# Macho or Geek/Nerd: STEM masculinity of Adolescents and its mark on science capital

# Abstract

The STEM field is still perceived by researchers and educators as a dominantly masculine arenas among adolescent boys and girls. However, these question of how the adolescents perceive this field and the intersectional aspect of the socioeconomic environment (SVETLANA – THIS IS HOW IT SHOULD BE TERMED?) interact with gender to shape this perspective is an important question for exploration in times in which there are much resources allocated to enhancing STEM studies and capital in the social periphery. Our paper addresses this gap by focusing on adolescents participating in STEM classes, living in both the social center and in the social periphery in Israel. We aim to understand how their social location shapes the way they construct the linkage between their STEM and masculinity self and other perspective and how this can further relate to their STEM capital and future opportunities. Specifically, we conducted 52 in-depth interviews with adolescents in the social center and the social periphery in Israel focusing on their gender perceptions and experience in their STEM class. We found that adolescent STEM learners in the social periphery adopt a perception of traditional masculinity, while adolescents in the social center have a perception of more fluid masculinity. These divergent perceptions of masculinity have an effect on acquiring and leveraging of science capital. While traditional masculine can reduce science capital, a fluid perspective of masculinity can enable better opportunities to leverage one’s scientific capital in the future. We conclude by offering practical implications for policies and educational practices that take intoconsideration the interplay between the socioeconomic environment and masculinity perceptions for encouragement of STEM and science capital cultivation.

# Introduction

Gender gaps in STEM education and employment are evident globally, with only about 35% of STEM students in higher education being women, and less than 30% of the global STEM workforce comprised of women, as reported by UNESCO (2022) and the World Economic Forum (2022). Furthermore, women hold a smaller percentage of leadership positions in STEM industries (Forum, 2022; Hencke, Eck, Sass, Hastedt, & Mejia-Rodriguez, 2022). This process starts earlier in life, as Martín-Gámez and colleagues (2022) argue that STEM disciplines are predominantly perceived as masculine domains by adolescent boys and girls. Thus, it is crucial to address and overcome gender biases and barriers early on, considering that choosing an academic path is a developmental process that begins at younger ages (Kark, 2016; Refaeli Mishkin, 2016). These data highlight persistent gender disparities and emphasize the urgent need for concerted efforts to promote gender equality and inclusivity in STEM fields worldwide (Forum, 2022; Hencke et al., 2022; Refaeli Mishkin, 2016).

Science capital, a framework conceptualized by Archer et al. (2020), has been used to explain some of these gender gaps. However, the influence of the socioeconomic environment, i.e., the social center vs. social periphery, on science capital and its interaction with masculinity perceptions have been overlooked. By conducting interviews with 27 adolescents from the social center and 25 from the social periphery in Israel, the current study explores the impact of socioeconomic environment on the adoption of diverse masculinity perceptions and the cultivation of science capital among students in STEM classes.

Drawing on theoretical frameworks such as Connell's (1995) concept of multiple masculinities and hegemonic masculinity, this study illuminates the interplay between masculinity, science capital, and the socioeconomic environment. It acknowledges the variety of gender constructions within social structures and emphasizes the implications of dominant cultural ideals. By addressing the intersection of masculinity, science capital, and socioeconomic environment, this study offers fresh and novel insights into the complex dynamics that contribute to gender disparities in STEM.

## Masculinity and STEM

In recent decades, numerous studies have explored the concept of masculinity in various social, occupational, organizational, national, and age contexts. Scholars such as Kimmel and others have delved into diverse areas, and have contributed to mapping a wide range of masculine identities across different domains (Kimmel, 2005; Kimmel et al., 2005, Gottzén, Mellström, & Shefer, 2019).

Connell (1995) cautioned against oversimplification when categorizing masculine identities and emphasized the dynamic interplay between different masculinities and social power structures. She argued against essentialist approaches and viewed "masculinities" as fluid social constructions that intersect with race, class, nationality, age, and religion (Carrigan, Connell, & Lee, 1985; Connell, 1995). This perspective raises questions and criticisms. For example, Duncanson (2015) criticizes the prevailing interpretation in many studies, influenced by Connell's approach, that changes in practices of hegemonic masculinity serve as a means to preserve masculine dominance rather than considering alternative forms of masculinities and the potential for shifts in masculine identities over time (Beasley, 2008). Despite criticisms, the theorization of masculinities, as proposed by Carrigan et al. (1985) and Kimmel (1987), remains a leading framework in the study of masculinities today.

The stereotypical hegemonic form of masculinity is ‘traditional masculinity’. Rooted in the industrial era, traditional masculinity emphasizes status, competitiveness, toughness, and emotional avoidance (Bourdieu, 2001; Kaplan, Rosenmann, & Shuhendler, 2017). However, in response to this hegemonic model, two alternative forms of masculinity have developed. The first alternative is the ‘new masculinity,’ influenced by therapeutic discourse, which emphasizes holistic self-awareness and authenticity, often associated with pro-feminist views. The second alternative is ‘consumer masculinity,’ which promotes self-expression through a metrosexual lifestyle, focusing on body-care practices and aesthetic awareness. These alternative models challenge the traditional norms and offer a broader spectrum of gender identities and expressions within STEM education (Almog & Kaplan, 2017; Kaplan et al., 2017).

In the context of masculinity and STEM, it is crucial to consider the phenomenon of ‘nerd masculinity’. Nerdiness is often stigmatized and associated with individuals perceived as intellectual overachievers but social underachievers. Nerd masculinity aligns with certain characteristics of traditional masculinity, such as rationality and technological proficiency, but contradicts others, such as physical strength and social skills. Nerds may enjoy certain privileges in higher education and the labor market due to their technological interests, but they also face low social status and difficulties in forming romantic relationships. Nerd masculinity occupies an ambivalent social location, benefiting from some aspects of hegemonic masculinity while experiencing derision and otherness (Almog & Kaplan, 2017; Lockhart, 2015).

Within this research framework, the literature presents a complex picture regarding the inhibitory and assistive factors that influence girls' and boys' decision-making in STEM. Traditional masculinity stereotypes associated with STEM fields often lead peer groups to encourage boys, to pursue advanced studies in these areas (Archer et al., 2016; Refaeli Mishkin, 2016). Additionally, over the years, science teachers have exhibited a tendency to provide less support and encouragement to girls compared to boys, while parents, similar to teachers and advisers, often steer their girls away from careers perceived as traditionally masculine (Bourdieu, 2001; Martín-Gámez, García-Durán, Fernández-Oliveras, & Torres-Blanco, 2022).

In summary, the study of masculinity in STEM education draws on theoretical frameworks developed by Connell and other scholars. By examining the concept of hegemonic masculinity and its interaction with social power structures, researchers can explore the influence of different masculinities on students' choices and experiences in STEM fields. Traditional masculinity, new masculinity influenced by therapeutic discourse, consumer masculinity emphasizing self-expression, and the ambivalent position of nerd masculinity all play a role in shaping the gendered dynamics within STEM education. Understanding these complexities contributes to efforts to create more inclusive and equitable learning environments in STEM disciplines.

## Masculinity in Israel

Most masculinity researchers in Israel have adopted the masculine hegemonic model (Antebi, 2021; Levy & Misgav, 2017; Lomsky‐Feder & Rapoport, 2003; Sasson-Levy, 2006), although the revolutions and changes that took place in perceptions of masculinity did not escape the Israeli society. The Zionist movement advocated for the liberation of Jewish men from their exiled, submissive, and weak character, seeking to establish a ‘new Jew’ who embodies masculinity in both physique and conduct. This new ideal is characterized by assertiveness, as well as the ability and willingness to protect oneself and others (Klein, 2002).

In this context, military service in Israel defines the boundaries of the Jewish-Israeli collective and plays a key stratifying role by determining the relative status of social groups in civilian lives, particularly the difference between groups that enlist and those that do not, and between men and women (Karazi-Presler & Wasserman, 2022; Levy & Misgav, 2017). Nevertheless, in recent years, the structure of the IDF has been transformed either by women’s integration into combat units' or by the growing use of technological tools (Avidar, 2022; Karazi-Presler, Sasson-Levy, & Lomsky-Feder, 2018).

The traditional perceptions of Israeli society are still reflected in attitudes regarding the traditional division of the genderial roles (Antebi, 2021; Herbst & Benjamin, 2012; Levy & Misgav, 2017). However, the perception of masculinity in Israeli society is intricate, as traditional societal expectations of gender roles conflict with evolving dynamics. While the traditional model links masculinity to financial provision and femininity to domestic responsibilities, there is a growing acknowledgment of the ‘new fathe’ model that emphasizes equality and active participation in childcar (REF?).

It is possible to point to a change in the way men in Israel refer to the terms 'family' and 'work', and there is no doubt that the masculinity and the father's role perceptions in Israel today challenge the traditional perceptions, according to which fatherhood is limited to providing for the family only (Antebi, 2021; Steyer in Katz, 2011). These changing perceptions encounter challenges and contradictions that may bring to the necessity to ongoing examination and active involvement (Berkovitch, 1997; Herbst & Benjamin, 2012; Maoz & Niv, 2015).

