engineering school participated in a series of portfolio studios. During the year, students created three portfolios (one per quarter); each portfolio articulated a different perspective on students' preparedness for an engineering career. The first portfolio studio involved students looking across their life experiences to support their claims of engineering preparation as they, themselves, defined it. For the second portfolio, students focused on the contributions of one course to their preparation; and for the third, students focused on one skill set or area of competence (e.g., communication, leadership). Each studio consisted of five, two-hour sessions in an academic quarter. There was a great deal of interaction in the sessions as students worked with their peers to develop their portfolios.

Goal theory as a framework

Goal theory provides a framework for understanding the ways in which goals are formed, and the likelihood of their attainment based on both personal and external factors. [3, 14] Since a goal is a "regulator of human action" that is self-determined or assigned, it is important that goals be specific rather than abstract visions. [3]

Often in engineering education, there are few opportunities for feedback in which goal monitoring can occur, particularly since professional goals are often distal and summative of a career, which can take years if not one's entire professional life to actualize. Therefore, it can be beneficial to set proximal goals that can work together to yield those more distant professional goals. [2] As we observed, the portfolio process enabled students to clarify their ultimate goal of becoming an engineer and develop strategic, specific intermediary goals for which they could more effectively monitor their progress.

According to Miner, goals positively influence performance in three main ways: (1) increase likelihood of accomplishment by energizing people to exert the effort necessary to do the tasks required to accomplish a goal; (2) encourage persistence of the task over time, and (3) provide focus, by directing attention toward goal-relevant activities rather than those unrelated to the goals at hand. [3] At the same time, a critical element that supports performance toward the goal is goal monitoring. As students developed their portfolios, the process of looking back on past experiences with an eye toward future, they engaged with their goals in these ways.

Goal monitoring is a process in which the progress of a previously set goal is assessed at multiple points along the goal trajectory. Feedback mechanisms are an important component of goal monitoring as they can help a person to gauge where they are, where they are going, and how their progress aligns with their ultimate goals. In the context of long term goals, feedback mechanisms are especially important as they are linked to the likelihood of achievement.[3] Feedback can help individuals determine areas where they need improvement, adjust their performance strategies, and monitor their overall progress toward a goal.[2] The peer review process in the portfolio studios serves as a feedback mechanism for students' goals. The

portfolios, themselves, help students to measure their progress against their own goals as well as against their peers' progress, which in turn impacts the types of goals they set.

Positive Relationship between Goals and Self-Efficacy

In engineering education, self-efficacy is important when considering issues of recruitment and persistence of students, especially underrepresented students.[15] Students with higher self-efficacy tend to have higher academic achievement, because they set higher goals.[14] Bandura defines self-efficacy as "the conviction that one can successfully execute the behavior required to produce the outcomes." [16] Relative to goal setting and monitoring, social learning theory articulates a causal relationship between self-efficacy and goals since "goals increase people's cognitive and affective reactions to performance outcomes as goals specify the requirements for personal success." [14]

Self-efficacy, along with other external factors such as peer groups and the extent to which a goal statement is made public, in turn affects the level of goal commitment. [2] Since failed goals decrease one's level of self-assuredness, persistence in attaining a goal is strongly correlated to maintaining one's self-efficacy.[14] Individuals with high self-efficacy tend to set higher, more difficult goals, and are "more committed to assigned goals, find and use better task strategies to attain the goals, and respond more positively to negative feedback than do people with low self-efficacy." [2, 16] Therefore, there is a mutually beneficial relationship between goal setting and monitoring and self-efficacy; self-efficacy influences the types of goals people set and increases goal commitment, while the accomplishment of goals has the ability to increase a person's self-efficacy. [2, 14, 16]

Issues related to goal setting and monitoring within Engineering Education

A challenge of goal setting discourse is the potential portrayal of goals as static, well-defined, and well-understood, which may be due to the lack of attention given to goal monitoring, which is equally important. To gain the full benefit of setting goals, it must be understood that goal setting and monitoring is a dynamic process that requires reflective practices to make sense of and make changes to goal trajectories. Reflection, or looking at experiences in order to understand what has been learned and how the experience contributes toward personal and professional goals, is known to have been particularly difficult to put into practice in engineering education as many students avoid reflective practices. [6, 7, 17-19]

