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Conceptions Towards Early Academic Studies in Computer Science: Focusing on Students, Lecturers, and Parents

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Abstract: The goal of this study was to identify conceptions towards early academic studies in computer science. We focus on a program which offers high school students the unique opportunity to earn a B.Sc. degree in parallel to their studies, resulting in them holding a prestigious degree at an early age. Activity theory framed the design of this study. Fifteen voluntary participants representing three distinct research groups participated in this study: students, parents, and lecturers. The data were collected using a qualitative research paradigm through semi-structured interviews. The findings demonstrated that the research groups mostly held distinctive conceptions. Little similarity may be detected. We argue that high school students are more likely to succeed in early academic programs when they have a rigorous curriculum, an on-staff educational consultant, and lessons that are exclusively attended by other students in their peer group. These types of programs, in our opinion, are well positioned to develop exceptional and gifted individuals' educational potential.

Keywords: advanced STEM students; early academic studies; activity theory

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1. Introduction

1.1. Early Academic Studies

The primary goals of early childhood gifted education are to facilitate intellectual engagement and challenge for young children through meaningful activities and to develop lifelong learning habits in them from an early age, which lead to success in college and beyond [1]. Education programs for gifted students provide valuable opportunities for them to learn and access resources not available in traditional classrooms [2]. Developing STEM interest and identity is influenced by students' perceptions of their abilities in mathematics and science [3]. Early preparation in mathematics and science is essential to the development of students' positive perceptions of their abilities, since as they transition from elementary to middle and high school, their perceptions of their abilities tend to change [2]. Being actively involved in academics is regarded as a necessary component for success, flexibility, and resilience in the classroom [4].

Academic programs for high school students affect academic achievement, specifically by promoting positive youth development and by integrating education-related activities that are critical to these processes during adolescence [5–7]. Embedding students in university courses is a framework dedicated to developing students with high intellectual potential, and one of its purposes is to integrate and coordinate efforts for the development of mathematically talented individuals [8].

One of the most common options for early academic studies is Advanced Placement (AP) courses, which provide high school students with the opportunity to take rigorous coursework in preparation for college [9]. In AP science courses, high school students study science and other subjects at a more rigorous level than is offered in standard high school

courses [10]. Several studies have shown that AP courses are beneficial to students [11,12]. The AP courses and their corresponding exams are a crucial part of the college preparation and admission process for students who hope to attend academically competitive 4-year colleges and universities [13].

1.2. High-Ability Students

The expectations placed on gifted and talented students to perform at a superior level to their peers often put them under pressure. When compared to an average-ability student, a high-ability student has a faster thinking speed, is more flexible in his use of strategies, has a better memory, knows more, and prefers complexity [14,15]. Given their abilities, these students often feel bored in courses intended for average students [16], resulting in a loss of motivation [17,18], and, consequently, underachievement may occur [19].

Due to their high intelligence, gifted students are often mistakenly believed to succeed without special programs or teacher efforts [20–22]. To bring out students' skills, talents, and abilities, they need differentiated learning and supportive teaching strategies. Gifted students need teachers who can identify their potential and assist them [23,24]. Studies typically positively portray academically gifted students' interpersonal skills, particularly their peer relationships [25–29]. Additionally, research shows that most gifted and talented kids have strong personal resources and are socially mature [30].

A suitable learning environment for highly able and talented students has always been promoted by gifted and talented education [31,32]. Students who might otherwise be underchallenged and undereducated in school are the focus of gifted and talented services [33]. Gifted students receive more educational support, advanced coursework, highly qualified teachers, and a more demanding learning environment than non-gifted students in gifted and talented education programs [34]. Two general strategies—acceleration and enrichment—have emerged. Academic acceleration is the process of moving high-ability students through a program of study more quickly or at a younger age than is customary [35]. Acceleration helps high-ability learners both immediately and later, especially academically [36]. Enrichment extends, supplements, and occasionally even replaces aspects of the regular curriculum [37]. Maintaining children with peers of the same age but also promoting the development of higher cognitive and affective processes is one goal of implementing enrichment programs [38].

Many nations have difficulty coordinating educational activities for gifted education with overarching societal goals because they lack specific goals for gifted education and talent development [39]. Education programs and practices benefit gifted and talented children over time by raising their goals for college and careers, assisting them in making post-secondary and career plans, and assisting them in obtaining more advanced degrees [40–42]. The goal of educational programs for gifted and talented students is to prepare them to contribute to society as independent, creative, and productive learners [43–45].

Achievement goals are internal, future-focused cognitive structures that give engagement a purpose and that control thoughts, emotions, and behaviors while a task is being performed [46,47]. The goals that are connected to students' motives for academic success, or achievement objectives, are the ones studied most frequently in educational psychology studies [48]. It is necessary to examine adolescents' social aspirations because social issues during this period become more prominent [49]. Additionally, in collectivist contexts, where social motivation is thought to be more potent, the study of social objectives may be even more crucial in educational research [50].

Aristotle is generally credited with the following wise words: "Educating the mind without educating the heart—is no education at all". It has been unclear how being talented might affect social–emotional competencies because giftedness has generally been defined by the individual's cognitive functioning and talents [51]. When it comes to academic and social emotional learning, gifted and talented individuals might sometimes struggle in traditional classroom settings [52]. There are two main concerns in the literature about children who are cognitively talented. The first has to do with the distinct profile of social–

emotional skills that distinguishes talented individuals. The second concern is over the educational environments and initiatives designed to support and foster the intellectual and social growth of gifted children and adolescents [53].

While some research suggests that gifted students have higher emotional intelligence than average-ability students [54,55], other research has found no discernible differences between these two learning populations [56]. The findings of a meta-analysis indicated that it is inaccurate to assume that students who are intellectually bright have high emotional intelligence. When comparing gifted individuals to non-talented students, the IQ gap is significantly larger than the emotional intelligence gap [57]. In the classroom and in daily life, gifted children experience a wide range of both happy and negative emotions of different intensities, all of which have the potential to engage their emotional aptitudes and talents. Additionally, they may feel fear when confronting a challenging math or science problem, envy when observing the achievements of talented peers, rage when subjected to unfair treatment by classmates or teachers, and guilt or shame when disappointing loved ones or falling short of expectations. Understanding and managing emotions are crucial emotional abilities for students to have because of the wide range of emotions they encounter [51].

