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First-Year Engineering Students' Quantification of "Self" in the Self-Regulation of their Learning

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Introduction & Background

First-year engineering programs are an increasingly popular inclusion into 4-year engineering bachelor's degree curricula and have become an important touch point for students to get acquainted with the field of engineering and the foundational skills necessary to be successful in the engineering program/degree of their choosing. Topics most frequently covered in this first year that are widely considered foundational skills for any engineering discipline that students may matriculate into include: problem-solving, teamwork, technical communication, programming, computer-aided design, the engineering design process [1], [2], [3]. Additionally, some programs and institutions have started incorporating the practice and development of professional skills into their first-year engineering courses and projects to better prepare students for entering the professional workplace as they seek out internships and co-op experiences in their second and third years (e.g., [4], [5]).

While a primary purpose of first-year engineering programs is to aid in preparing students for successful transitions into their specific engineering disciplinary classes with foundational engineering skill sets and knowledge, first-year engineering courses are also well-positioned to aid in students transitions between two starkly different educational contexts: high school to college. The transition from high school to the first year of college in an engineering program can be difficult for new students as they learn to navigate college and find success in the difficult math and science courses they must take [6]. Oftentimes students enrolled in engineering programs have been labeled as academically advanced or accelerated in their previous educational contexts and experiences and thus hold an identity as an academic high achiever [7]. Many academically successful high school students enter college and are surprised to learn that their previous strategies for achieving academic success are no longer effective in this new academic context [7]. When engineering students encounter academic challenges in college and receive lower grades than what they were used to receiving in their previous academic context, they sometimes experience stress or frustration, weak engineering identities, low self-efficacy, and some respond to this by leaving engineering programs entirely [8], [9], [10], [11].

Self-regulated learning (SRL) skills, habits, and behaviors have been shown to be related to academic performance and outcomes of students [12]. Self-regulated learning is a theory most popularly associated with educational psychologist Barry Zimmerman but was originally described by educational psychologist Paul Pintrich [13]. Since the early 2000s there have been many adaptations of self-regulated learning frameworks for various disciplinary or educational contexts, but Zimmerman's model describes the self-regulation of one's own learning to be a continuous cycle between three phases: forethought through task analysis and self-motivation, performance through self-control and self-observation, and reflection through self-judgment and self-reaction [14]. Students who develop better SRL skills can better adapt to college, especially in courses based on calculation skills [15]. However, if students are left to develop SRL skills on

their own, they very often fail to develop these skills in a timely manner enough so to avoid academic peril [16].

First-year engineering courses are well-positioned in the curriculum sequence to aid in students' adjustment to college learning and the early development of their SRL skills to avoid negative academic consequences. The work reported in this paper seeks to take the first steps in exploring students' perceptions of the transition from high school to college through the lens of SRL at a high level. Specifically, we will answer the research questions:

> Q1: What are first-year engineering students' reported levels of responsibility for regulating their own learning in upper-level high school courses compared to their teacher?
>
> Q2: What are first-year engineering students' reported levels of responsibility for regulating their own learning in college courses compared to their professor?
>
> Q3: How much do first-year engineering students' reported levels of responsibility for regulating their own learning change from high school to college?

Research Context: First-Year General Engineering Course & Advising

This work was situated within a first-year general engineering program at a large, public, land-grant university in the Southeastern United States. This first-year program can be completed by students in one of two ways: 1) as a 4-credit hour one-semester course (if specific pre-requisite credits are transferred in) or 2) as two 2-credit hours courses in a specific sequence. The data in this paper was collected only from the 4-credit hour one-semester course. While first-year program courses can cover some "college-readiness" and "student success" strategies – dependent on professor – this content is more often and consistently delivered to students in the program from the academic advising unit.

