https://doi.org/10.21061/jte.v14i1.a.2

Learning Good Electronics or Coping With Challenging Tasks: The Priorities of Excellent Students

Moshe Barak

In today's competitive society, the secondary school serves as a crucial stage in acquiring a higher education, a profession, and the social and economic status that these provide. Technology education in high school is the last stage prior to seeking employment and embarking upon a career or seeking further education. Unfortunately, it is an elective program in most countries. Thus, students who do not opt for technology studies in high school miss an essential part of the program. Not studying technology in high school creates a three-year severance—from the completion of technology studies in junior high school until graduation from high school and beginning the process of acquiring a higher education and a profession. Since technology has never been a basic part of education in the eyes of students and their parents, there is a considerable gap between the prestigious image of technology and the actual status of technology education as an elective subject in high school.

The situation in which outstanding students choose to opt out of technology studies in high school severely weakens the status and centrality of technology education. The effort to attract outstanding students to technology studies in high school is the spearhead of efforts to strengthen technology education and enhance its status. Without a cadre of excellent students, technology education may be perceived as being of secondary importance, not only in high school, but also in the entire spectrum of K-12 education.

In Israel, technology education plays a central role in high schools. Approximately fifty percent of high school students major in technology, at different levels, at comprehensive high schools. This system is subject to conflicting pressures. On the one hand, the system is intended to cultivate the excellent students, who are interested in topics such as electronics, computers, and robotics. On the other hand, technology studies in high school have become the main educational framework for students with lower achievement, who take the matriculation exams at the most basic level or finish high school without a certificate that enables them to go on to a higher education. This is a manifestation of the conflict between the prestigious image of technology on the

Moshe Barak (mbarak@bgumail.bgu.ac.il) is a Senior Lecturer in the Department of Education in Science and Technology at Ben-Gurion University of the Negev, Beer-Sheva, Israel.

https://doi.org/10.21061/jte.v14i1.a.2

one hand, and the perception of technology education as vocational education on the other. For many years, many schools in Israel accorded great prestige to electronics studies and attracted excellent students. However, since the beginning of the 1990s, Israel has undergone several social and educational changes, which have cast a growing shadow on the status of high school electronics studies. Paradoxically, the decrease in the number of excellent students choosing to study electronics occurred at a time when the Israeli high-tech industry was expanding at a dramatic pace, occupying a central role in the Israeli economy and achieving eminent status in world markets.

This article presents a longitudinal research study of teaching and learning electronics at twelve Israeli high schools over a period of four years. The research examines the processes that took place in the field, the pressures and conflicts to which the schools are subjected, and the efforts that they are making to preserve the high standing of electronics studies. Since electronics studies are, in many respects, the "engine" driving technology education in Israel, this research might cast more light on the development of technology education, and result in steps being taken to make the case for technology education in the K-12 curriculum (Cajas, 2000; Lewis, 1999).

Theoretical Background

Most of the literature on the goals and methodology of technology education explore technology education in the broader context of K-12 education (de Vries, 1994; Hill 1997, Zuga, 1999). However, little attention is paid to the unique aspects of technology studies in high schools. This is in inverse proportion to its central role within the general field of education. In recent years we have witnessed a growing recognition of the importance of education in developing higher order cognitive skills such as mathematical/logical thinking, problem solving abilities, and creativity (Glaser, 1992; Rogoff, 1990). More emphasis is accorded to authenticity of learning experiences, open-ended tasks, and teamwork (Barak & Maymon, 1998; Greeno, 1997; Roth & Bowen, 1993). The idea that learning is embodied in activities shaped by social and physical interactions is central to the cognitive apprenticeship approach (Collins, Brown, & Newman, 1989). Part of this point of view is based on making the teacher's role that of a facilitator and guide rather than a transmitter of knowledge and supervisor of achievements. Contextual learning is a central condition for meaningful learning and for the development of higher intellectual skills (Johnson, 1997; Resnick, 1987). Contextual learning is learning that occurs in close association with actual experience and is tied to the child's experiences and interests. Effective contextual learning results from a complex interaction of teaching methods, content, situation, and linkages with community, neighborhood, or workplace. These concepts are not easily implemented within technology education in high school. As students mature, their fields of interest expand, their life experience broadens, and their expectations from their studies in school in general, and

https://doi.org/10.21061/jte.v14i1.a.2

from technology studies in particular, increase. Students in the last few years of high school need greater challenges and a more advanced and sophisticated learning environment, compared to those in elementary school or junior high school. Students at the age of 17 and 18 expect to be dealing with "high-tech" areas such as computers, electronics, and robotics.