Based on empirical research, proponents of gifted and talented education programs contend that raising the academic potential of students and inculcating self-control and independence in the workplace call for high levels of educational services, advanced curricula, stimulating and challenging learning environments, and professionally trained teachers [32]. A gifted student's curriculum, according to [58], should provide regular opportunities for them to work in their areas of talent and passion. They must also be challenged in addition to working in these areas [59]. The educational curriculum mandated by gifted and talented students is different from the ordinary curriculum offered to students by regular schools. Since they may set themselves apart from their peers, they need educational programs that are tailored to their needs [60].

Most of the opposition to using acceleration seems to be based on the widespread worry that students will experience excessive stress or may develop social problems [61,62]. Ref. [61] claims that acceleration programs frequently assume that all students will achieve the same goals and outcome, so they present the same material to them all while paying little attention to individual needs. Despite concerns, the research on the effects of acceleration (mostly from the U.S.) suggests that gifted and talented students benefit academically from acceleration and that acceleration poses no direct risk to their social and emotional development [63]. With few negative side effects, acceleration seems to have a positive impact on students' academic performance [64]. When applied to larger populations of high and average achievers, the use of enrichment, differentiation, acceleration, and curriculum improvement has led to higher accomplishments of gifted and talented learners as well as regular students [65–69]. Studies have indicated that there are advantages to employing gifted education programs and techniques when teaching high-ability and gifted students from various ethnic backgrounds [65,70]. When educating gifted and high-ability students from many ethnic groups, recent research has shown the benefits of using gifted education programs and practices [65,70]. According to research [64], almost all students who participated in the acceleration program thought that it had improved their academic performance.

1.3. Activity Theory Model

Activity theory draws theoretical linkages between motives and activities, goals and actions, and conditions and tools [71]. Its organizational structure is hierarchical, with motives and activities preceding goal-oriented actions and underlying tasks or conditions determining operations and tools (Figure 1). Goal-oriented activities, which direct actions toward anticipated outcomes, are a crucial component of activity theory. Activities are made of groupings of actions, which can then be decomposed into operations depending on the circumstances in which they are carried out. The activity theory model provided

the conceptual and structural framework for this study's data analysis. The research groups shared the same motive and activity components, while the other components were determined through interviews.

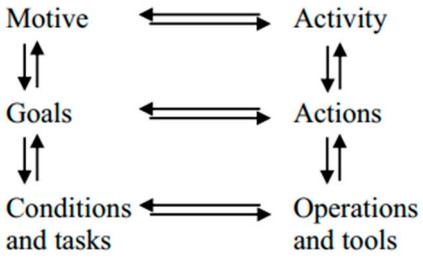

Figure 1. Activity theory model [71].

2. The Study

2.1. Research Goals

The goals of this study were to identify conceptions towards early academic studies in CS held by students, lecturers, and parents, and to analyze the similarities and differences between them. This will help us understand the best and most appropriate way to create programs of this type; e.g., designing more student-friendly programs will be made possible by understanding what aspects of these programs students deem useful vs. useless. Also, it will allow us to offer suggestions and instructions for running programs that are comparable.

2.2. Context

The context for this study was the Challenge (Etgar in Hebrew) program at the University of Haifa, a four-year program that offers adolescents the unique opportunity to earn a B.Sc. degree in CS in parallel to their high school studies. This program is designed for high school students with high abilities who are not sufficiently challenged by their school studies. Its purpose is to realize the students' academic potential to the maximum extent, which will allow them to earn a prestigious degree in CS at an early age.

2.3. Participants

Fifteen interviews were held with three different research groups with five participants each: students who studied in the program, parents of students who studied in the program, and lecturers who teach in the program. All participated voluntarily in this study. Table 1 presents the participants' characteristics; numerical references are used throughout the work.

Table 1. The participants.

Research Group	**The Students**					**The Parents**					**The Lecturers**				
Name	S1	S2	S3	S4	S5	P1	P2	P3	P4	P5	L1	L2	L3	L4	L5
Age	18	17	18	18	17	43	50	58	59	51	67	64	43	54	51
Gender	F	F	M	M	F	F	M	M	M	F	M	M	M	F	F
Sector	J	J	J	A	A	A	A	J	J	J	J	J	J	J	J

S: student; P: parent; L: lecturer; F: female; M: male, J: Jewish; A: Arab. Note: The parent research group consisted of different individuals who were the parents of students participating in the student research group.

2.4. Tools and Data Collection

Data were collected using individual semi-structured interviews. Different questions were posed to the participants, and each question was accompanied by a prompt. Overall, the interviews included 13–15 general questions accompanied by several clarification

questions. Each interview lasted from 60 min to 90 min. Table 2 presents examples of the questions.

Table 2. Examples of questions.

The Students	The Parents	The Lecturers
Why did you make the decision to apply for the program?	Would you be interested in accompanying your child to meetings with program personnel, or lectures?	What characteristics are required to be successful in the program?
How many hours do you devote to the program each day, outside of the classroom?	What kind of room does the program take up in your family's life? Do you discuss it at home?	What distinguishes program participants from those enrolled in regular classes?
What aspects of the program do you love and find relatable? What aspects of the program do you relate to and like the least?	What resources should parents be prepared for and invest in?	Would you want to take part in a program like this or one that was comparable when you were a high school student?

2.5. Data Collection Process

The first author addressed the participants, explaining the research and its goals, and conducted all the interviews and carried out all the data collection. After receiving their consent to participate in the research, the interview dates were set in advance. The participants were required to sign an informed consent form. Since the interviews were held during the coronavirus pandemic, all interviews with the students and the students' parents were conducted in Zoom sessions, video-recorded, and approved by the participants. Among the interviews with the lecturers, one was conducted frontally and was audio-recorded, two were voice-recorded during phone conversations, and two were conducted in Zoom sessions and were video- and audio-recorded, according to the convenience and at the request of the lecturers.

2.6. Data Analysis

The data analysis was performed in two steps and combined directed and inductive content analyses [72,73] (Figure 2). The activity theory model was implemented in relation to each research group's conceptions (author, in press). Correspondingly, we analyzed the interviews focusing on goals, actions, conditions, and tools, addressed and characterized by the following question words: "Why?", "What?", "How?", and in relation to "Who?":

Who is the interviewee, a student, a parent, or a lecturer?—This question focuses on the study participant;
Why study in the program?—This question aims to determine the goals;
What are the critical features of the program?—This question seeks to define the actions;
How can the goals be achieved during the program?—This question attempts to identify the conditions and tools.

