Measuring the Relationship Between Self-Efficacy Beliefs and Performance Attainments of First Year Engineering Students in the Programming Course

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December 7, 2023

Abstract
This article targets first-year engineering students' self-efficacy beliefs and their relationship with performance attainments in the first half of the semester and the final grade of the programming course. Self-efficacy is the belief in one’s capabilities to reach a desired goal or outcome by setting and implementing the required courses of action. In education, self-efficacy is crucial to academic growth, for it helps students take charge of their own learning, develop their skills, set goals, and regulate their motivation in order to accomplish these goals. Considering the difficulty of the programming course, self-efficacy plays a vital role in the challenges the students face in the programming course, their magnitude, and the skills the students use to overcome them. Self-efficacy beliefs were measured through a survey administered twice to 118 engineering students in the first half of the semester and correlated with the first quiz of the semester and the midterm grade, then with the final grade. The analyses targeted all engineering students, then each engineering major separately: Computer, Electrical, Mechatronics, Mechanical, and Industrial engineering. The results showed that there is in fact a relationship between students’ self-efficacy beliefs and performance in the programming course. However, the relationship was shown to be inverse in the first half of the semester but positive with the final grade. These findings highlight the importance of student efficacy beliefs especially in the first half of the semester while also presenting new empirical findings regarding each engineering major targeted.
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Index Terms—Self-efficacy, Programming course, Engineering students, Computer Engineering (COE), Electrical Engineering (ELE), Mechatronics Engineering (MCE), Mechanical Engineering (MEE), Industrial Engineering (INE).

I. INTRODUCTION

Programming is a course that has been gaining more and more value for engineering schools as a response to 21st century market needs. Students in programming do not merely learn academic concepts but acquire reasoning, sequential reasoning, critical thinking, and problem-solving skills. In addition to being vital, programming has also the reputation of being a very difficult course initially because first-year students are unfamiliar with university experiences, and more importantly, most of them have never been exposed to programming material [1]. [2]. Kanaparan et al., [3] argued that the high failure rates in the programming course are caused by two factors: difficulty of the cognitive requirements of the course, and the behavior of the students in terms of engagement and self-efficacy. Though the difficulty of the programming course content and its cognitive requirements are not within the control of the students, self-efficacy beliefs are. Self-efficacy plays a vital role in the challenges the students face in the programming course, their magnitude, and the skills the students use to overcome them [4]. Self-efficacy is a person’s belief in their ability to accomplish a certain task and thus is crucial to academic growth for it helps students take charge of their own learning, develop their skills, set goals, and regulate their motivation in order to accomplish these goals [5]. In fact, student self-efficacy beliefs and their academic performances are directly related; improving the first, will automatically improve the second [6].

Considering the need to further explore the challenges of the programming course from the perspective of students in terms of their beliefs in their abilities to overcome challenges, failures, stressful situations, and remain motivated, the current study focuses on self-efficacy beliefs in terms of cognitive, motivational, and affective processes [5] and their relationship with performance attainments of first-year engineering students in the programming course.

Previous research on self-efficacy in the programming mainly focused on factors affecting self-efficacy or considered self-efficacy as part of a construct or as a mediating factor to performance [7]–[11]. However, the current study considers self-efficacy beliefs as being the starting point and the origin of the internal processes that play a role in performance attainments in the programming course.

Furthermore, while efficacy beliefs and performance have been studied in different university majors, disciplines, and class standing, a study that targets efficacy beliefs and performance of first-year students from the five different engineering majors chosen, and especially in the programming course has not yet been found. Hence, the purpose of the current study is to explore the relationship between first-year engineering students’ self-efficacy beliefs and their...
performance attainments in the programming course, first for all engineering students, then for each of the five engineering majors targeted: Computer Engineering, Electrical, Mechatronics, and Industrial Engineering.

II. LITERATURE REVIEW

Self-efficacy is the belief in one’s capabilities to reach a desired goal or outcome by setting and implementing the required courses of action; it is the belief that people have control over events that influence their lives. People are motivated to accomplish certain goals only when they believe that they are able to implement the right courses of action to reach them [5]. Self-efficacy beliefs affect people’s thoughts as cognitive processes in terms of cognitive constructions and inferential thinking, motivation as motivational processes in terms of attribution theory, and emotional states as affective processes, as well as forethought, the perception of ability, and goal setting all of which affect their actions and subsequently performance attainments [5].