All first-year general engineering students are assigned one of ten professional academic advisors who specialize in secondary-to-post-secondary transitions, consistent with a total intake advising model [17]. The responsibilities of these advisors include orientation, academic planning, connecting students with academic and well-being support resources, assisting with the development of academic success skills, and guiding major and career exploration. While students have ready access to their respective assigned advisors through either appointments or rapid-turnaround email correspondence, no students are required to meet with their advisors at any point in their first semester. While academic advisors engage in systematic outreach to their assigned students, it is the responsibility of the students themselves to reach out to advisors for individual assistance. The academic advising team is embedded within the same department as the instructors of the first-year general engineering course, allowing for collaboration and integration of actions.

One manifestation of instructor-advisor collaboration is the semesterly visit of academic advisors to the first-year general engineering course to lead discussions about major and career exploration and academic planning. During this visit, an academic advisor takes over the class with a presentation or set of activities to introduce students to available career and major exploration tools and to contextualize the role of academic planning in the major selection process. For the accelerated version of the course in which major exploration is less emphasized, the academic advisor shifts the conversation more towards academic success skills for advanced courses in the middle years of engineering – those typically associated with a sophomore slump [18] – and experiential learning opportunities such as internships and study abroad. It was during this presentation that the data were collected for this study.

Methods

Data Collection

Data collection was done by administering a survey in the advising session of approximately 7 different first-year general engineering course to prime the ~350 students enrolled in these sections for the portion of the guest lesson and discussion with an advisor that covered study skills, strategies, time management, and help and resource seeking. These sessions occurred between weeks 3 and 5 of the Fall 2024 semester. Students were given the following prompting text:

> "Consider your entire educational journey - past, present, and future. Who has been / will be in charge of or responsible for your learning at each of these stages of your educational journey? When you were in Preschool - you were 0% in charge of your learning! Teachers set up activities, puzzles, games, and songs for you. You did all of these fun things and likely didn't have a clue you were learning. But your teachers knew what they were doing and designed all of it for your learning, growth, and development. They were 100% in charge of making sure you learned what you needed to. After you have finished all of your formal education - you are 100% in charge of your learning! If you want to learn something new it is completely your responsibility to seek out resources, determine their reliability / validity / accuracy, and put in the time and practice necessary to learn something new. No one else is going to make you learn or hold take every single step with you along the way. These are the two extreme ends of the spectrum on your educational journey. Let's look at and consider some middle points..."

Students were then asked to complete a survey that included the following four questions that only allowed whole integer responses using a numeric slide bar from 0 to 100:

Table 1: Prompts and questions provided on survey used to prime students for a lesson and discussion on study skills, strategies, time management, and help and resource seeking.

Prompt 1	Consider your ***late high school classes (Junior and Senior year)***. What portion of the responsibility for your learning do you believe belonged to your teachers? What portions of the responsibility for your learning do you believe belonged to you? Use the slider bars below to indicate each responsibility portion out of 100% (the total of your two slides should equal 100%)
Q1	Teacher Responsibility Portion %
Q2	Your Own Responsibility Portion %
Prompt 2	Consider your ***college classes (in your first year at [University Blinded for Review])***. What portion of the responsibility for your learning do you believe belongs to your professors? What portions of the responsibility for your learning do you believe belongs to you? Use the slider bars below to indicate each responsibility portion out of 100% (the total of your two slides should equal 100%)
Q3	Teacher Responsibility Portion %
Q4	Your Own Responsibility Portion %

Data Analysis

Once the data were collected, the responses to the four questions were cleaned. Specifically, we only considered the responses where the sum of responsibility between participants and their teacher/professors was between 85% and 115%. This range was collected because although ideally the sums would all be 100%, some participants may have incorrectly calculated the total in a rush to finish this survey in the time given or even decided that some of the responsibility was shared. However, because this study examined the responsibility of each group separately, any responses where the sum did not fall within this range was not considered. Additionally, if a participant responded about just one scenario (high school or college), their responses were only considered for the question they answered. In total, 273 participants responded with weights in these ranges for high school students, 270 participants responded with weights for college students, and 259 participants responded with weights for both.

