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Science and Engineering Students as Teaching Assistants in High Schools: The "Educational Clinic" Program

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Abstract
The Technion – Israel Institute of Technology has initiated a unique program called "Educational Clinic", which trains science and engineering students as teaching assistants in high schools. At the end of the training phase, the students integrate into the schools and help high school pupils with mathematics and science. Thirteen students took part in the first class of the program which lasts for one academic year. The study described in this paper used qualitative tools in order to examine the students' attitudes towards the program throughout the year. The findings indicate very positive attitudes towards the program. Alongside a fixed high level of extrinsic motivational factors, which express student satisfaction of improving their teaching skills, a notable increase was found in the level of intrinsic motivational factors, which reflect the students' interest in the program. These findings are explained in light of the self-determination theory.

1. Introduction
In light of the severe shortage of scientists and engineers [1-2] many universities offer programs which aim to increase high school pupils' interest in science and engineering and encourage them to develop a career in these fields [3-4].
Recently at the Technion – Israel Institute of Technology, a unique program called "Educational Clinic" has been developed and implemented. The program is designed to train science and engineering students as teaching assistants in high schools. At the end of the training phase, the students integrate into the schools and help high school pupils with mathematics and science.
Thirteen students took part in the first class of the program which lasts for one academic year. The study described here examined the students' attitudes towards the program and tracked changes in their motivation to participate therein.

2. Theoretical background
Motivation is defined as the individual's will to invest resources in a certain behavior. Motivational theories try to investigate the origins of motivation and explain processes which motivate the individual to behave as one does. The self-determination theory [5-6] is a leading motivational theory which identifies three inherent needs among human beings:

- Need for autonomy – the individual's need to feel a certain behavior was not imposed upon him/her;
- Need for competence – the individual's need to feel he/she is capable to accomplish challenging goals;
- Need for relatedness – the individual's need to be a part of a group.

When a person's needs are satisfied – then it will take him/her to a higher motivational level, intrinsic motivation, which is expressed in the interest and enjoyment the individual finds in the behavior. A partial satisfaction of needs will lead to a lower motivation level, extrinsic motivation, which includes several types of regulations. For instance, identified regulation, which is based on identifying value (which is not interest or enjoyment) which is embodied in behavior; introjected regulation, which stems from personal prestige considerations or the wish to fulfill other people's expectations; and external regulation which is derived of the hope of receiving material rewards for one's behavior, or alternatively, due to fear of punishment.

3. Program description
The program "Educational Clinic" comprises of two successive academic courses, "Educational Clinic 1" and "Educational Clinic 2", of three weekly hours each. The first course begins with a six weeks long theoretic chapter which deals with learning theories and teaching methods. On the seventh week,

a model lesson is held by the course faculty. The remaining weeks are dedicated to microteaching, as part of which each student gets to experience teaching a 45 minutes class in front of his/her course peers, on a subject of his/her choosing taken from the high school curriculum in mathematics or physics. The rest of the students actively participate in class while at the same time filling out a suitable evaluation form. At the end of the class, a discussion is held with the teaching student, his/her course peers, and the faculty.

As part of the second course, the students teach in high schools small groups of pupils. A variety of scientific subjects are taught with the guidance of a professional teacher. The students help high school pupils with difficulties and/or guide extracurricular activities for outstanding pupils, including tours of the Technion. It is important to note that the students are the ones to select the school and the subject, and they are not limited to the high school curriculum. Throughout the semester the course faculty holds guidance meetings with the students. During these meetings the students discuss experiences and jointly deal with difficulties.

4. Research goal and methodology

The goal of the research was to examine students' attitudes towards the program and track changes in their motivation to participate therein. The research population comprised of thirteen students who were in their 3rd - 9th semester of studies. Ten of them had some experience in teaching. As part of the program, the students taught at eight high schools in the north of Israel. The students taught mathematics, physics, chemistry, biology, and computer science to groups of pupils of the 8th to 12th grades, composed of two to twenty eight pupils.

In light of the small number of students who had taken part in the program, and since the study focused on characterizing students' attitudes and change processes they underwent during the program, we chose to use qualitative tools. The students were asked to fill out open questionnaires on three dates: a preliminary questionnaire at the beginning of the course "Educational Clinic 1" (Questionnaire 0), an intermediate questionnaire at the end of the course "Educational Clinic 1" (Questionnaire 1), and a final questionnaire at the end of the course "Educational Clinic 2" (Questionnaire 2). In addition, at the end of each course group interviews were held with the students.

5. Findings

In the preliminary questionnaire, the students were asked "Why did you choose to participate in the program?". 12 of the respondents (92%) gave practical reasons: "overcoming stage fright" and "improving my self-confidence". One student only (8%) mentioned interest as a factor for his participation in the program: "The subject of teaching is very interesting".

In the intermediate questionnaire, the students were asked "What are your feelings having experienced microteaching?". All students (100%) noted that it was an especially positive experience: "The experience I had is priceless". Excerpts from the interviews reveal that the positive experience was as a result of feeling able to successfully accomplish the challenge of teaching a class:

"I've experienced the real thing… it was really challenging… but I managed to do it!"