Perceived academic self-efficacy is a judgement of one’s capabilities to organize and execute courses of action to reach desired educational performance attainments [5], [12], [13]. In education self-efficacy is manifested through cognitive involvement in academic activities which influence motivation and achievements [13]. In order for students to appraise their self-efficacy, they evaluate the learning required, the skills and knowledge they need to possess, their existing knowledge, their previous experiences in learning, and the extent to which they can regulate their acquisition of new information [12]. Therefore, self-efficacy beliefs are to be measured and assessed before students take on new academic activities [13] especially because these beliefs are bound to change during and after academic performances [12].

On the other end of the spectrum, many situations cause discrepancies between self-efficacy beliefs and performance. The most frequent false judgement or optimistic judgment of self-efficacy stems from the person’s misunderstanding or underestimation of demands embedded in a certain task rather than their exaggerated appraisals of their capabilities. In some situations, self-appraisals of abilities are correct, but task demands are misjudged, while in other situations abilities are inflated but task demands are clear, and at times, both personal abilities are overestimated, and task demands are underestimated. Furthermore, faulty appraisals of efficacy occur when tasks require high cognitive skills [5]. Complex tasks that require complex cognitive performance are not always easily discerned by students especially because they are hidden in what appears to be simple tasks [14]. Even if tasks are deemed simple, when they demand more than one skill that may not be equally acquired, students are prone to base their efficacy appraisal on the skill they have mastered while neglecting the skill they have not entirely acquired and thus overestimate their abilities, or focus on the skill not yet mastered and underestimate their abilities [15]. Another reason for faulty self-appraisals of efficacy stems from ambiguities either of task demands or performance requirements rather than actual misjudgment of self-efficacy [5].

In the search for self-efficacy beliefs in first-year engineering students, programming was found to be one of the most challenging courses [2], [16] while also being a vital course for all engineering students. In the fast growing market and demand of today, programming has become an essential skill sought by the industry and thus focused on by all universities offering engineering programs[2], [3]. Most programming students struggle in completing the course and find that the skills required are too difficult to be mastered [2], [16]. Programming courses have the highest dropout rates in the discipline and are deemed extremely difficult by students and instructors alike which results in unsatisfactory outcomes ranging from repeating the course or even a change in majors[7].

While efficacy beliefs and performance have been studied in different university majors, disciplines, and class standing, as well as previous studies highlighting the differences in self-efficacy beliefs levels among students in different engineering majors [2], [17], [18] the researchers have not yet found a study that targets efficacy beliefs and performance of first-year students from the five different engineering majors chosen, and especially in the programming course. In fact, Kittur [2] recommend that a study on student self-efficacy beliefs in different engineering majors should be conducted.

A. Abbreviations and Acronyms


B. Hypotheses

Based on the theory and concepts of self-efficacy [5], [12], [13] as well as the literature relevant to the purpose of the current study [1]–[3], [7]–[10], [17]–[19], the following hypotheses are considered:

1) There is a positive correlation between students’ self-efficacy beliefs and their successes and failures in assessment tasks in the first half of the semester.
2) There is a positive correlation between students’ self-efficacy beliefs and their successes and failures in assessment tasks in the first half of the semester according to their engineering major.
3) There is a positive correlation between students’ self-efficacy beliefs in the first half of the semester and their final grade in the programming course across all engineering majors.
4) There is a positive correlation between students’ self-efficacy beliefs in the first half of the semester and their final grade in the programming course according to their engineering major.
III. METHODOLOGY

A. Sample

The current study targets undergraduate students at a high-ranking Lebanese higher education institution. The sample is comprised of 118 first-year engineering students in the programming course given in the first semester of the academic years 2020 and 2021. Student distribution across majors is as follows: 36.4% in Computer Engineering (COE), 18.6% in Industrial Engineering (INE), 17.8% in Mechatronics Engineering (MCE), 16.9% in Mechanical Engineering (MEE), and 10.2% in Electrical Engineering (ELE). Table I displays the frequency and percentage of students in each of the five engineering majors constituting the total sample.