Methods

In the context of a series of portfolio studios, we engaged engineering undergraduates in developing arguments about their engineering preparedness. Over the course of a three-quarter academic year, students developed three portfolios—life-wide (i.e., preparedness argument made from evidence drawn from one's entire life), course-based (i.e., preparedness argument made from evidence drawn from a specific course), and competency-based (i.e., preparedness argument made from evidence related to a particular competency). The students' efforts to construct each portfolio were supported through five, two-hour sessions in which students engaged in brainstorming, peer reviewing, and sharing. At the end of each portfolio construction

quarter, students were interviewed about their experience. While the interviews were the primary source of data, the portfolios that the students constructed serve as a backdrop for the analysis.

The professional portfolio is explained to the students as an opportunity to make an argument about their preparedness for a future in engineering practice. Within a studio setting, students are instructed to create portfolios consisting of a professional statement and annotated artifacts. The professional statement serves to describe the basics of their preparedness argument in a detailed essay, and the annotated artifacts, or products/by-products of formal and informal learning activities such as class assignments or extracurricular activities, act as supporting evidence to their engineering preparedness claims. The studio environment provides students with a collaborative environment with few constraints in which they can work in small groups, peer review each other's portfolio elements, and brainstorm upcoming elements over a consecutive amount of time. [13] A key feature of the activity studied in this paper was e portfolio studios is the opportunity to work with a small number of students throughout a year, as they engaged in three consecutive portfolio studios.

In this paper, we conducted case study analyses in which we compare and contrast the experiences of two students as they worked through the three consecutive portfolio studios. A key aspect of this paper was to explore the dialectics of goal setting and monitoring over time, so two case studies were the chosen method as they provide for a deeper understanding of the nuanced processes of the dynamics throughout the year. While case studies may not be generalizable of all students' experience, they may be transferable to other students' experience with portfolio construction.[20] The two students selected for the analysis are both underrepresented students (an African American male and a Caucasian female) who were in their senior year during participation in the studios. The students differ in that they came from different departments (i.e., Material Science & Engineering and Computer Science) and had identified different trajectories upon graduation (i.e., industry and travel). By focusing on these two students, a deeper understanding of the complexities and dynamics of goal setting and monitoring can be gleaned through a more holistic and in-depth study.[9]

Using constant comparison, the first two authors independently and collectively explored the data to find emergent themes related to goal setting and monitoring.[21] Then thematic analysis was used to understand the nature of the themes.[22] Focusing on two students' reflections on their experiences enabled us to gain a deeper understanding of how the processes of goal setting and monitoring unfolded in the context of the portfolio construction studios.[9]

Results: The dialectic of goal-setting and monitoring in the context of the portfolio studio

Nolan and Jessica both participated in all three portfolio studios, interacting with each other and other participants throughout the academic year. Both described goal setting and monitoring as a key aspect of portfolio construction. Over the course of the academic year, Nolan clarified his goals and found gaps in his experiences. Jessica recognized a potential conflict between her personal and professional goals, which she sought to reconcile. For both students, the construction and reconstruction of goals unfolded in the activities of individual reflection on their experiences, as well as in their interaction with each other.

In the following subsections, we describe these two students' reflections on their experience, focusing on the three goal setting and monitoring themes: (1) the dynamic nature of engineering students' goals, (2) instantiations of the dialectic of goal setting and monitoring, and (3) self-efficacy as an outcome of goal setting and monitoring.

The Dynamic Nature of Students' Goals

Both Nolan and Jessica explained a variety of goals—personal, academic, and career. These goals ranged from proximal (e.g., during the quarter) to more distant, and often less well-defined goals (e.g., long-term). Table 1 shows the goals Jessica and Nolan described, set, and monitored throughout the three quarters, and illustrates how their goals ranged from more specific, actionable goals to more abstract, visionary goals.

Table 1. A Summary of Students' Goals as Described in Longitudinal Interviews.