Once the final subset of data was prepared, we calculated summary statistics (including mean, mode, min, max, and standard deviation) of each data set (including the student's and teacher's responsibility in high school and the student's and professor's responsibility in college). We decided to represent the data as the difference between the two scores, such that a positive number represented how much more a survey response indicated that the student is responsible for the regulation and facilitation of student learning, a negative number represented how much a survey response indicated more the teacher/professor is responsible for the regulation and facilitation of student learning, and a zero represented that they had the same responsibility. We also decided to examine the change in student responsibility and teacher/professor responsibility between high school and college, so we calculated the change, where a positive number represented that a survey response indicated that the student or teacher/professor became more responsible. The summary statistics were also calculated for these values, and histograms of each of the distributions were plotted.

Limitations

One limitation of this work as it was designed is that this survey was presented only to students enrolled in the one-semester 4-credit hour course, the vast majority of whom already have prior experience with more academically independent course work through AP course, dual enrollment programs, International Baccalaureate, etc., experiences. and therefore, may be more aware of the personal responsibility for learning in these course contexts in comparison to high-school level courses. While previous research has indicated that students in these sections on average do not self-report having more advanced self-regulated learning skills of habits than their peers in the standard two-semester course sequence [19], their prior college-level course work may have primed them to be more aware of the increased personal responsibility for learning in college-level course contexts more so than their peers with no experience in AP or college-level courses prior to arriving to their first semester at University.

Additionally, we specifically asked students to share what they believe the percentages of shared responsibility were (in upper-level high school course) and are (in college course). This student population comes from a wide variety of high school experiences that span public, private, rural, urban, large, small, and international experiences – no other data about high school context were collected so we could not control for specific contexts or the influence those contexts might have had on how much responsibility for learning students assigned to themselves or teachers based on aspects of their high school experience that likely influenced their interpretation of and answer to this question. Along the same lines, students are all enrolled at the same university and also share many common courses, so their perceptions and therefore responses are likely to be more aligned in the college context questions.

Results

Table 2 shows the summary statistics for the data described in the previous section. Considering how participants weighed the percentage or responsibilities in high school, there was a nearly even split between the students and the teacher. On average, the participants thought the students were slightly more responsible for their learning, however the difference was small (about 2.5%). This result shows that they believed there was an equal responsibility by both parties.

Table 2: Summary descriptive statistics for student responses to Q1-Q4 and key differences between various combinations of Q1 through Q4.

	HS Self	HS Teacher	HS Difference	College Self	College Professor	College Difference	Δ Student	Δ Teacher
Mean	51.4%	48.9%	2.5%	74.8%	25.5%	49.4%	22.6%	-22.6%
Mode	50%	50%	0%	80%	20%	60%	20%	-20%
Min	0%	0%	-100%	30%	0%	-40%	-25%	-80%
Max	100%	100%	100%	100%	70%	100%	80%	25%
Std Dev	20.2%	20.1%	40.3%	14.2%	14.0%	28.1%	15.0%	15.1%

Figure 1 shows the histogram of the student responsibility weights. The distribution seems to be centered near 50%, and while the weights do spread out with a relatively large standard deviation of 20%, the data appears roughly symmetric with approximately the same number of students weighing HS students' responsibility above and below 50%. Because this distribution is centered near 50% and most participant responses summed to 100%, the histogram of the teacher responsibilities would be nearly the same except flipped across the 50% center. Interestingly, responses spanned the entire possible range, as some participants believed 100% of the responsibility fell to them as the students, and some that believed 0% fell to them as the students.