B. Measures

In order to measure self-efficacy beliefs, a tool was constructed based on Bandura’s theory of self-efficacy and the concepts it entails under three processes: cognitive, motivational, and affective [5]. The formulation of the questions was inspired [20] [21] in terms of sentence structure such as “I am confident that I can achieve good exam results if I really put my mind to it” [21, p. 32], and verb use such as “I’m confident I can understand the most complex materials presented in the graduate courses” [20, p. 915]. After the factor structure and items were finalized, reliability coefficients alpha with 95% bootstrap bias-corrected confidence intervals were calculated. Then, a normality test was conducted using Shapiro Wilk which showed a p-value bigger than 0.05 indicating that the variable is normally distributed. The content validity of the survey tool used in the current study was measured by submitting it to a committee of experts who examined the content.

The tool constructed and used in the current study focuses solely on self-efficacy as the core theory to be linked to performance and not under the umbrella of any other concept through ten survey items to which students were asked to rate their level of agreement using a 4-point Likert-type scale ranging from 1 (strongly disagree) to 4 (strongly agree).

Table II displays the self-efficacy survey constructed for the current study.

Successes and failures in assessments tasks in the first half of the semester were measured using Quiz 1 and the Midterm grades, while performance attainments in the programming course were measured through the final course grade consisting of in-class evaluation 5%, quizzes 40%, midterm examination 25%, and final Examination 30%.

IV. DATA COLLECTION PROCEDURE

Prior to implementation, the researchers obtained a certification as a Social-Behavioral-Educational Researcher from the Collaborative Institutional Training Initiative (CITI) and presented it along with the survey questions and data collection procedure to the Institutional Review Board (IRB) office at the targeted university.

The survey was first sent at the beginning of the semester before any graded assessments had taken place. The survey was sent second before the second graded assessment had taken place, and the third time the survey was sent before the midterm. However, the responses collected for the second survey were extremely low and thus were not taken into consideration. The main aim was to have the same students answer surveys in stages one and three so that the results would in fact track their self-efficacy beliefs at different stages of the first half of the semester and study the relationship with academic attainments Hence, the survey sent the first time is considered Survey 1 and the survey sent the third time is Survey 3. The total number of students who answered both surveys was 118 and thus formed the final sample of the current study.

The data collection took place during the Fall semester of 2020 for Mechanical and Industrial Engineering students, and the Spring semester of 2021 for Electrical, Computer, and Mechatronics Engineering students in the programming course.

A. Exploratory Factor Analysis

Exploratory factorial analysis (EFA), precisely principal axis factoring was conducted. For Survey 1, two factors were set, and the results are the following. Factor 1 (Q1,2,3,4,5,8,9)
Factor 2 (Q6, 7 and 10). The two factors explain 38.703% of the total variance. The results of reliability analysis show very good Cronbach Alpha for the first factor with $\alpha_1 = 0.761$. However, reliability analysis of the second factor suggests removing question 7 to obtain an acceptable level of $\alpha_2 = 0.58$. KMO of scale after removing question 7 is 0.795. Consequently, the exploratory analysis, in the method of principle axis factoring gives 2 factors: Factor 1 combining Q1,2,3,4,5,8,9 and Factor 2 combining Q6,10 that explain 41.148% of the total variance.

For Survey 3, two factors were set, and the results are the following. Factor 1 (Q1,2,3,4,5,8,9) and Factor 2 (Q6, 7 and 10). The two factors explain 43.179% of the total variance. The results of reliability analysis show very good Cronbach Alpha for the first factor with $\alpha_1 = 0.839$; reliability analysis of the second factor suggests removing question 7 to obtain an acceptable level of $\alpha_2 = 0.621$. Thus, the exploratory analysis, in the method of principle axis factoring for the third survey after removing question 7 gives 2 factors: Factor 1 combining Q1,2,3,4,5,8,9 and Factor 2 combining Q6,10 that explain 47.726% of the total variance. Principal axis factoring, oblique rotation direct oblimin of the new scale (excluding Q7) gives us a KMO=0.838, Chi-square = 440.498; $df = 36$, $p = 0.00$; the correlation between the two factors is 0.449; Cronbach alpha of scale = 0.830 Number of items = 9.

**V. RESULTS**

After conducting factorial analysis, factor 1, referred to as $dF1$, corresponds to the cognitive processes of self-efficacy and factor 2, referred to as $dF2$, corresponds to its motivational processes, and item 7 ("I adapt my studying strategies based on my exam results") was removed from the tool.