	Jessica	**Nolan**
Fall	• Help others with technology • Spend more time tutoring [a special needs child] • Live in Spain after graduation • Desire for more self-confidence in herself as an engineer/computer scientist	• Use engineering to benefit society • Use engineering to improve the medical field • Use engineering to improve home country in Africa • Gain more engineering experience
Winter	• Help others through technology • Obtain an industry internship • Create a personal website	• Use engineering to benefit society • Graduate from college • Develop more passion • Gain research experience • Gain industry experience
Spring	• Help others through technology • Obtain an industry internship • Travel independently • Engage in reflection more often	• Become more curious • Develop passion for his work • Gain real-world applications by finding a job in industry • Gain more work experience

Nolan discussed a variety of goals, focusing on career and personal goals. After graduation, he aspired to work in composites or biomaterials. In the first interview, Nolan described a desire to gain industry experience after earning his degree, and then return to school for a degree in a different field of engineering. He hoped this combination of knowledge from two engineering fields would enable him to be of greater service to his home country in Africa:

So my goal was to maybe like one day have like a firm where we can like -- sort of like Engineers Without Borders, but like my own firm and what we could do something like that, less privileged nations. So that's where my goal is.

Nolan's initial ambitious goal of using engineering to solve social problems was quite ill-defined. But as he continued through the three quarters, his goals became more specific and actionable over time.

Throughout the year, Jessica also emphasized a strong desire to use technology to help others. Her identity appeared strongly linked to her ability to accomplish this goal. In the first interview, Jessica described the dissonance between her perception of the work of most computer engineers and her goal to be of service to others. For example, she has no desire to do the "typical" non-stop coding, and as she seeks jobs and internships she's strongly inclined to work at companies that truly help others:

> You know…I feel like there are certain people in the major who just they love to code and they'll just–like…my boyfriend will like think of something that he-- like he wanted to like make a program that could solve a Rubics cube, and he spent hours and hours and hours and hours just sitting and working on it. Like I would never choose to do that….unless *it* [coding] was very relevant to helping someone, if I -- I don't think that I would ever just like sit down with a random puzzle and try to code it, you know.

Throughout all three quarters, she continued to emphasize a strong desire to help others through technology. At the same time, she developed more specific, actionable goals and continued to reflect on her struggle to find common ground between her professional and personal goals.

Instantiations of the Dialects of Goal Setting and Monitoring

In the portfolio studio, both Nolan and Jessica revisited their goals over time as they reflected on their past experiences in light of articulating their engineering preparedness. In many ways, this process of reflection can be seen as a dialectic or presentation of arguments and counter-arguments resulting in changes either to goals themselves or to reflections on and actions planned for achieving those goals. In the dialectics of goal setting and monitoring these two students engaged with issues of experience versus goals; internal versus external goals; specific, near-term versus abstract, long-term goals; and peer feedback.

Experience vs. goals as dialectic. The process of reflecting on experience in light of one's professional goals sometimes led to the recognition of the inadequacy of those experiences for fully achieving those goals. For Nolan, this dissonance led to both clarification of his goals and clarification of his plans for achieving the more specific goals. Over the course of the academic year, Nolan came to realize that the sum of his experiences had not yet prepared him to be an engineer. Reflecting on his first portfolio studio, he said he was surprised to find that he did not have enough evidence to support his engineering preparedness claims.

> I'd say most surprising thing was, um, I guess the -- I really had a problem with the artifact section of the portfolio. I mean I felt like I had a lot of experiences,

even as an undergraduate student and internship experiences and life experiences, but I didn't really feel like I was able to support my claims, so to speak…

Nolan compared his own work products to those that other students in the studio considered incorporating into their portfolios. In particular, Nolan compared himself to Jessica, noting that she appeared to have more specific experience to demonstrate her progress toward her goals. As a result, Nolan added conducting engineering research. By the end of the winter quarter, he had secured a research internship. In this way, Nolan transformed his more abstract long-term goal of gaining experience into an achievable action item.