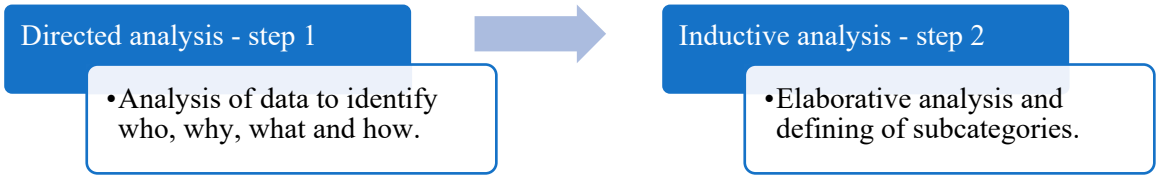

Figure 2. Data analysis.

3. Findings

The research findings are divided into three sections. Per the activity theory model, each section outlines the reference to the question "Who" and presents the findings for one of the three research groups. We discuss each study group's responses to the "Why", "What", and "How" questions, as detailed in the data analysis.

3.1. The Students

3.1.1. Why?

Four major goals were identified among the students: realizing their potential; interest and challenge; army service; and career. a. Cognitive goal—realizing their potential. The students stated that their participation in the program helped them realize their potential and strengthen their abilities, while acquiring knowledge. b. Affective goal—adding challenge to life. c. Pragmatic goals—the desire to secure a bright future through two main paths: meaningful military service and the development of a desirable career. Table 3 presents excerpts exemplifying these goals.

Table 3. Students' major goals and excerpts exemplifying them.

Cognitive Goals	
Realize potential (frequency—3/5)	• "I decided to go to the program because I thought it would allow me to express my strengths. . . I didn't feel that I was fulfilling my potential in other places, such as at school. Fortunately, in the program I do feel that way" (S2). • "I applied to the program because I think it is an option for me and other students to increase and strengthen abilities, fulfill our potential" (S5). • "My teacher told me that I should try and apply to the program because he thinks I have the ability to succeed in it and I can realize the great potential that I have, in his opinion" (S3).
Affective Goals	
Challenge (frequency—3/5)	• "I wanted to add challenge to my life. I felt that the things I learn today at school are easy for me" (S5). • "And then I said fine, maybe I should try since this field is interesting and will be very challenging for me. And to be honest I believe in adding challenge to life and not 'going' only for the easy and convenient things" (S1). • "I wanted to apply because I knew that it would be challenging for me, and I never say no to challenges" (S2).
Pragmatic Goals	
Army service (frequency—2/5)	• "With the knowledge you obtain in the program you can contribute a lot...in the army for example...I personally see something very important in contributing in the future to the army" (S1). • "Now I'm in the process of recruitment for all kinds of different positions in the army. I have many options thanks to my studies. I am still debating what to choose, but it is clear to me that I won't compromise and will apply for a position where I can make a significant societal contribution" (S3).
Career (frequency—2/5)	• "I want to apply to job positions in Rafael [an Israeli government company, engaged in the development and production of advanced weapons], or maybe the Ministry of Defense. They have programming positions that I will be able to apply to thanks to my studies in the program" (S2). • "I cannot leave my home to work for companies since it is against my religion. That is why I'm considering starting my own business and continue living in the village. With the knowledge I get through studying for my degree, I may establish a profession working from home in the subject of computers. The studies offer me work opportunities that I didn't have previously" (S5).

Table 3 shows that S1 and S2 discussed their inner desires in relation to the goal of realizing their potential, whereas S3 discussed an external want, in this case, his teacher's. All three of the students quoted agreed that one of the reasons they chose to enroll in the program was to add challenge to their lives. Students 1 and 3 mentioned that they opted to enroll in the program knowing that their studies and degree would enable them to be accepted into key positions, allowing them to make significant contributions to the army and society. This goal is congruent with the mandatory requirement to enlist in the army in the State of Israel. S2 did not specify this goal because she is from a religious family and is expected to perform national service instead; S4 and S5 did not specify this goal since they are from the Arab sector and are not expected to enlist. The pragmatic goal of a career came up in all the interviews conducted with the students. According to S2, she enrolled in the program because she hopes to be hired by a reputable organization. S5 said that because of her schooling, she now has employment opportunities that she previously did not have because of the nature of her religious life.

3.1.2. What?

One major action was identified among the students—the investment of time. All the students stated that to succeed in their studies, they invest a lot of time. Beyond the study hours, the studies in the program require time to prepare homework, time to prepare for tests, and time to practice the material at home. Table 4 presents excerpts exemplifying this.

Table 4. Students' major actions and excerpts exemplifying them.

Invest time (frequency—5/5)	• "I invested a lot in a specific home exercise in the probabilistic methods course, which was very challenging...it could take a few hours, it could be a little more...a few hours a day usually. I spend as much time as I can. I also go through the subject again before class" (S1). • "I spend as much [time] as I can practicing the material at home" (S4). • "I put in a lot of time. I also enroll in a lot of classes. I've taken three courses per semester up until now, and this semester I'm taking four. The program's courses take up 12 h per week; an English course takes up 4 h, and I also have a 2 h-per-week online course. I therefore spend 18 h per week studying. You must also factor in the hours that I spend practicing the material at home, doing exercises, and putting together assignments. Overall, I invest a lot of time in my studies" (S2). • "I go through the material I studied many times. I find it challenging at times to focus on Zoom. So, I go over the lessons and exercises again. Also, doing schoolwork takes time and a lot of it" (S5). • "I spend five to six hours each day. Some days more, some days less. It depends on the specific course" (S3).

Table 4 shows that all five of the students acknowledged investing a lot of time in their studies in the program. This time included the actual course time as well as the time spent reviewing the content at home, practicing exercises, and putting together assignments.

3.1.3. How?

Four major conditions and tools were mentioned by the students as significant elements in their success: two were internal—overcoming concerns and mathematical knowledge—and two were external—peer group and administrative and emotional support. I. Overcoming concerns—the students revealed that although they were worried about enrolling in the program, stressed out, and even afraid, they chose to apply in order to attain the aforementioned goals. II. Mathematical knowledge—according to the students, early mathematical knowledge is beneficial to students and allows them to be more successful in computer science studies. III. Peer group—all the students stated that studying in the program allowed them to get to know other students their age with whom they have a common language and common interests. This fact added to the positive experience of the students and helped them succeed in the demanding and challenging studies. IV. Receiving significant support from the administrative coordinator as well as emotional support from the program's educational consultant. Table 5 presents excerpts exemplifying the above.