For questions 6 ("Failing in the exams makes me doubt my abilities in the programming course") and 10 ("The more exams I fail, the more discouraged I am") in the survey, a reverse scoring system was used, where the responses were assigned values in the opposite direction of a typical Likert scale. In this case 1 corresponds to "strongly disagree" and 5 corresponds to "strongly agree." The interpretation of the average score of student self-efficacy beliefs was in accordance with the 4 levels of the Likert scale ranging from Strongly Disagree to Strongly Agree considering 2.5 to be the average mean.

**A. Hypothesis 1**

Spearman’s test of correlation shows ($p=0.092$, $r=-0.156$) which indicates that there is no correlation between all engineering students' self-efficacy beliefs and quiz 1 and midterm grades. Yet there is a weak inverse relationship between these variables though statistically insignificant.

Regarding factor 1 i.e., cognitive processes, Spearman’s test of correlation ($p=0.033$, $r=-0.196$). This indicates that in the sample of the current study, there is a weak inverse correlation between students' cognitive processes of self-efficacy beliefs and their quiz and midterm grades.

Regarding factor 2 i.e., motivational processes, Spearman’ test of correlation shows ($p=0.628$, $r=-0.045$). This indicates that in the sample of the current study, there is no correlation between students’ self-efficacy beliefs in terms of motivational processes and their quiz 1 and midterm grades. Yet, there is a weak inverse relationship between these variables though statistically insignificant.

**B. Hypothesis 2**

1) **Descriptive statistics:** The results of the descriptive statistics of self-efficacy beliefs of engineering students in survey 1 showed that engineering students across all majors had high self-efficacy beliefs. On average, Electrical Engineering students had the highest self-efficacy beliefs ($M=3.02$, $SD=0.70$), while Computer, Mechanical, and Industrial Engineering had the second highest efficacy beliefs ($M=2.93$), and Mechatronics Engineering students had the lowest self-efficacy beliefs ($M=2.86$, $SD=0.77$) at the beginning of the semester though remaining above average. When these beliefs were categorized according to factors, engineering students across all majors had high self-efficacy beliefs in terms of cognitive processes. ELE, MEE, MCE, and INE students showed also high motivational processes at the beginning of the semester ($M=3.1$, $M=2.91$, $M=2.85$ and $M=2.81$) respectively. Electrical Engineering students had the highest self-efficacy beliefs in their cognitive processes of self-efficacy ($M=2.99$) as well as the highest efficacy beliefs in their motivational processes of self-efficacy ($M=3.10$).

In survey 3, the results of the descriptive statistics of self-efficacy beliefs showed that Computer Engineering ($M=2.74$, $SD=0.79$), and Mechatronics Engineering ($M=2.73$, $SD=0.78$) students had the highest self-efficacy beliefs, while Industrial Engineering students had the second highest beliefs ($M=2.65$, $SD=0.81$), Electrical Engineering students the third ($M=2.54$, $SD=0.93$), while Mechanical Engineering students showed below average self-efficacy beliefs in the programming course ($M=2.49$, $SD=0.84$) in the middle of the semester, before the midterm examination. When these beliefs were categorized according to factors, engineering students across all majors had high self-efficacy beliefs in terms of cognitive processes and low beliefs in terms of motivational processes. Computer Engineering students had the highest self-efficacy beliefs in their cognitive processes of self-efficacy ($M=2.89$) while Mechatronics Engineering students had the second highest beliefs ($M=2.85$), Industrial Engineering students had the third ($M=2.78$), Electrical Engineering students fourth ($M=2.66$), and Mechanical Engineering students ($M=2.60$) had the fifth highest beliefs in their cognitive of self-efficacy and also the lowest beliefs in their motivational processes ($M=2.12$).

2) **Correlational statistics:** The results of the correlational analyses showed no correlation between students' self-efficacy beliefs in any of the five engineering majors and their successes and failures in the first half of the semester of the programming course. However, they showed inverse relationships between COE ($p=0.541$, $r=-0.096$), MCE ($p=0.138$, $r=-0.335$), MEE ($p=0.863$, $r=-0.41$), and INE ($p=0.263$, $r=-0.249$) students and their successes and failures in the first half of the semester of the programming course.
Although statistically insignificant. When factors were considered separately, results showed inverse relationships between students’ cognitive processes as well as motivational processes of self-efficacy beliefs and their successes and failures although also statistically insignificant. The results of ELE students showed a positive relationship between these variables although statistically insignificant (p=0.383, r=0.277). When factors were considered separately, results showed a positive relationship between students’ cognitive processes of self-efficacy beliefs and their successes and failures but an inverse relationship when motivational processes were considered though both statistically insignificant.

