

**Integration of Arab female students at the Technion-
Cultural aspects and mathematical identity**

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Research Thesis

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הכרת תודה

עבודה זו נכתבה בעזרתם של אנשים משמעותיים עבורי אשר ליוו אותי לאורך כל התהליך שעברתי בתקופת כתיבת התזה שלי ובדרך שעברתי לפניה. אני מבקשת להודות לכל אחד ואחת מהם:

למנחה שלי ד"ר עינת הד מצוינים, על ההנחיה הפורייה והמקדמת, על התמיכה ההכלה והחום שהענקת לאורך הדרך, על הסבלנות וההתחשבות, כל זה יחד עם מתן הזדמנויות רבות למחקר וללמידה וכתיבה מחקרית ותקנית לכל אורך הדרך. הרבה תודה על העידוד והדחף לכתוב באנגלית כי בלעדייך לא הייתי מקבלת החלטה כזו וגם לא הייתי מגיעה לשלב הזה בזמן הקצר יחסית שהיה לי. תודה ענקית על התמיכה לאורך ההיריון, הלידה וגם בכנס שנערך אחרי.

תודה לקבוצת המחקר, רחל הס-גרין, גלית שבתאי, רינת באור, מרב וינגרדן, מרים וולך, נעמה בן דור, סווטלנה עמונאולה על הייעוץ והתמיכה במהלך הכתיבה ועל האוזן הקשבת.

תודה לקבוצת המחקר תקשורת המדע, קרן דליות, יעל בראל בן דווד, אביב שרון, יעלה גולומביק וכאותאר זועבי. על התמיכה העזרה הייעוץ והעידוד והיחס החם שהענקתם לי בעתות ייאוש.

תודה לצוות המנהלי של הפקולטה ובמיוחד לשקמה כלפון על היחס החם, התמיכה, והעידוד המתמיד. תודה לחברים והחברות שלי על הייעוץ, האוזן הקשבת והתמיכה לאורך כל הדרך.

תודה לדודה שלי היקרה, דינה, ששמרה לי על התינוק לשעות ארוכות ובשבתות ונתנה לי את הזמן והשקט לשבת ולכתוב.

תודה עמוקה במיוחד נתונה להורי היקרים ולאחים והאחיות המקסימים שעזרו לי מקרוב ומרחוק, עודדו בעתות ייאוש, תמכו ועזרו בכל מה שהיו יכולים, והיו חלק משמעותי בכל התהליך.

תודה מיוחדת נתונה למחמוד, בעלי היקר, על הסבלנות והסובלנות, על העזרה בנשיאת הנטל, על שעות השיתוף ועל התמיכה וההכלה התמידיים, על ההתייעצות והדחף להמשיך הלאה. לילדיי המקסימים, מיראן שרה ועורסאן, תודה על הסבלנות, החיבוקים, המלים המקסימות שכתבתן לי, על השמחה, האהבה ועל הכוחות שנתתם לי לצבור ולהמשיך הלאה.

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1. Abstract

The purpose of this research was to understand Arab female students' acclimation process in studying STEM (science, technology, engineering and mathematics) in the academia, focusing particularly on the Technion. The main theoretical framework used was that of figured worlds, which are realms of interpretation with characteristic actions, values, actors, and roles. The figured world of the Technion was compared with the Arab females' home figured world. Figured worlds offer certain opportunities to author identities and enact agency with relation to the *space of authorship* – those narratives in the figured worlds that are authored by the person and are relevant to the author's identity. In addition, the study builds on the commognitive framework and its definitions of identity as a collection of reified and significant narratives about a person. These narratives can be about the current situation (current identity) and about the future, expected or wished for situation (designated identity). This discursive conceptualization of identity is coupled by the commognitive theorizing of mathematical learning as a process that develops from ritual to explorative participation.

The research questions were: (1) How do the participants author their identities, current and designated, during the first stages of their acclimation into university level mathematics studies? In particular, how do these identities develop in relation to assisting and constraining factors in the students' figured worlds? (2) In what ways do the participants enact agency in relation to: a. The narratives regarding ethnicity and gender in their space of authorship? b. The academic mathematical discourse they are expected to learn, specifically, calculus.

The study was qualitative and involved 13 Arab female undergraduate students from the faculties of Computer Science and Electrical Engineering studying at the Technion in their first semester. Research tools included two semi-structured interviews, at the beginning and end of the semester, two diary interviews during the semester and stimulated recall interviews around mathematics tutorials.

Data was analyzed using a grounded theory approach coupled by discourse and narrative analysis. The participants' mathematical discourse was analyzed according to the theory of commognition.

Findings included recurring gaps between the participants' evaluations of their selves as learners (current identity), which deteriorated as the semester progressed, and their expectations of themselves to excel (designated identity). Agency was found to be a crucial aspect of successful acclimation, cultivating choice in the face of very high academic demands, as well as complex social and political conflicts. The social stress to succeed, coupled by the structural constraints of learning in a foreign language and in a different figured world, led students to ritual participation in mathematical learning.

The significance of the study lies in turning attention to the importance of Arab female students' awareness of the social and ethnic conflicts they face upon entering a foreign figured world. Also, the study contributes to our understanding of the interaction between cultural and mathematical identities, showing how such interactions shape the ways in which students participate in mathematical learning.

2. Introduction

The Arab Minority in Israel suffers from decades of educational disadvantages. Arabs have consistent lower achievements in school, as measured by PISA and TIMSS studies (<http://cms.education.gov.il/EducationCMS/Units/Rama/MivchanimBenLeumiyim/>).

Yet in recent years, a growing number of high-school graduates enter universities and succeed in obtaining post-secondary degrees. Much of this growth is related to the increasing participation of female students in university studies (Arar & Haj-Yahia, 2016). This growth has not bypassed the Technion. According to the Unit of Advancement of Students at the Technion, there is a significant increase in the number of Arab female students who get accepted to study STEM. However, the Unit also reports that Arab female students' dropout rates are higher than average and many of them find it difficult to get past the first semester.

Not much is known from the research literature about the difficulties these female students' face, particularly with entry-level mathematics studies. In this study I aim to improve our understanding of Arab female students' acclimation process in studying STEM (science, technology, engineering and mathematics) in the academia, focusing particularly on their mathematical studies at the Technion.

Out of all the faculties, the highest percentage of Arab female students failing at the end of the first semester happens in the faculties of Computer Science and Electric Engineering. This makes these faculties an ideal place to learn in depth about the difficulties that Arab female students encounter and the factors that enable certain students to succeed, despite these difficulties.

Since the first semester at the Technion consists mostly of mathematical subjects, these subjects are often an obstacle for undergraduate students. Thus there is a good reason to believe that Arab female students do not only experience difficulties stemming from being a minority but also difficulties having to do with their mathematical identity and difficulties with studying skills, which may have been formed in a high-school environment very different from that of the Technion. Therefore, this study will track how cultural identity interacts with mathematical identities and how these interactions shape the ways in which female Arab students participate in mathematics courses.

3. Theoretical background

The Arab Minority in Israel is under-researched; not much is known about the challenges and processes students, and in particular, female students from this minority undergo in their quest for higher education. This scarcity of knowledge is most prominent with relation to mathematics and engineering academic studies. In what follows, I first review minorities and higher education, in particular, the Arab minority in Israel. Next I outline possible relations, based on existing literature, between cultural and mathematical identities of students in the university world. Finally, I introduce the concepts of identity, agency, space of authorship and forms of participation in mathematical learning (ritual vs. explorative) that will assist me in examining the relation between cultural and mathematical identities in the case of female Arab students.

3.1 The Arab community and higher education

Arabs in Israel consist of 20.5% of the general population (Central Bureau of Statistics, 2018). Out of these, 83% are Muslims, 9% are Christians, and 8% are Druze. The Arab minority in Israel are not a minority of migrants or immigrants, they are an example of an involuntary minority (Flum & Kaplan, 2016). There are long standing tensions between the Jewish majority and the Arab minority in Israel; these tensions have encouraged geographical, political and social separation between them (Flum & Kaplan, 2016; Kaplan, Abu-Sa'ad, & Yonah, 2001; Schiff, 2002). The separation also exists in the educational system - pre-college education is completely separated between Arabs and Jews. The Arab minority has an independent educational system, where Arabic is the official language (Cinamon, Habayib, & Ziv, 2015), however, this system suffers from decades of deprived resources leading to much lower achievements in the Arab sector, as compared to the Jewish sector (Al-haj, 2003, Mustafa & Arar, 2009).

One of the main difficulties that Arab students face when reaching post-secondary institutions is the Hebrew language (Roer-Strier & Haj-Yahia, 1998). Even students whose Hebrew speech and comprehension abilities are high, find themselves facing a challenge when they study for the first time in a system that is conducted entirely in Hebrew (Mar'i & Amara, 2002; Olshtain & Nissim- Amitai, 2010).

Arabs are certainly not unique in their challenges they experience as a minority group and the difficulties accompanied by it relating to education. Many studies (Flum & Kaplan, 2016; Nasir & Saxe, 2003; Phinney, Dennis, & Osorio, 2006; Shavit & Blossfeld, 1993) discussed the relationship between ethnicity (minority groups) and integration in higher education. For example, Shavit and Bolssfeld (1993) explored societal conditions which help reduce existing inequalities in educational opportunities among 13 industrialized countries. They show that students from different social and economic levels suffer from inequalities in educational opportunities and that inequalities have remained remarkably stable since the early 20th century. Nasir and Saxe (2003) talked about the tensions experienced by youth from minority groups, focusing on Afro-American students. These students experience tension between their ethnic and academic identities, while they position themselves or are positioned by others in relation to an academic practice.

Yet, despite the challenges, it is mostly agreed that higher education enriches the lives of minority students in general, and Arab students in particular. Often, it allows them to move from the margins of society closer to its centers of power (Arar & Abu Rabi-Queder, 2011; Arar & Haj-Yahia, 2016). According to Mustafa and Arar (2009), women from minority groups feel obliged to integrate into higher education more than men from the same group; they perceive higher education as a means for achieving equality with men. Because of their growing participation in higher education, the social status of women and their role in the Arab community in Israel has been changing (Mustafa & Arar, 2009; Shapira & Hertz-Lazarowitz, 2002). In the past few decades, the representation of the Arab sector in Israeli universities is growing slowly yet consistently (Arar & Haj-Yahia, 2016). According to the reports of the Council for Higher Education (<https://che.org.il>) The percentage of Arab students studying in Israeli universities in undergraduate, master and doctoral studies in 2010 was 10.2, and increased in 2017 to 16.1 (Council for Higher Education (2018, January 25)). The change is even more dramatic when looking at female Arab students' enrollment in higher education. The last two decades have seen a significant increase in the number of Arab female students, from 40% to 63.3% of all Arab undergraduate students (Arar & Haj-Yahia, 2016). This rise starts first in the secondary education. The proportion of

female Arab students completing matriculation in STEM subjects rose from 63% in 1999 to 82% in 2013 of all Muslim female students eligible for matriculation. Christian female students saw a similar rise, from 69% in 1999 to 85% of in 2013. Still the percentage of female students in tertiary STEM programs is very low. Only about 7% of Muslims women turn to STEM studies. Among Druze and Christian women, the percentages are slightly higher (13% for each group), but still lower than the percentage among female Jewish students (16%) and much lower than the percentage of men who apply to the STEM professions among Arab men (26% of Muslims, 34% of Christians and 38% of Druze) (Fuchs, 2017).

Again, the increase in Arab students' participation does not come without its challenges. Since universities are often the first multicultural encounter between Arabs and Jews, Arab students may feel like strangers in the Israeli academy, which is considered by them as essentially a Jewish institution (Arar & Abu Rabia-Queder, 2011). The challenges experienced by Arab male students are coupled by the difficulties female Arab students experience, which relate to changing gender roles in this relatively traditional society (Abu-Rabia-Queder & Weiner-Levy, 2008; Arar & Masry-Herzalah, 2014). University studies are often the first occasion for these girls to leave their home-village and be exposed to western, secular culture, a transition that often causes a "culture shock" (Arar & Haj-Yahia, 2016). Abu-Rabia-Queder and Weiner-Levy (2008) studied the psychological changes to Bedouin and Druze women's identities when they returned from studies in Israeli universities to their homes and culture. They found that these women experienced difficulties upon their return to their home culture, because the new culture (university culture), which was no longer strange to them, provided a new ideal and source of aspirations, which were foreign to the culture and values of their home village.

Though, as cited above, several researchers have already started inquiring into the challenges that the Arab minority face in general and Arab female students face in particular, the subject has not been addressed by studies in the field of mathematical education. The few studies that have been made on the Arab minority in relation to mathematics (e.g Forgasz & Mittelberg, 2012) have been on school students. These studies found that Arab female students in Israel are surprisingly equal to boys in

choosing advanced mathematics, and even superior to their male peers concerning school mathematics achievement and motivation. These findings are surprising because the situation is quite the opposite in the Jewish sector, where girls consistently choose less than boys to pursue advanced mathematics level courses in high school. Ayalon (2002) termed this phenomenon a “sociological paradox”, where “the poor curriculum of Arab high schools enhances the chances of Arab female students to be exposed to highly valued knowledge” (p. 63).

Yet the superiority of Arab female students in high-school mathematics does not carry on to academic level mathematics (Fuchs, 2017). Moreover, the internal data of the Unit for the Advancement of Students at the Technion shows that despite a sharp increase in recent years in the number of female students enrolled in engineering studies at the Technion, there is a higher dropout rate than usual among them, and a relatively high percentage of them finish their first semester with an "Improper academic status", which means their success rate and grade average are not acceptable.

According to Arar & Abu Rabia-Queder (2011) and Arar & Haj-Yahia (2016), Arab students face barriers and difficulties relating to higher education in Israel. Influenced by these barriers and difficulties related to a new and different cultural world for Arab students, they form their identities in the academic space.

Although previous studies deal with Arab minority and higher education, the process of integration of these students in Israeli universities is still not understandable. Understanding this process demands anthropological theoretical tools that would aid in characterizing the change that students experience in their transition from the home to the academic world, and the process of change in identity that takes place during this transition. For this, the theory of identity in figured world is particularly useful.

3.2 Identity within figured worlds

The focus on identity is related to socio-cultural conceptualizations of learning as becoming a participant in a certain community (Lave & Wenger, 1991; Sfard & Prusak, 2005). Communities are characterized by shared values, forms of action and

interpretative schemes. These communities have been defined by Holland, Lachicotte, Skinner, and Cane (1998) as “figured worlds”, where a figured world is defined as “a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued by others.” (p.52). In the case of Arab students, the home, family and village figured world is extremely different from the predominantly Jewish, technological and western figured world of the university. Arabs in Israel live in a traditional and collective world where women have little exposure to men, while in higher education, people from different genders and different cultures, religions and nations mingle (Abu-Rabia-Queder & Weiner-Levy, 2008).

In the literature, identity is defined while using different layers of reference. According to Wenger (1998), identity is "a way of being in the world" (p. 151) and "a layering of events of participation and reification by which our experience and its social interpretation inform each other" (p. 153). Sfard and Prusak (2005) distinguish between two types of identities, current identity and designated identity. Current identity is characterized by stories about the current situation, for example, "I am good in mathematics". Designated identity is characterized by stories about the expected situation- what the person will become in the future, for example, "I want to be a computer engineer in Google".

Since higher education is a new and different cultural world for Arab students, it has an impact on intrapersonal dynamics and the shaping of their identity (Brooks & Waters, 2011). As a result of these dynamics, students in this new world need to understand themselves and to shape their identities. Holland, Lachicotte, Skinner and Cain (1998) define identity as people's "self-understandings, especially those with strong emotional resonance for the teller" (p. 3). This definition can be related to Arab students, when they experience emotional conflicts between different circles of identity in higher education: academic, social, religious, gender, and national. As a result of these conflicts, Arab students formulate a new identity which is appropriate to their experience in that new culture. Shaping a new identity can be made possible by the different conflicts that students experience and the knowledge acquired through academic courses and social daily life (Arar, 2015). In a study conducted by

Vasquez-Salgado, Greenfield, & Burgos-Cienfuegos (2015), the researchers found that students from collectivist backgrounds experience a conflict in higher education in relation to their home-school culture. Whereas relationships with teachers and other students in high-school were usually long-lasting, in the higher education environment emphasis is put on individualism, alongside temporary relationships between teachers and students.