Internal vs. External goals as dialectic. Sometimes the processes of goal setting and monitoring can lead one to identify potential incompatibilities between professional and personal goals, and what one "wants" to do versus what one "should" do. Jessica perceived a conflict between what she wanted to do and what she felt she "should" do. She felt that engineering, as she understood it, required certain accomplishments that stood in contrast to her more passionate desire to help others.

Throughout the first quarter, Jessica dealt with issues of aligning experiences with desired outcomes. She saw a disconnect between current experiences (e.g., experiences documented in the portfolio) and intended outcomes. For example, she said:

> I guess it's surprising, like the inconsistency sometimes between what I say is important on paper and then my actions, like I feel like when I think about what I want to do, it's not go work at Amazon and sit at a desk for eight hours a day, but yet I'm like looking for internships in industry, and I -- I don't know, there's kind of this mismatch between like what I think that I really want to do and like the kinds of things I feel like I should be doing.

She emphasized the pressure she felt to engage in certain computer science experiences as she believed they would support her claim to be prepared for a computer science career. However, often these experiences contradicted her desire to help others through technology:

> I feel like I should be having experience in industry, where I am forced to like be very technical, where I'm coding a lot and where I'm like learning new languages and learning new -- like increasing my skill set, you know. But what I feel like my portfolio emphasizes is like I'm not as interested in that… I feel like I'm more interested in using technology as a way of helping people.

This internal struggle led Jessica to consider changes to her goals, but also led her to think more about her confidence in herself as she grew to recognize just how influential others were on her own choices.

Specific, near-term goals vs. abstract, long-term goals as dialectic. Portfolio construction encouraged Jessica and Nolan to recognize and remember the bigger picture. For example, they both described a growing realization of how a particular engineering course helped them toward the accomplishment of larger, often abstract goals. The relationship between specific, near-term

goals and abstract, long-terms goals became increasingly clear as these students moved from abstract to the specific in their narratives.

When asked what his chief take-aways were from the competency-based portfolio, Nolan indicated that being able to "focus in on one competency that I never really thought I had" was very important, especially within the context of employability. Before the portfolio process, Nolan was unaware of his personal, unique contributions to engineering, but after he was given time and space to reflect and in conjunction with talking with peers, Nolan discovered that he had a tremendous affinity towards leadership positions, which he hadn't realized before. Nolan was able to concretize his various life experiences into an attractive, employable skill that he could market to engineering firms after graduation.

For example, Nolan described being captain of the soccer team in high school and how he taught younger children to play soccer for his (high school) senior service project. He had not recognized these activities as preparatory for leadership in the context of engineering. "I didn't think of it as like a leadership. I just thought of it as something I'm enjoying." Through reflection on these and other experiences, Nolan was able to monitor his acquisition of leadership, which he described as an important engineering competency.

On the other hand, Nolan also observed that as he "was envisioning being hired as an engineer," he struggled to actualize some skills that would make him attractive to an engineering firm. This occurred most notably in peer interaction with Jessica, as we will discuss in the next section on the dialectics of peer feedback.

For Jessica, when asked what was rewarding about the portfolio studio, she simply acknowledged the way in which portfolio construction influenced her goal setting and monitoring activities in that it has given her "direction"—"I feel like it was rewarding to have the opportunity to sit down and solidify what -- what is important to me and just to think about that." Through reflecting on past experiences and gaining understanding of her future goals, she gained a better sense of direction and a more specific plan to accomplish her goals, "I mean it gave me a good opportunity to look and see like, okay, well, this is what I think is important, maybe I should be trying to follow that more closely."

At the same time, Jessica acknowledged that conditions of engineering education are not always favorable for ongoing goal setting and monitoring. For example, proximal goals like classes and grades, take priority over more distal, future goals:

> There's a lot of things…like reflection and taking care of yourself and, um, thinking about your future plans. Like…I need to have an internship and I need to think about what I'm going to do next year and stuff, but those things all get pushed to the back burner because I'm just trying to stay afloat with the stuff that I have to get done right now…It's really hard to like set aside time for those other things.