## **(Avidar, 2022; Karazi-Presler et al., 2018)(!!! INVALID CITATION !!! )(!!! INVALID CITATION !!! )(Klein, 2002)(Avidar, 2022)(!!! INVALID CITATION !!! )(Antebi, 2021; Steyer in Katz, 2011)**Masculinity and STEM Education in Israel

There is limited research in Israel on masculinity perceptions among adolescens and in general, and in the field of STEM education in particular. Most academic work has so far been reflected mainly in reports and publications initiated by the Ministry of Education and Ministry of Science, Technology and Innoveation in Israel (MOST, 2021; Schwartz, 2015). Somewhat uniquely to Israel, the army may also influence attitudes toward STEM fields. Both men and women in Israel face compulsory national military conscription after secondary school. Many military units in which both genders serve require the use of technology (Avidar, 2022; Cohen-Touati, Duek, & Pastenhaim, 2018). The IDF's preference among potential recruits are graduates of STEM classes (Ben Haim & Katz, 2020; Bochnik, Nathan, & Raveh, 2013). The IDF faces gaps in the level of scientific-technological training of graduates of the Israeli education system.These gaps are algnied with genderial and environmental social gaps (Arica, 2020a; Fares & Bernstein, 2019b).

Kutai (2017) claimed that while combat units used to be considered the most prestigious, today, army intelligence is probably the most desirable unit and it requires knowledge of STEM fields. Adolescents in Israel are highly motivated to study STEM in high school, in part due to a desire to be accepted into prestigious army units. These units then open doors to lucrative and prestigious careers in the high-tech industry, in part through networking opportunities (Kutai, 2017a). Thus, those who are disadvantaged educationally and socio-economically do not get into these units. As a result, they are disadvantaged in terms of later networking capabilities and thus in social mobility (Yablonko, 2019).

The disparities between social center and social periphery in Israel are large. The enormous gaps between the center and the periphery have existed for years, but recently have they expanded relentlessly (Bystrov, 2005; Central Bureau of Statistics, 2019; Talmi, 2018). In relation to STEM education, these disparities between the social center of Israel and its social periphery begin at a young age, in the education system (Arica, 2020b; Ehrlich, Gabai, Maor, Razek, & Asher, 2021; Fares & Bernstein, 2019a; Samuel Neaman Institute, 2021). The PISA (Programme for International Student Assessment) data reveal , lower levels of STEM achievement in the peripheral communities (Razer, Mittelberg, & Ayalon, 2018).

Proportionally more students from central Israel are eligible for STEM matriculation certificates. Thus, a higher ratio of these students is accepted to prestigious army units, then STEM faculties in higher education, and subsequently show a higher tendency to be employed in STEM occupations (Orpaz, 2022; Rabinovitz, 2017; Weininger, 2021). This uniqueness of the Israeli situation may be reflected by boys’ choosing STEM fields in secondary school, their science capital and their masculinity perception.

## Science Capital

Bourdieu (1986) identifies specific assets, or types of capital such as economic, symbolic, cultural and social. He defines cultural capital as the knowledge, skills and behaviors transmitted to individuals within their socio-cultural context. As educational institutions are central to socialization, Bourdieu expanded this theory to the educational sphere. Bourdieu and others believe that children from a high socio-economic status (SES) experience educational institutions as comfortable and familiar parts of their social setting, or habitus. Their attitudes, knowledge, personalities, and skills result in high cultural capital (Nieuwenhuis & Xu, 2021; Xu & Hampden-Thompson, 2011).

Using a Bourdieusian lens (Bourdieu, 1986), Archer and her colleagues proposed the concept of ‘science capital’ as a useful tool for explaining STEM-related aspirations of adolescents over time. They see science capital as forms of cultural and social capital that are science-related, a symbolic form of capital with a high exchange value in the labor market, owing to a high-status qualification that acts as a signifier of academic ability and competence. Their studies indicate that science capital in adolescence is influenced by social factors including gender perceptions, parental expectations, teachers and peers (Archer, Dawson, DeWitt, Seakins, & Wong, 2015; Archer & DeWitt, 2016; DeWitt et al., 2011).

Various studies have found parents and teachers hold gender-stereotyped beliefs and expectations in regard to adolescent STEM capabilities, such that boys are expected to excel in STEM and girls are not (Archer et al., 2013; Cheng, Kopotic, & Zamarro, 2017; Ikonen, 2020; Stahl, Scholes, McDonald, & Lunn, 2019). Moreover, Archer et al. (2017, 2020) found that science aspirations are largely ‘unthinkable’ to most girls, as they fit neither with their constructions of desirable or even intelligible femininity nor with their sense of themselves as learners, even when they are capable (Archer, Moote, Francis, DeWitt, & Yeomans, 2017; Archer, Moote, & MacLeod, 2020; Cohen-Touati et al., 2018; Kark, 2016; Tan, Calabrese Barton, Kang, & O'Neill, 2013) .

## Peer Group

Studies indicate peer group has significant role in adolesence. Ryan (2001) reports that adolescent students feel peer pressure regarding school learning issue involvement, and such feelings are significantly correlated with their individual approach and motivation regarding school achievements. (Ryan, 2001). Peer groups appear to be the major factor in students’ relationship circles at school across both social and learning spectrums. For some students, their peer group relationships are the most positive aspect of their school experience expressed directly or indirect and it also mediate access to social capital in the classroom (Choudry, Williams, & Black, 2017; Gowing, 2019). Morever, adolescents withinthe same peer groups particularly resembled each other in terms of academic achievement (Kiuru, Nurmi, Aunola, & Salmela-Aro, 2009).

Based on Bourdieusian perspective of social and cultural capital, some researchers have tried to look into how inequality in education manifests and even reproduces itself through social relations of peer groups, and specifically, social networks within STEM classrooms (Alcock, Hernandez-Martinez, Patel, & Sirl, 2020; Bourdieu, 1986; Choudry et al., 2017; Jørgensen, 2017). Past research has established a link between peer groups and interest, achievement, and retention in STEM fields. Adolesent girls may experience rejection and hostility from their boys peers regarding STEM achievement. In contrast, peer groups may validate adolesent boys sense of belongingness in STEM fields (Kiuru et al., 2009; Leaper, 2015).

## The current study

To shed more light on different perceptions of masculinity within STEM context, which can have an important impact in STEM capital, the current study presents here a cross-gender perception of masculinity, examining the role peers plays both for girls and boys participating in STEM classes in secondary schools in Israel. Importantly, the study takes into account the influence of center-periphery relations on shaping adolescents' science capital in the context of gender. (Stahl et al., 2019; Stahl, Scholes, McDonald, Mills, & Comber, 2021)

# Methodology

## (Kathy Charmaz, 2014; Shkedi, 2003)(Baker, Edwards, & Doidge, 2012)(Josselson, 2007; Levitt et al., 2018; Shkedi, 2003)Sample

The study population comprised of adolescent boys and girls who chose STEM fields as major subjects in their high school studies. Fifty-two STEM students in four groups at the ages of 14-18 (average age 16.5 years) were recruited for this study between June 2018 and January 2022. Groups were purposively selected to include participants with either low level or high level of science capital (Archer et al., 2016; Archer et al., 2012; Archer et al., 2013; DeWitt et al., 2013). Accordingly, participating groups were approached based on gender and SES (social economic status), from both the social center and the social periphery: a) 11 boys and b) 12 girls from the social periphery; and c) 14 boys and d) 12 girls from the social center. We aimed for a balanced sample. The final sample size was determined for each group separately as major ideas repeated constantly and saturation was reached [add reference about saturation in qualitative research]. The average socioeconomic status index[[1]](#footnote-1) of the social center was 8.7 and for the social periphery was 2.7 on a scale of 1-10. Demographic information of the interviewees can be found in Table 1.

<< Insert Table 1 about here >>

## Recruitment

Interviewees were recruited by contacting senior managers from the STEM Education community in Israel who connected me with school principals, STEM fields Ministry of Education supervisors, and education division managers at municipalities, both in the center and in the periphery. They all recommended students to join the study and to contact me to be interviewed. After haring about the study school student reached out to us and we scheduled interviews at their convenience either in his/her home or virtually due to the pandemic. In addition, especially in the center, a “snowball” method was applied, through peer recommendation. All interviewees' parents signed a written assent form. They were not compensated for their participation.

## Data Collection

This study sought to trace how gender, peer group, and social environment (periphery-center relations) as social factors shape science capital. To examine this, we chose in-depth interviews as our qualitative research methodology (Kathy Charmaz, 2014; Shkedi, 2003). The interviews allow for a more thorough investigation of each of the 52 adolescent girls and boys interviewees and help understand the interviewee’s reality from the private meaning that the person pours into his experiences (Baker, Edwards, & Doidge, 2012). This epistemic position, which seeks to present the experience of youth studying in STEM classes, allows us to trace the way in which adolescent girls and boys share their subjective experiences, the personal processes they go through, and their future aspirations. The ethic committee of Bar-Ilan University approved the study.

The interview guide contained open-ended questions related to STEM perception. It enabled participants to share and to extend issues that came up in the interview with maximum flexibility and in correlation with the subject of the study and with the study process as a gradual qualitative designed (Josselson, 2007; Levitt et al., 2018; Shkedi, 2003). The interviews took place either face to face or online. Notes were written while interviews being conducted and after the interviews they were professionally transcribed.

## Data Analysis

Interviews were recorded, transcribed, anonymized, and analyzed to develop a view of the STEM fields from the participants’ perspective. Supported by MAXQDA software, analysis involved three sequences of thematic coding: (i) Open coding for discovering themes in the text in relation to STEM perceptions; (ii) Axial coding for identifying links between the themes to assess the extent of commonality or difference between the codes; and (iii) Selective coding for finding and indicating the core themes (See core themes in Appendix A).