The concept of "identity" is common in research on learning in general, and in research about learning mathematics in particular. However, this concept is still fuzzy and controversial (Bishop, 2012). Many studies have found a relation between students' identity and learning mathematics (Bishop, 2012; Boaler & Greeno, 2000; Heyd-Metzuyanim & Sfard, 2012; Sfard & Prusak, 2005). Sfard and Prusak (2005) claimed that learning, is the "closing of the gap" between current and designated identities. In other words, those are the actions that we take in order to move from what we are to what we wish to become.

Students' mathematical identity is influenced by various factors in their social environment. Martin (2006) studied the influence of the social environment, and especially parental influence, on students' mathematical identity. He found that Afro-American students and their parents had perceptions of mathematics related to their racial origin. These parents emphasized the importance of learning mathematics in order to promote their children's integration into society. Like Afro-Americans who constitute a minority group in the United States, the Arab minority in Israel views mathematics as an important tool to allow them to be accepted to Israeli universities and academic subjects, which will enable them to integrate into the Israeli labor market and get broader employment opportunities (Shapira & Hertz-Lazarowitz, 2002).

In order to study the relation between culture and mathematical identity, I rely on Sfard and Prusak's (2005) study, where relations were found between students' narratives about culture and the learning and doing mathematics. Sfard and Prusak focused on the Israeli culture as opposed to the culture of former USSR. The participants of their study were native Israeli students and immigrants' students from the former Soviet Union, studying in grade 11 towards the 4-5 units mathematics matriculation exam. While mathematics was a deeper part of the immigrants' identity,

native students saw mathematics as a tool which allowed them to be accepted into various fields of study in universities.

Although Sfard and Prusak (2005) pointed to the importance of culture in shaping current and designated identities, they did not inquire into the process of transitioning from one culture to the other. For capturing the difference between the home and the academic setting, the theory of figured worlds (Holland et al., 1998) may be useful, since it enables characterizing and operationalizing the elusive concept of "culture" or "cultural differences".

Holland and colleagues' (1998) link between identity and figured worlds through the concept of "space of authorship", which are, broadly, the narratives from the figured world that form the basis for authoring a particular identity. Holland et al. point out that the space of authoring is always a contested space "where social languages meet, generically and accentually, semantically and indexically, freighted with the valences of power, position, and privilege." (p.191). I link these ideas with Sfard & Prusak's (2005) definition of identity as a set of reifying, significant and endorsable narratives about a person. Thus, identity stories told by a person about herself (1st Person stories) often echo 3rd and 2nd Person stories told to her by others (or about her to other people).

As explained above, the space of authorship is the realm of narratives from which identity narratives are picked up, contested against and negotiated. In the struggle to influence the words (or narratives) of oneself or others, we necessarily enact *agency* (Holland et al., 1998).

3.3 Agency

Agency was defined by Holland and her colleagues, as "the realized capacity of people to act upon their world" (p. 42). This capacity is enacted through the orchestration of various narratives: "arranging the identifiable social discourses/practices that are one's resources" and form his/her space of authorship (p. 272).

Previous studies investigated identity and agency in school mathematic classrooms (Boaler & Greeno, 2000; Braathe & Solomon, 2015; Cobb, Gresalfi, & Hodge, 2009). According to a study conducted by Boaler and Greeno (2000), students who learned

mathematics in didactic mathematics classrooms, where the teachers presented procedures and students were expected to enact these procedures, developed negative attitudes toward mathematics and were restricted in their ideas. In addition, they did not consider mathematics as a part of their future. In contrast, students in conceptually oriented classrooms, where the structure of the lessons afforded more agency, developed more positive attitudes toward mathematics and considered mathematics as a part of their designated identity. Also Cobb, Gresalfi and Hodge (2009) found that the forms of agency that students can legitimately exercise in particular mathematics classrooms, together with how authority is distributed, are influenced by the way they are accountable to mathematics and to other students. Braath and Solomon (2015) discussed the theoretical and methodological issues in exploring students' identity and agency within a narrative of "choosing mathematics". According to this study, mathematical identity is not fixed because individuals encounter, throughout their lives, new cultural resources. Agency is engendered by processes of appropriation or rejection of these cultural resources.

Despite the term 'agency' gaining increased attention, the term itself is difficult to define. In this study I relate to agency as a possibility of choice. By this, I rely on Braath and Solomon who stated that "It is requirement for choice, and continuous action, which almost forces agency". (2015, p. 155)

Though, as cited above, several researchers have already started inquiring into culture and mathematical identity, most of these studies focused on student interviews before or after learning, which is different from investigating mathematics learning in action. In order to investigate how identity affects and is influenced by the processes of learning itself, Heyd-Metzuyaninm (2011) investigated identity through the stories that students tell about themselves during mathematics class.

3.4 Ritual and Exploration mathematical discourse

Following a sociocultural view (Sfard & Prusak, 2005), I will relate to learning mathematics as a change of person's mathematical discourse while becoming part of a discourse community. Discourses were defined by Sfard (2007) as "different types of communication that bring some people together while excluding some others" (Sfard, 2007, p. 573).

In this study, I will use this sociocultural view of discourse - as communicating with oneself and others - to try to understand the process of learning mathematics as it happens concomitantly with changes in Arab female students' identity. Based on the sociocultural view of learning, the commognitive framework provides an appropriate set of conceptual tools to link between students' identity and their mathematical narratives. According to the commognitive framework, the process of learning can be studied from students' mathematical communication by examining identifiable mathematical narratives. For example: mathematical words (words that are related to quantities and shape), routines (patterned ways of how mathematics perform), and narratives (theorems, definitions...) (Adler & Sfard, 2017). To analyze students' mathematical discourse as it interacts with identity narratives, I rely on Heyd-Metzuyanim's (2015) methodology, where mathematical discourse in the classroom was divided into two categories: 'Mathematizing' which was defined as talking about mathematical objects, and 'subjectifying', which was defined as talking about the participants in the discourse. Subjectifying actions were divided into those about oneself (1st Person subjectifying) or about others (2nd P and 3rd P subjectifying). (p.5). Using these categories, it was possible to reconstruct students' identity authoring even when they were not directly asked about it. This was particularly useful for examining identity construction in mathematical participation (Heyd-Metzuyanim & Sfard, 2012).

Sfard & Lavie (2005) defined the process of learning mathematics as moving from a ritual phase, where the aim of the activity is pleasing others, to the explorative phase where the learner aims to produce new mathematical narratives by oneself for their own sake. Ritual and explorative participation are governed by certain meta-rules or "patterns in the activity of the discussants" (Sfard, 2008, p. 201). While exploration is a process of producing new narratives about mathematical objects, ritual routines are characterized as an act of solidarity with some socio-rules toward pleasing others rather than producing mathematical narrative in the activity.

Sfard & Prusak (2005) showed that instrumental goals leading to ritual participation have to do with cultural values that influence designated and current identities. In previous studies (Heyd-Metzuyanim, 2013; 2015), instrumental goals have been

connected with ritual engagement in mathematical learning, where the focus is on the performance of procedures according to external authority, rather than on producing new mathematical narratives for their own sake.

To summarize this literature review, I have shown that several researchers have already started inquiring into the challenges that the Arab minority face in general and Arab female students face in particular, yet the subject has not been treated yet by studies in the field of mathematical education. Thus, in order to study the interactions between cultural and mathematical identities and how these interactions shape the ways in which Arab female students participate in mathematical courses, I rely on the theory of figured worlds, including the concepts of identity, space of authorship, and agency. These concepts can assist in explaining the Arab students' transition between the two different figured worlds. I add to that the commognitive theory, including the concepts of discourse, mathematizing, ritual and explorative learning participation, to enable me to examine the interaction between students' identities and their mathematical learning processes.

Thus, my research concerns the interactions between cultural and mathematical identities, and the ways by which these identities shape students' participation in mathematical courses. My aim is to study the ways that Arab female students author their identities, the agency that they enact and their mathematical participation in the first stages of their acclimation into a new academic figured world – the world of engineering studies at the Technion.

3.5 Research questions:

- (1) How do the participants author their identities, current and designated, during the first stages of their acclimation into university level mathematics studies? In particular, how do these identities develop in relation to assisting and constraining factors in the students' figured worlds?
- (2) In what ways do the participants enact agency in relation to:
 - a. The narratives regarding ethnicity and gender in their space of authorship?
 - b. The academic mathematical discourse they are expected to learn, specifically, calculus.

4. Method

The aim of this research is to study the relation between cultural and mathematical identity among Arab female students. I apply the qualitative research paradigm, mainly based on in-depth interviews with the participants of the study. At the core of the in-depth interview stands the desire to understand the experience of other people and the meaning they attribute to this experience. The interview provides access to the cultural contexts of people's behavior (Seidman, 1991). To better understand the process of integration, I need to explore and conceptualize the participants experience (Josselson, 2011). Therefore, I examined students' explicit and implicit narratives relating to culture and mathematics as they author them in interviews. In order to investigate students' acclimation, I focused on their social and learning interactions in the Technion world during the semester, while applying ethnographic paradigms (Goetz & LeCompte, 1984) where two midterm diaries were completed by research participants, and included answers to questions sent to them by email. Alongside the ethnographic paradigm, I also implement the theory of commognition to investigate the tensions between ritualized and exploratory participation in the students' mathematical activity (Viirman & Nardi, 2018).

4.1 Research participants

This research followed 13 Arab female undergraduate students, nine of them Muslim, three Christians and one Druze. Participants' age range was 18-19.5 years old at the time of study. All the participants were studying in either the Faculty of Computer Science or the Faculty of Electrical Engineering at the Technion, both of which are among the most coveted faculties in this institute and have very high entrance qualifications. In these faculties, 40-50% of the courses taken in the first semester are mathematics courses (usually Calculus I and Algebra I) enabling the focus of the study on students' academic acclimation to be clearly related to their mathematical identities.

All students were recruited voluntarily, during the first week of the semester, through an institutional mentoring project for Arab students in which senior students mentor the incoming students (formerly known as "the Landa project"). The students were

promised complete confidentiality and signed informed consent forms. The study was approved by the Institutional Review Board of the Technion (approval no 2016 - 29).

4.2 Research tools and procedure:

The study was conducted between October 2016 and March 2017. All the students were interviewed at the beginning and at the end of this period, which consisted of the participants' first semester at the Technion.

Around 30 hours of interview recordings were collected for the study. The interviews were conducted in Arabic and were fully transcribed in Hebrew. Parts of these transcriptions were translated into English with the assistance of native English speakers for presentation of the data in this thesis. Interview data was collected via three main methods:

- a. Three semi-structured interviews during the semester, lasting between 30-90 minutes, as detailed below:
 1. The initial interview was conducted in October 2016 at the first week of the semester. Questions started with background information (e.g. the participants' track of studies at high school, previous experience with studying in Hebrew), continued to questions about the reasons for choosing the Technion, questions about the family and its influence on this choice, and finally questions regarding first impressions of the Technion and initial experiences of cultural conflict. (see appendix 9.1 for Initial interview protocol)
 2. The second interview was conducted in February-March 2016 after the end of the first semester. This interview consisted of questions eliciting reflections about the past semester, including successes and failures. In addition, I added to this interview a part where the students were requested to reflect upon and answer some of the questions in their final calculus exam. This part was intended to give access to the actual forms of the students' participation in mathematical learning, including how they identified themselves as mathematics learners while mathematizing. (see appendix 9.2 for Midterm interview protocol)

3. A final interview (at the end of the first year) was conducted with 3 out of the 13 students to validate the findings and gain a view of the more long-term development of the students' identities. (see appendix 9.3 for Final interview protocol)
- b. Students completed two midterm diaries that were sent to them by email during November 2016 (before mid-term exams) and January 2017 (after mid-term exams). The midterm diaries included answers to questions sent to them by email relating to their struggles, confusions and successes in learning and cultural acclimation process (see Appendix 9.2 for the email-interview protocol).
- c. Video-simulated recall interview, performed with the aid of video recordings of Calculus Tutoring sessions. The video-simulated recall method is based on a socio-cognitive technique, Stimulated Construction of Narratives about Interactions (SCNI). The SCNI method consists of sharing the perspectives of the participants in the activity in which they participated and was recorded on video (Jordan & Henderson, 1995). In this study I use video-simulated recall while the interviewee and interviewer sit facing a screen placed in front of the interviewee and streaming the videotaped calculus lesson (Chidiac, 2016). The goal of these interviews was to elicit more specific data about students' mathematical discourse and their reported feelings during a lesson. During the semester, I recorded three calculus tutorials taught by a teaching assistant in the Faculty of Mathematics. The interviews were conducted up to two days after the lesson with students who were present at the lesson. Four interviews were conducted with students who participated in the lesson and who agreed to be interviewed at the time allocated for it.

4.3 Data Analysis:

Data was analyzed using a grounded theory approach coupled by discourse and narrative analysis. The findings that relate to mathematics were analyzed according to the theory of commognition. Following is more specific information about the methods of analysis used.

4.3.1 Grounded theory analysis

In order to answer the first and the second questions, regarding participants' authoring of identity narratives, the process by which these narratives developed, and the ways that agency was enacted in relation to the narratives in the space of authorship, data was analyzed using a grounded theory approach (Corbin & Strauss, 1990). This was coupled by discourse analysis in which narratives related to current and designated identities (Sfard & Prusak, 2005) were highlighted. I used a combination of inductive and deductive coding (Saldana, 2016) to first identify general themes (domains) where each domain comprised of several categories (specific issues and recurring themes). Categories were reduced, revised and refined using an iterative process (Corbin & Strauss, 1990).

Then, through inductive coding, I searched for recurring themes in students' interviews. For example, a common conflict described by the students regarded social encounters - whether to "hang out" with certain people or not, and with whom to study. Deductive codes were based on the theoretical orientation of agency within Figured Worlds (Holland et al., 1998). In particular, I searched in the interviews' transcripts for valued actions, valued outcomes, significant actors and roles in the Home vs. Technion Figured worlds. The main themes arising in all the interviews in relation to conflicts between the home figured world and the Technion figured world related to narratives about ethnicity and gender. In relation to these conflicts, I searched for indications of agency both in the actions described by participants (e.g. "I try to study hard"), or lack thereof ("I feel I am not focused" – with no mention of possible action to become focused). I also searched for agency in the manner in which interviewees spoke about the conflicts - as a given situation or as something that can be acted upon.

4.3.2 Mathematical discourse analysis

In order to investigate the way that the identity narratives of the participants interact with mathematizing, mathematical segments from the interviews were analyzed according to the theory of commognition, mainly inspired by the analytical tools used in Heyd-Metzuyananim (2015). First, I identified episodes that dealt with a specific mathematical problem. Then I identified words, routines, and narratives from

students' discourse, and then I categorized them to explorative and ritual participation according to the goal, characteristics focused on and on what authority the participation was based on (see table 1 below based on Sfard (2008)).

Participation	Ritual	Explorative
Goal	Connecting to others, being identified as a "good student"	Solving problems by using mathematics
Characterized by	Symbols unrelated to mathematical objects	Mathematical objects with different presentation
Based on	External authority	Internal authority and discourse rules
Focused on	Results (steps and activity)	The mathematical narratives produced in the activity

Table 1: Explorative and ritual routines (Sfard, 2008)

4.4 Positionality Statement

In such an ethnographic study, it is important to mention my own position as a researcher. "Research is a process, not just a product" (England, 1994, p.82). It is a space that is shared by the researcher and research participants, and where their identities have an impact on the research process (England, 1994). I identify myself as an Arab, religious Muslim female student from a conservative village. Ten years ago, I was in a similar situation to that of the study's participants - I was accepted to study at the Technion (although my B.A degree was in Medical Laboratory Sciences). When five years ago I moved to study Mathematics Education, I experienced some similar difficulties with mathematics.