Project-based learning is one of the leading models in technology education, with projects aimed at developing a higher level of cognitive skills, creativity, teamwork abilities, self-discipline and responsibility (Barak & Dopplet, 1999, 2000; Cross & McCormick, 1986; Thomas, Mergendoller & Michaelson, 1999). Implementation of project-based learning in high school is more complex and problematic compared to such studies in elementary school and junior high school. Dealing with advanced technological subjects requires careful selection of project topics in accordance with the knowledge and experience of the students and teachers and depends upon the means at their disposal (Barlex, 1994). In high school there is pressure to attain high scores, which, in turn, determine the chances of acceptance to prestigious university faculties. School programs are to a great extent dictated by national exams or detailed standards for learning and performance like those in the United States (AAAS, 1993; NRC, 1996; ITEA, 2000) or England (Department of Education, 1995). These constraints call into question the ability and the motivation of teachers to search for meaningful learning, to foster initiative, and to encourage originality—which are at the heart of technological projects (Lewis, 2000, Atkinson, 2000).

Research Goals and Methodology

The research described in this article is a longitudinal investigation of electronics teaching in Israeli high schools over a period of four years. The research aimed to:

1. Explore the status of electronics studies provided in a comprehensive high school as viewed by teachers and students.
2. Examine the content and methods of electronics studies customary in the field and their implications for attracting excellent students.
3. Identify the causes for the decline in the status of electronics studies.
4. Trace the steps taken to change and bring about innovation in schools and their effect upon the students and teachers.

This study adopted the methodology of qualitative research (Hoepfl, 1997; Johnson, 1995; Lincoln and Guba, 1985; Patton, 1990). This methodology enables one to follow the researched phenomena closely and to examine, in a naturalistic way, as many aspects of the investigated phenomena as possible. In accordance with the concept of qualitative research, questions or specific variables that the research examines were not defined in advance. Instead, maximal flexibility and openness were adopted in order to identify the processes taking place in schools over a period of time in the subject matter taught and methods of instruction adopted in schools, the learning environment, and original initiatives taken in schools over a period of years and their effects.

https://doi.org/10.21061/jte.v14i1.a.2

Research Population, Data Collection, and Analysis

The research was conducted in twelve comprehensive schools where electronics studies are conducted within the comprehensive schools. The schools were selected in order to represent a range of populations and standard of living common in Israel: Large, well established cities and small peripheral towns comprising middle-low socioeconomic classes.

The data for the study were obtained using participant observations, interviews and document evaluation, as detailed below:

1. Visits were made to every school two to three times a year (a total of more than 100 visits). Interviews were conducted with principals, teachers, and students, as they were working in the lab.
2. The researcher actively participated in ten regional meetings of teachers as a part of a program of in-service training courses and workshops. The subjects studied in these workshops and the matters raised by the teachers were documented as authentic information of the research.
3. Informal conversations were held with approximately 30 electronics teachers, most of them participated in previous research projects headed by the researcher. Close links between the researcher and teachers is a desirable element in qualitative educational research. These links facilitate the transfer of authentic information such as instructional problems, feedback on in-service courses in which the teachers participated, or personal concerns in view of the changes taking place in the schools.
4. Observations were conducted in two schools while the national examinations of the students on their final project were being conducted. Discussions were held with the students and the examiners during and after the examinations.
5. During the last year of the research, semi-structured group interviews were conducted with the three to four electronics teachers from six of the schools. The teachers were asked to summarize the status of electronics studies in their school and the impacts of the changes that were attempted in recent years. These interviews were recorded, and in the course of the discussion a written summary was prepared with the assistance of the teachers.
6. Schools provided statistical data on students' achievement in the matriculation examinations in electronics over a period of four years and on late registration of students for electronics studies.

The analysis process and the development of conclusions were iterative, and the subjects of research were also included: Every interpretation or conclusion formulated was examined and verified through repeated discussions with students, teachers, and principals. The extended observation time, peer debriefing, member checks, and the use of multiple data sources helped ensure credibility of the findings (Guba & Lincoln, 1994). Thus, the research methodology and procedures were in line with the characteristics of qualitative research that Hoepfl proposed (1997, p.49): "Qualitative research uses the

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natural setting as the source of data. . . .The researcher acts as a 'human instrument' of data collection. . . . The research has an emergent (as opposed to predetermined) design."