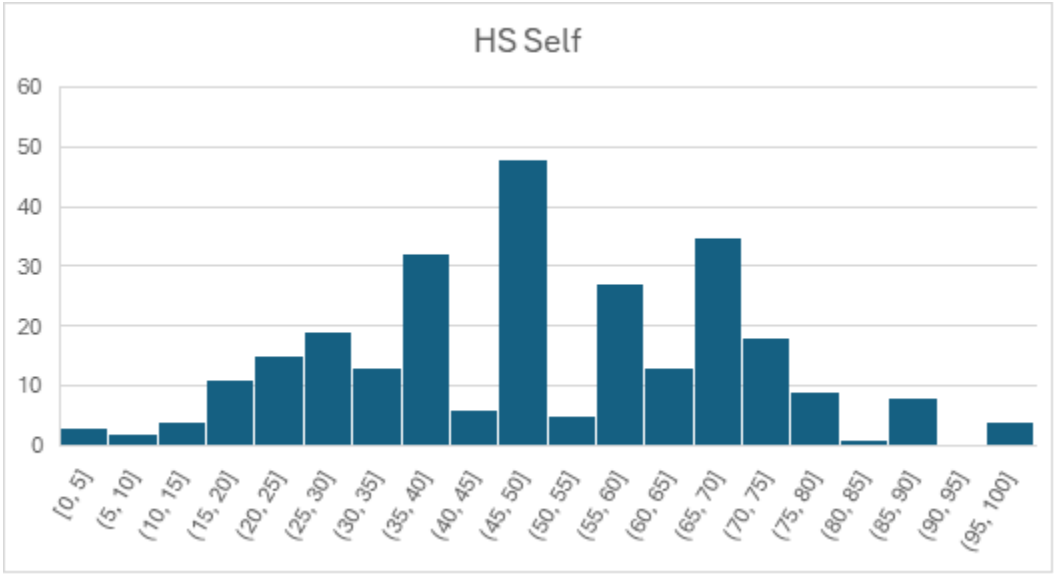

Figure 1: Distribution of responses indicating the % of responsibility for student learning that students hold in Junior & Senior-level high school courses.

For the responses that reflected the % responsibility students felt they had for their own learning as college students, there was an increased weighting in the direction of students being responsible for their learning, with an average of about 75% of the responsibility belonging to them and only 25% of the responsibility belonging to their professor. These results show that the participants typically believed that they were more responsible for their learning in college than their professors. Figure 2 shows the histogram of weights of student responsibility in college, showing a center near 75% and most of the responses above 65%.

It can also be seen that the standard deviation of these responses is smaller than the HS responses, with a standard deviation between responses of only about 14%. This indicates generally more alignment amongst respondents when they consider their college context compared to the late high school context.