Analysis was driven by grounded theory (Bowen, 2006; K. Charmaz, Thornberg, & Keane, 2018; Gibton, 2001, 2004). Grounded theory methods aim to develop conceptual categories in relatively small samples, and thus data collection is directed to illuminate properties of a category and relations between categories (Kathy Charmaz, 2014). The complexity of the interviewees' attitudes was fully captured and a holistic and well-rounded picture of the factors that could influence their responses was developed (Charmaz et al., 2018; Shkedi, 2003). We found that these analytic tools were particularly suitable for the transcripts, and they facilitated the ability to organize them flexibly. As such, the conceptualization and the analysis stages were an evolving process for the researchers (Bowen, 2006; Charmaz et al., 2018; Gibton, 2001). As researchers, we met regularly to discuss the themes that arose from the data and to organize them into higher-order themes that relate to the connections between them.

# Findings

This research refers to these perceptions of masculinity in relation to the social environment, periphery versus center, and in relation to gender, girls versus boys. Research findings point to two main perceptions of masculinity expressed by adolescent boys and girls studying STEM fields in the social periphery and in the social center of Israel. We describe these perceptions as ‘traditional masculinity’ perceptions, and as ‘hegemonic masculinity’ perceptions. In the periphery we found three themes that related to the construction and representation of the **traditional masculinity**: First, the construction of macho masculinity, represented by physical characteristics and the suppression of emotions. Second, an interlock between STEM and financial success. And finally, masculinity was embedded in the oppression of girls and femininity within the STEM classes.

In comparison with the themes of masculinity that arose in the social periphery, in the social center themes of alternative hegemonic masculinity were expressed, demonstrating a continuum of diverse forms of masculinities ( Connell, 2012; Kimmel, Hearn, & Connell, 2004). The first way to construct masculinity was by the negation of the ‘nerdy boy’. Second, by highlighting the hegemony and superiority of the boys over the girls, and third, the theme focused on unique characteristics including the ambitious, utilitarian and forward thinking boys. We describe in more details the themes found below.

## Traditional Masculinity Among STEM Learners in the Social Periphery

### Macho masculinity

The macho masculinity is one of the expressions of the traditional perception of masculinity. A macho man is expected to be strong, athletic, and not worry about his appearance, all while avoiding the expression of emotions and adopting rational and practical thinking. The findings show the most boys in STEM classes in the periphery, construct (or refer to) masculinity in terms of traditional masculinity, of the "Macho man". One example is Ilan, 17 years old, who lives in a city in the social periphery in northern Israel, his mother is an administrator within a formal educational institution, and his father works to advance youth at-risk within informal educational framework:

"Our class is 100% boys. There were no girls in the grade above us either. In general, not only at this age, cyber and things like that, we perceive as something related to boys, not necessarily masculine, because a macho man is not some high-tech man. But yes, boys are on the computer and women are less. This is the social construction we are going with. There is nothing to do". (Ilan, 17)

According to Ilan, masculinity means machoism, while the STEM fields "are related to the type of smart boys with glasses" as he defined it. Ilan tried to explain his perception regarding STEM studies:

"There is no parent who would not want his child to invest in studies, and be a 'Shackel'. Studies are important... knowledge is power... simply power, I have no way to explain it. Knowledge doesn't even necessarily need to be used, but it can't subtract from something... it can only add, so it's a kind of power." (Ilan, 17)

Here he highlights again the macho masculinity by using the phrase "shackel", which is an idiom used in the Israeli Military. It means a strong and energetic fighter. Ilan uses this idiom to describe the character of the successful man in his eyes. He continues to relate knowledge in the fields of technology and engineering to power. Power is viewed as a necessity. Beyond strength that the term shackle implies, Ilan also adds an element of respect:

"In our society, you cannot be a person without any certificate, and get a job that you will be proud of... People are not necessarily proud if they work now as a mechanic or as a municipal worker, ... there is nothing to do. Our society forces you to study as well, if you're really not up to it" (Ilan, 17)

In Ilan’s view, a clear link emerges between the STEM studies and how it is respectable, as an attempt to link to images of macho masculinity.

Unlike Ilan, Gerry frames his model of masculinity in a negative way. Gery, a 17-year-old from the periphery who studies computer science and physics in a boarding school, draws a profile of the high-tech man and does not consider himself to fit this profile from a masculine-behavioral point of view:

"I think it's a very specific profile of the people who go to study computer science and maybe I don't quite fit that profile, or I just don't... can't manage to like it. If you look at people like Bill Gates or Mark Zuckerberg, the way they behave, the way they speak... there is a difference between how most people behave and how he [Zuckerberg] behaves." (Gerry, 17)

We found that the social constructions in the periphery contain elements of respect, power, and draw the figure of the hi-tech man as far from the boys, despite their participation in the STEM classes. In their way, they distance themselves from the hi-tech image that does not have the traditional macho characteristics.

As part of the macho image, boys in STEM classes in the periphery avoid raising their difficulties in these classes. They themselves do not share this fact, but we learn about it from the girls in their class. As an example, a girl of 16-year-old describes how the boys do not feel comfortable sharing their difficulties in the classroom:

"Boys are more closed and don't talk about what's bothering them. And you realize that all this year they kept it inside and they kind of kept it in, and didn't tell anyone because they didn't feel comfortable... I think they experience the same amount of stress and depression (as the girls) and all this impact of society, um..., and boys have to be strong so they don't tell." (Rita, 16)

Hence, avoiding any expression of feelings and difficulties that arise in STEM classes is a clear expression of masculinity among the boys in the periphery. This practice expresses a traditional perception of masculinity, which requires hiding emotions or any sign of weakness and difficulty.

The macho masculinity is also expressed in a physical aspect, in particular in the context of the military service. For the interviewees military service is the next phase after high school. The overwhelming majority of boys in the periphery shared their desire to serve in the combat units of the Israel Defense Forces (IDF). Such a service requires physical preparation and a lot of practice in sports, in order to arrive physically fit at the recruitment stage. This desire is surprising, considering that participation in STEM classes opens up possibilities for either a service in elite technological units or within the academic reserve track, in which one first acquires a technological science degree. Ilan shared his determination for combat service:

"I'm going to fight, I hope anyway I will be a fighter! At first, my parents tried to 'kick' me to the academic reserve track, I couldn't handle it, no... I preferred, I prefer being a fighter. These days I am exercising for the army, about four times a week, something like seven or eight hours a week." (Ilan, 17)

18-year-old Amit also showed his determination in choosing a physical path in the military. Amit studies in a regional school in the periphery to which people come from distant settlements. His father engages in physical work, and his mother does not work for health reasons. Amit shared, "I believe I want to go to a combat unit, to a good one, we'll see where we end up." (Amit, 18)

Similarly, 15.5-year-old Doron, who lives in the social periphery, his mother is a welder, and his father works as a food supplier for airplanes, shared:

"I want to be in the field, in the YASAM combat unit, any kind of such (combat units)...My uncle served, I have more, I have two uncles, one is an officer in a combat unit, and the other is a commando officer. Mmm, I like to do things that are more related to the path that is my goal...that it will lead me in the combative direction." (Doron, 15.5).

According to the literature, the combative path was previously associated with the Israeli macho figure (Sasson-Levy, 2006). Uriel, 16 years old, explains why a combat military track is the preferred track:

"I believe very much in my guts...doing scientific studies does not give me confidence, they even bring me down. It's completely two different worlds. I used my head, and now I'm going to use my hands." (Uriel, 16)

Uriel emphasizes elements of strength and physicality. He joins the desire of Ilan, Amit and Doron to serve in the physical combat track, as one that enhances a sense of confidence for his macho masculine perception. Positioning the track as a physical strength component is preferred among the boys participating in the STEM classes in the periphery.(MOST, 2021)

### The breadwinner: Studying STEM as renforcing masculinity

The focus of adolescents on physical fitness and intent to serve in physically demanding military unit does not extend to their career plans. However, their perceptions on careers in the labor marker reveal another element of traditional masculinity, whereby the man is expected to protect and provide for his family. This also emerged from the traditional perception of masculinity presented by the boys in the periphery. They see themselves as the ones who are responsible for making money and providing for their future families, in accordance with the perception of their environment, thanks to their academic success participating STEM classes.

Most of the boys grew up in an environment with traditional gender roles. Most of the time, the father is seen as a the hard-working breadwinner, and the mother is a housewife, or is engaged in feminine professions with low wages (MOST, 2021). The narratives of the participants reflect their own perceptions but also those of their families’. For example, Amit expressed his desire to study theater but gave it up in favor of STEM studies. He described choosing the STEM classes as a masculine choice, enabling him to remain a breadwinner:

" I thought about theater as a major. Maybe because it's more social I gave up, but in any case, I preferred [STEM]... you know, there's a high school average, bonuses, and more... it helps in the end... for a job with a good salary. And yes, I want that too, I won't lie. My father worked for many years in a physical work, by hands, he wanted his children not to have to work hard like him." (Amit, 18).

Although Amit had a passion for the social studies or the arts, he decided to obtain a degree in the sciences which is of higher value in his eyes, in order to avoid physical labor in the future, as someone who sees himself as the man entrusted with providing for the household like his father. He puts forward a "formula" according to which the average of the matriculation certificate means a good salary. The bonuses he refers to are the result of an incentive policy for matriculation test scores, and exist in STEM subjects only (Weiss, 2018).

Ilan reinforces Amit's perception: "Although the studies are not that easy, but after that the salary is good, it's...like, all kinds of benefits that come with the positions...that the conditions are relatively easy for physical work or things like that." (Ilan, 17). For Ilan, too, STEM studies mean a good salary, and thus constitute a better economic alternative to physical work. By striving for a "good salary" through STEM studies, he justifies his choice of studies in STEM fields.