Findings

The Framework of Electronics Studies in Israeli High School

Students in Israeli high schools study electronics for about sixteen hours per week for three years (grades 10, 11, and 12). At the same time they take general subjects such as mathematics, English, literature, and history. Electronics studies comprise basics in electricity, analog electronics, digital electronics, microprocessors, control systems, and communications. Each subject is studied for three or four hours per week, for two years. At the end of high school the students take two or three matriculation exams in electronics. The grades of these exams are credited toward acceptance for university or college studies, although some of the academic institutions assign more weight to achievements in mathematics and physics.

Attitudes of Teachers and Principals Regarding Electronics Studies in High School

In a series of preliminary meetings held with principals and teachers, eight of the twelve principals expressed concern about the state of electronics studies in their school. They presented data showing a decline in the number of excellent students choosing to major in electronics. For instance, whereas ten to fifteen years ago excellent students "fought" for a place in electronics classes, now more and more students in electronics classes are on an intermediate level. Teachers used terms such as "urgent aid" and "rescue measures." At a meeting with twelve teachers, in preparation for a proposed project in northern Israel (Barak, 2001), the teachers made over 30 different suggestions for improving electronics studies. They suggested, for example: Changing teaching methods, accelerating the use of computers, initiation of projects, improvement of labs, reducing the students' workload, and "marketing" electronics studies to students at the enrollment stage. In the present study, the teachers sought to enhance their pedagogical knowledge (Shulman, 1986) rather than their knowledge in specific subject matter, as was found in a previous program put forth a decade earlier for the same region.

Conventional Electronics Studies

The main component of electronics studies is the theoretical "talk-and-chalk" lesson. Lab experiments, aimed at "validating the theoretical principles," lag weeks or months behind theoretical studies. At the beginning of the 1990s, for the first time, the Ministry of Education published specifications (a sort of "standards") for the achievements required of students in theoretical and laboratory electronics studies. The official program spells out in detail the requirements for each build the circuit lab experiment, such as: "The student should draw a sketch of the circuits… connect the measuring instruments…

https://doi.org/10.21061/jte.v14i1.a.2

measure input and output voltage… draw a graph… calculate the amplification and write a report." Teachers and students hold a list of mandatory experiments, and all lab studies are determined in accordance with this list. Some of the experiments are conducted only with the use of computerized simulation.

In the course of the visits to schools, the students were asked to explain what they were doing in the laboratory, why they had chosen to study electronics, and what their expectations were. The students were freshmen or in their second or third year of high school. Some students were interviewed two to four times over the course of their electronics studies. When the students were asked to explain what they were doing, the typical answer was "I'm performing an experiment with a diode . . . a transistor . . . an OR gate." In other words, the students conceived the topic of the experiments in terms of the particular components they employed. They gave theoretical examples of the use of these components in daily life, but not a single school examined possessed appliances such as radios, tape recorders, or alarm systems in their laboratories. As the students advanced through the 11th and 12th grades, the studies became more and more abstract, and a growing gap emerged between the electronics studied in school and electronics in everyday life. For example, a 12th grade program was comprised of a course in communications systems. The students drew a block diagram of a transmission–reception system, wrote down the formulae of AM and FM signals and conducted experiments using a signal generator and oscilloscope. However, the experiments were conducted at low frequencies, such as 10 KHz. None of the school laboratories were equipped with a transmitter of commercial frequency, which could be checked with a commonly used radio receiver. In one case, the teacher improvised a demonstration of a FM broadcast at 100MHz, which was received on the portable radios some of the students possessed. They immediately started to ask questions, such as the distance over which it was possible to broadcast; how much a "real" transmitter, power amplifier, and antenna would cost; and how to set up a private radio station. This example shows that the conventional program for electronics studies in Israel is weak in one of the main purposes of technology education: linking what is learned in school with the real world and dealing with topics that interest the students and arouse their imagination.

