Academic Motivation of Sophomore and Junior Electrical Engineering Students

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***Abstract* - Given the importance of motivation in engineering education, the research described here analyzed the factors driving sophomore and junior students to study electrical engineering. The study involved 399 students (192 sophomore students and 207 junior students) at a leading technical university in Israel. At the beginning of the relevant year, the participants completed an anonymous Likert-like scale, based on self-determination theory. According to the results, both sophomore and junior students were mainly driven by autonomous factors. It was also revealed that the intrinsic motivation of junior students was significantly higher than that of sophomore students. Based on the curriculum, the paper provides a possible explanation for these findings.**

Keywords - motivation; electrical engineering; sophomore students; junior students.

I. INTRODUCTION

It is common to analyze learning from different perspectives which are often intertwined. The cognitive point of view deals with thinking processes [1]. The social aspect focuses on interactions between the learner and his/her environment [2], and the affective domain deals, among other things, with academic motivation, i.e., the individual's desire to learn [3].

Motivation plays a central role in higher education, including engineering education. Its importance is validated in view of the ongoing lack, in many parts of the world, of engineers [4]. Therefore, mapping the factors driving engineering students to peruse their studies, despite the difficulties involved, has both theoretical and practical values. Such an analysis may even constitute a preliminary step to reduce dropout.

In light of the above, studies have characterized motivational factors among different groups, such as high-school students majoring in engineering [5], students at two-year technological colleges [6] and mechanical engineering students [7]. The current study focused on analyzing the motivational factors of electrical engineering students, at a leading technical university, at the beginning of their sophomore and junior years. The theory of motivation that served as the framework for the analysis was self-determination theory [8], which is considered one of the most important theories today.

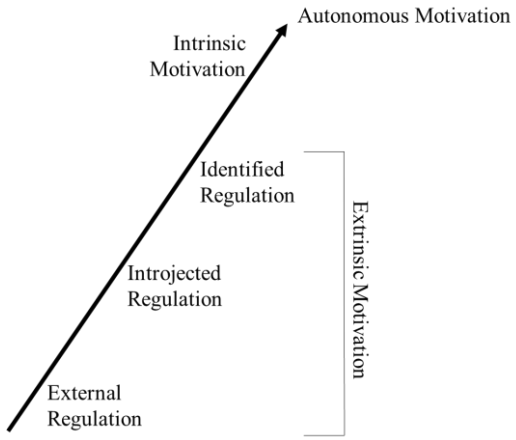

Figure 1. Major motivational factors (self-determination theory)

II. SELF-DETERMINATION THEORY

Self-determination theory suggests that the person strives to satisfy three basic needs [8]:

- Autonomy refers to the person's need to feel that his/her behavior stems from free will.
- Competence refers to the person's need to feel that he/she is capable of meeting objectives.
- Relatedness refers to the individual's need to be in meaningful contact with others.

When some (or all) of the needs are not met, the individual is at a lower level of autonomous motivation, which does not allow for self-actualization. On the other hand, fulfilling these needs leads the person to a higher level of autonomous motivation, which enables self-actualization.

In addition to identifying the basic needs, self-determination theory classifies the factors that drive the individual according to the level of autonomy that characterizes them (Fig. 1). The motivational factor characterized by a maximum level of autonomy is intrinsic motivation. This factor originates from the interest or enjoyment inherent in the activity and is considered long-term [9]. The other motivational factors are extrinsic factors, the most important of them are listed below:

- Identified regulation – a factor arising from the recognition of value associated with the activity. This factor is closest to intrinsic motivation.
- Introjected regulation – a factor stemming from the individual's wish to avoid feelings of guilt or to receive positive feedback from his/her environment.
- External regulation – a factor originating from the person's desire to receive material rewards from the environment or fear of punishment. This factor is the furthest from intrinsic motivation.