There are also power differential between boys and girls were demonstrated in the social center. However, boys in the center expressed different masculine perceptions compared to those in the social periphery.

## Alternative perceptions of masculinity among STEM learners in the social center

Differently from the periphery, in the social center a different way of understanding masculinity and STEM was evident in the boys words.

### The practice of negation: I am not a nerd

The findings show that adolescent boys in the social center try to construct their perception of own masculinity by negotiating and negating a ‘nerd’ image they hold in their minds. Specifically, the boys from the social center who study in STEM classes distinguish between their own image and the image of their peers in their STEM class. They describe the character of the STEM student as a "nerd" by definition (Godec, Patel, Archer, & Dawson, 2020), but they are afraid of being perceived as "nerds" and anti-social. As an example, Roy shares that:

"there is life, not everything is studies. People judge negatively, they tell you who you are, smarter, different. You don't want this labeling...I can study alone at home, but my reputation is that I like to teach others in class, and that connects me to them." (Roy, 17)

Roy considers it important to be perceived as a sociable member of his peer group as a way to resist his own labeling of the "nerd" image and stereotype. He considers himself smart, but disapproves of any labeling that goes with it. He demonstrates a practice of sociability within the educational framework of STEM, the perception of which helps him to eliminate his image as a "nerd".

Nitay reinforces the practice of negation in a similar way:

" I'm a boy who connects with people quite easily and I'm very sociable, and I have no problem talking, but .. in class there are people who don't have the same vibe, .. don't have that click. And now the problem is... that Technology and Sciences majors is considered one of the geeks." (Nitay, 17)

Nitay labels his peer classmates as "nerds", fears this labeling and carefully insists he is different than his peers. Like Roy, he tries to act against the nerd stereotype, and it is also very important for him to be perceived as sociable, and as someone who communicates with his friends. Niv, on the other hand, uses the practice of negation to exclude his entire peer classmates from the image of the nerd, in order to exclude both himself and his peers studying STEM:

"It's all about stigmas. It's a fact that our class has broken the stigma. It's like our class is the most unstigmatized. A student who studies physics and computers is perceived as a nerd who sits at home and studies all day. Our class is not like that." (Niv, 16)

In the above quotes, it is evident that the girls perceive the STEM professions as masculine, and the boys as having abilities and knowledge in the field, but not investing as much as girls, and especially not wanting to be perceived as putting in too much work. For the boys, negating the image of the nerd, the hard worker, is achieved by combining pleasures, activities and more versatile interests. All of this influences the girls’ perception themselves.

### The practice of resistance: Challenging Masculine Hegemony and Superiority

The study demonstrates that even in the social center, there are gendered perceptions of both boys and girls in the context of STEM fields. However, these perceptions and the practices for structuring masculinities are different in relation to the periphery. Some participants express them as deeply held gender biases. One such example is Niv, who presents his un-acknowledged gender bias by saying:

"Not in a chauvinistic way, but boys have willpower, and girls are told that women can't be in technology and science. They have less willpower." (Niv, 16)

Although Niv begins by apologizing for the chauvinistic argument that follows, he still holds a chauvinistic view that boys, unlike girls, have the willpower required to persist in STEM studies.

Similar discourse can also be seen in Elad's words. Elad, 15 years old boy from the center of the country, his father owns a consulting firm for technology companies and his mother is self-employed. He said:

"Scientifically...this class of mine is a very stiff one...a lot of the girls don't fit in there....we study at a very high level...but the boys, in my opinion, the boys in the class...it's not because I'm one of them... In my opinion, their chances of leaving this class are much lower than the chances of the girls. (Elad, 15)

Elad insists on defining a "problem" of integrating the girls in the STEM class and explains that the level of study is too high for girls, while he and his peer boys deal with it better.

The arrogant and chauvinistic attitudes are directed not only towards the girls participating in the class but also towards the feminine teachers, as can be learned from Nitay's example:

"I don't understand why, it annoys me terribly. Terrible... We have a computer teacher who doesn't understand computers at all, and she's a terrible feminist and it's terribly annoying." (Nitay, 17).

Nitay rails against his feminine teacher, assuming she has feminist attitudes and low level of computer science knowledge. He connects feminist views and being a feminine teacher, to her level of knowledge in the field of computer science.

From their point of view, the girls also experience the arrogance of the boys. Galia, a 17-year-old studying biotechnology, living in the social center, describes how the boys practice gender segregation: "the boys' group is closed and locked". The repetition in relation to the group of boys, which is both closed and locked, comes to emphasize Galia's perception in this context of the boys distinguishing themselves from the girls in order to express their masculinity among peers learning STEM.

The boys’ perceptions in the social center also influences girls’ perceptions. The girls themselves believe that the boys are smarter than girls, and in Talia's words, "there are some smart girls and...there are a lot of smarter boys." Talia experienced the boys as "not only competitive..., very arrogant. From their point of view, they already know everything!" (Talia, 16) . The perception that boys are more knowledgeable in STEM fields is also described by Ilil, who has an absolute majority of boys in her class:

"I was annoyed that most of the boys knew the course material in advance, and all the girls knew nothing. Um... the boys understand the material better, and on the other hand, we girls need more help." (Ilil, 16)

Ilil expresses the power relations between genders in the way that girls are weak and need help.

From the above findings it appears that the boys in the social center resort to a practice of condescending over the girls in order to strengthen their masculinity. Another practice the boys use to preserve their masculine superiority is the "practice of resistance", conceptualized by Bourdieu, as they complain that they are being discriminated against in relation to girls (Rose & Strine, 2014).

The interviewees discussed various programs and activities taking place within and outside their school, in order to engage girls in STEM. The findings show that in the periphery, such efforts address both boys and girls, and even if there is gender segregation in certain activities, it was not mentioned as an issue by the interviewees. In contrast, in the social center, the environment in general and educators specifically put vigorous efforts to engage girls in the STEM fields. Such efforts include exposure sessions for girls and their parents, tours in academia and in tech companies for girls only, reinforcement classes and individual hours, as well as availability and accessibility of the teaching staff for girls. The discourse on the topic of encouraging girls rose among both boys and girls, as both felt uncomfortable with the separation and directing of the girls to the STEM professions.

The boys feel that the efforts to encourage girls into STEM discriminate against the boys. One example is Nitay, 17 years old from the center, who studies in computer science, physics, and mathematics classes. Nitay is a gamer in his afterschool hours, and is also active in a youth movement. He expresses anger and frustration with respect to the girls’ activities:

"Why refuse my participation in such activities? because I'm a boy?! It's frustrating...Why preventing me the possibility of something in the future?!" (Nitay, 17).

Similarly, Niv, a 16 years old boy, perceives it as discrimination. Niv lives in the social center near a high-tech industry area and a science museum. His mother is a tech-entrepreneur and owns an e-commerce company. Niv expressed his point of view, claiming that:

"this is affirmative action, but still discrimination. Discrimination that is not so fair. And the boys were not given the opportunity to participate at all." (Niv, 16)

Even for 17-year-old Nir, whose parents both work in the STEM fields, there is no justification for affirmative action because, as he perceived it, the choice is given to everyone and there are no gender barriers:

"I don't think that because they are adolescent girls they should be pushed more into the sciences. I don't see anything that would push them against because they are girls, so I don't push for it." (Nir, 17).

In conclusion, the boys express a sense of frustration and reluctance to understand the need to actually encourage girls in STEM, despite their low numerical representation in their STEM classes.

### Ambitious, utilitarian and forward-thinking

The boys in the social center have already delineated their way to their future at this stage of their teenage years. They choose STEM studies for ambitious and utilitarian reasons in such a way that STEM studies will open doors to academic studies with high earning potential and high status. One such example is 18-year-old Nadav, who lives in a large city in the center of the country, studies physics, mathematics and computer science. His parents both engage in the worlds of STEM. Nadav describes the reason for choosing the hard sciences as part of his thoughts about the future:

"There are those in our class who talk about working in it later on. This is what you have in mind, thinking about the future. I realized that I could not choose biology but prefer computers because it is the future. I think that most of my friends have the same outlook more or less, we all preferred Computer Science to Biology". (Nadav, 18)

From his point of view, the field of computer science is the future, and Nadav wants to be a part of it, as does his peer group. The leverage of STEM studies is also reflected by 18-year-old Matan. Matan is involved in sports and is an instructor in a youth movement. His father works in the field of digital printing. Matan was identified as gifted in his childhood and was sent to a gifted class starting in elementary school. He repeats and details the motivation for a scientific major also in terms of the options of military service this major opens:

"If you want something that will open doors for you... most of the youth are deep in the issue of the army service... science ad a major gives an advantages in the army (sorties)... it's good that I didn't give up and I went for science as a major because it does give priority... my class is quite boring and everyone is on the same page. Among almost everyone there is thinking about the future - what, what will they do in the army, what will they do after the army... everyone continues on the path that they(teachers) direct us on, almost all of my class goes to intelligence forces except for those who go for academia to acquire their scientific degree prior to the army service." (Matan, 18)

Matan emphasizes the options of military service. All of them are directed to elite technological units. He has a vision of what it means to serve in these units. His peer group makes similar choices, almost overwhelmingly according to him, and this also has an effect on him. Boys not only demonstrate a clear and forward-thinking perspective when it comes to choosing STEM subjects, but they also approach it with ambition and utilitarian motives, considering it as a significant means of structuring their masculinity at the core of society.