Students' Attitudes Toward Electronics Studies

As previously mentioned, electronics studies in high school are elective, giving the students additional points for the Israeli Matriculation Certificate—the "Bagrut." Therefore, students' answers to questions such as "Why did you choose to study electronics?" or "What are your expectations?" reflect to a large extent the status of this field in Israeli education. Discussions with students at the end of their first year (10th grade) focused on expectations for the future. Although they study only basic subjects in their first year, they expect to study more "practical" topics as they progress. They regard electronics as an important and interesting field in which they may find work after graduation. For most students the first year studies are interesting, but not exciting. The 11th and 12th

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grade students study a number of advanced subjects in analog and digital electronics, but they hardly see the correlation between one subject and another, and how they all relate to everyday electronics applications. Electronics students spend two or three hours more per day in school than those studying only scientific or humanities subjects. Most of them do so willingly, in the hope that it will benefit them in the future. Many of the excellent students, who concurrently study mathematics and physics at the highest level, are disappointed. They expressed opinions such as, "If I had known what we would be studying, I would not have chosen electronics studies"; "This is not what I expected"; "I don't really need this for my matriculation certificate." In one of the schools an excellent student said that he did not recommend electronics studies to his brother because "The studies are difficult and not interesting."

Efforts for Change and Renewal

In order to cope with the decline in demand for electronics studies by excellent students, as described above, nine out of the twelve schools examined in this research took steps to improve electronics studies. For example, teachers gave students exercises in searching the Internet for data bases, circuits and mini-projects; schools offered electronics students enrichment courses in computers, such as HTML and C programming, beyond the formal curriculum requirements; schools renovated their laboratories and installed new equipment such as computers, digital oscilloscopes and programmable logic controllers; laboratories were equipped with air conditioning and new furniture, some of them designed like those in Israeli high-tech companies; and mini-projects were introduced into first year (tenth grade) studies. The students themselves built small electronic products such as an alarm or power supply.

Introducing Final Projects as Part of Matriculation Exams

Until about ten years ago each student was required to complete a final project as part of the requirements for receiving an Israeli Matriculation Certificate. Veteran teachers remember this as the "golden era" of electronics studies in Israel. "We used to remain with the students in the laboratory until 10 o'clock at night," recalled one of the teachers nostalgically. Of the twelve schools studied in this research, nine took upon themselves to replace one of the conventional matriculation exams in electronics with a final project in electronics in the 12th grade. This decision was quite difficult, since principals and teachers were apprehensive about taking a step where final results were uncertain. "Why take a chance?" asked one of the principals. "The students' achievements in the regular exams are excellent. We cannot risk their matriculation certificates." In one of the schools the electronics teacher claimed that "The projects are time-consuming, making it impossible to teach the theoretical material and perform the experiments." He focused on the national exams by drilling the students in the compulsory experiments, claiming that this was the best way to succeed. Despite the vacillation, two hundred twelfth grade projects were completed in nine schools in one year, whereas none had been

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completed during the previous year. The following are some examples of events in schools involving final projects:

- The teachers and students from six schools participated in a preparation camp during their summer vacation.
- When projects were approaching their culmination, students and teachers voluntarily remained at school in the afternoons, evenings, and during weekends.
- The standard of topics dealt with by students, in many projects, considerably surpassed what was being taught at school. For example, one of the students conducted a project entitled "Peripheral Protection of a Museum." He built a complete model of a museum including detectors on doors, windows, and exhibits. The system comprised smoke, temperature, and humidity sensors. The whole system was operated by means of programmable logic controllers (PLC). The student devoted days and nights to obtaining information on the sensors from the Internet, building the electronics circuits, and trouble-shooting. He dealt on his own with matters such as measurement, signal amplification, calibration, digital to analog conversion, and programming. This student achieved the maximum that could be expected as far as motivation, initiative, creativity, and diligence. Although he had studied most of the specific topics for the project on his own, the theoretical knowledge of electronics that he had learned at school provided him with a foundation.
- Not all of the projects were on the same level. Some were trivial, like building an electronic circuit that was taken from a popular journal.
- From the above-mentioned examples it is apparent that projects varied considerably in scope, content, and degree of complexity.
- There were occasions when the students changed or expanded their projects on their own initiative without the teacher's consent. Students purchased components or specific tools with their own money in order to further and improve their project.
- Out of approximately two hundred students who undertook a project, only a handful received a low grade or failed in the final matriculation exams.
- The vast majority of the teachers are engineers. While they demonstrate fundamental professional knowledge in all basic electronics subjects, they are not up to date on matters such as advanced programming or digital communications systems.
- A close look at the work of students reveals that they use the "classical" tools and methods for electronics design, drawing, simulation, construction, measurements, and documentation.