Peer feedback as dialectic. Additional "arguments" entered the goal setting and monitoring dialectic via peer feedback. Throughout the portfolio studios, Nolan and Jessica noted the

importance of peer review and collaboration during the portfolio construction process. During the studios, students were asked to give feedback on each other's portfolio. Nolan explained that this process of giving and receiving feedback helped him to monitor his goal of becoming an engineer, which was based on the responses he received from peers about his competencies and artifacts that he included in his portfolio. Through peer feedback, his opinion of himself as a leader and as an engineer was positively reinforced.

> I think getting a lot of feedback from my peers, probably one of the most rewarding aspects of it, people actually saying, oh, I like your artifact, I like the fact that, you know, you included a variety of leadership qualities or aspects, so that was actually rewarding.

He also described how peer interaction helped confirm his goal of becoming an engineer, which reignited his passion for returning to his home country and helping society. He explained how Jessica endorsed this humanitarian goal:

> Jessica…has a student she tutors, autistic student, and she was talking about how she wants to use computer science to, you know, help her out and things like that. So that made me feel -- I feel like there was someone else who had the exact same -- not the exact same major or anything like that, but she's also trying to be of benefit to someone else, and so if anything, this whole process has helped me back up that.

He also discussed how peer interaction helped motivate him to take action and put effort toward achieving his goals:

> Yeah. It actually allowed me to think of myself as -- I felt like I hadn't done -- I mean what [Jessica's] doing is pretty remarkable, and I just -- to me I was just like I have to put in more effort, so like those kind of -- more of like she inspired me to do more.

Jessica emphasized the importance of the peer review process, specifically the feedback that was exchanged between students, as they look at each others' work. She expressed the importance of peer review and gaining others' perspectives:

> You have that perspective of what other people did, and that's helpful when you sit down to work on yours again… yeah, that's what I would emphasize that, that like talking to someone else about what they did and how they did it, and having them look at yours and give you feedback is really helpful.

She went on to articulate how understanding other peoples' engineering competencies through ways in which they demonstrated their engineering preparedness engaged herself in this process. She explained how looking at others' approaches to the portfolio helped her to understand ways for personal improvement:

> I think that the most valuable thing is just seeing how other people like approach the same problem as you -- you know, like looking at how other people structured their portfolio so that you can, you know, make changes based on other ideas and stuff. And that's the whole thing that I'm talking about, like teamwork is better than individual work,

and so if you have everybody's brains all working and like everybody thought about it in a different way and then you can like see how everybody else has thought about it, that's valuable.

The peer feedback mechanism was not only a means toward developing and improving the professional portfolio, but it also provided additional points of reference–arguments–for Jessica and Nolan as they engaged in the dialectic of goal setting and monitoring.

Self-Efficacy and its Relationship with Goal Setting and Monitoring

Over the course of the three portfolio studios, Nolan and Jessica appeared to have developed greater self-efficacy. In the first interview, both indicated a longing for more self-confidence and an admiration for their peers who seemed to have that desirable level of self-efficacy. In the third and final interview, at the conclusion of the third quarter, they described how their self-efficacy had increased.

Self-efficacy was an outcome of goal setting and monitoring through portfolio studio involvement. For example, through participation, Nolan increasingly realized that he was on the right track towards becoming an engineer. Nolan felt that Material Science & Engineering students were perceived by other engineering students as those unable to get into the other, more selective engineering programs. Positive feedback in the portfolio studios from students in other engineering programs gave him a boost in self-confidence:

> Going into the College of Engineering, I've heard, you know, stereotypes about, oh, [Material Science & Engineering] MSE is just where those – those students who can't get into like mechanical or civil or aeronautical, and based on my, you know, my portfolios and hearing people talk about what they like and how they found like my professional statement pretty cool and interesting, um I definitely think it's been a positive thing for me.

Self-efficacy was also an input to goal setting and monitoring. After the first quarter, Jessica acknowledged her dependency on others' validation of her abilities; she recognized a need for more self-confidence. For example, she recognized others' influence on her decisions through portfolio construction, "I guess I learned something about trying to have more confidence in myself…I mean it shouldn't take someone telling me for me to know it." However, "I don't think I've really learned that." In the spring quarter, Jessica actively engaged in becoming more independent while working through difficult problems:

> And so me and my partner were working on a program in C, and it was a really hard project, and we were pretty close, but we had one main memory leak left, and she had to work on something else, and so I was like, okay, I'm just going to find it. And so I plugged in my iPod and I sat there, and I stared at it for like -- probably like two hours…And by the end of the time, I could explain to her exactly what was wrong and fix it, and I fixed it… I was really proud of not having to turn to someone else and that I got it all by myself.