These findings constitute novelties regarding self-efficacy beliefs of first-year engineering students from Computer, Electrical, Mechatronics, Mechanical, and Industrial majors, and the relationship between these beliefs and student performance on assessment tasks in the first half of the semester of the programming course. The descriptive analyses showed that Electrical Engineering students had the highest self-efficacy beliefs in the first three weeks of the semester but witnessed the highest drop, though remaining above average after having taken two quizzes and before the midterm examination which resonated in a decrease in their average midterm examination grades. Although no correlation yet a weak positive relationship was found between ELE students’ self-efficacy beliefs and their successes and failures in the first half of the semester of the programming course, showing that among all five engineering majors, ELE students were the only ones displaying a positive relationship between their self-efficacy beliefs in the programming course and their successes and failures in assessment tasks in the first half of the semester although statistically insignificant. Computer, Mechanical, and Industrial Engineering students had the same levels of efficacy beliefs in the first three weeks of the semester, but after taking two quizzes and before the midterm examination, Mechanical Engineering students displayed below average beliefs making them the only major that fell below average. However, these beliefs did not affect their average midterm grades for they witnessed an increase. Therefore, though showing no correlation, the inverse relationship displayed by MEE students’ self-efficacy beliefs and successes and failures in the first half of the semester of the programming course, although statistically insignificant, was not surprising. As for Computer and Industrial Engineering students, they both witnessed a drop in their efficacy beliefs yet remained above average and exhibited an increase in their average midterm examination grades. Additionally, both majors showed no correlations but inverse relationships between their self-efficacy beliefs and their successes and failures in assessment tasks in the first half of the semester of the programming course. Regarding Mechatronics Engineering students, they displayed the lowest drop in their efficacy beliefs and notably showing high beliefs in many of the survey items answered, as well as the highest increase in their average midterm examination grades. Yet, a weak inverse relationship was found between their efficacy beliefs and successes and failures in the first half of the semester of the programming course although statistically insignificant.

C. Hypothesis 3

Pearson’s test of correlation between students’ self-efficacy beliefs and their final course grade across all engineering majors shows the following results: (p=0.025, r=0.206). Hence, there is a weak positive correlation between students’ self-efficacy beliefs and their final grade. In regard to correlations between each factor separately and final course grade, results showed no correlations (p=0.063, r=0.172) for factor 1, and (p=0.114, r=0.146) for factor 2.

D. Hypothesis 4

According to the results of the correlation analysis, there is no correlation between students’ self-efficacy beliefs in the first half of the semester and their final grade in the programming course in any of the five engineering majors.

COE, ELE, MEE, INE students showed positive relationships between their self-efficacy beliefs in general as well as by factor and (p=0.073, r=0.276) and their final grade in the programming course although statistically insignificant. Correlations of COE students showed (p=0.061, r=0.288), (p=0.189, r=0.204) for factor 1, and (p=0.073, r=0.276) for factor 2. Results of ELE students showed (p=0.205, r=0.394), (p=0.101, r=0.497) for factor 1, and (p=0.775, r=0.092) for factor 2. MEE results showed (p=0.142, r=0.340), (p=0.456, r=0.177) for factor 1, and (p=0.390, r=0.240) for factor 2. INE results showed (p=0.688, r=0.91), (p=0.692, r=0.09) for factor 1, and (p=0.881, r=0.034) for factor 2.

MCE students showed an inverse relationship between their general self-efficacy beliefs in the first half of the semester and their final grade in the programming course, but displaying an inverse relationship when only cognitive processes were considered, and a positive relationship when motivational processes were considered although statistically insignificant.

VI. DISCUSSION

The inverse correlation between cognitive processes of self-efficacy beliefs and all engineering students’ successes and failures in assessment tasks in the first half of the semester [p=0.033 and r=-0.196] can be explained by self-regulatory mechanisms that students need to employ in terms of perceived self-efficacy or self-efficacy appraisal, and long and short-term goal setting in order to guide and motivate their efforts.