Table 5. Students' major conditions and tools, and excerpts exemplifying them.

Personal	
Overcome concerns (frequency—4/5)	• "At first, I came to the program with a little apprehension...you know. Like everybody. But I decided to try it" (S3). • "At first, I didn't plan to apply to the program, especially not in something that you don't study at all in school and I'm a little unfamiliar with it, or I don't know at all to be more precise. But I told myself it is worth a try" (S1). • "I never thought I would go to university alone at a young age and deal with the difficulties alone. But I did. And it was a good call" (S5). • "So, I started with this program when I didn't really want to, I must say. It sounded so scary in the open day when they presented the program" (S2).

Table 5. *Cont.*

Personal	
Mathematical knowledge (frequency—3/5)	• "Mathematical knowledge is required. It's preferable to have a good and strong mathematical knowledge. I am positive that it helped me" (S5). • "Obviously, a background in mathematics and a background in CS helps. I don't think I would have passed the first summer without a good background in mathematics" (S3). • "I think that CS is based on mathematics. Without mathematics, CS would not exist. I started studying in the program after completing five units of mathematics, so I had good mathematical knowledge" (S4).
Impersonal	
Peer group (frequency—4/5)	• "You study beside those who are your age, and in the same situation as you. A common language all the students understand. You also meet new friends who accompany you, which makes the studying more enjoyable. For me personally, this encouraged me to stay in the program even when it was hard and challenging" (S1). • "I really liked that it is with kids my age and I can connect with more people like me. I have more to talk about with them. And that was really one of the things that made me decide to stay and study in the program" (S2). • "I have a few friends from before the program, and more friends that I got to know in the program, and we became a group of good friends that love each other... Everyone becomes attached to whoever is more like them. . . Socially, I'm fine. I have a lot of friends that I'm glad I found thanks to the program" (S3). • "It is very convenient for me that we study in classes only with other students from the program, and not students from the department. It made it very easy for me. I am relieved that these are children my age" (S4).
Administrative and emotional support (frequency—3/5)	• "You always have someone who listens to you, for example- when registering for courses at the beginning of the year. You really have someone to talk to, it is pleasant and helpful. My personal meetings with the educational consultant are also a big help for me when it comes to succeeding in the program" (S3). • "They register me, and I don't have to deal with all the administrative stuff, which is great for high school students. Like when I phone T. [the administrative coordinator], she is immediately available to assist me. She enrolls me in courses and other things" (S2). • "I never miss a personal meeting I have with the educational consultant. That is where I express myself, let off steam, get support, and feel encouraged" (S1).

Table 5 shows that S2 and S3 both admitted that they began the program's study sessions with a sense of concern. The latter even asserted that, in his view, all students begin their studies with a comparable level of unease. S5 revealed that she did not think she had the potential to attend a university at such a young age and without family or friends she knew from before, and S1 did not think she would enroll in a program in which she would learn a new subject that she knew nothing about. And yet, despite everything, they all expressed happiness about their choice to enroll in the program. S3 and S5 argued that success in CS studies requires a solid background in mathematics. Along with S2, all three students said that their strong mathematical backgrounds benefitted them in their program studies. S2 and S1 agreed that one of the main factors in their decisions to continue studying in the program, despite the difficulties and tremendous challenge, was the fact that only students of their age are enrolled in it. Because of this, the program's participants share a common language and set of interests, which makes interactions and the program itself easier and more enjoyable. S4 added that this is also an advantage within the various courses, and S3 shared that he is appreciative of the opportunity to meet new friends who have similar interests, thanks to the program. Both S2 and S3 mentioned that they receive administrative support that facilitates and aids them. They are not expected to deal independently with administrative matters on their own, which, in their opinion, is challenging for those in their age group. In addition to administrative support, an educational consultant provides the students with emotional support. S3 noted that this assistance also aided in his success. S1 added that, among other things, she uses her one-on-one sessions with the educational consultant for self-expression and feeling uplifted.

Figure 3 presents the implementation of the activity theory model in relation to the students' conceptions that were analyzed focusing on goals, activities, conditions, and tools.

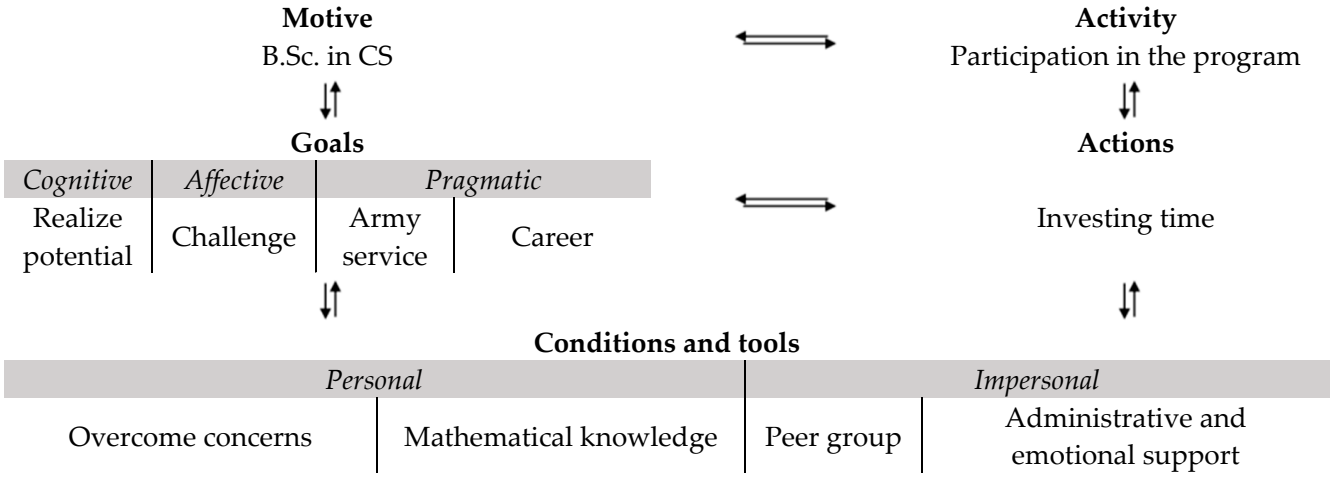

Figure 3. Activity theory model implementation in relation to students' conceptions.