Jessica's increasing self-confidence not only enabled her to work more independently on a particular task, but will also enable her to be more independent in her career choices.

Discussion

This paper addresses how two students' goals, as well as their plans and actions for achieving those goals, evolved over time while they engaged in portfolio studios. The processes of goal setting and monitoring are shown to be dialectic in character; that is, a positioning of arguments and counterarguments against each other about their preparation to be engineers. This argument they were having with themselves was instantiated in a number of ways.

First, positioning their relevant experiences against their goals could result in both changes in goals and changes in plans and actions for achieving those goals. Nolan was surprised to learn that his experiences in leadership outside engineering related activities contributed to his preparation as an engineer, thus reinforcing this goal. On the other hand, he found that his experiences were not quite adequate in supporting his argument, and he made plans and took action to close the gap.

Goal setting and monitoring in the portfolio studio also enabled students to look across their goals and determine if they complemented one another. Jessica had a chance to consider her personal and professional goals and saw a potential conflict. Rather than change her goals, she worked on her self-confidence, which she felt was a critical component in the achievement of those goals. It remains to be seen how Jessica will find a balance between her personal and professional goals and/or remake those goals to suit her needs better.

Many students have goals that are lofty but lacking in detail. Goal setting and monitoring in the portfolio studio enabled Nolan to clarify his goals and plan specific activities for achieving those more distal goals. Peer feedback introduced new perspectives into the individual processes of goal setting and monitoring. Comparing his accomplishments to Jessica's in part motivated Nolan to find and get a research internship. Jessica found that new ideas were helpful to her in clarifying her goals, also.

Finally, as described at the beginning of this paper, self-efficacy is associated with goal setting and monitoring in the literature. The portfolio process encouraged goal setting and monitoring and thus had the potential to improve students' self-efficacy. Nolan is a case in point; seeing just how much he had accomplished thus far helped him to better envision himself as able to accomplish his professional goals. Alternatively, self-efficacy can be shown to be an input to goal setting and monitoring. Recognizing in herself a lack of independence, Jessica took action to develop this quality.

Conclusion

There are a couple of implications for engineering educators. First, we ought to recognize that students' goals are often in a state of flux during their undergraduate education. As they navigate their engineering curricula, engage in our programs, and take part in extra-curricular activities while they prepare for their futures, students may change course. We already recognize this to

some degree, but we do not necessarily provide the time for students to engage in goal setting and monitoring. As a result, goals may not be well-defined and actionable as they have little time to reflect on their past in relation to their future aspirations. In allowing for time to process their goals, students may develop more specific goals, which will help students perform better and more intentionally.

Second, we ought to understand the relationship between self-efficacy and the processes of goal-setting and monitoring. Self-efficacy as an input to these processes can result in greater goals. As an outcome of these processes, it can help facilitate greater academic performance. Further, as students begin to monitor their goals more closely and begin to incorporate more specific, actionable goals, the likelihood of accomplishment increases, leading to higher self-efficacy. Therefore there is a positive feedback loop in which goal setting affects self-efficacy and self-efficacy in turn affects the types of goals that students create for themselves. By allowing students the opportunity to hone their goals during portfolio construction within studio sessions, they may be able to enter into this positive relationship, which may ultimately increase their career preparation.

Finally, we should embrace the notion that goal setting and monitoring can be complex and rich with conflict. This continued argument within students can be a difficult struggle for them, but it also can be a rewarding learning experience. By providing a safe environment for students to struggle through their previous experiences and future aspirations as they construct preparedness portfolios, students may develop a greater appreciation for reflective practices, a habit of continuously monitoring and setting their goals, and an increased level of self-efficacy.

Acknowledgements

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