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- In a concluding discussion with teachers, one of them expressed the following: “The projects put us under pressure. The students were accustomed to the idea that we (the teachers) know everything and expected us to immediately solve every problem. When they realized that this was not the case, situations that we had not previously encountered developed.”
- In two schools, 12th grade students presented their projects at a get-together with 9th grade students who were about to enroll, and were accompanied by their parents. One of the teachers said: “We must carry out projects next year too so that we will have something to show the 9th graders during their enrollment for school.” In other words, the execution of projects by the 12th graders developed into a means of enhancing the image of the field and attracting new students.
- From information received in the year following the visits to the school, the 12th grade students in all nine schools intend to submit a final project instead of taking the conventional matriculation examination.
- Four of the nine schools reported a significant rise in the number of freshman students desiring to study electronics.

The National Supervision Perspective

The processes described above evolved as an independent initiative taken by schools on the local and regional levels in an attempt to upgrade their programs and to attract excellent students to electronics studies. The national supervision authorities encouraged the introduction of projects into the matriculation exams in electronics and presented the schools’ achievements at teachers’ conferences. Concurrently, a process of upgrading the electronics curricula was started by introducing new and advanced topics such as digital communication, computerized control, robotics, sound processing, and computer vision. The new curriculum aimed at increasing the significance of the use of computers in performing experiments, measurements, and simulations. The study of digital electronics will be carried out through programmable logic devices such as ALTERA, and the work with individual components will be reduced. The guiding principle is the elevation of the level of studies, and matriculation examinations—even if this gives rise to a temporary decline in the number of students enrolled in electronics in the high schools. The title of electronics studies in high school (10th – 12th grade) has been changed to “Electronics and Computer Engineering”.

Discussion

This research examined the processes occurring in electronics studies in a group of Israeli schools over a period of four years. The reference is to technology education within the comprehensive high school. Parallel with the

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study of technological subjects, which comprise approximately one-third of school hours, students learn a wide variety of general subjects. The research was undertaken on a background of a downward trend in the number of excellent students opting for these studies and continuing until the completion of high school. The objectives of the research were to explore the processes occurring in the teaching of electronics in schools, including conventional curricula and pedagogical techniques, changes and innovations implemented in schools, and their influence on teachers and students.

In order to understand present trends in electronics studies in Israel, one must think back 10-20 years ago to the time when electronics studies flourished and reached a peak of success. There were a number of reasons for this. They include the flourishing of the electronics industry in Israel, which created a prestigious image for this area of study; school studies combined theory, laboratory work, and projects; most of the studies took place in laboratories that were more sophisticated than those serving other school subjects; the students were involved with subjects at the cutting edge of electronics at that time; energetic teachers, with a great deal of professional experience spearheaded the subject and influenced the national supervisory authorities who sometimes lagged behind developments in schools. Despite the heavy burden that electronics studies imposed on students, they flourished for a period of some two decades. This picture changed gradually during the last decade of the 20th century. While there has been an accelerated development in computers and computer sciences, electronics studies appear to remain behind. Schools suffered a continual cutting of study hours, as well a shortfall in resources for maintenance of laboratories and renewal of components. There was also a hidden pressure to reduce the workload on students. In the wake of the publication of official "standards" for electronics studies, all schools adopted the minimums. The laboratory studies were confined to the implementation of a list of obvious experiments on which the students were to be tested in the matriculation examinations. All of these have resulted in a sharp reduction of lab studies and almost complete elimination of independent student projects. According to the teachers themselves, in retrospect, this was the main reason why independent and original initiatives of schools to advance electronics studies became more and more infrequent. It took five to ten years before schools noticed the gradual retreat of the status of electronics studies. Some of the teachers made efforts to introduce the use of computers into electronics studies, especially through the wide utilization of computer simulations for the analysis and design of electronic circuits. All too often, however, computer simulation served as an alternative to practical laboratory work and distanced students even more from the world of 'real' electronics.

The critical phase in the efforts to introduce innovations in schools was the inclusion of projects into the 12th grade. The fact that some two hundred students from twelve schools simultaneously submitted a final project as an alternative to conventional matriculation examinations proves that the time was ripe for this change. The advantages of the project approach were etched in the

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memories of teachers from earlier times. The most important step was to stimulate teachers and principals to start this process and to overcome the hesitations, which were based mainly upon the question of preparing the students for the national matriculation examinations. However, after the first two schools began, the idea gathered momentum, and additional schools joined the process. Students' and teachers' work on the projects introduced a breath of fresh air into the classrooms. Despite the extra burden involved in working on projects (in comparison with studies toward the conventional national examination), few students dropped out prior to completing their project. The meetings with students involved in projects, the discussions with teachers and principals, and the events that took place in schools after the introduction of projects in the electronics curriculum proved that this was a turning point in the status of these studies both inside and outside the school. The introduction of projects to electronics studies affected the community and served as the main trigger for the upward trend in the demand for electronics studies among new registrants to the school.