To assess the individual's degree of autonomous motivation, it is customary to use the Relative Autonomy Index (RAI) [10]. This measure takes into account the four factors described earlier with appropriate coefficients (suggested by literature) reflecting the degree of autonomy that characterizes each [11]. Therefore, intrinsic motivation and identified regulation have a positive coefficient, while external regulation and introjected regulation have a negative one. Additionally, since the distance between intrinsic motivation and external regulation is the maximum, the coefficient, in absolute value, of each of them is higher than the coefficient, in absolute value, of identified regulation and introjected regulation. The measure is:

$$RAI = 3S_{intrinsic} + S_{identified} - S_{introjected} - 3S_{external} \quad (1)$$

In (1), S_i stands for the score of motivational factor i, measured by a validated tool.

III. Research Goal

The aim of the research was to analyze the motivational factors of electrical engineering students, at a leading technical university, at the beginning of their sophomore and junior years.

IV. Research Setting

The Technion – Israel Institute of Technology is the leading technical university in Israel, and is ranked among the top 100 universities in the world [12]. The Faculty of Electrical Engineering offers a four-year program (BSc) that provides in-depth training in diverse subjects, such as computers, communication, control, nanoelectronics, photonics, electromagnetism and power systems.

TABLE I. Electrical Engineering Program

Year	Main Topics
1	Basic courses: • Mathematics • Physics
2	Introductory courses: • Electronic devices & circuits • Signals & systems • Electromagnetism
3	
4	Elective courses: • Computers • Communication • Control • Nanoelectronics • Photonics • Electromagnetism • Power systems

The freshman student focuses on mathematics and physics (Table I). In the second and third years of study, the student takes introductory courses on electronic devices and circuits, signals and systems, and electromagnetism. In the senior year, the student specializes in elective topics that reflect the broad areas of practice of electrical engineering detailed above. Along with in-depth theoretical training, the students receive practical training in teaching laboratories.

V. Methodology

Three hundred ninety-nine electrical engineering students at the Technion – Israel Institute of Technology (192 sophomore students and 207 junior students) were involved in the study.

At the beginning of the relevant academic year, the participants completed an anonymous questionnaire, designed to assess their motivational factors for studying electrical engineering. This five-level Likert-like scale, ranging from "strongly disagree" to "strongly agree", was based on the concept of Self-Regulation Questionnaire – Academic (SRQ-A) [13] adapted to engineering students.

The instrument consisted of twenty statements that reflected the four motivational factors mentioned above. For instance, the statement "I am studying electrical engineering because I think the studies are interesting" represents intrinsic motivation. As for the three extrinsic factors, the statement "I am studying electrical engineering because I think working in electrical engineering would be a good job for me" reflects identified regulation, the statement "I am studying electrical engineering because my parents want me to do so" expresses introjected regulation, and, finally, the statement "I am studying electrical engineering because I do not have a choice" reflects external regulation. Two engineering education experts validated the statements. As for reliability, Cronbach's alphas were $0.78 \leq \alpha \leq 0.86$, thus indicating acceptable internal consistency.

The data were statistically analyzed and the RAI was calculated. Based on (1) and the fact that the questionnaire was a five-level scale, it turns out that $-16 \leq RAI \leq 16$. It should be noted that since the correlation between some of the motivational factors is high [7], MANOVA was not performed. Instead, *t*-tests with Bonferroni correction were conducted.

VI. Findings

Table II displays the RAI (mean m and standard deviation s) for students at the beginning of their sophomore and junior years. It can be concluded that in both groups of students the average value of the measure is close to the third quartile, i.e., students' autonomous motivation is relatively high. According to a *t*-test (unequal variances), no significant difference between the two groups is observed ($t = 1.08$, $p > 0.05$).

TABLE II. RELATIVE AUTONOMY INDEX

Year	*m*	*s*
2	7.81	3.37
3	8.21	4.04

A more subtle analysis appears in Fig. 2. It shows the distribution of the motivational factors for students at the beginning of their sophomore and junior years. It can be seen that in both cases the highest score is assigned to intrinsic motivation, and that identified regulation is ranked slightly lower, far from introjected regulation (third place) and external regulation (last place).