The girls also experience the boys as utilitarian who invest in their future. For example, Galia shares:

"There are people who see the point of high school is to earn bonuses for university. Studies do not really matter now, but they matter later. There are those who simply press for the matriculation certificate for the university. That's the discourse. There are boys I know who have chosen their majors taking into consideration the university requirements. Scientific matriculation certificate will give them bonuses so later on they could study physics, engineering, something like that, so that’s why they choose the majors for. The majority do not aim at a specific profession but look for opening up more options for themselves.” (Galia, 17).

Yahli, a 17-year-old girl from the social center who as a child attended a science school for gifted pupils near her area of residence, also confirms:

"All of the boys who study physics with me want to be either an engineer or a doctor... Even those who are with me in computer science, most of them want to be in high-tech (industry). Many (classmate boys) enrolled in the STEM classes are thinking of going to high-tech, specifically, many enrolled in computer science thinking of working in high-tech."(Yahli, 17)

The perceptions are expressed by Maya, a 17 years old girl from the social center, who joined mathematics and physics classes. Her father is a physics professor. Her family lives near an academic research institute and a high-tech industrial park. Similar to the boys, Maya describes her perception of the abilities of the boys in her class who are paving their future while still at the stage of being students: "

Boys in these classes are thinking about the future. Most of the boys want to continue in computer science... and I assume that they will continue in this field, because it is something they can do." (Maya, 17)

From the findings above, it appears that, for both boys and girls, the boys at the social center structure their masculinity by presenting a cohesive perception of their future in the STEM fields. This perception is due to the importance that they, and their peer group, attribute to participating in the STEM class as a lever to open doors in the future for military service in elite technological units, and subsequently for STEM fields at the university. It will guarantee for them the preservation of their masculinity as future, successful hi-tech men.

In conclusion, similar to the periphery, also in the center, the STEM fields are perceived as masculine professions. The boys in the center studying these masculine professions are perceived both by themselves and by the girls as smart, arrogant, and forward-thinking. Unlike the periphery where the macho image is inspired, in the center boys seek to be perceived as sociable, they put effort into dismissing themselves from the "nerd" image, and they aim for technological units in their military service. Finally, even if the need to encourage girls to go into STEM classes is rationally understood, boys in the social center perceive this as discrimination against them, they fear change, and the girls support the boys’ perceptions.

# Discussion

Our research examines how masculinity perceptions of boys and girls studying STEM in high schools, both in the periphery and in the social center, affect and shape science capital (Archer et al., 2015). Our research findings show different perceptions of masculinity in the social center in comparison with the social periphery. Hence, social environment, center versus periphery, is a significant factor in structuring perception of masculinity and shaping science capital.

## Self-perception

Our findings indicate that patterns of hegemonic masculinity are expressed both in the periphery and in the center. In the periphery, distinctly traditional views emerge from both boys and girls (Derlega & Mikulka, 1993; Kaufman, 1987; Kimmel, 2005; Kimmel, Hearn, & Connell, 2004). In the social center gender power relations are maintained, but they are expressed differently (Connell, 2012; Connell, 1995). While we did not explicitly ask about masculinity in the interviews, the fact that the topic was heavily discussed in the interviews highlights the importance of masculinity for these adolesents both in the periphery and in the center.

Our findings show that a peer group has a great impact on the boys in the social center, and they are influenced by it in relation to their perception of masculinity, driven by their desire to meet peer expectations. They even express this in the plural form of their speech, using "all of us", "everyone", "the whole class" terms, as we saw in Nadav and Amit’s descriptions. Hence, the peer group has a central place among boys from the center. Comparably, in the social periphery the interviewees are mostly influenced by their parents in choosing STEM majors, and their perception of masculinity is influenced by their traditional environment.

The masculine model for the boys in the social periphery is characterized by the image of the macho, the militarist, the combat warrior (Antebi, 2021; Sasson-Levy, 2003, 2006) and includes components of hegemonic masculinity, such as physicality, strength, courage, danger, and violence (Archer et al., 2016; Gattario et al., 2015; Stahl et al., 2021). The girls in the periphery even added additional pattern of traditional masculinity manifested in the boys' avoidance of expressing emotions in the STEM class (Almog & Kaplan, 2017; Robert William Connell, 1996; Schwartz, 2015).

Militarism is an ideology that sanctifies masculinity and preserves dichotomous and hierarchical gender relations(Levy & Misgav, 2017). The gender division exists within the army and has a social effect on shaping gender identities, even outside its framework in civilian arenas, and especially in societies founded on people's army (Avidar, 2022; Kaplan, 2009). The influence of combat militarism is stronger in the periphery than in the social center among research participants.

Compared to the macho figure in the periphery, boys in the social center are directed to elite technology units in their military service. They see it as a path that will lead them to the high-tech industry, and as part of their alternative hegemonic perception of masculinity,. There is a clear connection between the military role and future civilian roles, where the military and civilian technological roles are manned majorly by young white men whose class level is middle-high. This class group sees the technological roles as a gateway to citizenship, while shaping and adopting masculine behavior patterns fit for civilian technological roles in the prestigious and rewarding high-tech industry. Thus, affinity is created between the army to the reproduction of class-masculine also in life outside the army (Kutai, 2017b; Swed & Butler, 2015). This hegemonic group in the center leverages its high level of science capital to build its future while maintaining its hegemony (Archer, DeWitt, & Willis, 2014; DeWitt, Archer, & Mau, 2016).

(Avidar, 2022)(Kutai, 2017b)In our research, we found that boys from the social center have a unique perception of masculinity, which is still influenced by traditional norms (Avidar, 2022; Edley & Wetherell, 1997). Similar to Avidar and other scholars, our findings reveal that these boys perceive their STEM classmates as "nerds" (Almog & Kaplan, 2017; Archer et al., 2014; Lockhart, 2015), but actively avoid being labeled as such themselves. They fear that being associated with nerdiness would challenge their masculinity. . Avidar's (2022) findings suggest a cohesive identity of nerd masculinity among elite technology unit members but he argues that this identity does not serve as an alternative to hegemonic masculinity. As of Avidar, that technological masculinity has limited influence on the military hierarchy, as combat is still perceived as more masculine(Avidar, 2022). This argument differs from Kutai's (2017) research, which supports our own, as technological military service perceived as prestige and hegemonic.

As the boys in the social center remains influenced by traditional norms and challenged by the fear of being labeled as a nerd, they strategically emphasize their social capabilities in the classroom, and aiming to gain social validation of their masculinity from their peers. Characteristics such as superiority, intelligence, friendliness, and sociability become important for them to project and maintain their desired masculine image. Schwartz (2020) referred to this type of perception as "fluid masculinity". Fluid masculinity means a movement between different types of masculinities under the pressure of social norms. The fluid perception of masculinity is an expression of the movement between perception of masculinity accepted in a certain social group, and immediately after a move to a readjustment to the accepted norms of masculinity. On the one hand, of the boys express the desire for normative and hegemonic masculine ideas, but on the other hand, they deal with the limitations of these ideas. According to this view, there is a kind of negotiation about masculinity, social changes and the perception of masculinity (Karolak, Guta, & Alexander, 2014; Schwartz, 2020). Jackson et al. (2020) found that middle-upper class boys reported high pressure to conform to the behaviors stereotypically assigned to men(Jackson & Bussey, 2020).

The findings show that among boys studying STEM at the social center, their image as perceived by their peer group, in and out their classroom, is very significant and related to the perception of masculinity. On one hand, the boys claim to surpass the girls in their wisdom and ambition, and on the other hand, they raise concerns about the stereotypical "nerd" image of themselves as students in the STEM classes. The boys constantly repeat their need for social involvement in the context of their participation in the STEM class, striving to meet the expectations of their peer group, and to be perceived as social and sociable. Their social networks are also leveraging their science capital since these networks influence access to mathematical knowledge(Choudry et al., 2017). On the other hand, competitive atmosphere is instilled in the classroom. Competitiveness is also a distinct masculine character and helping the boys strengthen the perception of their masculinity (Almog & Kaplan, 2017; DiMuccio & Knowles, 2020; Kaplan et al., 2017).

## Masculinity under threat

As mentioned, while in the social periphery there is an explicit expression of traditional patriarchal perceptions, in the social center we witness hegemonic masculine supremacy. As an expression for it, we see the use of the practice of resistance which reinforces a gender distinction under the pretext of discrimination. The boys make allegations regarding their discrimination in connection with the preferential attitude the girls receive in STEM classes, as they claim. They take a generalizing approach regarding the women's qualities and a defiant skepticism regarding the integration of girls and women in STEM fields (Antebi, 2021). They express this in condescendingly way, by claiming they are smarter, more suitable, and have a higher motivation for learning, as Niv, Nir and Elad explained. This perception carries significant implications as it leads girls to internalize and collaborate with the notion of boys' superiority based on gender traits, resulting in the belief that they are less competent than boys, a perception that becomes ingrained within them (Cohen-Touati, Duek, & Pastenhaim, 2018).

Fragile masculinity is referred to men who fear they are not meeting stringent masculine standards, resulting in their masculinity being "precarious". This means they are expected to actively attain and defend their high-value status as men (DiMuccio & Knowles, 2020). The boys express a fear of failing to meet the rigid masculine norms, and they risk losing their status as "real men" in their perception (DiMuccio & Knowles, 2020; Renold, 2001). The pressure to earn or maintain their status and to prove their masculinity, as an expression of their "fragile masculinity", provokes frustration leading to behaviors that require compensation (DiMuccio & Knowles, 2020; Renold, 2001).