My self-identification as a religious Muslim woman had productive elements in this study, as well as some possible obstacles. As a researcher who dresses similarly, speaks the same language, and is generally identified as "one of them", it was not hard for me to access and interview Arab students during their first encounter with the university. They seemed to be relaxed talking in Arabic about dealing with different situations they face, and my feeling was that they talked to me as a person

who listened to them. However, my identity was possibly also in conflict with some of their narratives. Not all of the participants discussed with me cultural conflicts, perhaps of fear that, as a conservative person, I would not approve of these narratives. In addition, since the research participants and I share a similar cultural background, large parts of what was said in the interviews was assumed to be understood implicitly. Although I felt at the time that I understood what my interviewee meant, upon analysis I discovered that often narratives had to be explicated. Although I did my best to explicate these implicit messages, these are still my own interpretations, not necessarily the explicit meanings intended by the interviewees.

5. Findings

The results chapter is divided into three sections. Section 5.1 gives an overview of the main themes that were found in the interviews. Through it, I describe the ways by which these themes shaped the participants' cultural and mathematical identities in their first semester. Section 5.2 presents an in-depth analysis of two students: Mira and Lena. It demonstrates these students' remarkably different identification trajectories throughout their first semester. In an attempt to understand the relation between their cultural and mathematical identity, in section 5.3 I deal with Mira and Lena's mathematical participation, pointing to relations between their agency in their space of authorship of gender and cultural narratives, and their forms of participation in the mathematical discourse.

5.1 The main themes that were found in the interviews

This section is built around the main themes that were found in the interviews. I start from an examination of students' current and designated identities as they entered the Technion and as the semester progressed. Then I turn to social expectations, which were strongly related to the students' designated identities. From there, I turn to challenges and assisting factors. Finally, I report findings regarding the students' mathematical activity during the semester.

5.1.1 Current and Designated identities

Generally, almost all the participants entered their studies with a strong mathematical identity, backed up by stories of repeated success in high school. The participants

reported having liked mathematics, having had it “easy”, and having been identified by their peers at school as strong in mathematics. This is not a surprising finding since the selection criteria for the Technion rule out, by the high admission requirements, most students who have struggled with school mathematics.

Coinciding with their strong current mathematical identities, most of the participants also had very high aspirations for the future. When asked why they choose to study at the Technion, many of them talked about getting the best opportunity to work. For example, Ranin said:

The Technion is an international institution known all over the world. Hence, if I move to another country or face some difficulties in Israel, I will find lots of opportunities (Ranin, 1st interview).

Aya talked about specific high-tech companies in the industry that she is hoping to work in:

(I'd like) to work at international companies like Google, Microsoft and Intel. (I hope) to gain experience that will form a basis for establishing a private business. (Aya, 1st interview).

Others talked about self-actualization. For example, Dina said about her field of study (computer science):

(I wish to gain) self-actualization. It's a wide subject that has many specializations. I like astronomy very much, so I can take something in computer science and combine it with that. One can also combine (it) with physics. I'm a person that likes many subjects so it suits me well. (Dina, 1st interview).

Interestingly, the girls' high-status designated identities were not affected by the extremely low prospects of getting a job in the high-tech industry as can be understood from current statistics of the ministry of workforce. These show that the percentage of Arab women in high-tech jobs is only 0.1% of the high-tech working force (<https://www.ynet.co.il/articles/0,7340,L-5008228,00.html>).

As the semester progressed, and especially after the first mid-term exams, students' narratives about themselves started changing. This was, no doubt, affected by the low grades many of them got in the midterm and final exams. Many of the students

refrained from stating their grades directly, and due to ethical reasons (students were promised total confidentiality in context of personal information), I had no access to their actual grades. However, according to their self-reports, 7 of the 13 students ended the first semester in an “improper academic status”, meaning they either failed more than 40% of their courses or they had an average of less than 65 in all their courses. Six of them had to repeat the Calculus course and only one of them (Dalal) reported that she got relatively good grades and ended the semester with an average of 85. These ratios of failure are slightly above the general failure rate of Arab students (as reported internally by the Unit for Students’ Advancement) which stands on around 35%-40% percent (compared to 25% failure rate of the general student population). In accordance with these less-than-optimal results, one of the most consistent narratives students expressed, both in interviews and in their writing diaries reflected a gap between their evaluation of their current performance and their expectations of themselves. In other words - there was a consistent gap between current and designated identities. Students repeatedly claimed that they “should have studied more”, or that they studied “a lot” but still “not enough”. For example, Lena, in her second diary, wrote:

At the beginning I would rehearse (the material) a lot and would rehearse the lecture as much as possible when I came back to my (room at the) dorms, but when I got to the algebra quiz, I understood my rehearsals were not good enough, and that I should study more thoroughly. (Lena, 2nd diary).

Hend, in here last interview, also expressed discontent with her studies:

Interviewer: How did you feel regarding the calculus test?

Hend: I felt I knew to solve (the problems) but still I felt that I hadn’t worked enough

Interviewer: How did you come to that conclusion?

Hend: I should have started studying from the first day of the semester. But during the semester I concentrated on another course and I let go on (this) course.

At the end I got myself into a mess. (Hend, 2nd interview)

Another student, Aya, talked about her feelings in the Calculus exam:

Perhaps I felt that my learning of the Calculus (course) since the beginning of the semester was not right (Aya, 2nd interview)

Overall, students' discontent with their actions during the first semester was often connected to social expectations. This aspect will be detailed below.

5.1.2 Social expectations

In the Arab society, members are highly accountable to their society for all their actions and values (Khattab, 2005). This was very prominent in students' talk. Many of them talked about entering the Technion with high expectations, especially from their family:

When you were born in a family with a parent whose dream was to learn, it lets you fulfil his dream to learn, to research, and not stop at a bachelor's degree. You feel that he lives his dream through you, especially which we both (feel) connected to mathematics (Dina, 1st interview).

Stressing high expectations from the social milieu was not reserved to students that were 1st generation university students in their family. For example, Mina talked implicitly about high expectation that were putting pressure on her, she said about her parents and brothers that have an academic degree:

It encourages you to be like them. It's like something that reminds you all the time to study hard (Mina, 1st interview)

In addition to others' expectations about them as students, there were also frequent references to narratives that the students "heard about" the Institute, before they had enrolled. For example, Aya, explaining in her 1st interview why she chose the Technion, said:

The Technion is the best institute for engineering. Also in terms of job (prospects), many have told me that priority goes to the graduates of the Technion. (Aya, 1st interview).

Through comparison between the Technion and another optional university, Rasha talked about her choosing to study at this Institute:

First of all, many have told me that priority goes to the graduates of the Technion than other universities. In my opinion it is so important to be here at the Technion, ... I also see my relatives who studied the same field (computer science) both at the Technion and at [another university] and they told me that priority goes to the graduates of the Technion (Rasha, 1st interview).

However, the social expectations reported by the participants were not always supportive. The students talked also about cases where people around them lowered their expectations for success, or warned them that coping with the demands of the Institute will be very difficult for them. In particular, these warnings were issued in relation to the students' gender. For example, Dina said:

Most people around us don't expect that we will choose to study engineering. I want to show other girls that we can do it and there are no gender differences, despite the previous opinions that this profession is not suitable for women ... I asked an Arab (male) student who studies this profession and he answered that it's not appropriate for girls (Dina, 1st interview).

The social expectations students' talked about were often connected to culture and to cultural conflicts. These are discussed below.

5.1.3 Cultural conflicts

Out of the 13 students, only two were wearing a Hijab, yet most of the other (9) Muslim girls were conservative in one way or the other. For example, they refrained from drinking Alcohol, wore modest clothes and did not participate in parties. The three Christian students were overall less conservative, and the one Druze student was conservative in a similar level to the Muslim conservative girls. Yet out of the 13 students, only six talked explicitly about expecting cultural conflicts at the beginning of the semester. For example, Rasha said in her 1st interview that she had already experienced some conflicts between her cultural values and the Institute's norms:

On 'Wednesday noons' (a regular social outside party organized by the Institute's student association), there was DJ music and beers. I am not used to such things. I, as an Arab student, there is no way that I would do such things. So I went back to my dorms. (Rasha, 1st interview).

Rasha was also one of the students who continued to experience cultural conflicts during the semester, she wrote explicitly about these conflicts in her 1st diary:

There is a very open environment (non-conservative) at the Technion, there is no limit for freedom, even in wrong things. You can behave as you like and nobody warns you that your behavior is inappropriate. In my home, it is not like that. Although there is freedom, there is always someone to remind you

to stay away from wrong (bad) things, and to focus on the purpose you are here for. (Rasha, 1st diary).

Other participants reported in the first interview that they are not expecting much conflict. For example, Aya (Muslim) answered the question about possible conflicts as follows:

No (I do not expect conflicts). Our home is not that closed (conservative) that they say 'this is not allowed and that is not allowed'. Also, here at the Institute there are no extraordinary things. Everything is acceptable by me. (Aya, 1st interview).

However, some of the students who did not expect cultural conflicts started talking about them later on. For example, the same student, Aya, quoted above, wrote in her first diary:

Of course I've encountered cultural differences. One of them is that I live in the dorms with around 50 (female) students. We all have limited and shared WC ... The problem is that guys are allowed into the building and that is not acceptable by me. Since some of the girls belong to other cultures, they let guys enter their rooms and it has become something normal to wake up in the morning and run into a guy in the kitchen or in the bathroom. (Aya, 1st diary).

Many of the students, even when not talking explicitly about cultural conflicts, talked about the difficulties of getting accustomed to a new environment. Mira wrote about such difficulties in her first diary:

As I've heard from many students, the first weeks of the semester are the hardest weeks for a new student. And I've just felt this and the difficulty of the first days. We encountered many difficulties like getting to the lecture on time, sitting in a comfortable place in this class (lecture hall) which is usually cramped. There were also difficulties with new things like homework and submission guidelines and other things. (Mira, 1st diary).

Notable in this excerpt is the lack of any reference to difficulties that stem from language, gender or ethnicity. Rather, Mira talks about "many students" and about being "a new student" without any mention of the gender or ethnic label of these "new students". However, as will be shown in the following chapter, it was precisely Mira who talked, when explicitly asked, about her difficulties with the new culture.

Thus, there are reasons to suspect that behind the "normalizing" of the difficulties that "any new student" experiences, lay also particular difficulties that were less talked about.

Students rarely mentioned any comparison to Jewish students in their new environment, unless asked for that directly. When they were asked, several of them expressed the belief that Jewish students had it easier in their studies. For example, Dalal said:

I think they (Jewish students) have it easier. For starts, Hebrew is their language. But with regard to discrimination and such, there's no such thing (here)'...' (Dalal, 1st diary).

Unlike Dalal, some participants (though very few), did express some worry of discrimination, although they admitted to not having felt it directly. Mira said:

I haven't yet felt (any discrimination). If, for example, I ask a professor or teaching assistant a question, worrying about how he looks at me - that I haven't yet felt. But I expect it in the future. It's everywhere (Mira, 1st interview).

Another example was provided by Rasha:

There is no discrimination against Arabs or others here (at Technion). The lecturer teaches all of us the same. If I, as an Arab (student) want to ask (a question), he will give me a chance to do so. However, I do not ask questions (at the lecture), because I do not know how to ask in Hebrew. I think if I do, he will answer me. So there is no difference between Arabs and others (Rasha, 1st interview).

Here, Rasha talked for the second time in the same interview about the difficulties of asking questions during the lecture. However, she related almost all of her difficulties to her own individual difficulties with the language ("I do not know how to ask in Hebrew"), rather than to social elements such as the studies in the institute not being conducted in her mother tongue.

Most participants thus talked about their Arab identity as possibly constraining their success in their studies, for example, by relating to the difficulties with language or possible discrimination. Other narratives, however, which related to the positive

aspects of being an Arab in this situation, were also expressed. Anna, for example, said:

I studied until 12th grade, I had one year of a break and then I started my studies straight away. But a Jewish student does not start directly (because of the Army service), so I feel that I'm better off in terms of subject matter and that stuff. (Anna, 1st interview).

An interesting finding was that almost all participants repeatedly tried to minimize any possible cultural conflicts they could be experiencing. When I asked direct questions about such conflicts, many of them stated that they concentrate on their studies and were trying not to engage with people that may pose conflicts with their cultural values.

Yet despite these declarations, some of the students talked implicitly about cultural conflicts. For example, when Aisha was asked about cultural conflicts in her first interview, she talked about her unchanging values:

Values are something that remains with the person regardless of where he is. If I'm studying here it doesn't mean that I will change (Aisha, 1st interview).

Although the explicit message here was that the Technion world posed no conflicting values to Aishah, in fact an implicit narrative lay behind it. This implicit narrative could be restated as "it may be expected that the Technion would change me because of its conflicting values, but I intend not to change".

Later on, Aisha also talked implicitly about conflicts in her diary:

I have no conflict because most of my friends are from the same ethnicity (Aisha, 1st diary).

The implicit message that could be understood from this was that, "if my friends *were not* of the same ethnicity, there could have been a conflict".

Even more than avoiding any talk about cultural conflicts, political conflicts were completely disregarded in participants' talk. This is remarkable since the main conflict between Jews and Arabs in Israel stems from political conflicts over land, resources and historical heritage (Kaplan et al., 2001). A rare exception to the avoidance of the Israeli-Palestinian political conflict occurred when one of the participants, Mira, shared with me the conflict she felt around the "Rafael" logo, printed on backpacks

given to all students at the Technion as an incoming gift. Rafael is a large Israeli defense-systems company, serving the Israeli Defense Forces.

Mira: When I saw the word “Rafael” (on the backpack) I felt that I’m going against values that I believe in... I don’t know... we as Arabs are against things like this. Then comes the Technion under this company and gives us (such a bag), it’s like forcing us, and all that.... A few days ago a Jewish student sitting next to me at one of the lectures looked at the bag and started laughing and asked me, ‘who gave you this bag?’ I felt bad, he hurt my feelings and I’ve been thinking how to delete it (the word Rafael).

Interviewer: Why did you feel that way?

Mira: He was looking at me as an Arab and Arabs are Palestinian, now we’re starting to talk politics... (laughs), I don’t want to talk about it.

Notably, Mira described here a complex situation. First, it appears that up until the Jewish student mocked her, she was willing to accept (perhaps reluctantly) the backpack with the controversial logo. However, what changed the situation for her was not that some of her Arab friends raised an eyebrow regarding the bag, but that a Jewish guy mocked her about it and reminded her that the bag and its logo was conflicting with her Arab identity. The stress Mira felt could be seen by her words that the Technion “forces us” to have these bags, although the bags were, as mentioned, a gift, and no one forced the students to use them. It could be that her feelings of being coerced stemmed from the sense that the Institute was not taking her identity as an Arab into account.

In any case, the subject could not be pursued because Mira explicitly declared that she “doesn’t want to talk politics”. Interestingly, this was in spite of my belonging to the same ethnic/national group as she. Other girls simply refrained from touching upon political issues.

5.1.4 Challenges

With relation to challenges encountered during their first months of studies, I mapped the following challenging factors: comparison with others (especially with male students); low self-confidence; anxiety; social loneliness and language difficulties. Some of these were already mentioned above. In relation to these difficulties, it is important to add that psychological language referring to “self-confidence” and

“anxiety” was quite common. Relations to social and structural constraints were very rare.