3.2. The Parents

3.2.1. Why?

Two major pragmatic goals were identified among the parents: army service and career. This program allows their children to earn a B.Sc. degree in CS before starting military service and before their assignment to positions in this service. The parents perceive the program as promoting the chances that their children will be placed in key positions. The children will contribute to the country, but, at the same time, will weave connections and knowledge that will also advance them, as they will be able to be accepted into desirable job positions, develop careers, and earn high salaries. Table 6 presents excerpts exemplifying the above.

Table 6 demonstrates that according to P3 and P4, the program enables students to apply for critical roles in the military, for instance, in the domains of computing and intelligence. P5 revealed that her two kids' initial enrollment in the program was motivated by their explicit aspirations regarding their army service. P1, P3, and P4 stated that because of the program and receiving a degree, the students can be accepted for prestigious positions in the workforce. P1 noted that her son's desire is motivated by his drive to earn a high monthly salary.

Table 6. Parents' major goals and excerpts exemplifying them.

Pragmatic Goals	
Army service (frequency—3/5)	• "These students are the elite who can later be in the army in all fields of computing and intelligence. It's a very nice thing since during the recruitment process, the program gives her an advantage over others" (P3). • "It's important for them to enjoy their army service and that is why they applied the program. Otherwise, they wouldn't have come. It is specifically important for them to enlist for a unique and competitive position" (P5). • "They won't be able to advance far in the army without participating in the program. The program is a springboard for them" (P4).
Career (frequency—3/5)	• "I'm trying for a moment to put an emphasis on the future part. Because that's what's interesting. These guys can get accepted into desirable jobs, because of participating in the program" (P4). • "He said: 'I want to be a manager, a CEO of a high-tech company, and I want to earn at least 50,000 shekels a month'. We believe that he will succeed to thanks to his studying" (P1). • "They may find employment in high tech. They can obtain good jobs once they have earned their degree" (P3).

3.2.2. What?

Among the parents, we identified two major actions: the provision of emotional support and transportation. All parents stated that they do everything in their power to make it easier and help their children to succeed in the program. The parents' express interest, ask questions, and, above all, listen. Most of the interactions between the parents and their children revolve around the program. Additionally, they make every effort to provide their children with transportation to and from the university. Table 7 presents excerpts exemplifying this.

Table 7. Parents' major actions and excerpts exemplifying them.

Provide support (frequency—3/5)	• "The program takes up at least 60% of the time when he interacts with us, his parents. We pay attention, support, and help. Whatever he requires" (P4). • "He shares with me and says things like: 'Dad, I think that I answered the question wrong' etc.'. And there is nothing to do, despite you being so tired. It doesn't matter, you must listen and must understand. And sometimes he talks to you in Chinese or Yiddish and you don't understand what he's talking about. But you listen to him" (P2). • "The main thing is to talk to her and inquire about the world around her. Sadly, we only have a little time with her. Both of us are incredibly busy. So, in the limited hours we do have, we are highly engaged, listening, asking questions, and providing any assistance we can" (P3).
Transportation (frequency—4/5)	• "Sometimes I ask my husband to stay extra hours at work so that he can pick up our son from the university so he can avoid having to take the late bus alone" (P1). • "Until he got his driver's license, we drove him to the university. It was held twice a week some semesters and once a week other. I occasionally make time just to drive them to the program and back home" (P4). • "The transportation is another aspect of our side that contributes. Whenever we could, we took her to the university" (P3). • "Since I work nearby, I occasionally pick him up late in the evening after classes" (P2).

According to Table 7, the parents shared that the program occupies a sizable portion of their families' lives. P3 and P4 said that they, the parents, support and assist in every way that they can. P3 noted that despite being extremely busy, they continue to do this. P2 said that despite his extreme exhaustion and inability to comprehend his son's remarks, he constantly listens to him. All parents except P5 stated that, whenever possible, they drive their children to the university and/or back home. P4 specifically schedules time for this, and P1 mentioned that she specifically asks her husband to work longer hours for this.

3.2.3. How?

Among the parents, we identified two major conditions and tools: the peer group and money. The parents stated that the fact that the students are in the same age group is important and essential for their children. Furthermore, they referred to their investment of money to facilitate and help their child. Table 8 presents excerpts exemplifying this.

Table 8. Parents' major conditions and tools, and excerpts exemplifying them.

Personal	
Money (frequency—3/5)	• "We paid for his studies, of course, and gave him money to spend on meals and snacks. Without money, it is more difficult to succeed in the program. The cost of university studies is very high, and I think that some families struggle to make ends meet, which unfortunately prevents their children from enrolling in such a program" (P4). • "The financial burden is significantly larger because I have twins studying in the program. It was likely that we would assist them in paying for their education after their army service, but in that case, they would also have been able to work and to partially support themselves. Since now they are high school students, we are the only ones paying" (P5). • "Parents need to understand that taking part in this program costs money, and lots of it. Along with paying for the academic degree, you must assist with things like printing and binding. This is also a financial expense" (P3).

Table 8. *Cont.*

Impersonal	
Peer group (frequency—2/5)	• "Since all students are in the same age group, social gatherings among these particular students, will create some kind of catalyst that can ignite all different kinds of relationships within the group, whether boys and girls, all different kinds of connections that then help them collaborate on shared goals" (P3). • "They benefit from the Corona pandemic because they are not required to go outside, attend school, or interact with other kids. They don't have many friends at school because they are different from most of them. In the Challenge program they are all great kids who are comparable to one another. They are in the same peer group. They have made friends and want to hang out with them even outside of class hours" (P5).

Table 8 shows that P3 emphasized the significance of having a group of students the same age since it fosters teamwork and mutual inspiration among the students. P5 mentioned that her sons have made friends because they are the same age with similar characteristics, and they have even expressed a wish to meet and hang out with them in their free time. In the interview conducted with P3, P4, and P5, the importance of money was mentioned. P4 stated that it is difficult to succeed in the program without money, and that children from families with low socioeconomic status are unable to enroll in such a program. P5 and her husband bear a double financial burden because both of their boys are enrolled in the program. P3 also mentioned that there are additional costs besides the cost of the studies themselves, such as that of printing files.

Figure 4 presents the activity theory model implementation in relation to the parents' conceptions that were analyzed focusing on goals, activities, conditions, and tools.

3.3. The Lecturers

3.3.1. Why?

Two major goals were identified among the lecturers: to help students realize their potential and to improve the quality of the students in the CS department: a. cognitive goal—the lecturers stated that by participating in the program, the students may reach their full potential; b. pragmatic goal—the desire to improve the quality of the students in the CS department. Table 9 presents excerpts exemplifying the above.