Our findings show militant attitude towards girls trying to protect the threat boys experience towards their high status as young men in general, and in the STEM field in particular. According to DiMuccio (2020), the consequences of the fragile masculinity, as also revealed in our findings, may bring to a decrease in the self-confidence of the boys in their masculine identity, in expressions of anger, gender tension in front of the other gender in their environment, and especially opposition to girl's or women's preferences. They hide under the pretense of social justice, much less support gender equality, their beliefs and perceptions are stereotypical and aggressive (DiMuccio & Knowles, 2020).

Our findings indicate that the girls from the social center "protect" the boys, and even justify the boys' arguments of discrimination in everything related to the experience of STEM studies. The girls fear that they are socially punished, paying a social price, by being separated for the purposes of encouraging their participation in STEM activities. Above all, the girls see such separation an act of prominence, as they are different, compared to boys. These surprising findings contradict other studies that indicate that girls experience discrimination in favor of boys by the system. (Forgasz, Leder, Mittelberg, Tan, & Murimo, 2015; Rogers, Boyack, Cook, & Allen, 2021). Such studies indicate STEM classes girls reported discrimination based on science-gendered stereotypes, typically from peers, but also occasionally from adults, such as teachers, school staff, or even parents. Differently, in our study most girls in the center argue for boys' discrimination and girls' preference by teachers, school staff and the feminist environment around.

## Forward-facing Masculinity

The findings indicate a very cohesive perception of the future among the boys, with the gender biases present in the background, both in the social periphery and in the social center (Antebi, 2021), but expressed differently. In the social periphery, the traditional perception is rooted in that the responsibility for providing for the family is solely on the men (Antebi, 2021; Derlega & Mikulka, 1993; Gilmore, 1990). Previous research shows the influence of parents on their children entering STEM fields and their achievements (Archer et al., 2013; Cheng et al., 2017; Ikonen, 2020). Our findings indicate the significant influence of the boys' parents to choose the STEM fields from the perception of "learn = succeed", meaning that these fields will provide their boys with a guaranteed source of income. Such a source of safe income does not require physical effort, like their fathers do, as described by Ilan and Amit. And yet, masculinity is expressed in the responsibility for providing for the household, so their future choice of professions has to allow this.

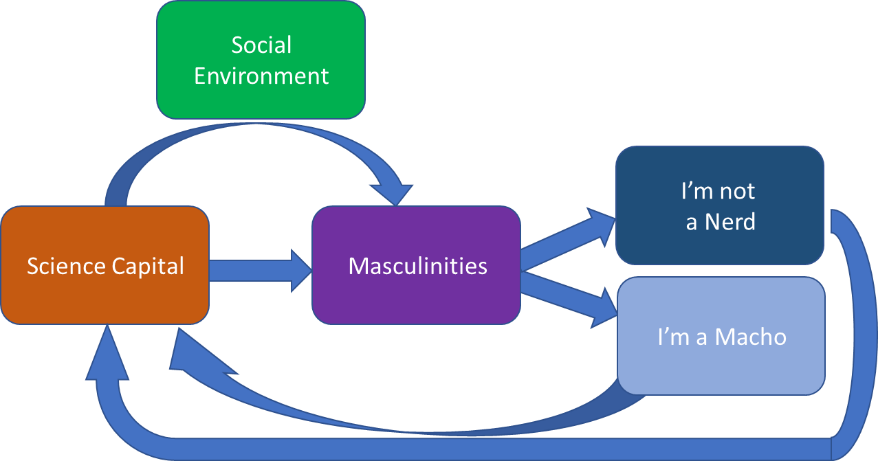
In contrast, the boys at the social center understand that in order to maintain their high socioeconomic level in the future, not necessarily in order to support a family, they must choose a path that is both rewarding and prestigious, as the STEM fields offer to their perception (Duek, Kark, & Chachashvili-Bolotin, 2023). This perception is expressed by directing themselves to the technological units in the army, to STEM studies in the academy, and to a rapid integration in the local high-tech industry (Avidar, 2022; Kutai, 2017b; Noam Zusman, 2019). This industry is characterized by masculine homogeneity in terms of the human capital that participates in it (Authority, 2022). Moreover, as most of the boys' parents in the social center work in STEM fields, they contribute to their boys' future perception, thus to their high level of science capital, as they act as role models for them (Archer et al., 2013; Cheng et al., 2017; Ikonen, 2020; Stahl et al., 2019).

The disparities between the center and periphery in Israel regarding science capital, both presently and in the future, manifest as gaps in perceptions and practices as presented in figure 1 below. The know-how possessed by boys from the social center enables them to navigate their educational and career paths, benefiting from their high level of science capital, which is leveraged through military service and ease engagement in the high-tech industry. This perpetuates the socioeconomic inequalities, and thus the science capital gaps, between boys from the social center and those from the social periphery, sustaining the gaps in Israel. (Botosh, 2020; DeWitt et al., 2016).

In the boys' perception, paradoxically, being in the center leaves them with little choice due to the strong desire to maintain their high status and science capital. However, the relatively privileged socioeconomic status in the center seemingly provides them with the opportunity to explore diverse fields of their interest. Nevertheless, their understanding of the importance of science capital leads them to prioritize STEM occupations, as it offers a pathway to secure high economic and social status in the future. For example, the case of Nadav, who realized he could not choose a biology major because his future is in computer science, clearly demonstrates this point. Compared to the periphery, where the perception is mainly financial, in the center the "lack of choice" combines both the economic and social class aspects (Duek et al., 2023).

The boys from the social center actively define the STEM track as they construct a vision of their future, leveraging the high level of science capital in their upbringing. They are motivated by their sense of responsibility for shaping their professional, economic, class and social future. .These patterns integrate the high level of science capital with the perception of white hegemonic masculinity, a result of socialization and the social structuring of masculinity in the environmental-social context (Flowers Iii & Banda, 2015; Stahl et al., 2021).

* Figure 1 -



In conclusion, the findings raise a major concern regarding masculine perceptions of adolescent boys and adolescent girls learning STEM, in reference to their social environment, periphery versus center. The perception of the macho, the breadwinner, in the periphery versus the "social technologist" in the center, who is not a nerd, whose masculinity is threatened, and the perception of his future is formed out of adherence to maintaining his socio-economic status.

## Limitations

The findings of this study are limited to those studying STEM, so they may not be transferrable to other student populations. While the total sample of the study was large, the number of participants in each group was rather low; however, the interviews reached saturation at that point. Additionally, the participants were Jewish only; the influence of masculinity perceptions on shaping and acquiring science capital might take a different form among non-Jewish populations. This might be additional lens derives from the segregation between social center and social periphery and between Arab Israelis and Jewish Israelis structured by curricular differentiation(Razer et al., 2018). The Arab population, the largest minority in Israel, faces significant poverty, with a poverty rate of 45.3% in 2018. Arab men suffer from various structural and informal barriers to employment. (Karazi-Presler & Sasson-Levy, 2022). Unfortunately, the Arab population participation in the high-tech industry remains extremely low, at less than 3%, and has not witnessed any significant increase since then (Kheir Abedel Razek, 2021; Orpaz, 2022).

## Implications and conclusion

The study's contribution lies in advancing our comprehension of the influence of social factors, specifically gender and the social environment, on the level of science capital among adolescents studying STEM. It elucidates how these factors interact with the perspective of masculinity, shedding light on the complex dynamics that shape science capital development in this context. This knowledge can inform educational interventions and strategies aimed at promoting equal engagement and participation of adolescents, irrespective of gender, in STEM fields. It suggests that “one size fits it all” approaches are unlikely to engage adolescent boys and adolescent girls to STEM fields equally (Archer et al., 2013).

It is recommended to take approaches that are sensitive to gender and social environment (periphery vs. center) of adolescents and to produce interventions aimed at increasing future participation in STEM appropriately as emerged in this study. As an example, parents of STEM students from social periphery should be invited to take part in producing such innervations. There is a place to consider implementation of strategies designed to increase science capital within social periphery STEM students' families (Archer et al., 2017).

Nevertheless, the study findings suggest that education for gender equality in general and for STEM in particular should start at an earlier age than adolescence. The disparities in the perceptions of masculinity may perpetuate gender gaps and contribute to the underrepresentation of the social peripheral populations in the STEM fields, if such recommendation are not be implemented. Moreover, our findings clarified the essential role of schools in structuring adolescent masculine and genderl perceptions (Schwartz, 2020). Concretely, awareness should be raised among educators regarding the resistance of adolescent boys at the social center. Appropriate preparation for both adolescent boys and adolescent girls should be incorporated, before offering girls to special girls-only STEM programs. Such preparation may help both boys and girls in the social center to understand the importance of engaging girls into STEM and to avoid girls' exclusion.

This study findings indicate an inverse relationship between traditional masculinity and science capital, so that an increase in one causes a decrease in the other and vice versa. Additional studies should be carried out among similar populations, perhaps in different grades, in order to examine the consistency of this finding. It is also suggested to carry out comparative studies with other groups, such as adolescent girls or boys who did not choose STEM, deepening the theoretical and practical insights regarding masculinities perceptions and the impact science capital level has on it.

Future research should examine other countries coping with challenges of economic development, gender and social inequalities in STEM, to expand our theoretical knowledge of the intersection between science capital and masculinities (Robert W. Connell & Messerschmidt, 2005; DeWitt et al., 2016; Kimmel et al., 2004). Israel represents an excellent case study of a country that has managed to deal with complex social and economic development challenges in a relatively short period of time. Nevertheless, the fields of technology and the hard sciences still suffer from a shortage of human capital and of underrepresented populations globally. Therefore, extension of studies in other countries, emphasizing the uniqueness of each country, should be conducted.