Language difficulties were only mentioned when asked about explicitly. Participants mostly claimed in the opening interviews that they expected no problems with the Hebrew language. However, as the semester developed, some of them did mention some difficulties, especially concerning their ability to talk freely, ask questions at lectures and understand other Hebrew speaking students. For example, Aya wrote in her diary, in relation to the question: *How do you cope with the issue of language in your studies so far? Is all the Hebrew understandable? Are there places where you encounter difficulty around the Hebrew language?*

Not everything said (in lectures) is understandable for me. I encounter difficulties in physics because, there, one needs to know more Hebrew. So far I’m also having difficulties with understanding the problems in physics homework. (Aya, 1st diary)

Notably, Aya mentioned, as some other participants did, that mathematics was relatively easy for them in relation to language difficulties. For example:

The language we deal with is more mathematical than Hebrew language. But in the context of discussions I don’t understand everything that they say, because I don’t know all the words in Hebrew and then I avoid asking questions. I am afraid to make mistakes in phrasing questions (Rasha, 1st interview).

Double-meaning utterances with regard to challenges were common in participants’ discourse. They seemed to show that on the one hand, participants were aware of the external challenges that they were encountering (difficulty of course material, language barriers, etc.). On the other hand, participants related almost all of their difficulties to inner mental constraints (not knowing, not feeling confident), rather than to external forces.

5.1.5 Assisting factors

As the semester advanced, participants talked about various factors that helped them cope with the challenges of studying at the Institute. I mapped the main factors mentioned to be mentors, expert friends, videotaped lectures and tutorials, special tutorials provided in Arabic (through the Unit for Students’ Advancement), and study

partners. Many of these are known to be of assistance to all students at the Technion (for example, videotaped lectures are a regular resource used by most students).

The most complex of these assisting factors was the subject of study partners. Participants in the study experimented with different study partners and experienced some conflicts regarding who would be most productive to study with.

Aya, for example, wrote in her diary:

Sometimes I study with other students, most of the time they are my friends, so our study (process) is slow because of our preoccupation with external subjects. However, the study together is useful, it helps me to understand some of the points which I did not understand well from the lecturer (Aya, 1st diary).

Here, Aya explained why it is useful to study with friends, but on the other hand, she claimed that their study is not the most effective.

Mira explained in detail the importance of choosing study partners. She wrote in her first diary:

Sometimes I study with a friend who has come with me (to the Technion) from high school... I study with him for several reasons. First, I know his rate (of learning) and his learning abilities and I think he will not affect my learning rate negatively. Second, I do want to share my ideas and my solutions with people that I trust. Share the approach and not just the solution. In addition, the sharing of stress with someone else makes (the stress) easier. In practice, I see that our learning together is effective and devoid of interruptions. (Mira, 1st diary).

Mira's elaborate explanation of how and why she chooses her partner is not only illuminating with regard to factors that she found assisting (sharing ideas, strategies and stress). It also sheds light on the multiple dangers that she sees in collaborative study, the main one of them being that learning would not be "effective" and would include "other things" besides pure studies (though what these "other things" were, was never detailed).

5.1.6 Narratives about learning mathematics

As stated above, most of the girls started the semester with a strong mathematical identity, stating they liked mathematics at school and that it was one of their strongest

subjects. Yet from their talk about mathematical learning, it was mostly difficult to extract what mathematics learning actually meant for them. Participants talked in general terms such as "I was good in mathematics", "I got a score of 100" or "I find Calculus very interesting", but they did not detail what "being good" meant, or what was specifically "interesting" in a certain mathematical subject.

Still, some patterns could be identified in many of the participants' talk about mathematics. One was the repeated reference to "memory" as an explanation for success or failure. Participants repeatedly explained their lack of success, in quizzes or tests, by claiming they did not "remember" something. For example, while attempting to solve a calculus problem during the final interview, Anna claimed she could not proceed because she forgot a certain formula. When the interviewer pressed her reasoning, the following exchange occurred:

Anna: I forgot the name of the theorem

Interviewer: would you like to try again?

Anna: I forgot

With that, Anna made it clear her "forgetting" was a sufficient justification for giving up on the problem solving effort. This implied a narrative about mathematics which could be restated as "mathematics is about remembering".

Another such occurrence happened with Hala:

Interviewer: according to which idea are you (attempting) to solve the problem?

Hala: During the test I got up to here (points to a stage in the solution process) and I didn't know how to go on. When I came back home I started thinking that it's the sum of an arithmetic series and so is this (points to another part of the expression). So if I solve it I'll get the answer. But I don't remember the formula.

This interaction indicated that, for Hala, "not remembering the formula" was sufficient justification for halting the problem-solving effort during the test. In addition, she did not make attempts to overcome this "forgetting" after the test. This hints that for Hala, success in the test was about memorizing, and there was no reason to refresh one's memory, other than the test.

Some students expressed awareness about the tension between technical memorization of procedures and the necessity to understand concepts more deeply. This could be seen in the girls' comparative narratives about the studies at the Technion in relation to their high-school mathematics studies:

Aya: You know how it is in high school. I thought... 'I was at the lectures and I know the strategies for solving problems so I'll manage.' But at the end I didn't manage ... I didn't insist on points that I didn't fully understand and I figured there's not much chance it will be in the test. But the tests here cover all the material, not like in high school.

Some of the participants (6 out of the 13) expressed some anxiety or embarrassment about solving problems from the test in front of the interviewer. Five of them avoided it altogether, stating they forgot the material. One did attempt to engage with the problem but asked me "not to look at her" while she was solving. Seven out of the participants did attempt to solve the calculus problem from the test, with various levels of confidence expressed during the solution process. Many of them, however, gave up on trying to solve the problem stating they simply "did not remember" how to solve it. There was a remarkable lack of exploratory talk, attempting to tackle the problem from various sides.

In general, I found a tension between the participants' descriptions of themselves as "constantly studying", day and night, paired with their lack of some basic skills from high-school and the lack of interest in tackling problems after the test was over. This gap leads to hypothesize, though very cautiously, that some of the "endless studies" of the girls may not have been very productive, as they may have been focused on memorization of procedures for the sake of passing the quizzes and tests, rather than on deeply understanding new mathematical concepts.

The following figure summarized the main themes that were found in participants' interviews and diaries, related to students' current and designated identity, cultural conflicts and social expectations.

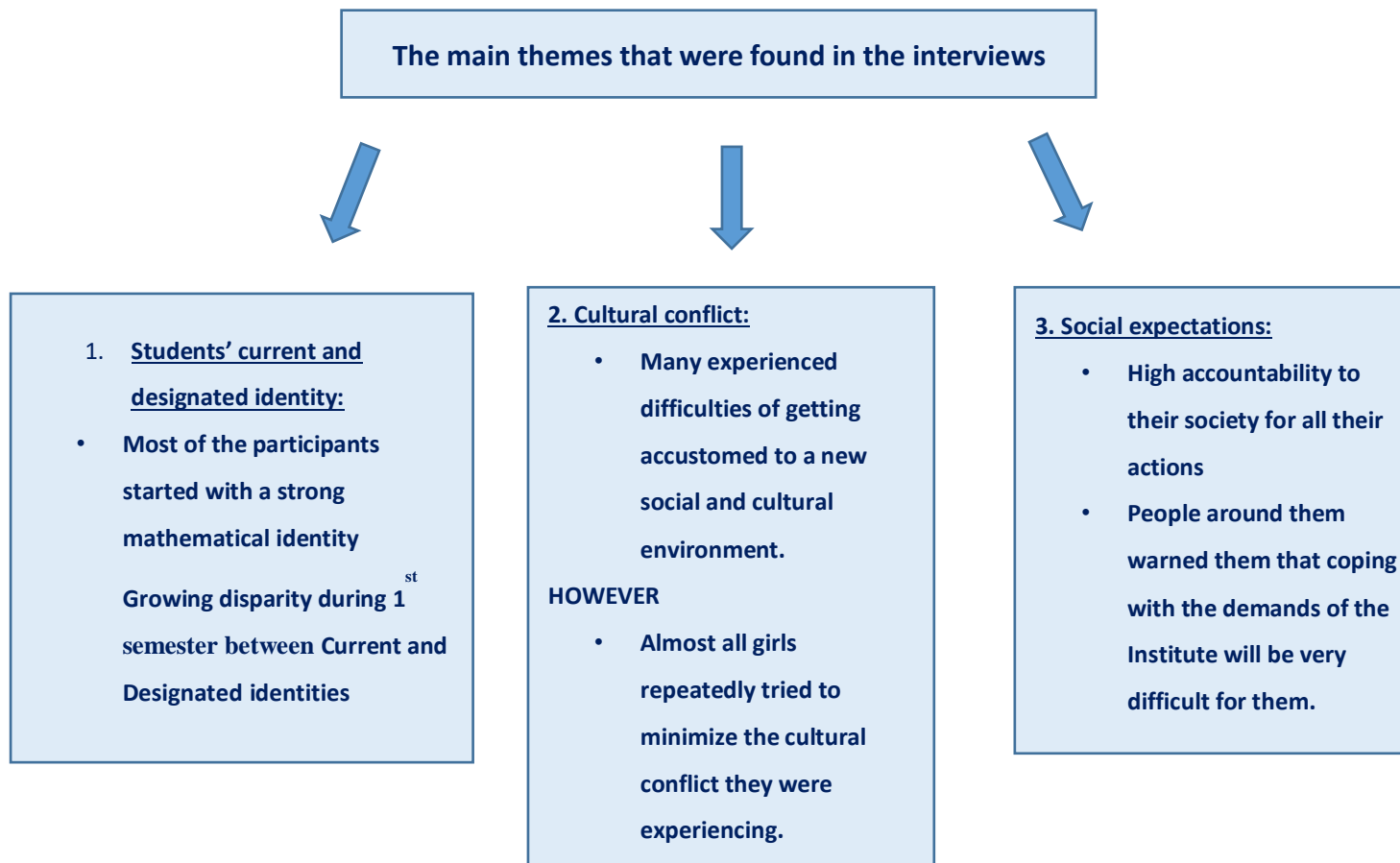


Table 2- Data summary table

Table 2 summarizes the findings of this chapter, as they were found in the interviews and diaries of each of the research participants.

Student pseudo name	Age	Religion and self-identification	1st generation in academic studies?	Psychometric grade (self-report)	Mathematics unit in school	1 st P identification of achievements	Affect towards mathematics	How much data was collected	Cultural conflicts	Response to calculus question	Results at the end of the semester
Rash	19	Muslim	No	648	5	Strong	Like	1 st , 2 nd interview. 1 st diary	Explicit	Avoided doing mathematics	Improper academic status ¹
Mira	19	Muslim	Yes	704	5	Very strong	Dislike	1 st , 2 nd interview. 1 st , 2 nd diary	Explicit (ethnic conflict)	Solved a question	Success with an average around 80
Aya	18	Muslim	No	742	4 ²	Very strong	Neutral	1 st , 2 nd interview. 1 st diary	Implicit	Solved a question but not finished	improper academic status, but also got around 85 in Moed B calculus exam
Dena	19	Muslim	No	Non available	4	Strong	Dislike	1 st , 2 nd interview. 1 st , 2 nd diary	Explicit (ethnic conflict)	Solved a question but not finished	Improper academic status
Mina	19	Christian	No	710	5	Very strong	Like	1 st , 2 nd interview. 1 st , 2 nd diary	Implicit	Started solving but quickly gave up on it	Self-reported passing all courses

¹ "improper academic status", meaning they either failed more than 40% of their courses or they had an average of less than 65 in their total courses

² Student with 4 math units, passed a math classification test

Dalal	19	Christian	No	667	5	Strong	Like	1 st , 2 nd interview. 1 st diary	Implicit	Avoided doing mathematics	Success with an average around 85
Hala	19.5	Muslim	No	653	5	Strong	Like	1 st , 2 nd interview. 1 st , 2 nd diary	No	She solved the question but avoided sharing her solution	Improper academic status
Hend	18	Muslim	No	680	4	Strong	Like	1 st , 2 nd interview. 1 st diary	Implicit	Solved a question	Improper academic status
Lena	19.5	Muslim	No	N/A	5	Strong	Like	1 st , 2 nd interview. 1 st diary, video-simulated recall interview	Explicit (gender conflict)	Avoided doing mathematics	Improper academic status
Kareen		Druze	Yes	670	5	Strong	Like	1 st , 2 nd interview. 1 st diary	No	Avoided doing mathematics	She reported that she succeed but did not share much information
Ranin	19.5	Muslim	Yes	670	5	Strong	Like	1 st , 2 nd interview. 1 st diary	Explicit	Avoided doing mathematics	Failed on calculus exam Moed A, she did not report about the other courses
A'isha	19	Christian	No	698	5	Very strong	Like	1 st , 2 nd interview. 1 st , 2 nd diary	No	At the beginning, she avoided solving, during the interview she stated solving the question	Improper academic status

Anna	19	Muslim	No	729	5	Very strong	Like	1 st , 2 nd interview. 1 st , 2 nd diary	Implicit	Solved a question but not finished	It was not good in Moed A and B in calculus exam, she did not report about the other courses
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In the next section I present a more close-up analysis of Mira and Lena, two students who have been chosen for the following reasons: First, they were enthusiastic and very cooperative participants in the study, thus I had detailed data from their interviews and diaries. Second, they presented contrasting trajectories of acclimation, which enabled me to compare between various features of their identity and agency, in relation to their space of authorship.

5.2 Mira and Lena- Identity and Agency

Mira and Lena are both Muslim, coming from a conservative background. Mira wore a Hijab while Lena did not. As stated above, they exemplified very different trajectories of acclimation to the figured world of the Technion. While Mira ended the first semester with passing grades and relative success, Lena failed several courses and was quite discontented with herself at the end of the semester (see table 2). Through analyzing Mira and Lena's interviews, I explore in more detail the development of their identity and agency in relation to the figured world of the Technion. In particular, I pay attention to what the two students say about gender/ ethnicity and their positioning in relation to the conflicts in their space of authorship.

5.2.1 The beginning- Mira and Lena's 1st Person current identity at the start of the semester

Mira's stories about her family and village drew a world that is mono-ethnic and mono-religious. She reported in her first interview that she was having trouble living in a multi-cultural environment. She also identified herself as a "non-social person by nature". Mira also reported being the first in her family to attend university and that she felt pressure from her family to succeed:

I'm the first one [from my family] to ever attend a high academic institution. Everyone at home has expectations (from me) and that's a bit stressful (Mira, 1st interview).

Positioning her academic skills in relation to her family seemed to be important to her:

I have four older brothers and they were not strong at school, and a sister (who is) a year older than me. I'm better than her academically. She has not yet begun her academic studies (Mira, 1st interview).

Although Mira authored herself as "strong" academically, she confessed in her first interview that mathematics was not a subject she preferred: "to tell (you) the truth, I do not like mathematics". Her goal was to study computer science and mathematics was seen only as a means towards that cause.

Unlike Mira, **Lena** was not a first generation university student in her family. Her parents both had academic degrees. Yet similarly to Mira (and to other students' as

described in the previous chapter), she also reported feeling stress from her family's high expectations. Again, it was clear from her talk that she was highly accountable to her family and community with relation to her academic choices and achievements. Lena was not hesitant about her relation to mathematics in the first interview. Her 1st person mathematical identity was authored in the interview as highly successful. To signify her success, she narrated the following story:

I don't know if you know the Elkasmi competitions? (Interviewer nods), I participated in this competition from fourth till ninth grade. I almost won the first place. Once I won second place and once third place... that means it (Elkasmi competitions) was for me" (Lena, 1st interview).

Elkasmi is a competition for gifted students in mathematics in the Arab community. Lena was signifying her strength in mathematics by drawing on the significance that participating and winning these competitions has in her community, a significance she made sure was shared by me.

Apart of the Elkasmi story, Lena relied, similarly to Mira, on her family's narratives when authoring her 1st Person academic and mathematical identity. She reported that she has being identified by her peers at school as strong in mathematics "Many students in my class envied me that I don't study for hours like them and succeed". In addition, she reported that her family thought of her as a strong student, who could achieve anything she wanted; these expectations were talked about both as a reassuring element and as a stress factor:

They (parents and family) always remind you that you have potential. So I somehow try to turn this potential (to reality) ... So that's my parents' expectations in particular, and my sisters think that I'm 'Rambo'. That I could do anything and get along. Most people expect so. (Lena, 1st interview).