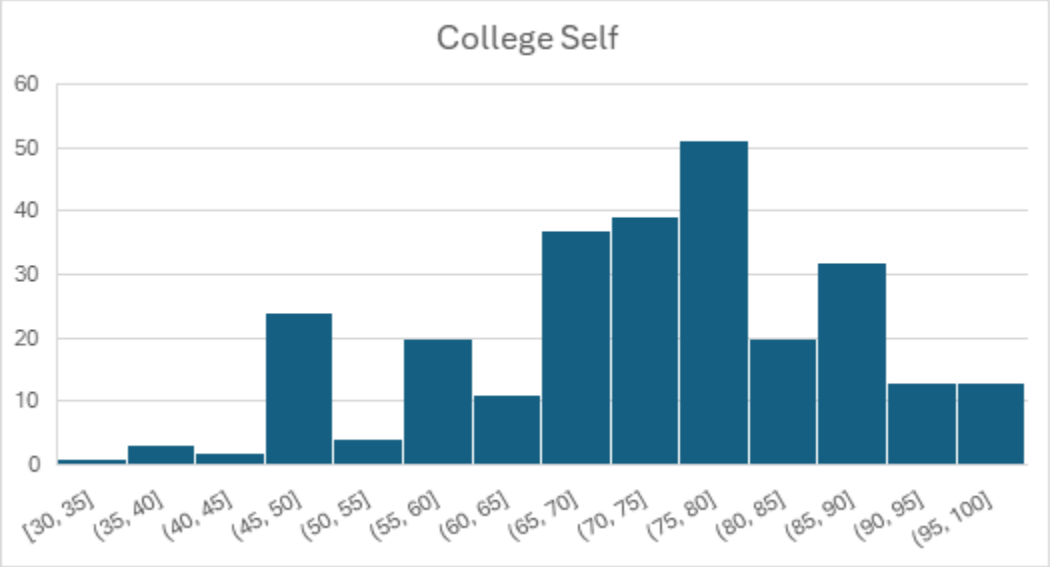

Figure 2: Distribution of responses indicating the % of responsibility for student learning that students hold in college courses.

Table 2 also showed the changes (or delta) of responses for participants that reasonably answered both prompts. This table shows that participants believed on average the responsibility of students increased by around 23% when moving from high school to college. This result matches the trend we see in the histograms where the center of the data shifted from about 50% to about 75%. Figure 3 shows the distribution of weights for this change.

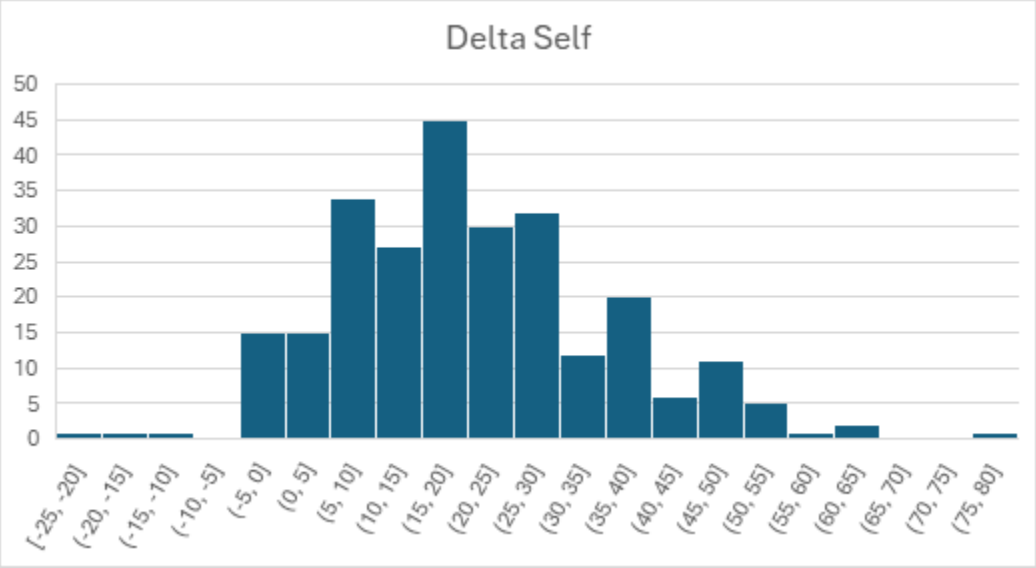

Figure 3: Distribution of calculated differences in % of students' responsibility for learning moving from HS to college classes by participants with responses to both questions

Notably, not every participant agreed that the responsibility of students increases when in college. While the vast majority of respondents indicated a positive increase in students' responsibility for learning, a few (18) did indicate they felt it stayed the same or decreased when moving from a high school learning context to a college learning context.

Discussion

These results indicated while there is a strong majority consensus that students are required to take on more responsibility for their own learning as they move from a high school to college educational context, there is a relatively high amount of variation in how much responsibility for their own learning students believe they have in the two contexts, and how much that responsibility increases when the leave high school and come to college.