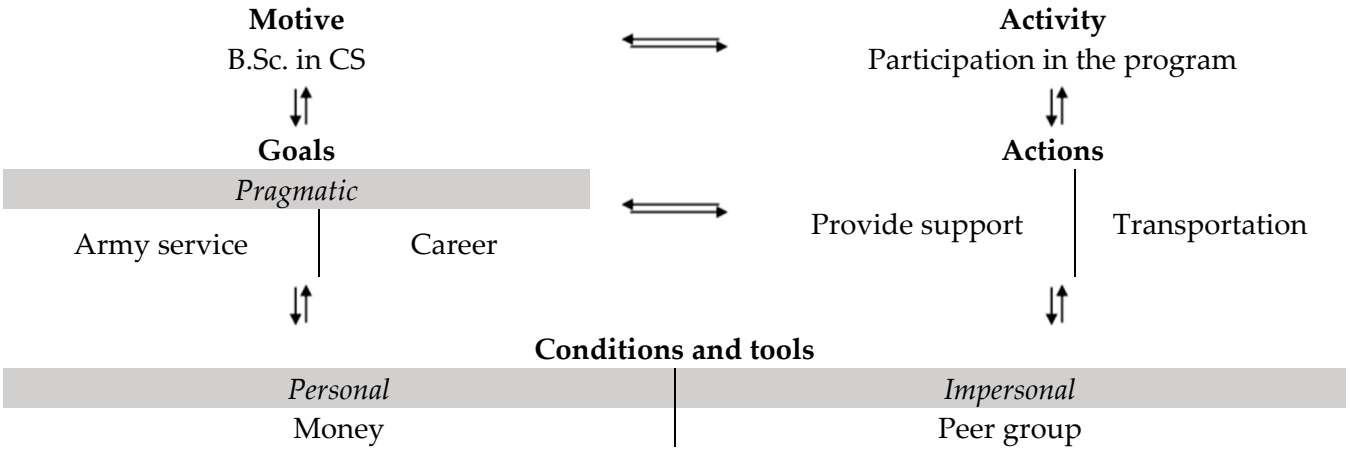

Figure 4. Activity theory model implementation in relation to parents' conceptions.

Table 9. Lecturers' major goals and excerpts exemplifying them.

Cognitive Goal	
Realize potential (frequency—5/5)	• "This is truly a life-changing kind of program. These kids fulfill their high potential. If they are successful, I believe that it can change their lives for the better, including their sense of independence, and their perception of their abilities. I believe this will have an extremely long-term impact" (L5). • "The program was established to find a solution for outstanding high school students in the municipal system. . . In the 15 years since the beginning, the program has been serving outstanding and exceptional students in the country's north. . . Looking back, the program far exceeded expectations, and offers a solution for those outstanding students. These students, exactly as planned, realize their high potential. . . this program encourages and helps them reach their full potential" (L1). • "Of course, most of them are outstanding, gifted, and brilliant children. They can achieve and realize their huge potential thanks to this unique program" (L4). • "This program addresses very bright youth with exceptional ability and helps them reach their full potential" (L2). • "Every semester I get to teach in the program, I meet more and more gifted adolescents with amazing skills. There is no question that this program is ideal for them. This is the place they can fulfil their potential" (L3).
Pragmatic Goal	
Improve the quality of students in the CS department (frequency—3/5)	• "The program, in my opinion, is the best thing that happened to the CS department. The program's student population is without a doubt the most successful group in Israel for obtaining a bachelor's degree; if you compare it to the average first-year enrollment at other universities, which is between 300 and 400, it becomes obvious that these program students are more successful. It's obvious" (L2). • "The Challenge program students improved the quality of the students in the CS department by two orders of magnitude and they are currently the spearhead of the department's students" (L1). • "It is impossible to compare the level of discussion, or the level of questions, or even the level of understanding between a student in the Challenge program and a student in a regular class. The Challenge program students are ten levels above, in every matter, such as in understanding the requirements and in the mathematical discourse in general" (L5).

3.3.2. What?

Among the lecturers, we identified one major action. Lecturers see their action as providing enrichment and deepening students' knowledge. Among other things, these aspects include mathematics and academic learning that is immersive and enriching. Table 10 presents excerpts exemplifying this.

Table 10. Lecturers' major action and excerpts exemplifying it.

Enrichment and deepening students' knowledge (frequency—3/5)	• "I consider my work in the program to be kind of a mission. I come to show the students the beauty of mathematics. . .the things they never got to see before. Certainly not at school, and I'm not sure if they see it at the academy either" (L5). • "I try to incorporate learning challenges, inquiries, and creative problem-solving into my lessons. Giving the program's students this room is important to me because I believe they can think deeply and extensively" (L3). • "My field of teaching is unfamiliar to them. Many of them know nothing about psychology. Most of them have never heard of it. And I believe that my contributions go far beyond what is learned in the program" (L4).

Table 10 reveals that L5 stated that one of her goals for the program's students is to introduce them to new and exciting mathematical concepts. L4 stated that she benefits students and broadens their perspectives by introducing them to the discipline of psychology. Both lecturers asserted that the students are unfamiliar with these subjects. L3 stated that he hopes to give the program's students a challenging and stimulating learning environment since he thinks they are capable of thinking creatively and outside the box.

3.3.3. How?

Among the lecturers, we identified three major conditions and tools: the peer group, administrative and emotional support, and designing a dedicated, unique curriculum that includes courses specifically for the program's students, carefully chosen lecturers who have undergone a background check, and more. Participating in the program allows the students to meet and get to know other students similar to them and create new and essential friendships. In addition, the program staff includes an educational consultant who provides essential emotional support alongside an administrative coordinator for the program. Table 11 presents excerpts exemplifying the above.

Table 11 shows that L2, L1, and L3 all mentioned that they have each created a special curriculum specifically for the classes they are teaching in the Challenge program. L2 and L3 said that they increased the difficulty and challenge of the program's lessons because of the students' high abilities. The peer group within the program was emphasized in the interviews with L4, L1, and L5. According to L4 and L5, most of these students struggle socially in school. However, they succeed socially in the program because they interact with children who are generally like them. The peer group, L1 continued, is crucial because the program participants and regular departmental students are at completely different stages of life. L1 and L4 pointed out the significance and necessity of the administrative and emotional support that the students receive as part of their studies. The students, according to L1, are the focus of the program, and they assist them in every way possible, including emotionally. L4 stated that this support benefits all students.