As the semester progressed, Mira and Lena each encountered a conflict and their identities turned to different trajectories.

5.2.2 Conflicts throughout the semester

As mentioned above, Mira's academic identity included narratives of relative strength and did not include many conflicts. In contrast, regarding her ethnic identity as an Arab

student, Mira's space of authorship (namely, the narratives she was drawing upon to describe herself) was much more conflictual. In the initial interview, Mira reported that she had not encountered people from other religions before she started studying at the Technion. Her first close encounter with someone of a different religion occurred when she entered the dorms:

I live with a Christian student in the dorms; she is from a different religion. At first, I worried about the idea of living with her, because I am a Muslim and she is Christian. I was worried I would feel restricted and not able to behave freely (Mira, 1st interview).

Mira reported worries from the first encounter with someone of a different religion. As mentioned above, Mira wore a Hijab which signaled her belonging to the conservative Muslim community. Thus there was no question about me identifying her as a Muslim. Still she repeated the fact that the "Christian student" was "from a different religion" twice (also in "I am a Muslim and she is Christian"), thus signaling that the important conflict between her and her peer was related to religion.

Mira's justification of her worries as based on the fact that the student was "Christian" while she was "a Muslim" indicated that in her space of authorship, the mere religious identity of a person could cause problems while living together and "not behaving freely". Notably, the fact that the Christian student was also Arab was not mentioned but taken for granted, and the possibility of living with a Jewish student was not mentioned at all.

As the semester progressed, Mira repeatedly recounted encounters with students of other religions and gave them significance. Although Mira expressed an acceptance of students from different religions, her diary entries clarified that she was engaged with conflictual narratives around ethnicity and religion and that these were entering her space of authorship:

Every day and all the time, I face differences. First, the atmosphere at the Technion is not like the atmosphere at home at all. Here everyone is independent and each person is responsible for himself and his own decisions. There are people from different places, different religion[s], different thoughts

and different values and cultures. For example, I came from a village where everyone is Arab and we all belong to the same religion, whereas at the institute I meet people from all over the world and from different religions. (Mira, 1st diary).

In this excerpt, Mira mentioned several issues which are worth observing. First, Mira is explicitly talking about "differences" between the "Technion" and "home". In other words, it is clear that she is constructing the two locations as different figured worlds. The differences mainly point to differences in relations between the individual and the social community ("here everyone is independent"), hinting that in her home figured world, people are interdependent and not responsible for their own decisions. The interdependence is linked in Mira's words to the Arab ethnicity and to the religious homogeneity of her home village.

As opposed to Mira, the main conflict Lena talked about from her first interview was related to her gender:

I will not begin now by saying that boys are smarter than girls, but I believe that boys have more self-confidence in the science fields than girls. They (the boys) always think that science is for them, and girls think that they are less ... that is what I read and see around me. Here I see the difference between boys and girls, but that does not mean anything about the final results because sometimes the way the girl thinks help her beat all her competitors" (Lena, 1st interview).

As can be seen in this quote, Lena, already in her initial phase of her studies, was contesting voices that were saying "boys are smarter than girls". She was negating them, yet endorsing the narrative that "boys have more self-confidence than girls", which she justified based on what she "read and saw around her".

As the semester progressed, the gender related narratives turned into 1st P identity narratives. In her first diary, Lena wrote:

Despite all the faith I have in myself, I feel that I'm not confident enough, in comparison with boys, at least with a boy who I study with. I think it comes from old stereotypes about the composition of the boy's brain versus the girl's brain.

Sometimes I fear that these stereotypes are true and that my mental ability is not enough (Lena, 1st diary).

Again, Lena's authoring of the narratives around gender and mathematics/technological studies was solely diagnostic and devoid of agentic descriptions. She was examining her "beliefs in herself" and her "self-confidence" against "old stereotypes", indicating at least a partial endorsement ("sometimes I fear these stereotypes are true") of these narratives about "the composition of the boy's brain versus the girl's brain".

5.2.3 Authoring the self as a site of agency

In this part I will present how Mira and Lena enacted agency in relation to their conflicts.

Mira reported about ethnic conflicts, through talking about encounters and experiences that were always authored as already resolved. These solutions signaled that for her, conflicts were something that she needed to enact her agency and to resolve. For example, as she authored her first encounter with a religious conflict of living with a Christian student in the academic dorms (see above), she ended the story by:

Later I discovered that if I give her the space to behave according to her beliefs and religion, she would give me back the same space I need (Mira, 1st interview).

In this excerpt, Mira's agency in relation to this religious conflict could be seen in the actions she described ("I give her space") that resulted in gaining what she needed ("space " to "behave freely").

Another example of authored agency in relation to cultural conflict could be found in Mira's first diary. It included description of differences between Mira's "home" world and "Technion" world. She ended that story about these differences she encounters, by:

I see people behaving in a way that goes against my values and that is a new atmosphere for me, I am constantly trying to stay on the side and not get involved with anyone (Mira, 1st diary).

It is clear from Mira's words that she was able to articulate the conflict she is experiencing, the values that are at stake, and her positionality with relation to this conflict. Notably, this story is authored as a site of agency too. Mira writes about the conflict and immediately states her actions in relation to it ("I try to stay on the side and not get involved").

Later in the semester, this action of "staying on the side" seems to have matured into a more nuanced positioning and identification of Mira with relation to the "others":

I came from a traditional and relatively conservative family, where I grew up with values that I believe are correct. However, at the Technion, I encounter many people who behave against my beliefs, and it makes me feel that I am an extreme person or something like that. Yet I continue to believe in my tradition as they continue to believe in theirs (Mira, 2nd diary).

This excerpt hints at several processes that Mira underwent during the semester. First, there are beginnings of separation from "her beliefs". Whereas these beliefs were stated in the first diary as simply "her values" ("I see people behave against **my** values"), here, these beliefs are located in time and space ("I came from a traditional ... family", "I **grew up** with values"). Moreover, the statement about values "that I believe are correct" shows hints of voices that position these beliefs as "incorrect". These voices are later located in people "who behave against my beliefs" and that, whether directly or indirectly, make Mira feel she is "an extreme person". The taken-for-granted "beliefs" and "values" have thus been questioned and contested for Mira, and this has raised a conflict with regard to identity narratives concerning religion and ethnicity. In the face of these conflicts in her space of authorship, Mira enacts agency in choosing to adhere to her home values.

Unlike Mira, Lena's talk about her studies was mostly devoid of agency. Her authoring of herself as successful was based on the diagnosis that "math is for me", justified by her winning math competitions during her childhood. Also, in revoicing the voices of parents and significant narrators ("they always remind you"), these voices narrated her as "having potential" and "turning this potential into reality". The lack of agency

in Lena's talk was most noticeable when she authored herself with relation to the gender conflict. The "stereotypes" she was talking about were about "brains" of males and females, something that was clearly beyond Lena's agency to change. Lena was examining and identifying herself within this figured world of fixed-ability gender-related narratives, without any indication that she had a choice in accepting or rejecting them. The gender-related narratives evolved in the second diary entry into a mini-theory of the relation between her "self-confidence" and her actions:

When a person is less-confident, I don't know how (to explain this) ... But sometimes you do not believe in yourself, sometimes you do not want to meet anyone. That (decision), not wanting to meet anyone, is not the best decision in the world. You have to be with people who you see every day and share with them what you solved, and what you did not (solve). So that it helps you keep going. Sometimes it made me stop or slow down (Lena, 2nd diary).

This quote exemplifies well the psychological discourse that Lena drew upon to explain her perceived failure during the first semester. Explanations about her failures (which are not mentioned here explicitly, only hinted at) use psychological keywords ("self-confidence", "belief in oneself") to justify her decision "not to meet anyone". The self-diagnostic statements are written about as pre-given and beyond Lena's control. Further, these psychological states have led Lena, according to her narrative, to certain decisions that she regrets ("you have to be with people"), yet there is no indication that Lena had a choice regarding these decisions. They were a direct result of her low "self-confidence". In the final interview at the end of the semester, Lena's discourse was full of such regrets:

I started the semester as a little girl, I was not focused, I thought too much about nonsense, I was very nervous about people around me so I did not study in the library and stayed in the dorms. Everyone asks you 'what's going on?', 'Did you solve the homework?' Why should they ask me? I felt pressure from this (Lena, 2nd interview).

Again, this quote is full of psychological terms relating to maturity, cognitive and emotional functioning ("a little girl", "not focused", "very nervous"). As was common

in all her interviews and diary entries, there is no mention of any difficulties relating to her ethnic or cultural status.

The final interview also had indications that Lena was re-authoring her identity as a high-school student (at least to the audience of the interviewer). She said:

I have never been in a place like this, even in high school there were difficulties but it isn't like here. (Lena, 2nd interview).

This narrative was different than those authored in the first interview, where Lena talked about herself as successful and being "made for" mathematics. Unlike her earlier recounts of extraordinary success (winning competitions, etc.), she now talked about her high-school career as containing some difficulties, yet not as extreme as in the Technion.

To summarize, Mira retold her identity at the end of the semester as stronger in mathematics than at the beginning, despite authoring many stories of conflicts with relation to her ethnic and religious identity in a foreign figured world. With relation to almost all the descriptions of conflict, Mira's talk was full of agency, whether it was related to decisions she made to adhere to her religious values, or with regard to changing her methods of study. Along with that, some changes in the space of authorship of her ethnic and religious identity occurred. These could be detected mainly in how she narrated her "values" and "beliefs" - from being inherently "hers" to being a result of her "upbringing" and her home figured world. In addition, the space of authorship came to include also 3rd P narratives about her being identified as an "extreme" person by others, something which forced Mira to reexamine her beliefs and values and to make choices regarding them.

In contrast, Lena retold her identity at the end of the semester as "a little girl", "not focused", and "very nervous". Lena's space of authorship about gender and mathematics was diagnostic and devoid of agentic descriptions. In addition, her report about her experience was full of psychological discourse which lacked agency in relation to her difficulties. Lena talked about wrong decisions that she made during the semester (such as not meeting people or not asking for help) but always in retrospect, and always in relation to how these decisions were unhelpful.

5.3 Mira and Lena's Mathematical Participation

In this chapter, I will address Mira and Lena's mathematical participation based on their mathematical interviews. This, in order to characterize the ways that Mira and Lena enacted agency in relation to their mathematical learning. Mira's mathematical discourse was elicited from her interview around a question in her final calculus exam. Unfortunately, Lena avoided talking about the calculus exam in her final interview. Therefore, her mathematical discourse could only be accessed from the stimulated recall interview where we discussed some specific calculus problems. Although the data is somewhat different, these interviews give us a better view of what mathematical learning was for Mira and Lena, and how they identified themselves as mathematic learners 'in action'.

5.3.1 Mira's mathematical participation

As reported above, Mira started the semester reporting that she did not like mathematics and that she came to the Technion to study computer science, not mathematics. During the semester, she reported finding her mathematics studies to be surprisingly satisfying. In her 1st diary, she wrote:

The most interesting lecture in my weekly schedule is a Calculus lecture, because I learn mathematics differently... I learn how to learn mathematics, how to think outside the box and how to find ideas or solutions for different mathematics problems. It is a hard course but the lecturer is a wonderful person and he makes it an enjoyable course. (Mira, 1st diary)

Her satisfaction with her mathematical studies continued throughout the semester despite hurdles and setbacks. In the last interview, Mira reported failing in the first take of the calculus exam because of being "unprepared like I should have been", then studying better and passing the second take with a satisfying result.

At the end of the semester, an interview was conducted with Mira regarding the final calculus exam, during which I asked her to solve one of the questions in that exam. Unlike most of the other participants, Mira did not hesitate and started solving the question right after being asked to.

In this part, I will present the question that Mira solved in the interview and the official solution which was implemented by the course staff (fig 1), then I will analyze the solution that Mira produced during the interview.

3. (א) (10 נקודות) תהי f פונקציה בעלת נגזרת רציפה ב- $[0, 1]$. הוכיחו שקיים קבוע c כך שהפונקציה $g(x) = f(x) - c \cdot e^x$ מונוטונית יורדת בקטע $[0, 1]$.

(ב) (10 נקודות) תנו דוגמא לפונקציה f בעלת נגזרת רציפה ב- $(0, 1)$, כך שלכל $c \in \mathbb{R}$, $g(x) = f(x) - c \cdot e^x$ היא לא מונוטונית יורדת ב- $(0, 1)$. יש להוכיח שהדוגמא מקיימת את כל התנאים. דוגמא לא מנומקת היטב לא תקבל ניקוד.

פתרון:

(א) מהנתון נובע כי גזירה בקטע $[0, 1]$ ומתקיים $g'(x) = f'(x) - c \cdot e^x$. נוכיח כי קיים c כך ש- $g'(x) < 0$ לכל $x \in (0, 1)$ ולכן g מונוטונית יורדת (ממש) בקטע. נשים לב כי

$$g'(x) < 0 \Leftrightarrow f'(x) - c \cdot e^x < 0 \Leftrightarrow f'(x) < c \cdot e^x \Leftrightarrow f'(x) \cdot e^{-x} < c$$

לפי הנתון f' רציפה ולכן גם $f'(x) \cdot e^{-x}$ רציפה בקטע הסגור $[0, 1]$. לכן לפי משפט ויירשטראס יש לה מקסימום בקטע, נסמנו M . לכן אם ניקח $c > M$ אז יתקיים $f'(x) \cdot e^{-x} < c$ כלומר $g'(x) < 0$ כפי שרצינו.

Figure 1– Calculus exam question discussed with participants

The question in Figure 1, asks to find C, given that f is a function which has a continuous derivative in the segment $[0,1]$, and $g(x)= f(x)- Ce^x$ is a monotonically decreasing function.

In the following analysis I divide Mira's discourse to episodes. In each episode, I segment Mira's discourse to mathematical narratives, supporting narratives and implied narratives. Then, according to these narratives, I categorize Mira's participation to explorative or ritual.

Episode 1:

Table 3- Mira's solution of calculus question-part 1

1	Mira	(After reading the question) I know, when you know that (a function) has a continuous derivative, it means there is a maximum and a minimum. (So here) we need to relate to the maximum.
2	Interviewer	Do you want to solve it?
3	Mira	Let me see (in the exam) I did not solve all of it.

		(starts solving and works quietly for 2:20 min)
4	Interviewer	Let me see what you did here.
5	Mira	5.a. I derived $g(x)$ because f is a differentiable (function) and e^x is differentiable, that is known ...
		5.b. In the beginning we need to show that it (g) is a monotonically decreasing function, that is to say $g'(x)$ is smaller than or equal to zero.
		5.c. That is to say $f'(x)$ is smaller than or equal e^x times c . Because when we subtract ... (unclear speech).

In line 1, Mira began her solution with the mathematical narrative $g(x)$ is a continuous derivative, which means it has a maximum and minimum. Then she decided, relying on internal authority (evidence of explorative participation), that the solution procedure would be related to the maximum (value).

In line 5, Mira produced several new narratives, which she derived from narratives that were declared or implied in the question. These narratives are presented in table 4. To map the extent to which her narratives were based on formerly established narratives (a characteristic of explorative instruction), each narrative in table 4 is mapped to a supporting narrative. Narratives that were not stated explicitly, but relied upon, are placed in the column "implicit narrative".

Table 4- Narrative analysis of Mira's solution

Line	Narrative	Supporting narrative	Implicit narrative
1	$G(x)$ has a maximum	$G(x)$ is a continuous differentiable function	
5.a	$G(x)$ is derivative	$F(x)$ is a differentiable function and	Difference of differentiable

		e^x is differentiable function	functions is a differentiable function
		e^x is differentiable function	e^x is a continuous function in the segment $[0,1]$
			$(Ce^x)' = Ce^x$
		$(Ce^x)' = Ce^x$	The derivative of a constant multiplied by a function is equal to the constant times the derivative of the function
5.b	$G(x)$ is a monotonically decreasing function	$G'(x)$ is smaller than or equal to zero	
5.c	$F'(x)$ is smaller than or equal e^x times c .	$G'(x)$ is smaller than or equal to zero	$F'(x) - Ce^x \leq 0$

As can be seen in episode 1, Mira's narratives were all based on formerly established mathematical narratives (such as the theorems about derivatives and continuous functions), though not all of them were stated explicitly. All of her discourse in this episode was based on her own authority and did not seek external approval. These characteristics indicate explorative mathematical participation.