First, consider the reported % of responsibility for learning in just the upper-level high school courses. While the mean and mode of student responsibility for their own learning in upper-level high school courses stayed centered at ~50%, the standard deviation was 20% and the distribution was symmetric. With just over 50 respondents answering in the "45-55%" range, that leaves ~220 responses left that are relatively split between whether students have more or less responsibility to ensure they are learning compared to the HS teacher, and responses ranged from 0% to 100%. In our sample of 270 engineering students – which research has shown to be students who are identified in formal education systems as gifted, accelerated, and/or smart [7] - there were students who believed in HS they took little or no responsibility for their learning (3 students in the 0-5% range), students who believed they were entirely responsible for their learning (4 students in the 95-100% range), and nearly every variation of distribution in between.

Consider for a moment being in the shoes of a high school educator of junior and senior level students and the range of expectations placed upon you by students with regards to your role in the classroom and their learning. While public schools have been struggling and grappling with the challenges and implications of differentiating instructional strategies based on ability to improve student performance [20], [21], our results indicate evidence of students' views toward the roles and responsibilities of the teacher in their high school classrooms varies significantly as well. This finding creates an additional layer of challenge for high school educators who are working to motivate and engage students while also teaching and promoting learning.

The results also show a similar challenge for faculty, particularly of first-year students who are in the process of transitioning from a high school teaching and learning context to that of a college teaching and learning context. While the range and standard deviation for % of responsibility of faculty for students' learning reported by students is narrower and smaller, respectively, there is still wide variation, and therefore likely a wide range of expectations that students have for faculty members who teach their classes. Early and often transparency with first-year students related to what they are responsible for and what faculty and advisors are responsible for may be one way to manage students' expectations and encourage them to take steps to regulate their own learning. Many students may come from environments in which guided notes or study guides are provided by all teachers, or forms are completed for them by a parent, guardian, or advisor. Clear communication of roles and responsibilities can be one way in which students can navigate discerning what their increased responsibilities for their own learning might be in a college classroom context or in an advisor-advisee relationship.

The difference – or delta – calculated for each survey respondent is also insightful and has significant implications, particularly for anyone who works closely with first-year college students. We found that the "jump" in how much responsibility students report belonging to them is sizable – with a mode of 20% and a mean of ~23%. Consider a person's journey through education and their percentage of responsibility for their learning at each point in that journey. At pre-school and kindergarten levels we have 0% responsibility for our own learning, and as we move through our education, mature, and gain knowledge and experience responsibility for our learning and development as a person incrementally shifts away from others and toward ourselves. While there are no definite "correct" answers to what percentage of responsibility students should take of their own learning at any given educational step, let us hypothetically say these students are correct with a 50-50 estimate in their upper-level high school courses. We can agree that as students advance through their education, they gain more responsibility for their own learning. For simplicity of this example, we can conceptualize a constant rate of progressively increasing responsibility – this would mean every year students advance through school, they incrementally gain about 4.2% between kindergarten to senior year of high school. This number likely isn't consistent each year, assuming smaller jumps through elementary school and larger jumps when transitioning across traditionally grouped education levels (i.e., elementary to middle school, middle school to high school), but it is likely that incremental changes are on the smaller side.

The students who took this survey – who are all likely considered "high-achieving" students by most academic standards as they all brought at least 8 college credits into their first semester at a four-year institution – reported believing the transition from high school to college involved an average 22% increase in students' responsibility for their own learning. Considering the scenario presented in the previous paragraph, this would theoretically being the largest jump most students ever experience in their educational journey – significantly larger than the incremental increases as students move through grade levels in their K-12 experiences. The ~20% increase in students' responsibility for their own learning is a number based on averages, a small data set of historically strong academic students. There is a likelihood that that this number is realistically much larger for many students depending on their prior educational experiences or opportunities.