A *t*-test (equal variances) reveals a significant difference between the two groups of students regarding intrinsic motivation ($t = 3.07$, $p < 0.01$). As for identified regulation ($t = 0.17$, $p > 0.05$), introjected regulation ($t = 0.88$, $p > 0.05$) or external regulation ($t = 1.16$, $p > 0.05$), no significant difference is observed. The effect size associated with the significant gap is small-medium ($d = 0.31$).

As an example, a histogram of responses to the statement "I am studying electrical engineering because I think the studies are interesting" is given in the Appendix.

VII. DISCUSSION

The study shows that the autonomous motivation of electrical engineering students at the beginning of their second and third years of study is relatively high and that they are mainly driven by intrinsic motivation and identified regulation. Other studies also reveal that sophomore and junior engineering students are primarily motivated by these factors [7, 11]. An explanation for this may originate from the fact that students who were mainly driven by introjected regulation and/or external regulation, which are short-term factors, dropped out of their studies during the first year.

In addition, a significant gap (small-medium effect size) was found in intrinsic motivation in favor of the junior students. An explanation for this finding may stem from the characteristics of the curriculum. As described in Section IV, the freshman year focuses on mathematics and physics, and only in the sophomore year the student begins to study the basics of electrical engineering. Therefore, the interest (reflected in intrinsic motivation) of the average student may increase during the second year and manifest itself at the beginning of the third year. An alternative explanation, according to which students who were primarily motivated by extrinsic factors dropped out of their studies during the sophomore year, is not in line with this year's lower dropout rates compared to the first year.

The study had one main limitation due to the fact that only one program was examined. However, the research has both theoretical and practical contributions. The former is the characterization of the motivational factors of electrical engineering students at the beginning of their sophomore and junior years. The latter may be reflected in the application of the findings for the purpose of fostering students' autonomous motivation and reducing dropout. These contributions are becoming more important in view of the ongoing shortage of engineers in many parts of the world [4].

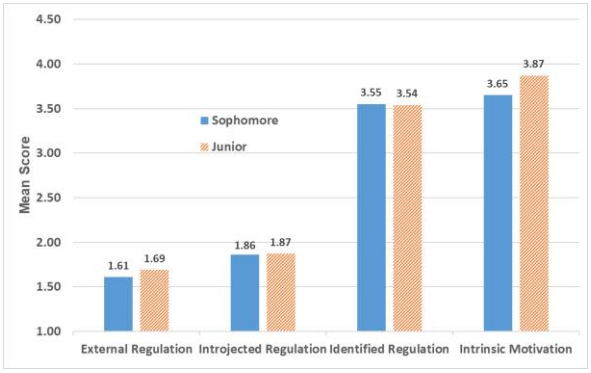

Figure 2. Motivational factors

VIII. CONCLUSION

Electrical engineering students at the beginning of their second and third years of study are mainly driven by autonomous factors. Moreover, the intrinsic motivation of junior students is significantly higher than that of sophomore students.

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APPENDIX

A histogram of responses (sophomore students) to the statement "I am studying electrical engineering because I think the studies are interesting" is given in Fig. 3. The five-level Likert-like scale ranges from "strongly disagree" (1) to "strongly agree" (5).

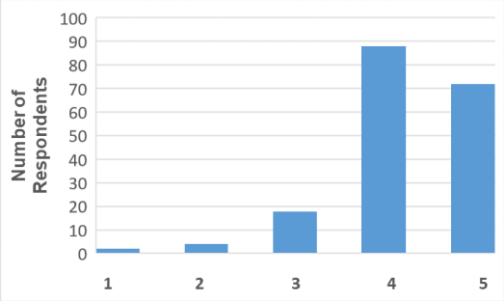

Figure 3. Histogram (sophomore students)