A careful observation of the projects with which students are involved indicates that technology studies and the implementation of projects in high schools vary considerably from situations in which younger students are involved. The more outstanding students seek complex tasks such as those combining analog and digital components, sensors, microprocessors, peripheral components, and programming (e.g., assembler, Pascal, or C). The students use "professional languages" as well as engineering tools such as: physical variables, formulae, drawings, literature, technical catalogues, databases on the Internet, and computer simulation. The instrumentation in a high school electronics laboratory is no different from that in a college electronics lab or in industry. All of the teachers who instruct the students are electronic engineering graduates themselves, and some of them have a background in industry. In many classes there are students whose parents are electronic engineers, who assist them with their projects. As mentioned earlier, not all the projects undertaken by students were at a high level of originality or complexity. When tens and even hundreds of projects are undertaken, it is natural that there would be a variety of levels and diversity among students, teachers, and schools. However, the fact that all the projects were conducted under the wide umbrella of professional electronics reflected on the motivation of the students and their achievements.

Conclusions

There are those who would question whether the in-depth study of electronics, or any specific technical field, leads to the achievement of the goals professionals set for technology education. The answer is that teaching good electronics by itself is not enough. What matters is the kind of task with which we confront the students. Outstanding students elect to study electronics in high school in anticipation of dealing with the design and construction of sophisticated instrumentation and advanced systems for electronics,

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communication, control, and robotics. However, more often they find themselves studying a series of unconnected theoretical subjects and undertaking standard laboratory experiments, the results of which are obvious from the outset. We attempt to raise students' motivational levels by trying to convince them that, after the basic studies, they will be able to engage in what really interests them. But in fact they never seem to achieve this. The result is disappointment and frustration. Educational literature has emphasized for years that the role of education is to develop higher order cognitive skills and intellectual competencies. Schools continuously struggle with the question of how to arouse the interest of students in their studies and how to foster curiosity, initiative, and consistency in confronting aims and challenges. These are unquestionably the declared objectives of technology education. The present research shows that implementation of pedagogical methods that develop students' intellectual capabilities is an overt as well as covert demand of the students themselves and not merely a matter of a determination from above. Outstanding students seek challenging tasks, open-ended assignments, freedom to experiment, to err and learn from mistakes, and to reach their own capability. A major stumbling block preventing schools from adopting this conception in the high schools is what appears to be the risk of confronting students and teachers with open, challenging assignments.

One should not ignore the fact that high school studies are largely oriented toward the national matriculation examinations. On the face of it there appears to be a conflict between realizing the expectations of students to deal with advanced technological subjects and the responsibility of teachers to help them achieve high marks that will open the portals of desirable universities. Apparently, students and teachers must choose between confronting the unknown or the well-trodden path. The results of this research demonstrate unequivocally that deep at the heart of the matter, excellent students are prepared to invest tremendous effort in technological studies provided they anticipate an interesting assignment. They are not, however, willing to engage in technological studies in which the objective is to obtain another good mark in the final certificate. This conclusion is in consonance with what is known to educational and psychological literature, namely that creativity, the motivation to study, and consistency in action are inspired by intrinsic rather than extrinsic gratification (Sternberg, 1988; Hennessey & Ambile, 1998).

Students cannot grapple with open-ended assignments and challenging tasks unless they acquire a foundation of theoretical knowledge and practical expertise in a specific area, such as basic electronics or control systems. There is nothing wrong with theoretical studies and conventional laboratory work as part of the school day. Educators and curriculum developers should identify core curricula and focus on this, but there is no need for the comprehensive study of methods for analysis and design, as is so often demanded. What is required is the optimum balance between basic theoretical studies and grappling with open-ended assignments and projects throughout the period of studies rather than just

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at the final stage. This is the key for transforming high school technology studies into a desirable objective for the most outstanding students.

A Final Observation

Two medical students, high school graduates in electronics, were invited by the school principal to meet with new students and their parents. One of the parents asked them why, after putting so much effort into the study of electronics in high school, they did not continue in the same field in university. The graduates' answer was that studying electronics in high school does not necessarily mean continuing in this field later. Once they had graduated from high school, they could have been accepted into any field of academic studies in the university. Furthermore, they felt that their electronics studies equipped them with the knowledge and tools to succeed in medicine and perhaps to be better doctors.

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