Table 11. Lecturers' major conditions and tools, and excerpts exemplifying them.

Personal	
Designing a dedicated, unique curriculum (frequency—3/5)	• "If there was a similar program when I was in high school, I would have applied. What draws me to the program is the fact that the program is very organized and very suitable for young students. Everything is structured very correctly. The program's classes I teach are more difficult and require deeper thinking than the others. People that truly appreciate learning and want to learn are those who enroll in the Challenge program, not those who come only to earn a degree and check it off the list" (L2). • "This course did not happen by accident, just because... It is like I imagined and wanted it to be. I have been managing it for so many years and I do so entirely on my own" (L1). • "I think it is a great choice that they learn apart from the other students in the department and do not mix. Designated classes only for the program students is a wise decision. The courses I teach as part of the program have a different format than the courses I teach as a regular part of the CS department. Among other things, I make improvements and add another level of creative thinking because the program participants frequently have more aptitude" (L3).
Impersonal	
Peer group (frequency—3/5)	• "There are children for whom the program is the best social motivation that could happen to them... and some of them create a group of equals that they don't have anywhere else, and it helps them a lot. . . Every year I can point to students for whom the program has given them the opportunity to meet new friends" (L4). • "The fact that the students studying in the program are from the same peer group is important. The jokes are not as funny to program participants as they are to regular students. A 26-year-old student already resides with his girlfriend. The Challenge program students live with their parents and siblings. They are preoccupied with other issues. Life is different at this point" (L1). • "If we identify the children for whom this program is a good fit, we will genuinely promote them in every possible way, socially as well. These are adolescents that occasionally struggle socially in high school. In the program, they interact with kids who are very much like them here, which helps them develop" (L5).

Table 11. *Cont.*

Impersonal	
Administrative and emotional support (frequency—2/5)	• "This program differs from similar programs in that the student is at the center of interest, the focus of this program. And we think that safeguarding the learner is of utmost importance. And so, for example, we have an educational consultant, who looks after all issues which are unrelated to the academy, from mental strain through interactions with the parents, the school, etc." (L1). • "Not to mention the superb employees. The greatest thing to ever happen to this program is T. [the administrative coordinator] her assistance. And the personal counseling they receive from L. [the educational consultant]. Here, every little thing has been considered. Sensitivity toward every single child" (L4).

Figure 5 presents the activity theory model implementation in relation to the lecturers' conceptions that were analyzed focusing on goals, activities, conditions, and tools.

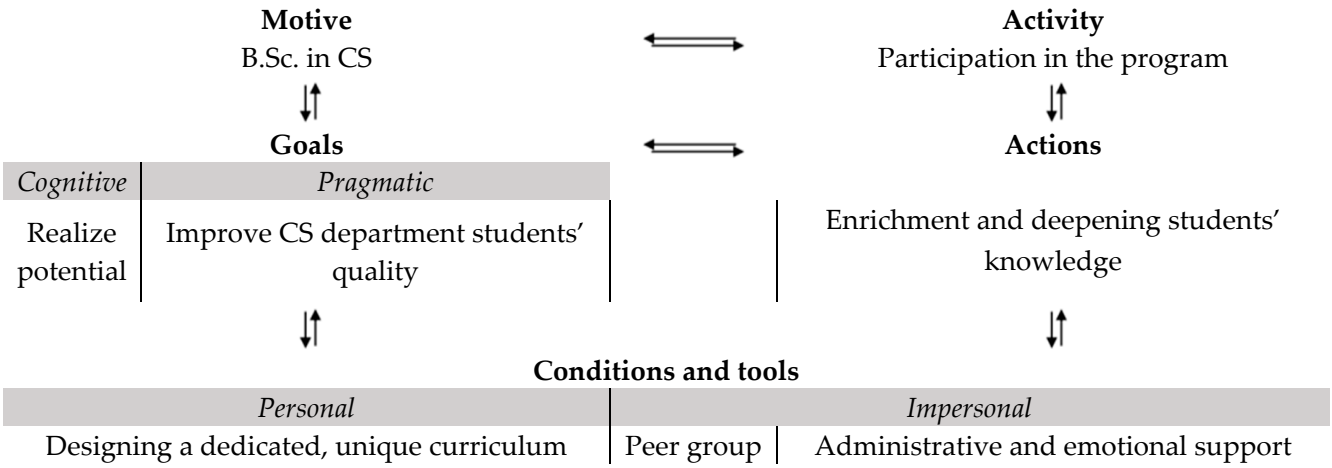

Figure 5. Activity theory model implementation in relation to lecturers' conceptions.

4. Summary and Discussion

This study aimed to identify conceptions towards early academic studies in CS held by students, parents, and lecturers who teach in the program, and to analyze the similarities and differences between them. To attain this goal, we performed individual semi-structured interviews. The findings demonstrate that while the three research groups' responses to certain activity theory model's dimensions varied, there were some aspects for which there was similarity among the participants. The three research groups' conceptions are compared in Table 12, along with the frequency of each one.

The three research groups stated a total of five major goals as reasons to enroll in the Challenge program (Table 11). Realizing the potential of the students was a cognitive goal that all five lecturers and three students agreed upon. Three students indicated their desire to add interest and challenge to their lives as an affective goal. The three additional goals identified were pragmatic goals. Enlistment in important and valuable military positions and entrance to desired and lucrative career positions were two goals that aimed to secure a bright future for the students. Both goals were expressed by two students and three parents. During three interviews with the lecturers, the third pragmatic goal was discovered: the students participating in the Challenge program raised the quality of the students in the CS department.

Four distinct actions were noted among the participants. All five of the students recognized their actions as dedicating time to their studies in the program. Three interviews with the parents revealed that they gave their children support, and four parents stated their action as transporting their kids to and from the university. Among three of the lecturers, the action of enrichment and deepening students' knowledge was identified.

In order to address the question of how these goals can be attained, six major conditions and tools—four personal and two impersonal—were discovered in the interviews. Between the three research groups, there was no commonality among the four personal conditions mentioned. Four students said that they had to push past their reservations and that their understanding of mathematics helped them with their coursework. Three parents mentioned using money as a tool, while three lecturers mentioned creating a special curriculum. The conception of a peer group was cited by all three research groups—four students, two parents, and three lecturers—as a factor in the students' success and general well-being. The administrative and emotional support that comes with participating in the program was discussed in three interviews with students and twice with lecturers.