# Bibliography

Alcock, L., Hernandez-Martinez, P., Patel, A. G., & Sirl, D. (2020). Study habits and attainment in undergraduate mathematics: A social network analysis. *Journal for Research in Mathematics Education, 51*(1), 26-49.

Almog, R., & Kaplan, D. (2017). The nerd and his discontent: The seduction community and the logic of the game as a geeky solution to the challenges of young masculinity. *Men and Masculinities, 20*(1), 27-48.

Antebi, O. (2021). Masculinities in Israel – Current Attitudes. Retrieved from <https://il.boell.org/en/2021/10/22/masculinities-israel-current-state-of-affairs#_ftn1>

Archer, L., Dawson, E., DeWitt, J., Seakins, A., & Wong, B. (2015). “Science capital”: A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching, 52*(7), 922-948. doi:10.1002/tea.21227

Archer, L., Dawson, E., Seakins, A., DeWitt, J., Godec, S., & Whitby, C. (2016). “I’m being a man here”: Urban boys’ performances of masculinity and engagement with science during a science museum visit. *Journal of the Learning Sciences, 25*(3), 438-485. doi:10.1080/10508406.2016.1187147

Archer, L., & DeWitt, J. (2016). *Understanding Young People’s Science Aspirations: How Students Form Ideas about ‘becoming a Scientist’*.

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2013). ‘Not girly, not sexy, not glamorous’: Primary school girls’ and parents’ constructions of science aspirations. *Pedagogy, Culture & Society, 21*(1), 171-194. doi:10.1080/14681366.2012.748676

Archer, L., DeWitt, J., & Willis, B. (2014). Adolescent boys’ science aspirations: Masculinity, capital, and power. *Journal of Research in Science Teaching, 51*(1), 1–30. doi:10.1002/tea.21122

Archer, L., Moote, J., Francis, B., DeWitt, J., & Yeomans, L. (2017). The “exceptional” physics girl: A sociological analysis of multimethod data from young women aged 10–16 to explore gendered patterns of post-16 participation. *American Educational Research Journal, 54*(1), 88-126. doi:10.3102/0002831216678379

Archer, L., Moote, J., & MacLeod, E. (2020). Learning that physics is ‘not for me’: Pedagogic work and the cultivation of habitus among advanced level physics students. *Journal of the Learning Sciences, 29*(3), 347-384. doi:<https://doi.org/10.1080/10508406.2019.1707679>

Arica, Z. (2020a). *Advancing girls into physics coalition*. Jerusalem: Israel Ministry of Education

Arica, Z. (2020b). *Advancing girls into physics coalition*: Israel Ministry of Education.

Authority, I. I. (2022). *Annual Report of State of High-Tech 2022*. Israel Innovation Authority

Avidar, M. (2022). *Challenges to Hegemonic Masculinity? Gender Integration, Technology and Remote Violence in Military Service.* Bar Ilan,

Baker, S. E., Edwards, R., & Doidge, M. (2012). How many qualitative interviews is enough?: Expert voices and early career reflections on sampling and cases in qualitative research.

Beasley, C. (2008). Rethinking hegemonic masculinity in a globalizing world. *Men and Masculinities, 11*(1), 86-103.

Ben Haim, R., & Katz, S. (2020). *Advancing girls in computer science*: Federman School of Public Policy.  <https://bit.ly/3ecEdow>.

Berkovitch, N. (1997). *Motherhood as a national mission: The construction of womanhood in the legal discourse in Israel.* Paper presented at the Women's Studies International Forum.

Bochnik, T., Nathan, O., & Raveh, A. (2013). *Scientific and technological education in Israel: Selected indicators for building a strategy for risk management due to the shortage of high-tech science and technology teachers*. Israel: Samuel Neaman Institute.

Botosh, N. (2020). *Employment and Salary Gaps, Center VS Periphary*. Israel: Israeli Parlament Retrieved from <https://fs.knesset.gov.il/globaldocs/MMM/64f30c05-0b0e-eb11-811a-00155d0af32a/2_64f30c05-0b0e-eb11-811a-00155d0af32a_11_16406.pdf>

Bourdieu, P. (1986). The forms of capital. Handbook of theory and research for the sociology of education. JG Richardson. *New York, Greenwood, 241*(258), 19.

Bourdieu, P. (2001). *Masculine domination*: Stanford University Press.

Bowen, G. A. (2006). Grounded theory and sensitizing concepts. *International journal of qualitative methods, 5*(3), 12-23. doi:10.1177/160940690600500304

Charmaz, K. (2014). *Constructing grounded theory*: sage.

Charmaz, K., Thornberg, R., & Keane, E. (2018). Evolving grounded theory and social justice inquiry. *In N. K. Denzin, & Y. S. Lincoln (Eds), The Sage handbook of qualitative research (5th ed., pp. 411–443). Sage.*

Cheng, A., Kopotic, K., & Zamarro, G. (2017). Can parents’ growth mindset and role modelling address STEM gender gaps? In EDRE (Ed.).

Choudry, S., Williams, J., & Black, L. (2017). Peer relations and access to capital in the mathematics classroom: A Bourdieusian social network analysis. *British Journal of Sociology of Education, 38*(7), 1037-1053.

Cohen-Touati, E., Duek, R., & Pastenhaim, K. (2018). *Cyber and technology girls training: Factors that help and delay the choice and persistence in these training*. Rosh Ha'ayin: Cyber Education Center.

Connell, R. (2012). Masculinity research and global change. *Masculinities & Social Change, 1*(1), 4-18. doi:10.4471/mcs.2012.01

Connell, R. W. (1996). Teaching the boys: New research on masculinity, and gender strategies for schools. *Teachers College Record, 98*(2), 206-235.

Connell, R. W., & Messerschmidt, J. W. (2005). Hegemonic masculinity: Rethinking the concept. *Gender & society, 19*(6), 829-859. doi:10.1177/0891243205278639

Derlega, V. J., & Mikulka, P. J. (1993). Manhood in the Making: Cultural Concepts of Masculinity. By David D. Gilmore. *Journal of Men's Studies, 1*(3), 305.

DeWitt, J., Archer, L., & Mau, A. (2016). Dimensions of science capital: exploring its potential for understanding students’ science participation. *International Journal of Science Education, 38*(16), 2431-2449.

DeWitt, J., Archer, L., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2011). High aspirations but low progression: The science aspirations–careers paradox amongst minority ethnic students. *International Journal of Science and Mathematics Education, 9*(2), 243-271.

DiMuccio, S. H., & Knowles, E. D. (2020). The political significance of fragile masculinity. *Current Opinion in Behavioral Sciences, 34*, 25-28.

Duek, R., Kark, R., & Chachashvili-Bolotin, S. (2023). ‘I chose to study where the money is’: The differential perspective of science capital among girls and boys from the social periphery and center. *In Progress*.

Edley, N., & Wetherell, M. (1997). Jockeying for position: The construction of masculine identities. *Discourse & society, 8*(2), 203-217.

Ehrlich, E., Gabai, U., Maor, G., Razek, K. A., & Asher, A. (2021). *2020 high-tech human capital report*: Innovation Autority.

Fares, M., & Bernstein, I. (2019a). *Advancing scientific excellence in peripheral localities*. Paper presented at the [Conference presentation].  The "Periphery in the Center" conference,  Knesset Research and Information Center, Jerusalem. <https://main.knesset.gov.il/activity/info/mmm/pages/mmmconf031219.aspx>

Fares, M., & Bernstein, I. (2019b). *Advancing scientific excellence in peripheral Localities*. Paper presented at the The Periphery in the Center, Jerusalem. <https://main.knesset.gov.il/activity/info/mmm/pages/mmmconf031219.aspx>

Flowers Iii, A. M., & Banda, R. M. (2015). The Masculinity Paradox: Conceptualizing the Experiences of Men of Color in STEM. *Culture, Society & Masculinities, 7*(1), 45-45-60. doi:10.3149/CSM.0701.45

Forgasz, H., Leder, G., Mittelberg, D., Tan, H., & Murimo, A. (2015). Affect and gender. In *From beliefs to dynamic affect systems in mathematics education* (pp. 245-268): Springer.

Forum, W. E. (2022). *Global Gender Gap Report 2022*. Retrieved from

Gattario, K. H., Frisén, A., Fuller-Tyszkiewicz, M., Ricciardelli, L. A., Diedrichs, P. C., Yager, Z., . . . Smolak, L. (2015). How is men’s conformity to masculine norms related to their body image? Masculinity and muscularity across Western countries. *Psychology of Men & Masculinity, 16*(3), 337.

Gibton, D. (2001). Teoria hameugenet basadeh: Mashmaut tahalich nituach hanetunim uvniyat hateoria bemechkar eichutani (Grounded theory: The significant of data analysis processes and theory construction in qualitative research). *Masorot uzeramim bamechkar haeichuti*, 195-228.

Gibton, D. (2004). Minding the gap: Principals' graphic mindscapes on educational policy and law-based reform: A qualitative technique for evaluation and policy analysis. *Studies in educational evaluation, 30*(1), 37-59.

Gilmore, D. D. (1990). *Manhood in the making: Cultural concepts of masculinity*: Yale University Press.

Gowing, A. (2019). Peer-peer relationships: A key factor in enhancing school connectedness and belonging. *Educational and Child Psychology, 36*(2), 64-77.