Episode 2:

While Mira continued her explanation about the solution, she talked about e^x which is a monotonically increasing function in $[0,1]$. Then she explained:

Table 5- Mira's transcribed solution of calculus question-part 2

1	Mira	According to Weierstrass theorem it ($f'(x)$) has a maximum... so we take C as maximum. But they (those who wrote the solution) did not solve in that way [...]
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2	Interviewer	What do you want to get? (My question is) not what they did
3	Mira	Because it ($f'(x)$) has a maximum, we multiply it with an increasing function... but it is not necessary that it would be bigger than here (pointing to $f'(x)$) ... but we multiple it ($f'(x)$) with a positive value (e^x) ... it has to be a specific C... we take C as maximum... what is wrong here? Could I have made a mistake?

Here, Mira started with an explorative explanation, based on her previous narratives, using the Weierstrass theorem. Table 6 maps her narratives in this episode.

Table 6- Narrative analysis of Mira's solution

line	Narrative	Supporting narrative	Implicit narrative
	e^x is a monotonically increasing function in the segment $[0,1]$	Not stated. Probably assumed based on previous knowledge	
1	$f'(x)$ has a maximum	According to Weierstrass theorem	
	C is a maximum	Not stated. Unclear where this narrative came from.	
3	e^x is a positive value	e^x is a monotonically increasing function in the segment $[0,1]$	
	The product of a maximum value with positive value is positive	C maximum	The maximum of $f'(x)$ is positive (wrong assumption)

Here, Mira started with an explorative explanation, based on her previous narratives, using the Weierstrass theorem. However, she assumed C is a maximum without a supporting narrative for her assumption. The excerpt above shows that Mira was

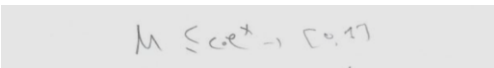
deliberating between two alternative narratives, those produced by the examiners (or writers of the solution) and those produced by her. An indication of ritual participation can be seen in line 2 table 5, where the way that I respond to Mira is urging her to let go of external reassurances.

When Mira came up with a solution that was different from what she remembered (line 1) from the official solution, she first halted, indicating elements of ritual participation (relying on external authority). However, when prompted by me to continue her own train of thought, Mira continued her explanation in an explorative manner. She attempted, based on her previous narratives that $f'(x)$ has a maximum and e^x in that segment is increasing, to find the specific C that she needed. However, the assumption of C as a maximum probably depended on a wrong implicit narrative that the maximum is a positive value.

Episode 3:

In the following segment a discussion took place between me and Mira, where I asked her to further explain her reasoning.

Table 7- Mira's solution of calculus question-part 5

1	Mira	If f' ... the maximum of e^x in the segment $[0,1]$ is e to the power of 1. That is in this segment, e to the power of 1 is the highest value which it will have.
2	Interviewer	The maximum of e ?
3	Mira	The maximum is e to the power of 1. That is the highest value it'll reach.
4	Interviewer	(Here I asked Mira to explain how the function e^x related to $f'(x) \leq Ce^x$ and why she wrote M instead of $f'(x)$) Why did you write M instead of $f'(x)$? 
5	Mira	One second (thinking) but it is not supposed to be e^x in the segment $[0,1]$. If e to the power of zero is one, then we cannot take C instead of M . That is, C is the maximum of the derivative.

6	Interviewer	If I understood you, you need a value of C which matches this (points to $f'(x) \leq Ce^x$). Now you are trying to ask me if that value is M?
7	Mira	That is the value I found.
8	Interviewer	How did you get that (value)?
9	Mira	Since $f'(x)$ is less than M
10	Interviewer	Ok...
11	Mira	So, if we assume M is equal to C, that is, we multiple it with an increasing (function), this (Ce^x) value is bigger and $f'(x)$ is still less than it... but I think that I missed something, I still do not know what, there is something missing.

Table 8 maps Mira's narratives in part 5 of the solution.

Table 8- Narrative analysis of Mira's solution

line	Narrative	Supporting narrative	Implicit narrative
5	C is equal to M (the maximum)	There is M for the function $f(x)$	
		the maximum of e^x in the segment $[0,1]$ is e to the power of 1	
			$F'(x) \leq M \leq Ce$
			$M \leq Ce^x$ and e^x is an increasing function

In line 5, Mira's narrative stated that C is equal M. Mira assumed that according to the supporting narratives, M is a maximum of $f'(x)$. This assumption was based on the Weierstrass theorem and the narrative that the maximum of e^x in the segment $[0,1]$ is e to the power of 1. Although this assumption was wrong, the implicit narratives that were built upon (for example $F'(x) \leq M \leq Ce$) indicated a logical coherence between new narratives and supporting narratives, which is a characteristic of explorative

participation. From the supporting narrative "M is the maximum of $f'(x)$ ", Mira derived correctly the narratives: " $f'(x) \leq M$ " and " $M \leq Ce^x$ ". She relied on the supporting narrative that the maximum of e^x in the segment $[0,1]$ is e^1 to justify the narrative " $M \leq Ce$ ". Then, she assumed $C=M$, relying on the wrong assumption that the maximum of $f'(x)$ is positive (see table 6). Based on that, she concluded that if $C=M$ then the product of C with e is bigger than M . All these narratives were built one upon the other, in a logical fashion and with hardly any gaps.

Although Mira asked me questions during her activity, she relied on her internal authority to produce new narratives. Thus, most of her participation could be characterized as explorative. Though there were some indications of ritual participation in Mira's discourse when she talked about the alternative narrative that was produced by the examiner, this section was very short.

5.3.2 Lena's mathematical participation

As described in chapter 5.2.1 Lena reported that she had always engaged enthusiastically with mathematics (from elementary school until high school). During the semester Lena talked about her self-confidence being lowered, and after failing in the calculus midterm exam she generally avoided talking with me about her mathematical achievements.

When I asked Lena in the final interview to solve the calculus question, she replied: "Solve now?! I don't feel like remembering (restore to my memory), really don't feel like remembering!" It was unclear if Lena did not want to remember the mathematics or the whole situation of the exam. In any case, she did not provide any access to her mathematizing during that period.

Since Lena avoided talking about the calculus question at the end of the semester, I do not have much information about her mathematical discourse from that interview. Instead, I extracted data about her mathematical discourse from the stimulated-recall interview that was held around a calculus tutorial³.

In this analysis, I focused on parts where I encouraged Lena to mathematize (communicate about mathematical objects).

The interview took place during the eighth week of the semester. I asked Lena to watch a tutorial I had videotaped several days before and talk with me about it. In what follows, I describe the interaction with Lena around several instances where there was some opportunity to gain access to her mathematical discourse.

Episode 1:

In the part of the lesson we were viewing, the TA (teaching assistant) talked about the limit of a function. He explained that the limit of $\sin(x)/x$, when x approaches zero, is one. He gave an example on the board (see fig 2), where he stressed that the expression inside the function must approach zero, that is to say that the limit of $(\sin f(x)) / f(x) = 1$ when $f(x)$ approaches zero.

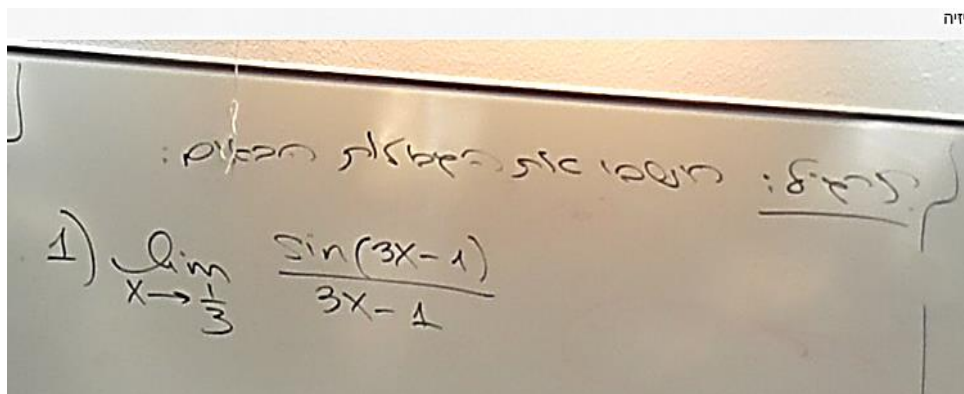


Figure 2- Tecaheer Assistant's explanation in episode 1

While we watched this part, I asked Lena about the mathematical theorem that the TA had explained, about limit $\sin (f(x)) / f(x) = 1$ when $f(x)$ approaches zero. I expected a mathematical explanation or a quote of the theorem, but Lena avoided talking with specificity about the mathematics. Her answer was:

Table 9- Lena's transcribed discussion about calculus lesson-part 1

1	Lena	Specifically, this is what I knew was going on when he wrote $\sin(x)/x$. It was a little obvious; this specifically, was obvious. But he wants to generalize here. Sometimes what is good in a TA is that he allows you to follow harmoniously with the material that he explains, maybe if someone else did that, it would not be as obvious
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Although Lena started talking about the purpose of the theorem that the TA presented ("he wanted to generalize"), she quickly went on to talking about the way he taught mathematics (that "allows you to follow harmoniously with the material"). She answered my question without giving any mathematical explanations to the theorem

and without regard to the mathematical purpose of that example. Instead of mathematizing (talking about mathematical objects) she subjectified (talked about the TA and about herself).

Episode 2:

We continued watching the video, where the TA continued talking about the theorem $\lim_{f(x) \rightarrow 0} \frac{\sin f(x)}{f(x)} = 1$. The TA presented an example (see fig 3 below) where $(3x-1)$ does not approach zero, in which case the limit of the expression $\frac{\sin(3x-1)}{3x-1}$ is not one.

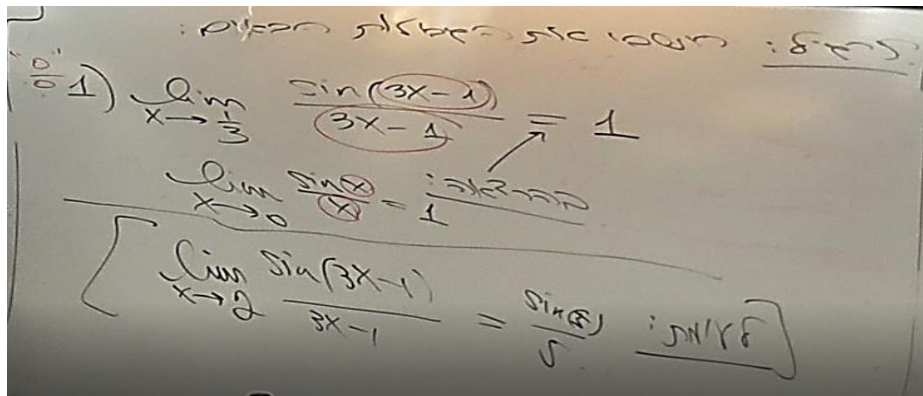


Figure 3- Teacher Assistant's explanation in episode 2

While we were watching, I asked Lena if she noticed what the TA meant in that example, and she replied yes. Then I asked her to explain. Lena's answer was:

Table 10- Lena's transcribed discussion about calculus lesson-part 2

1	Lena	You need to see that there are all the conditions you need, and not to look at limit sin something divided by something and directly say it is one. The TA helps us to zoom out (the question) and that thing, in my opinion, is good and because that I always come to his class. Although there is a mess in the seating in class and some students say that it is not worth (the trouble), I still think it is worth to be there and to hear (the TA's lecture)
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Again, we can see that Lena's answer in relation to the TA's explanation and to my expectation is full of subjectifying (e.g. "**you** need to see", "The TA helps **us** to zoom out") with only a little mathematizing. My expectation was that her explanation would be about the theorem of $\frac{\sin f(x)}{f(x)}$ and that $f(x)$ must approach zero in order that the limit be one. However, Lena talked about the mathematical situation in general

terms: "You need to see that there are all the conditions you need". She did not give any specific details about the actual "conditions" necessary to achieve a limit of one. In the little mathematizing that did occur in this excerpt, Lena said: "not to look at limit sin (as) something divided by something" but she did not detail that the "something" should be a function approaching zero. Instead, she lapsed into talking about the TA and his ways of teaching ("The TA helps us to zoom out (the question) and that thing"). She then dislocated the focus of her talk even further, to the physical conditions of the classroom ("mess in the seating in class") which was even more remote to the mathematics that I urged her to discuss. This typical behavior repeated itself in many instances in Lena's discourse.

Episode 3:

We continued watching the video; in this part of the lesson, the TA began to solve a new exercise (fig 4) about combined functions. While we were watching the video, I asked Lena if she understood why Z equals epsilon. I expected a mathematical explanation because I asked directly about a mathematical object, but her answer was:

Table 11- Lena's transcribed discussion about calculus lesson-part 3

1	Lena	I am not in focus. I thought about another thing when I heard that, I am trying to be in focus
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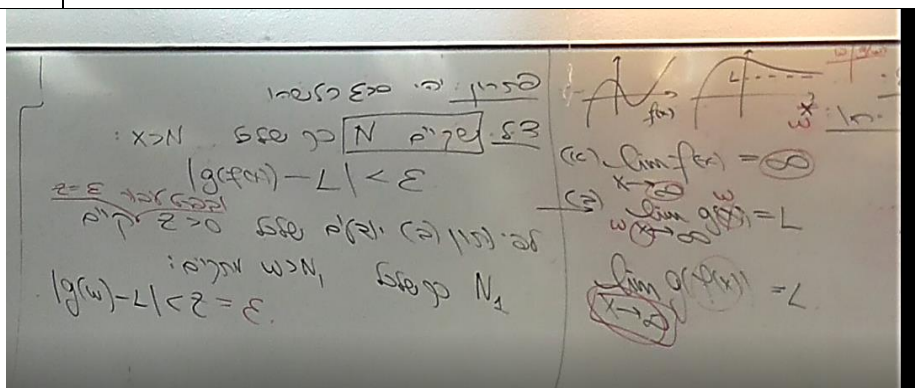


Figure 4- Teacher Assistant's explanation in episode 3

Here, it is possible that indeed Lena lost attention for a moment. However, it is more probable, given her general avoidance of mathematizing, that she was using an explicit avoidance strategy ("I lost focus") since this is the first question that I asked directly about mathematical objects (Z, epsilon, and their equivalence).

Episode 4:

While we continued watching the video, I asked Lena to solve an exercise (see fig 5) that the TA wrote on the board.

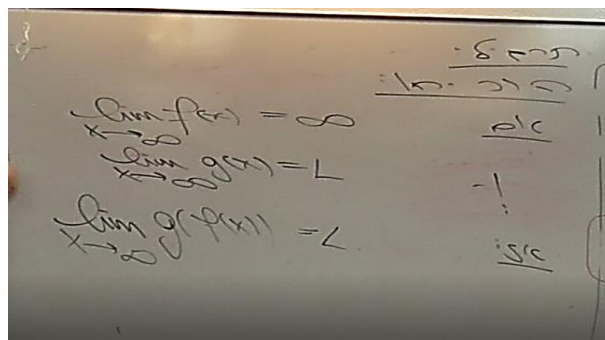


Figure 5- Teacher Assistant's explanation in episode 4

Table 12- Lena's transcribed discussion about calculus lesson-part 4

1	Interviewer	If I ask you to solve that exercise now, will you do it with formal mathematics?
2	Lena	I want to think about it, I do not remember it now
3	Interviewer	But it was in the midterm exam, you learned that before
4	Lena	No, functions were not (at the midterm exam), I did not learn it

This excerpt exemplifies again Lena's tendency to avoid mathematizing (at least in front of me), excusing herself in various ways. In line 1, I attempt to encourage Lena to mathematize by asking "will you do it with formal mathematics?" This request came after several failed attempts to elicit from Lena specific talk about the mathematics in the episode. I continued to press in line 3, when I tried reminding Lena that the subject was in the midterm exam. However, she again avoided my request, stating "I did not learn it" (line 4).