Table 12. Frequencies, similarities, and differences between the three research groups' conceptions.

Who?	**Students**	**Parents**	**Lecturers**
Why?			
Cognitive Goal			
Realize potential	3	-	5
Affective Goal			
Challenge	3	-	-
Pragmatic Goals			
Army service	2	3	-
Career	2	3	-
Improve the quality of CS department students	-	-	3
What?			
Invest time	5	-	-
Provide support	-	3	-
Transportation	-	4	-
Enrich and deepen students' knowledge	-	-	3
How?			
Personal			
Overcome concerns	4	-	-
Mathematical knowledge	3	-	-
Money	-	3	-
Designing a dedicated, unique curriculum	-	-	3
Impersonal			
Peer group	4	2	3
Administrative and emotional support	3	-	2

According to research on gifted and talented students, many of them fail to reach their full potential in part due to school-related problems that induce underachievement [52]. Therefore, it makes sense that the goal of realizing potential came up in all interviews conducted with the lecturers and with three students. Rawlins [64] investigated acceleration programs in mathematics within New Zealand secondary schools from the perspective of the participating students. It was discovered that a secondary benefit of these programs was that they raised students' expectations for their potential career pathways. The students as well as the parents in the current study acknowledged that pursuing a career was also a goal for studying in this program.

Challenge is frequently brought up in research findings on the characteristics of the ideal learning environment for high-ability students [18,52,74–76]. Gifted and talented students, particularly those in elementary and intermediate schools, are not challenged in the classroom [52]. A differentiated curriculum that offers challenge at an appropriate pace is essential for the highly capable student, as is their social and emotional well-being [77].

Marra and Palmer [75], in their study on the learning preferences of university students with high and low developmental levels, conclude that high-ability students prefer more challenge. Students' reports on the processes of their learning, motivations, challenges, and abilities showed that they perceived that learning was at its peak in the period in which the challenge level most exceeded the ability level [78]. Many students valued the chance to study one or more Year 12 subjects before the rest of their age group and appreciated the challenge of working at a higher level [64]. All of these findings are consistent with our research, which demonstrates that one of the students' enrolment goals was to increase challenge in their lives.

According to Gottfried et al [79], there are significant differences between the homes of children identified as gifted and those of children not identified as gifted. The former are distinguished from the latter by higher levels of intellectual stimulation, more active parental involvement, more exposure to both academic and cultural activities, and lower levels of domestic and family conflict. Families with high-achieving children share traits such as more active parenting and more encouragement for schoolwork at home [80,81]. As the current study demonstrates, the parents' support-giving actions toward their children are consistent with the literature.

One action was noted in the interviews with the lecturers in this study. The delivery of instruction ought to be planned to best match the needs of students. Finding techniques to enhance student learning performances should be the main objective of modifying or revising how instruction is delivered [82]. One of the four key features of high-quality learning experiences in the context of an accelerated course, as outlined by [83], is the teaching methodology. Active learning techniques stress the depth rather than the breadth of the given subject, combine small and large group discussions, and use practical and experiential learning techniques, which are all examples of good teaching techniques.

All three research groups identified the conception of a peer group, indicating that all agreed on the importance of this conceptualization. A review of the literature supports this. It has been shown that participating in talent-related activities with peers not only makes these activities more enjoyable but also affects decisions about how gifted students express their abilities and which academic activities they choose to pursue [84,85]. Children need friends and the approval of others, so they identify with and are influenced by their peers [86,87]. This need might even be more pressing in adolescence than in earlier years. A person's motivation and relative success can be aided by relationships, which can be a significant source of happiness and well-being [84,88,89]. The teenage stage of life is defined by several cognitive, emotional, and social changes [90–93]. Hence, the literature supports the peer group conception that was identified in the findings of this study.

There are positive relationships between adolescents' perceptions of social support, academic success, and social growth, [94]. Research conducted in New Zealand found that many educators and parents were concerned about the unacceptably high risk of social and emotional maladjustment that students in acceleration programs face [61,62]. Studies show that certain intellectually gifted children frequently struggle with social and emotional difficulties because of a mismatch between their strong cognitive skills and their susceptibility to psychological issues [95,96]. It follows that administrative and emotional support were of great value in the eyes of the students and lecturers.

The lecturers stated that designing a dedicated, unique curriculum for high school students is their best personal method to accomplish the program's goals. This is supported by the literature. Compared to their peers, gifted students have different learning, social, and emotional needs. As a result, the research strongly supports the need for programs to have curricula that are well prepared and differentiated [97]. A differentiated gifted curriculum, according to [98], comprises acceleration, complexity, depth, challenge, and creativity.

According to the current study's findings, programs for high-ability students should emphasize their cognitive, affective, social, and pragmatic program goals. The curriculum should provide students with challenge, and the lecturers in these kinds of programs should enrich, develop, and broaden the students' knowledge. The lecturers' assessments

that the students greatly enhance the faculty are another noteworthy discovery. Even while this calls for extra investment, of several types, and a specialized curriculum, the institutions that offer them stand to gain in the long run. The fact that the chance to be challenged was enough to attract their interest even if they were not particularly interested in the computer science field indicates that the program's design is more significant than the subject matter studied, which implies that these programs can be marketed to gifted and talented students with a wide range of interests.

Also, the significance of the social setting should also be considered when designing specialized acceleration programs for youth, since numerous studies demonstrate the significance of peer groups at these ages. In accordance with our study, the majority of students understood the value of socialization and considered the program's ability to help them connect with like-minded classmates. Our research highlights the value of relationships with peers who are of the same age, as opposed to acceleration programs where students learn with significantly older peers. Furthermore, we think it is crucial for students participating in programs of this kind to have an educational consultant, since accelerated students may be socially or emotionally harmed due to stress. In the higher education system, educational consultants are rare, yet the results of this study indicate that they have a significant—possibly even indispensable—role, when it has to do with gifted and talented students in general and gifted and talented high school students in particular.

Meeting the many and varied needs of students in today's schools is a challenge for educators, but it is possible. In addition to improving student learning results, higher education programs must also become more marketable [99]. This study's findings have implications for schools looking to create or change their policies regarding gifted and talented students, as well as other acceleration initiatives. All parties involved in the implementation of gifted and talented student education must reconsider what it means to be gifted, how to assist students who require gifted programming, what these programs are, how to structure them, and how to assess their effectiveness. This includes teachers, administrators, policymakers, parents, and the students themselves.

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