Hencke, J., Eck, M., Sass, J., Hastedt, D., & Mejia-Rodriguez, A. M. (2022). Missing out on Half of the World's Potential: Fewer Female than Male Top Achievers in Mathematics and Science Want a Career in These Fields. IEA Compass: Briefs in Education. Number 17. *International Association for the Evaluation of Educational Achievement*.

Herbst, A., & Benjamin, O. (2012). *It was a Zionist act: Feminist politics of single-mother policy votes in Israel.* Paper presented at the Women's Studies International Forum.

Ikonen, K. (2020). *Socio-cultural factors contributing to adolescents' gendered education and career exploration in STEM.* Itä-Suomen yliopisto,

Jackson, E. F., & Bussey, K. (2020). Under pressure: Differentiating adolescents’ expectations regarding stereotypic masculine and feminine behavior. *Sex roles, 83*(5), 303-314.

Jørgensen, C. H. R. (2017). ‘Peer social capital’and networks of migrants and minority ethnic youth in England and Spain. *British Journal of Sociology of Education, 38*(4), 566-580.

Josselson, R. (2007). The ethical attitude in narrative research: Principles and practicalities. *Handbook of narrative inquiry: Mapping a methodology, 21*, 545.

Kaplan, D., Rosenmann, A., & Shuhendler, S. (2017). What about nontraditional masculinities? Toward a quantitative model of therapeutic new masculinity ideology. *Men and Masculinities, 20*(4), 393-426.

Karazi-Presler, T., & Sasson-Levy, O. (2022). Two Steps Forward, One Step Back: Gender Relations in Contemporary Israel. In *Routledge Handbook on Contemporary Israel* (pp. 337-350): Routledge.

Karazi-Presler, T., Sasson-Levy, O., & Lomsky-Feder, E. (2018). Gender, emotions management, and power in organizations: The case of Israeli women junior military officers. *Sex roles, 78*, 573-586.

Kark, R. (2016). *One and another are two: Students in physics, mathematics and science (Hebrew)*. Retrieved from Israel:

Karolak, M., Guta, H., & Alexander, N. H. (2014). Fluid masculinities? Case study of the Kingdom of Bahrain. *Masculinities in a global era*, 159-174.

Kheir Abedel Razek, A. A. (2021). *Israel HighTech Industry Human Capital Report 2020*. Innovation Autority

Kimmel, M. S., Hearn, J., & Connell, R. W. (2004). *Handbook of studies on men and masculinities*: Sage Publications.

Kiuru, N., Nurmi, J.-E., Aunola, K., & Salmela-Aro, K. (2009). Peer group homogeneity in adolescents' school adjustment varies according to peer group type and gender. *International Journal of Behavioral Development, 33*(1), 65-76.

Kutai, M. (2017a). *The struggle over the definition of hegemonic masculinity among men serving in the Intelligence Forces*: (Unpublished doctoral dissertation). The Hebrew University of Jerusalem, Jerusalem.

Kutai, M. (2017b). *The struggle over the definition of hegemonic masculinity among men serving in the Intelligence Forces.* (MA). The Hebrew University of Jerusalem, Jerusalem.

Leaper, C. (2015). Do I belong?: Gender, peer groups, and STEM achievement. *International Journal of Gender, Science and Technology, 7*(2), 166-179.

Levitt, H. M., Bamberg, M., Creswell, J. W., Frost, D. M., Josselson, R., & Suarez-Orozco, C. (2018). Journal article reporting standards for qualitative research in psychology: The APA publications and communications board task force report. *American Psychologist, 73*(1), 26-46.

Levy, O. S., & Misgav, C. (2017). Gender Studies in Israel in the Early 21st Century: Between Neo-Liberalism and Neo-Colonialism. *Megamot, 41*(2), 165.

Lockhart, E. A. (2015). *Nerd/geek masculinity: Technocracy, rationality, and gender in nerd culture's countermasculine hegemony.*

Maoz, d., & Niv, d. (2015). *Parenting without masks: what is told about raising children*. Bnei Brak, Israel: Matar.

Martín-Gámez, C., García-Durán, D., Fernández-Oliveras, A., & Torres-Blanco, V. (2022). Factors to consider from education to promote an image of science and technology with a gender perspective. *Heliyon*, e11169.

MOST, M. o. S. a. T. (2021). *Promoting gender equality in STEM education - Policy review and implementation report for Ministry of Science and Technology*. Israel Retrieved from <https://www.gov.il/he/departments/general/szold_institute_report>

Nieuwenhuis, J., & Xu, J. (2021). Residential segregation and unequal access to schools. *Social Inclusion, 9*(2), 142-153.

Noam Zusman, D. M. (2019). *Evaluating the effectiveness of "Latet Hamesh" and " Science & Technology Pipeline" programs*. Jerusalem: Bank Of Israel

Orpaz, I. (2022). *Annual innovation report – State of high-tech 2022*: Israel Innovation Authority.  <https://bit.ly/3D6jInX>.

Rabinovitz, M. (2017). *Searching process for gifted students*. Jerusalem: Knesset Research and Information Center. <https://bit.ly/3AU5qnD>.

Razer, M., Mittelberg, D., & Ayalon, S. (2018). The ability-track glass ceiling of Israeli schooling: lessons from a comparative analysis of Israeli and Australian PISA 2012 data. *International Journal of Inclusive Education, 22*(2), 192-214.

Refaeli Mishkin, H. (2016). *Motivation and Gender Factors Affecting Career Choice of Engineers and Students.* (Doctor of Philosophy Quantitatve). Technion- Israel Institute of Technology, Israel.

Renold, E. (2001). Learning the'hard'way: Boys, hegemonic masculinity and the negotiation of learner identities in the primary school. *British Journal of Sociology of Education, 22*(3), 369-385.

Rogers, A. A., Boyack, M., Cook, R. E., & Allen, E. (2021). School Connectedness and STEM Orientation in Adolescent Girls: The Role of Perceived Gender Discrimination and Implicit Gender-Science Stereotypes. *Sex roles, 85*(7), 405-421.

Rose, J., & Strine, M. (2014). Pierre Bourdieu and the Practice of Resistance. *pdf] London, Acedemia. edu. Internet:* [*http://www*](http://www)*. academia. edu/202471/Pierre\_Bourdieu\_and\_the\_Practice\_of\_Resistance2009,[Aug 3, 2014]*.

Ryan, A. M. (2001). The peer group as a context for the development of young adolescent motivation and achievement. *Child development, 72*(4), 1135-1150.

Samuel Neaman Institute. (2021). *Periphery Academy Relation*. Virtual. <https://www.neaman.org.il/Files/Periphery%20Academy%20relations%20report.pdf>

Sasson-Levy, O. (2003). Military, masculinity, and citizenship: Tensions and contradictions in the experience of blue-collar soldiers. *Identities: Global Studies in Culture and Power, 10*(3), 319-345.

Sasson-Levy, O. (2006). Identities in uniform: Masculinities and femininities in the Israeli military. *Jerusalem: Magnes [In Hebrew.]*.

Schwartz, Y. (2015). *(New) men teaching (old) boys: Youth educational dilemmas’ in Israeli high schools through the “Nemesh” intervention program.* Bar Ilan, Ramat Gan.

Schwartz, Y. (2020). “I Present a Role Model of Fluid Masculinity…”: Gender Politics of Pro-Feminist Men in an Israeli High School Gender Equality Intervention Programme. *Masculine Power and Gender Equality: Masculinities as Change Agents*, 133-156.

Shkedi, A. (2003). Words that try to touch. *Qualitative Research: Theory and Practice. Tel Aviv: Ramot-Tel Aviv University (Hebrew)*.

Stahl, G., Scholes, L., McDonald, S., & Lunn, J. (2019). Middle years students’ engagement with science in rural and urban communities in Australia: exploring science capital, place-based knowledges and familial relationships. *Pedagogy, Culture & Society*, 1-18. Retrieved from <https://doi.org/10.1080/14681366.2019.1684351>

Stahl, G., Scholes, L., McDonald, S., Mills, R., & Comber, B. (2021). Boys, science and literacy: place-based masculinities, reading practices and the ‘science literate boy’. *Research Papers in Education*, 1-29.

Steyer in Katz, R. (2011). משפחות עובדות: הורים בשוק העבודה בישראל-היבטים חברתיים, כלכליים ומשפטיים. In: JSTOR.

Swed, O., & Butler, J. S. (2015). Military capital in the Israeli hi-tech industry. *Armed Forces & Society, 41*(1), 123-141.

Tan, E., Calabrese Barton, A., Kang, H., & O'Neill, T. (2013). Desiring a career in STEM‐related fields: How middle school girls articulate and negotiate identities‐in‐practice in science. *Journal of Research in Science Teaching, 50*(10), 1143-1179.

Weininger, A. (2021). *New academic student dataset by SES cluster*. Jerusalem: Knesset Research and Information center. <https://bit.ly/3QpO5Zt>.

Xu, J., & Hampden-Thompson, G. (2011). Cultural reproduction, cultural mobility, cultural resources, or trivial effect? A comparative approach to cultural capital and educational performance. *Comparative Education Review, 56*(1), 98-124.

Yablonko, Y. (2019, 09/05/2019). Friend Brings Friend: The ideal recruitment method or a problem to be addressed? *Globes*. Retrieved from <https://www.globes.co.il/news/article.aspx?did=1001285046>

1. Socioeconomic status index: An index characterizing geographic units according to the socio-economic level of the resident population, including parameters such as demographic composition, education, standard of living, employment, and pensions. Published by Israel Central Bureau of Statistics. (2021) <https://bit.ly/3BlxSjP>  [↑](#footnote-ref-1)