To summarize, this chapter showed several interactions between Lena and me, where she made every attempt to avoid mathematizing, either by answering my questions vaguely and by turning to subjectifying, or by explicitly excusing herself from the interaction by stating she was not in focus or did not learn the subject. This avoidance indicates that Lena was probably very peripheral to the calculus discourse that she

was introduced to in the first semester. She used her agency mainly to avoid engagement, rather than to attempt producing mathematical narratives. Since my access to Lena's discourse was so scarce, it is difficult to say if she participated ritually or avoided participating altogether. However, her accounts of "studying day and night" hinted that most probably when she *did* participate in the mathematical discourse, this participation was ritual.

6. Discussion

Multiple studies have discussed the relationship between being part of a minority group and success in school or academic studies (Arar & Abu Rabia-Queder, 2011; Arar & Haj-Yahia, 2016; Flum & Kaplan, 2016; Nasir & Saxe, 2003; Shavit & Blossfeld, 1993). According to these studies, higher education allows minority students to move from the margins of society closer to its centers of power.

In this study I followed 13 Arab female students who varied in their personal characteristics. Some were outgoing and energetic, others were shy and introverted. Almost all of them entered their studies with strong mathematical identities, yet as the semester progressed, most of them experienced difficulties with their studies, leading to failure (at least in some subjects) at the end of the semester.

The first question of this study concerned students' authoring of their identities (current and designated identities) and how these identities develop during their first semester in relation to assisting and constraining factors. I found that Arab female students were experiencing a set of challenges that may be unique in its intensity. These challenges come from the gaps between the students' extremely high aspirations (excelling in their studies, getting prestigious jobs in the high-tech industry) and the external constraints of studying in one's 2nd and 3rd languages (Hebrew and English), and having limited access, in certain cases, to social support from one's familiar cultural milieu. Also, I found that there are assisting factors which help Arab students in their studying, for example, special tutorials provided in Arabic (through the Unit for Students' Advancement), and study partners. One of the most important finding is that the students seemed to be trapped in a cycle where pointing to such

external constraints would be considered as “making excuses”, while the extra energy needed to deal with such challenges was not always in their awareness.

As Sfard and Prusak (2005) claimed, learning is the “closing of the gap” between current and designated identities. In this study, I found recurring gaps between students' evaluation of themselves at present and their expectations of themselves to excel and compete with other students. However, there are reasons to believe that such tensions are common to many students in the highly competitive tracks of Computer Sciences and Electrical Engineering, regardless of gender and ethnic origin. Yet the high accountability to the family and community, common in the Arab culture (Khattab, 2005), probably assisted in making these tensions even more pronounced for the female Arab participants of this study.

The students in my study entered the Institute setting themselves very high goals of excellence, including landing prestigious jobs in the high-tech industry, becoming scientists or opening private technological businesses. This, in spite of the sociological reality where women in the Arab society in Israel still mostly end up as housewives or teachers (Mustafa & Arar, 2009). This gap, between aspirations and reality can be interpreted in two ways. On the one hand, it brings hope that a new generation of Arab female students is on the verge of making a significant change in Israeli society. On the other hand, the dry statistics still show that the chances of these young women to fully achieve their aspirations are, unfortunately, very low. The gaps between current and designated identities thus exist both at the local level of their current studies, and at the level of long-term aspirations.

The barriers that Arab minority students in Israel, and in particular, female students, face in higher education are only starting to be understood (Arar & Haj-Yahia, 2016). In order to better understand these barriers, I asked in my research about the ways which my participants do enact agency in relation to narratives regarding ethnicity and gender. An important finding is the consistent efforts students made to minimize the ethnic and cultural conflicts that they experience in the Technion world. In this case, the agency expressed itself in the way the participants chose to try and avoid conflict (Braathe & Solomon, 2015). There seemed to be good and bad sides to these attempts. On the one hand, the minimizing efforts helped students to integrate while

minimizing schisms and conflicts with the majority population. This seems to have left them time and energy to concentrate on their studies. On the other hand, I had a strong feeling that some of the political tensions are so silenced, to the extent that students did not feel comfortable to talk about them with someone of their own milieu, that such silencing may itself be taking a toll on the students' well-being and their chances to actualize their abilities.

The results resonate with Erdreich and Rapoport (2006), who found that studying in the academia and living outside the family home constitute a new and different sphere for Arab female students in constructing and investigating their ethnic and feminine identity. In addition, Arab female students enact their agency to read and interpret the power relations in that space.

To compare between various features of participants' identity and agency, in relation to their space of authorship, I focused on two case studies, Mira and Lena. In my study, I found that Mira's story demonstrated a case of high agency, along with very explicit positioning of herself in relation to ethnic and religious conflicts. This agency seems to have helped her overcome difficulties in the social Technion's figured world in relation to her home figured world. In contrast, Lena's story demonstrates a case of very little agency, along with a total neglect of her positionality with regard to ethnic and religious conflicts. Paradoxically, although Lena seemed to start the semester as better acclimated to the figured world of the Technion, her lack of awareness of the constraints imposed on her by her minority status may have led to lack of agency. According to previous studies (Holland et al., 1998; Solomon, Radovic, & Black, 2016) this awareness may cultivate choice, which is the necessary condition for these students' agency to cope with challenges they face in the academic space.

In addition to the cultural space, I examined in my research the way which participants enact agency with relation to the academic and mathematical aspects of the Technion figured world. In Sfard & Prusak's (2005) study, it was shown that instrumental goals, leading to ritual participation, have to do with cultural values. There, the authors found newcomers from the former USSR (students in 11th grade) to be more aligned with explorative mathematical goals and these were aligned with the goal of studying mathematics for the sake of becoming a "cultural person". In contrast, Israeli-born

students expressed more instrumental goals for mathematics high-school studies and in accordance, engaged in the learning of mathematics more ritually. In order to understand how do the identity narratives of the participants interact with their participation in the mathematical discourse, I focused on their agency in relation to their mathematical participation. An interesting finding was that Mira, who enacted agency regarding her ethnic conflict, also showed agency in her mathematical discourse, which was mostly explorative. Even in a stressful situation, such as being "under examination" in an interview, she attempted to solve a question (despite remembering she did not succeed in solving it during the exam), and did so according to her own ideas. In contrast, Lena continuously avoided mathematizing in front of me, and whatever mathematical discourse that she did produce, had mostly ritual characteristics (such as reliance on "remembering"). As shown in the analysis of her space of authorship, Lena faced a gender conflict in the Technion figured world, which made her suspect her mathematical and mental abilities. This lack of confidence was coupled by feelings of anxiety about mathematics. According to Heyd-Metzuyanim (2015), such feelings may go hand in hand with ritual participation. Similarly, to the case of Mira, where agency seemed to cross the boundaries of discourse, there could be seen relations between Lena's lack of agency in the mathematical discourse and her lack of agency in relation to the gender discourse.

Lena's case was not unique. Many of the participants in this study exhibited some form of ritual engagement, as could be seen from their anxiety and reluctance to talk with me about their calculus exam, or their repeated reference to memorizing procedures and theorems as means for succeeding in their studies. Previous studies (Heyd-Metzuyanim, 2013; 2015), showed that instrumental goals are connected with ritual engagement in mathematical learning, where the focus is on the enactment of procedures according to externally given rules, rather than on producing mathematical narratives for their own sake. In other words, a ritual participant satisfies herself with getting external approval for her execution of procedures (e.g. by a grade in a test) rather than achieving a sense of understanding the subject matter. Ritual engagement may go hand in hand with anxiety of mathematics (Heyd-Metzuyanim, 2015), since the focus is on how the person is identified by his/her

mathematical activity, not the mathematical activity itself. There are not sufficient indications in this study that can attribute this ritual engagement to the minority or gender identity of these students, as there are good reasons to believe that other students engage more or less ritually in academic mathematics courses as well. However, I do wish to point to the connection that may exist between the high aspirations, including the social stress for success, that these students experience, and ritual mathematical goals. As shown in the findings above, very few students in this study talked about learning mathematics for its own sake, as means for understanding the world or achieving wider knowledge. The only exception was Mira, who talked explicitly about how she suddenly enjoyed mathematics, unlike her studies in high-school. The rest of the participants rarely talked of enjoyment or interest in academic mathematics.

Another similarity between Lena and most of the participants related to the lack of awareness of structural constraints. Although Lena was a relatively extreme case, many of the participants placed all the responsibility of their difficulties on themselves, their lack of studying or lack of confidence. Rarely did they talk about language or cultural difficulties, unless asked about it specifically, and even when asked directly, they usually minimized conflicts.

It is hypothesized that for most of the students, the social stress to succeed, coupled by the structural constraints of learning in a foreign language and in a figured world very different from the home figured world they were used to, led to ritual participation in mathematical learning. Lack of access could be seen not only in language barriers, which most participants confessed to have only after they experienced the reality of learning in a second language; it could also be seen in the participants' unawareness of the studying actions that were needed to succeed in relation to academic mathematics, that were different than high-school studying skills. There are good reasons to believe that the lack of awareness to cultural conflicts made the participants under-estimate the energy needed to overcome barriers. Such awareness would have enabled them to enact more agency to overcome the barriers that were leaving them in a state of ritual participation.

7. Conclusion

Arab female minorities entering universities, and in particular, male-dominant fields such as Computer Science and Electrical Engineering, may be at a particularly vulnerable nexus between the collectivist and conservative values of the Arab society, and the individualistic and highly-competitive values of the Jewish-Western society. As such, they require extra attention from educational institutions, to cater for their needs. The significance of this study lies not just in turning attention to the importance of Arab female students' awareness of the social and ethnic conflicts they face upon entering a foreign figured world, but also in the implications of this awareness to success in mathematical learning. Awareness allows choice, which is necessary for these students to enact their agency to cope with challenges, cultural as well as mathematical.

The limitations of this study are, first, the small sample which does not allow generalization to the full population, neither of the Technion Arab female students, nor to the general Arab population in Israel. Still, the sample of 13 students allows one to draw some tentative conclusions which can be examined in future studies on a larger sample, using measures such as surveys and questionnaires. Second, a semester is a long time, and includes multitudes of experiences. The diaries and interviews provide only a glimpse into these experiences. Third, the present study relied almost solely on first person identity narratives (self-reports). This presents a limitation, especially with relation to the mathematical skills of the students. For example, I could only rely on their reports of how they were in high-school, but did not have access to their actual performance or to third person identity narratives of them as told by their former teachers. Finally, the conclusions regarding the relation between agency, awareness of conflicts and mathematical performance are very tentative. They rely mostly on two contrasting cases (Mira and Lena), yet substantiating the causal relationship between agency, choice, and awareness of conflicts necessitates not just more such case studies, but also a fuller view of the interactions between choice, agency and mathematical performance.

Despite these limitations, this study has two main contributions. Firstly, the study of Arab female students contributes to the study of the development of learners'

identities in general (Abu-Rabia-Queder & Weiner-Levy, 2008; Arar, 2015), and of mathematical identities in particular. Secondly, this study applies these identity theories, particularly of mathematical identities, to Arab students in Israeli universities, a growing and under-researched population with unique needs and difficulties.

Future studies should examine whether the main findings in the current study can be extended to Arab students (male and female students) in other academic contexts that demand academic-level mathematics. Another future avenue would be to unpack the general notion of "Arab culture" and its relation to mathematical learning. For example, in this study, I treated all the participants as part of one group (Arab females). However, through this study, I learned that the subgroups of the Arab community (conservatives, secular, Muslims, Christians, Druzes, specific villages or clans (Hamulas)) are also very important and members of these groups may vary considerably with relation to their figured worlds. Therefore, future studies could examine more closely members of various groups of the Israeli Arab community, to compare and contrast between the different figured worlds. Finally, this study was focused on students after their acceptance to the Technion. It would be interesting to follow students in their transition from Arab schools to the predominantly Jewish academic institutes, to see how identities change from one context to the other.

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9. Appendix

9.1 Initial interview protocol

ראיון התחלתי (בוצע בשבוע הראשון ללימודים בטכניון)

זהות סטודנטיות בטכניון בהקשר התרבותי, האתני והמגדרי

ראשית, הרשי לי להודות לך על נכונותך להשתתף במחקר שאני עורכת. חשוב לי להדגיש שהראיון נועד לצרכי מחקר בלבד ושלא אחשוף אף פרט מזהה אודותיך בדיווח על תוצאות המחקר. בראיון הקרוב אשאל אותך שאלות בנוגע להיסטוריה שלך כתלמידת בית ספר. אתייחס גם לנושאים של הזהות התרבותית והאתנית שלך. בכל שלב שהוא, את זכאית להפסיק את הראיון או לבקש ממני לכבות את מכשיר ההקלטה. כמו כן את זכאית להחליט שלא לענות על שאלות מסוימות במהלך הראיון. הפסקת הראיון ו/או יציאה מהמחקר לא יפגעו בך בשום דרך.

האם אני יכולה להפעיל את מכשיר ההקלטה?

תאריך: -----, שעה: -----.

חלק (א) סגור:

משתנים דמוגרפיים:

1. גיל: -----
 2. יישוב: -----
 3. מגמה בתיכון: -----
 4. רמת מתמטיקה תיכונית: -----
 5. השתתפות בפרויקטים אקדמיים בתיכון: (1) כן (2) לא.
- אם השתתפת באיזה פרויקט: -----.
6. השכלת האב: -----
 7. השכלת האם: -----
 8. ציון בבחינה פסיכומטרית (כמותי): ----- (כללי): -----

חלק (ב) חצי מובנה:

רקע אישי, משפחתי ותרבותי:

9. ספרי לי קצת על עצמך. מי את? מה מעניין אותך?
10. כמה נפשות אתם בבית? איך זה משפיע במעבר שלך לטכניון, לימודית/ חברתית?
11. האם את מרגישה השפעה של הורים שלך? אם כן/לא למדו תואר אקדמי? (אם כן, כיצד?
אם לא מדוע).

זהות מתמטית:

12. כיצד היית במתמטיקה בבית הספר? (אם אומרת שאהבה – שאלו ממתי. האם מאז ומתמיד או שאולי היא זוכרת נקודת ציון שבה היא שינתה את דעתה על מתמטיקה? כנייל לגבי קושי וכישלון). (במידה והמרואינת אומרת מוצלחים, נסי להבין לפי מה היא קובעת את קריטריונים להצלחה).

12.1. האם במהלך לימודי המתמטיקה בתיכון חווית קשיים הקשורים לנושא השפה הערבית והעברית?

12.2. האם חלק מהתכנים במתמטיקה נלמדו בעברית?

12.3. האם היית צריכה להבחן בעברית?

12.4. האם את צופה להיתקל בקשיי שפה בלימודים בעברית?

לימודים בטכניון והציפיות מהם:

13. אילו גורמים השפיעו על בחירתך בטכניון?

14. אילו שיקולים עמדו בפניך בעת בחירתך את מקצוע הלימוד שלך בטכניון? מה את מקווה להשיג באמצעות הלימודים הללו?

15. כמה קורסים את לומדת הסמסטר? כמה מהם קורסים למתמטיקה?

16. מה הציפיות שלך מעצמך לתקופה הקרובה (הצלחה/ ביטחון/ כישלון...).

17. האם את משתתפת בפרויקטים הקשורים למלגות? אם כן, כיצד השתתפות זו משפיע על זמן הלימודים שלך?

תרבות ערבית והשתייכות לקבוצת מיעוט

18. האם לדעתך היותך אישה מהמגזר הערבי/דרוזי תשפיע על לימודי המתמטיקה שלך בטכניון? אם כן, כיצד? ואם לא, מדוע?