Students in the current study had faulty efficacy appraisals that resulted in incompatibilities with their successes and failures because they might have had incorrect estimations of their capabilities and/or task demands underestimated or misjudged task demands of the programming course, or overestimated their abilities, or both. They might have also faced difficulties with the complex cognitive demands of the
programming course rendering them unable to correctly appraise their efficacy, or the point in time when these beliefs were measured did not work for the benefit of the students since self-efficacy beliefs at the beginning of a task can be inaccurate because students have no previous experience with the context presented to them i.e., first-year students with no prior experience in undergraduate studies and more particularly the programming course demands.

Programming is a difficult course which encompasses high cognitive demands and complex skills acquisition. Therefore, it would be sensible to assume that students in the current study suffered from faulty appraisals of their efficacy due to the fact that they were faced with complex demands in the assessment tasks. Since quiz 1 and the midterm examination targeted identifying errors in programming language as well as writing codes, the complexities lied in writing codes [7], [22]–[24] rather than identifying errors. Hence students might have found it easy to identify errors in codes already written and thus have appraised their efficacy based on this knowledge while neglecting the fact that they had yet to master the knowledge to write full and efficient codes. Or, they might have focused on their inability to write full codes which overshadowed their ability to identify errors in codes and thus undermining their efficacy beliefs. In both scenarios, students had faulty appraisals of efficacy in relation to their performance abilities on assessment tasks in the programming course in the first half of the semester.

Finally, Bandura’s short and long-term goals theory [5] did not apply to the sample of the current study for short-term goals did not guide students’ performances maybe because they had faulty efficacy appraisals to begin with, mixed with the novelty of the programming course especially in the first half of the semester, or because, as he also stated, self-efficacy beliefs are formed through a vast range of tasks rather than judged directly before each performance.

Hence, it has been found that students from different engineering majors have different approaches to their self-efficacy beliefs and the programming course. While they all had different beliefs in the first three weeks of the semester compared to before the midterm examination, especially MEE students who showed beliefs below average, they all witnessed a drop in these beliefs but to various degrees. Four out the five majors showed an increase in their average midterm examination grades and inverse relationships between efficacy beliefs and successes and failures except for ELE students who witnessed a significant drop in their beliefs as well as a drop in their average midterm grades, as well as displaying a positive weak relationship between these beliefs and their quiz and midterm grades although statistically insignificant.

These overall discrepancies between efficacy beliefs and academic performance highlight the lack of awareness that the students in the current study displayed regarding their efficacy appraisals as well as the appraisal of the cognitive and skill demands of the programming course.

The data presented for hypothesis 3 showed a positive correlation between all engineering students’ self-efficacy beliefs in the first half of the semester and their final grade in the programming course [p=0.025 and r= 0.206]. This finding reveals that students who exhibited high self-efficacy beliefs in the first half of the semester, up until the midterm examination, scored a higher final grade, and those who exhibited low self-efficacy beliefs scored a lower final grade in the programming course.

This result coincides with Bandura’s theory stating that self-efficacy plays a highly important role in performance attainments [5] as well as numerous previous studies confirming that student that student self-efficacy beliefs play a role in their academic performance [8]–[10], [19].

The data presented for hypothesis 4 showed no correlation between students of each engineering major COE, ELE, MEE, MCE, and INE separately with the final grade in the programming course. The result of the fourth hypothesis showed positive relationships though statistically insignificant between COE, ELE, MEE, and INE students’ self-efficacy beliefs in the first half of the semester and their performance attainments in the programming course. MCE students displayed a negative relationship between these variables though also insignificant. The researchers believe that if the sample size in each engineering major had been larger, the current study might have shown correlations and/or statistically significant relationships between self-efficacy beliefs of students of each engineering major and their final programming course grade.

However, the current study showed a positive relationship between COE, ELE, and MEE students’ self-efficacy beliefs in the first half of the semester and their final grade in the programming course. Students with high efficacy beliefs were able to predict the outcomes of their actions and might have been able to put together effective ways to control them and were ultimately able to reach higher performance attainments.