In the intermediate questionnaire the students were also asked "What is your opinion of the course?". All students (100%) wrote the course was able to provide teaching skills: "The course provides very necessary tools for all students and tutors at the Technion". Six of them (46%) also noted the interest they had found in the course: "It is definitely the most interesting course I took during these studies".

In the final questionnaire, the students were asked about their considerations when choosing the high school in which they had taught. Seven students (54%) noted they preferred teaching in the same high school they went to as pupils and to which they feel a sense of belonging: "I viewed this experience as closure and an opportunity to give back a little to the place where I grew up". Others wrote that they had chosen the high school according to the characteristics of the pupils who attend it "I felt comfortable standing in front of stronger pupils with a liking of the subject".

In reply to the question of "What do you think of the program?", all students (100%) noted their positive impression of it and mentioned both the benefit they had gained therefrom: "I learned how to improve my teaching skills", and the enjoyment they had experienced: "This is the most fun thing I have had since I started studying at the Technion".

Excerpts from the interviews reveal that the sense of autonomy had contributed to the enjoyment which characterized teaching at a high school:

"A really fun experience… there is no other place – school or academic course – which gives you such a free hand as they do here… which lets you try and dare… make your own decisions regarding what to teach, how, and at what pace."
The sense of competence also contributed to the enjoyment:
"My self-confidence improved really rapidly… I felt wonderful that I was able to teach."
Fig. 1 presents the frequency of mentioning intrinsic motivational factors (interest and enjoyment) and extrinsic motivational factors which reflect identified regulation (deriving benefits) in the answers received in the different questionnaires. It is important to emphasize that other extrinsic motivational factors were not found in the students' answers. The chart indicates that while the frequency of extrinsic factors which express identified regulation remained nearly fixed, the frequency of intrinsic factors considerably increased during the program.

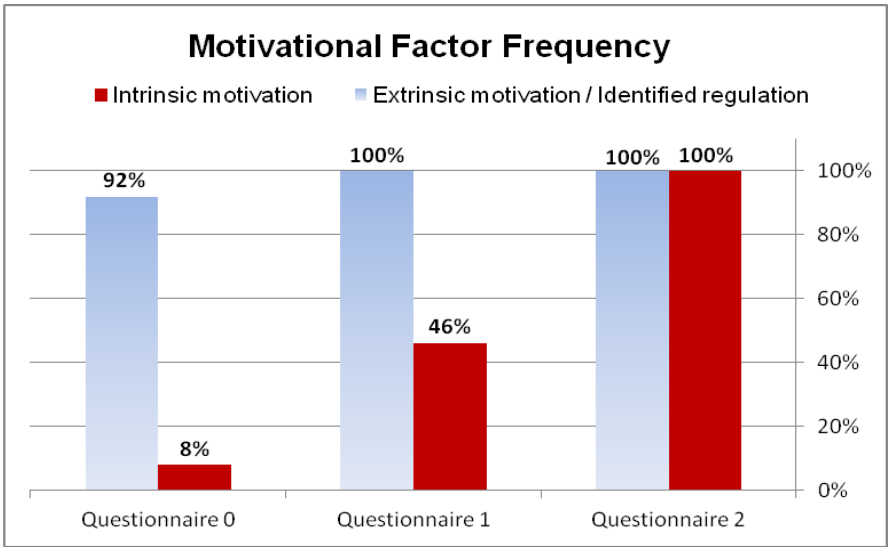

Fig. 1: Intrinsic and extrinsic motivational factors: Frequency of mentioning in questionnaire answers

6. Discussion

According to the findings, the weight of identified motivational factors was nearly unchanged throughout the program and maintained a very high value. This would indicate the students' expectations to benefit from the program – expectations which were expressed in their answers to Questionnaire 0 – were indeed met as can be seen from their answers to Questionnaires 1 and 2. However, a notable change in intrinsic motivation factors was evident during the program. In the beginning of the program the weight of intrinsic factors was very low compared with the weight of extrinsic factors. As the program progressed, the weight of intrinsic factors increased to the point where all students noted their interest in and enjoyment of the program.
The gradual improvement in intrinsic motivation can be explained in light of the self-determination theory [5-6]. According thereto, improvement is the result of the program's ability to gradually satisfy the individual's three basic needs. The need for competence was fulfilled by successfully accomplishing the challenge of teaching a class; the need for autonomy was satisfied with the sense of a "free hand" the students had felt when determining their high school teaching subjects; and, finally, the need for relatedness was fulfilled by teaching at a high school where the students themselves had studied and felt a sense of belonging thereto. While the need for competence was beginning to be fulfilled already following their experience with microteaching at the Technion and continued to be fulfilled during their teaching at a high school, the two additional needs were satisfied only during their teaching at the high school.

7. Summary

The study described in the paper examined throughout the year the attitudes of thirteen students, who had participated in the first class of the program "Educational Clinic". The findings indicate very positive attitudes towards the program. Alongside a fixed high level of extrinsic motivational factors,

which express student satisfaction of improving their teaching skills, a notable increase was found in the level of intrinsic motivational factors, which reflect the students' interest in the program.

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