It is well documented in both engineering education literature and higher education and student affairs literature that many first-year college students struggle to transition from high school to college with regards to their academic performance. While many factors contribute to these challenges in this transition (e.g., increased course content difficulty, faster course pacing, increased distractions, and changes in personal autonomy, etc.), it is possible the rapid increase in responsibility for one's own learning plays a significant role in academic challenges as well. Students may be unaware of how much additional responsibility for their own learning they gain in a college educational context. Not knowing or acknowledging your own level of responsibility or control over your learning in academic contexts can result in lower academic outcomes. Perry et al. reported that students with higher (relative to lower) perceptions of control obtained better course grades, reported higher levels or motivation, and also put in more effort [22]. Similarly, Stupnisky et al. found in a research study of first-year college students that perceived control was a stronger predictor of academic success than self-efficacy [23].

Even if students are aware that additional control and responsibility for their own learning will increase and by a larger amount than they have yet to experience when entering this new educational context, many students find themselves unprepared or ill-equipped to successfully regulate their own learning. Saundra McGuire in her book "Teach Students How to Learn" explains that oftentimes the students who college faculty teach in our courses are students who were academically successful in high school. However, the habits students develop to be successful in high school (not needing to study, the use of teacher provided study guides, cramming, rapid memorization and immediate recall, etc.) are not habits that promote learning or strong self-regulation of one's own learning, but they are the habits that students associate with academic success, so when student arrive at college they use those same strategies only to find they are ineffective [7].

Implications for Practice & Future Work

McGuire notes in her book that students are not likely to integrate good self-regulated learning practices and study strategies by just faculty or advisor advice alone, but are most receptive to these strategies when they are disappointed or upset by what they consider to be a poor academic

performance [7] – or in other words, when their old "shortcut" ways of being academically successful didn't work.

Unfortunately, in the scenario described above, students often must have a poor academic performance (or many poor academic performances) until they are open to adopting new practices or strategies. Depending on the severity of these poor academic performances and the assessment structures of their courses, e.g., reliance on high stakes testing, the outcomes may have serious implications on students' course grades, GPA, scholarships, enrollment, etc. Raising awareness of the magnitude of this "delta" could increase students' openness to integrating strong self-regulated learning practices into their study patterns that had previously been unused or deemed unnecessary by them in a high school context. By pointing out to students that 1) they have never traveled so far, so fast with regards to taking on responsibility for their own learning, and 2) they are likely in uncharted territory in how to do so, they may be more receptive to learning about and attempting to use positive self-regulated learning strategies prior to experiencing instances of poor academic performance and suffering negative consequences [16].

While these findings are interesting, this was a limited sample in a very specific context. Our intention is to expand this line of inquiry beyond our own institution and beyond our own context in engineering to gain a broader understanding of this landscape and how to better support students in their transition across learning contexts and their individual development of the self-regulation of their learning. We hope to pursue funding that would facilitate a larger, national sample and include faculty and teacher responses as well to acknowledge two dichotomies of the two perspectives and identifying any large responsibility "gaps" or misalignments between learners and teachers in educational contexts by gathering perspectives on levels of responsibility from both sides of the educational relationship.

Conclusion

First-year engineering programs play a crucial role in helping students transition from high school to college and into their chosen engineering disciplines. These programs cover foundational engineering skills, and some have begun incorporating professional skills to prepare students for internships, co-ops, and future work experiences they may have after graduation. Given their position in a traditional four-year engineering curriculum, first-year engineering courses can also be utilized to support students in developing self-regulated learning (SRL) skills, which are essential for academic success in college-level courses where more self-guided and independent learning is required. This paper explores students' perceptions of the transitions from high school to college through the lens of how much responsibility students feel they have in regulating their learning in each context. The results indicate that students have a wide range of perceptions with regards to how much responsibility they possess in facilitating and regulating their own learning in a high school setting but generally agree that when transitioning to a college setting the amount of responsibility students have increases. The average increase in the % of responsibility and regulation students have over their own learning from high school to

college was about 22%. These results give first-year engineering educators such as faculty and advisors a helpful tool in having conversations with students about navigating the abrupt academic transition from high school to college, encourage the early adoption of practices and habits associated with good SRL strategies.

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