Self-efficacy beliefs are malleable and have negative and positive relationships with student performance in the programming course. Hence, proper intervention should exist especially in the first half of the semester because as the results show, there is a positive relationship between COE students’ self-efficacy beliefs in the first half of a semester and their performance attainments at the end of the programming course. Meaning that, COE students carried their efficacy beliefs which they had constructed in the first half of the semester all through the course, and these beliefs have displayed a positive relationship with students’ final course grade.

COE students with high efficacy beliefs might have viewed failures as learning opportunities and learned through making mistakes. They were not discouraged by failures but might have considered them as opportunities to learn and better perform in the future, shortcomings might not have meant personal failures but rather that they needed to improve their plans and exert more effort in the future and thus reached higher performance attainments. However, students with lower efficacy beliefs might not have sought to expand their knowledge and perfect their skills, in opposition, they
preferred low-risk tasks. Failures might have been viewed as a testament of their inability to accomplish challenging tasks in the programming course because of their intellectual impediments in the face of the cognitive demands of the course.

Results also showed that by expressing their ability to overcome stressful situations, COE and MCE students who displayed high self-efficacy beliefs might have been able to control their thought processes, and by regulating their thoughts, they were able to control their feelings and thus their actions. However, students with lower efficacy beliefs expressed their doubts in facing stressors in the programming course and in turn, might have had lower attainments because they might have allowed these stressors to jeopardize their performances. But, the results of MCE students showed an inverse relationship between their efficacy beliefs in the first half of the semester and their final grade in the programming course maybe because at the targeted university, Mechatronics Engineering aims at researching and developing technologies in automation, control, industrial, and robotic systems which all require programming, and so, MCE students might have been feeling more pressure than other majors to perform their best in the course which might have clouded their judgements when appraising their abilities in the course as well as affected their performances in the course.

No previous study has been conducted on self-efficacy beliefs of INE students or has linked these beliefs to student performance and especially no previous study has targeted these components in the programing course.

Therefore, the results of the current study can be added to the body of literature regarding INE students, their self-efficacy beliefs, and their performance in the programming course. In the first half of the semester, INE students showed below average efficacy beliefs in survey 1 (M=2.93) and survey 3 (M=2.65). However, these beliefs experienced a significant drop of 9.56% (since p=0.01<0.05). Correlational analysis showed no correlation between INE students' self-efficacy beliefs and their final grade yet, there was a strong positive relationship between these variables although statistically insignificant (p=0.688, r=0.91). These results show that, self-efficacy beliefs played a role in performance attainments in terms of final grade in the programming course since INE students who displayed high efficacy beliefs in the first half of the semester reached higher performance attainments than those who displayed lower efficacy beliefs in the first half of the semester of the programming course.

VII. CONCLUSION

Measuring self-efficacy beliefs of first-year engineering students in the first half of the semester of the programming course has added to the theories of self-efficacy in education [5], [12]–[14] as well as the literature regarding efficacy beliefs in the programming course [7]–[10], [19]. The results confirmed that, in fact, there is a relationship between student self-efficacy beliefs and academic performance attainments. The results of the current study highlighted the inverse relationship between engineering students’ self-efficacy beliefs and their successes and failures in the first half of the semester of the programming course calling attention to the lack of awareness that the students displayed regarding the appraisals of their abilities as well as the appraisal of the cognitive and skills demands of the programming course. When the relationship was measured according to each engineering major, only ELE students displayed a positive relationship between their efficacy beliefs and performance in the first half of the semester. It is the researcher’s belief that if the sample had been larger in each engineering major, the results would have been significant, and correlations would have been established, and thus recommend a large representative sample of each engineering major in future research studies.

Furthermore, the current study revealed that students who exhibited high self-efficacy beliefs in the first half of the semester, reached higher attainments at the end of the programming course. This finding shows that self-efficacy beliefs that are formed at the beginning of the experience are carried all throughout and thus, play a role in student performance attainments which emphasizes the importance of self-efficacy beliefs and the need to build these beliefs in order to better face the challenges of the programming course.

A positive relationship between Computer, Electrical, Mechanical, and Industrial Engineering students’ self-efficacy beliefs in the first half of the semester and final grade in the programming course was found, while an inverse relationship with Mechatronics Engineering students showed that further attention needs to be given to these students for they might be feeling more pressure than others to perform their best in the course. In addition, Focus Group Discussions could have been beneficial to deeper explore the reasons behind these relationships.

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