18.1. במידה והמרואינת מדברת על רקע תרבות אחר, במה לדעתך החוויה שלך תהיה שונה מזו של סטודנטית יהודייה?

19. בטכניון יש גברים ונשים מכל התרבויות השונות בישראל, מה הציפיות שלך מהם?

19.1. האם יש לך חברים שאינם מהקבוצה אתנית תרבותית אתנית שלך, אם כן מאיזה קבוצה הם ומה אתם עושים ביחד? ואם לא מדוע?

20. האם לדעתך תחוו קונפליקטים בין הלימודים בטכניון לבין הערכים שעליהם גדלת בבית ושעליהם מקפידה המשפחה שלך? אם כן, מה הם?

20.1. כיצד את מתמודדת אתם? כיצד את מתכוונת להתמודד איתן?

9.2 Midterm interview protocol

שאלות ליומן

יומן שיתנהל עם משתתפות המחקר דרכו אוכל ליצור מעקב להשתלבותן של הסטודנטיות הערביות בטכניון דרך שאלות כלליות שאעביר להן במייל ויחזירו לי תשובה וישתפו אותי בחוויותיהן.

שאלות לדוגמא :

1. איך עוברים עלייך השבועות הראשונים של הלימודים? מה מוצלח יותר? מה מוצלח פחות?
ממה את נהנית? ממה את פחות נהנית?
2. תארי את לימודיך בקורסים המתמטיים שאת לוקחת. אילו קורסים אלו? איך ההרצאות?
איך התרגולים?
3. האם היו לך עד כה מטלות, תרגילים ובחנים בקורסים המתמטיים? אם כן, כיצד הם
עברו? אם לא, האם את מתכוונת לגשת לבחנים הקרובים ולהגיש את כל המטלות? אם
כן, כיצד את נערכת לכך? אם לא, מדוע?
4. כמה זמן את מקצה ללימודים ביום באופן ממוצע ובין אילו פעילויות את מחלקת את זמנך?
5. האם יצרת קשרים חברתיים חדשים עם סטודנטים בטכניון? אם כן, האם אלו סטודנטים
מהמוצא שלך או ממוצאים אחרים?
6. האם את לומדת עם סטודנטים אחרים או סטודנטיות אחרות? אם כן, ספרי עם מי את
לומדת, באיזו תכיפות ובמה אתם עוסקים בלימודים המשותפים.
7. האם נתקלת עד כה בקשיים מסוימים? אם כן, מהם? כיצד את מנסה להתמודד אתם?
האם היו דברים שציפית שיהיו קשים אבל בסוף דווקא קלים יותר ממה שציפית?
8. האם נתקלת עד כה בהבדלי תרבות בין הסביבה בטכניון לבין הסביבה שלך מהבית? אם
כן, במה הם באים לידי ביטוי? אנא פרטי ספציפית ככל שניתן.
9. כיצד את מתמודדת עם נושא השפה בלימודים עד כה? האם כל הדברים הנאמרים
בעברית מובנים לך? האם יש מקומות שבהם נתקלת בקושי סביב השפה העברית?
10. האם יש דברים נוספים שתרצי לספר לי עליהם שקרו לך במהלך השבועיים-שלושה
הראשונים ללימודיך בטכניון?

9.3 Final interview protocol

זהות סטודנטיות בטכניון בהקשר התרבותי והאתני של מוצאם

ראשית, הרשי לי שוב להודות לך על השתתפותך במחקר שאני עורכת ואני מאוד שמחה לפגוש אותך עוד פעם אחרי שסיימת סמסטר ראשון בטכניון. חשוב לי להדגיש שהריאיון נועד לצרכי מחקר בלבד ושלא אחשוף אף פרט מזהה אודותיך בדיווח על תוצאות המחקר. את זכאית להפסיק את הריאיון או לבקש ממני לכבות את מכשיר ההקלטה. כמו כן את זכאית להחליט שלא לענות על שאלות מסוימות במהלך הריאיון. הפסקת הריאיון ו/או יציאה מהמחקר לא יפגעו בך בשום דרך.

האם אני יכולה להפעיל את מכשיר ההקלטה?

תאריך: -----, שעה: -----.

מבחן באינפי

אני רוצה לדבר אתך עכשיו קצת באופן יותר ספציפי על המתמטיקה, וחשבתי שיהיה טוב פשוט להתמקד במבחן האחרון שהיה באינפי.

1. איך היה לך המבחן באינפי 1? כמה מועדים עשית? את יכולה לסבר קצת על כל מועד.
2. באיזה סדר בחרת לפתור את השאלות? (שאלי בהתאם לתשובה, מדוע בחרה להתחיל בשאלה כזו או אחרת).
3. האם הנוסח של השאלות היה ברור? האם היה משהו לא ברור? הסבירי
4. האם לדעתך הציון שלך במבחן משקף את הלמידה וההבנה שלך לחומר?
5. בואי ננסה לפתור ביחד אחת השאלות שהרגשת שהיא קשה עבורך?
6. האם את יכולה לכתוב פתרון ולהסביר אותו עבור שאלה שלדעתך הייתה קלה יחסית עבורך?
7. (אבקש מהן טלפונית להביא סריקה של המבחן) בואי נעבור ביחד על מה שכתבת וננסה להבין איה היה קשה לך? (שאלות שלא הסתדרה איתן)

הסמסטר באופן כללי:

8. הסתיים הסמסטר הראשון שלך בטכניון. איך את מסכמת אותו ?
9. האם היו לך קורסים שלא ניגשת למבחנים שלהם בכלל? אם כן, מה היו הסיבות לכך?
10. כעת, בסוף הסמסטר, ולעומת תחילתו, האם לדעתך תפיסותיך ועמדותיך לגבי לימודים בטכניון השתנו? אם כן, במה?
3.1 מה ציפית ולא התגשם? מה ציפית והתגשם כפי שציפית?

הרגלי למידה:

11. כמה זמן הקצית ללימודים ביום באופן ממוצע?
11.1. בין אילו פעילויות חילקת את זמנך? (בית, נסיעות...)
12. היכן וכיצד את לומדת בדרך כללי? ולמה?
12.1. האם למדת באופן יחידני/ עם אנשים?
12.2. אם היא עונה עם אנשים, שאלו לגבי זהות אתנית.
12.3. האם יש לך חברים/ חברות מקבוצות אתניות שונות משלך? איך אתם מבלים את זמנכם יחד?
13. איך הסתדרת במהלך הסמסטר עם השפה העברית?
אם מדברת על קשיים, שאלו איך התמודדה. אם אומרת שהתחיל קשה, בדקי אם היה שיפור לדעתה, ואם כן, ממה הוא נבע. במיוחד כדאי להתעמק אם אומרת שהיה יותר קשה ממה שהיא ציפתה. מדוע? מה היה במיוחד קשה עם השפה? וכי

תקופת מבחנים:

14. איפה למדת למבחנים? בבית? במעונות? בספריה?
14.1. איך זה השפיע על יעילות הלמידה שלך?
15. איך עברה עליך תקופת המבחנים?
16. עכשיו אחרי סיום סמסטר, האם את רואה לימודי המתמטיקה בטכניון? האם הם שונים מלימודי המתמטיקה שחווית לפני שנכנסת לטכניון? במה?

**השתלבותן של סטודנטיות ערביות בטכניון - היבטים
תרבותיים וזהות מתמטית**

סורינה סבאה

השתלבותן של סטודנטיות ערביות בטכניון - היבטים תרבותיים וזהות מתמטית

חיבור על מחקר
לשם מילוי חלקי של הדרישות

לקבלת התואר מגיסטר למדעים בהוראת הטכנולוגיה והמדעים

סורינה סבאח

הוגש לסנט הטכניון - מכון טכנולוגי לישראל

טבת תשע"ט, חיפה, דצמבר 2018

המחקר נעשה בהנחיית ד"ר עינת הד-מצויינים בפקולטה לחינוך למדע וטכנולוגיה.
אני מודה לפקולטה לחינוך למדע וטכנולוגיה על התמיכה הכספית הנדיבה בהשתלמותי

רשימת פרסומים:

Sabbah, S., & Heyd-Metzuyanim, E. (2018). Identities of female Arab undergraduates and their integration in mathematics courses in an Israeli university. Paper presented at a symposium titled "Venturing the terrains of mathematical identities: Theoretical Perspectives on participation and inclusion in mathematics education", *the Conference of American Educational Research Association (AERA 2018)*, New York.

Sabbah, S. & Heyd-Metzuyanim, E. (accepted). *Agency and identity of female Arab students entering a technological university*. Paper accepted as an oral presentation at the 11th Congress of the European Society for Research in Mathematics Education (CERME11), Utrecht, the Netherlands.

תקציר

המחקר הנוכחי נועד להעמיק את ההבנה של תהליך השתלבות סטודנטיות ערביות בקהילת לימודי ההנדסה, המתמטיקה והמדעים (STEM) באקדמיה בכלל ובטכניון בפרט.

בטכניון לא קיימת אפליה מתקנת לאף מגזר, ולכן סטודנטים ערבים המתקבלים לטכניון הם בעלי נתוני קבלה גבוהים, בדומה לסטודנטים ממגזרים אחרים. במדעי המחשב, כל הסטודנטים המתקבלים הם בעלי תעודת בגרות איכותית, הכוללת בין השאר 5 יחידות במתמטיקה, וציון פסיכומטרי גבוה. יחד עם זאת, על-פי נתוני היחידה לקידום סטודנטים בטכניון, לאחר הסמסטר הראשון, אחוז הסטודנטים הערבים הנמצאים ב"מצב אקדמי בלתי תקין" גבוה בהרבה משל סטודנטים יהודים. למרות שביחידה לקידום סטודנטים בטכניון צברו בשנים האחרונות ידע מעשי רב בנוגע להתמודדות של סטודנטים ערבים, ידע זה איננו מגובה מחקרית. בנוסף, גם לאנשי היחידה הסיבות לקשיים של סטודנטיות ערביות אינן ברורות עדיין, שכן הן ממעטות לפנות לסיוע של גורמים מוסמכים במוסד. מעט ידע מחקרי נצבר עד כה בנוגע להשתלבות סטודנטים ערבים בכלל, וסטודנטיות ערביות בפרט, במקצועות עתירי מתמטיקה. לפיכך, יש צורך בבירור המכשולים והגורמים המסייעים להצלחת סטודנטיות ערביות במקצועות המתמטיקה האקדמית, הן במישור התיאורטי והן במישור המעשי.

המסגרת התיאורטית העיקרית שעליה התבססתי היא המסגרת של עולמות נרקמים (figured worlds). עולמות נרקמים הם תחומי פרשנות עם פעולות אופייניות מסוימות, ערכים, שחקנים ותפקידים. במחקר זה העולם הנרקם של הטכניון מושווה במחקר עם העולם הנרקם של הבית עבור נשים ערביות. עולמות נרקמים אלו מציעים הזדמנויות לבנות זהויות מסוימות. הם גם מאפשרים הפעלת סוכנות (agency) ביחס לנרטיבים השונים על העולם הנרקם. סיפורי הזהות מבוססים על מרחב מסוים של סיפורים - נרטיבים ששייכים לעולם הנרקם, אשר נוצרים על ידי האדם ורלוונטיים להבניית זהותו. בנוסף, מחקר זה מתבסס על המסגרת הקומוניטיבית ועל הגדרת הזהות כאוסף של סיפורים (נרטיבים) על אדם אשר עברו רה-איפיקציה (reified) והנם משמעותיים עבור המספר. נרטיבים אלו יכולים להיות על המצב הנוכחי למשל: אני טוב במתמטיקה (זהות נוכחית) או על המצב העתידי, המצב הצפוי, למשל: אני רוצה לעבוד בחברת הייטק (זהות מיועדת). ההמשגה הדיסקורסיבית של הזהות יחד עם התיאוריה הקומוניטיבית של למידת מתמטיקה כתהליך של התפתחות השתתפות מהשתתפות ריטואלית להשתתפות חקירתית.

שאלות המחקר הן: 1. כיצד המשתתפות מספרות את זהותן, הנוכחית והמיועדת, במהלך השלבים הראשונים של השתלבותן בלימודי מתמטיקה באוניברסיטה, ובמיוחד כיצד מתפתחות זהויות אלו ביחס לגורמים מסייעים ומגבילים? 2. באילו דרכים המשתתפות מפעילות את הסוכנות שלהן ביחס ל: א. הנרטיבים לגבי אתניות ומגדר במרחב הסיפורים סביבן? ב. השיח המתמטי אקדמי שהן צריכות ללמוד, במיוחד סביב קורס חשבון דיפרציאלי ואינטגרלי (אינפי).

שיטת המחקר הינה איכותנית. במחקר השתתפו 13 סטודנטיות ערביות לתואר ראשון בפקולטת מדעי המחשב והנדסת חשמל, בסמסטר הראשון ללימודיהן בטכניון. נתוני המחקר נאספו באמצעות ראיונות עומק חצי מובנים שנערכו בתחילת הסמסטר ובסופו, וראיון נוסף אשר נערך בסוף שנת הלימודים (2016-2017) (ראיון זה נערך עם חלק ממשתתפות המחקר). בנוסף לכך, שני ראיונות יומן נשלחו למשתתפות המחקר באימייל, במהלך הסמסטר. כמו כן, עבור חלק מהמשתתפות התבצעו

ראיונות מאזכרים סביב צילומי וידאו של תרגולים בקורס אינפי בו הן למדו. הנתונים נותחו באמצעות תיאוריה מעוגנת בשדה, יחד עם ניתוח שיח וניתוח נרטיבי. השיח המתמטי נותח לפי הגישה הקומוניטיבית (תקשורתית) לחקר שיח.

הממצאים העיקריים של מחקר זה הם : 1. רוב משתתפות המחקר התחילו את הסמסטר עם זהות מתמטית חזקה. עם התקדמות הסמסטר נפתחו פערים בין הנרטיבים של המשתתפות על עצמן בזמן הנוכחי (זהות נוכחית) לבין הציפיות שלהן מעצמן (זהות מיועדת). 2. רוב המשתתפות חוו קשיים בהסתגלות לאווירה החברתית והתרבותית החדשה, אך רובן נסו למזער את הקונפליקטים התרבותיים שהן חוות בעולם התרבותי של הטכניון. 3. המשתתפות הרגישו אחריות גבוהה למעשיהן בהקשר לציפיות החברתיות מאנשים סביבן, כולל אנשים מהסביבה החברתית שלהן אשר הזהירו אותן שההתמודדות שלהן מול הדרישות הגבוהות של הטכניון תהיה קשה מדי עבורן. 4. שני מקרים מנוגדים של שתי סטודנטיות נבדקו לעומק. הניתוח של שני מקרים אלה הראה שהסוכנות עשויה להיות היבט מכריע בהסתגלות מוצלחת, אל מול דרישות אקדמיות גבוהות מאוד, כמו כן גם מול קונפליקטים חברתיים ופוליטיים מורכבים. 5. הלחץ החברתי להצליח, יחד עם אילוצים מבניים של למידת מתמטיקה בשפה זרה ובעולם נרקם שונה מעולם הבית, הובילו את מרבית הסטודנטיות להשתתפות ריטואלית בלמידת מתמטית.

חשיבותו של המחקר טמונה בהפניית תשומת הלב לחשיבות המודעות של הסטודנטיות הערביות לקונפליקטים החברתיים והאתניים הניצבים בפניהן בהכנסתן לעולם זר וחדש (האקדמיה). מודעות זו עשויה לעודד בחירה, שהיא תנאי הכרחי לסוכנות בהתמודדות עם אתגרים. בנוסף, המחקר תורם לתיאוריה הנוגעת לאינטראקציות בין זהות תרבותית וזהות מתמטית, ומראה כיצד אינטראקציות אלה מעצבות את הדרכים שבהן לומדים משתתפים בקורסים מתמטיים.