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INVENTION EDUCATION AND THE DEVELOPING NATURE OF HIGH SCHOOL STUDENTS' CONSTRUCTION OF AN "INVENTOR" IDENTITY

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This article explores the development of high school students' identities as inventors at the end of their participation in the national InvenTeams™ invention education initiative sponsored by the Lemelson-MIT Program. Our study was guided by an interactional ethnographic perspective through which we sought to understand students' emic perspectives as to why they did or did not see themselves as inventors after working as inventors across the school year. Analyses focused on student responses to a self-descriptor question on the end-of-the-year survey taken by 196 students and on semi-structured interview dialogues about identity with three male and three female InvenTeams participants. Multiple analytic passes through survey and interview data revealed that while only three of the six students (two women and one man) self-identified as inventors on the survey, all six were in the process of constructing their identities as leaders, creators, innovators, engineers, and inventors. Domain analyses of student interview responses also made visible that home, school, and out-of-school contexts had the potential to influence student identity choices. The variety of student identity choices and explanations of their self-identification with the term "inventor" make visible the possibility that invention—and self-appellation as an inventor—may be accessible to more youth from diverse backgrounds if young people have access to environments rich in science, technology, engineering, and mathematics during high school and are provided multiple opportunities to engage with their communities as inventors.

Key words: Invention; Inventor; Identity; InvenTeam

This article reports findings from the first year of an ongoing three-year ethnographic study of a national invention education program known as InvenTeams™. The program has a fifteen-year history of engaging high school student teams and their teachers in collaborative problem-solving practices and processes common to inventors. Program staff work with student teams across an academic year as each InvenTeam conceptualizes, designs, and builds a working prototype of a technological solution that is useful and unique (i.e., an invention) to solve a problem the team has identified in their community. InvenTeams activities take place within the school day at the school as well as after school and in students' local communities. The proportion of time allotted to activities in each of these contexts varies from team to team. The program staff work with student teams and their teachers remotely, with periodic in-person visits.

In this article, we explore the following research questions: 1) Do high school students identify themselves as inventors after participating in an

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InvenTeams? 2) How do they explain their choice of identity descriptions? and 3) What prior experiences with science, technology, engineering, and mathematics (STEM) do students have that may influence their take-up of an "inventor" identity?

THEORETICAL PERSPECTIVES GUIDING THE RESEARCH

Social Construction of Identities

Our exploration of student self-identification as an inventor is based on views of identity as socially constructed in time, in particular moments and interactions, as well as over time through multiple opportunities for engaging in activities designed to develop particular identities, such as an inventor. We draw on social constructionist theories of identity in which identity development is seen as a process (1), as identity work (2), and as social action (3) that is being continuously created and reformulated in and through interactions with others (4,5). Social constructionist views of identity posit that identity is situated and constructed in particular ways within different interactional environments and processes of performing social life (1,6). Identities are dialogic, dynamic, polyphonic, and interactionally accomplished in situated interrelationships, thus identities develop and change over time. While some identities remain permeable and flexible, others can become stabilized through repeated interactions and patterned positionings in particular social groups (7). Yet, as Bloome and colleagues (4) argue, even the identities that are stabilized within a particular social group can evolve and change when the social structures and interactional relationships change. Bloome and colleagues add that "beyond social identities with appellations are social identities that are not named" (4); thus, there is always potential for formulating new identities, strengthening others, and/or disconfirming or leaving previously formed ones. Social constructionist and sociocultural theories of identity converge on the common premise that identities are flexible, interrelational, situated, and partial (1–3,8). Many scholars also add that identities are discursive and constructed in and through language-in-use across time and events (9–13).

Discourse, and the analysis of language as it is used in particular social and academic contexts and interactional spaces, is key to developing understandings of the ways identities develop, change, and flex across times and events. Bloome et al. (4) succinctly stated, "The processes through which social identities are named and constituted are language processes; that is, it is through the use of language that people name, construct, contest, and negotiate social identities. Analysis of social identity, therefore, requires attention to language use." How language is used in particular social spaces and learning communities is consequential for creating situated identity potentials and opportunities for the take-up of those identities. An inscription of an identity at a particular moment in time in a text or an interaction can become an anchor for exploring larger academic, interactional, and socioeconomic contexts that may play a role in identity development, naming, and change.

Kelly and colleagues (13), in their study of engineering identity development in elementary school, argued that identity work in science occurs at two levels: epistemological and ontological. Students learning science develop epistemological identities that include disciplinary knowledge of science. However, knowing and understanding science is not enough to start seeing oneself as a member of the scientific community. Being a scientist, an engineer, or an inventor (among other potential appellations) at an ontological level requires student self-identification with a particular identity and its ways of being, doing, and talking in the disciplinary community. These ontological identities develop over time as students, individually and collectively, talk knowledge and views of self into being and as they self-position and are positioned by others in particular ways in the epistemological communities of disciplinary practices and discourses (14–16).

Researchers have called for utilizing complex and multiple methodologies to reveal the multifaceted, fluid nature of learning and identity development (17,18) associated with the complex processes through which identities are socially and discursively constructed across time and events in particular social and academic settings. Multiple methods and sources of information are needed to uncover the progressions and shifts in identity development. In this study, we draw on principles of an interactional ethnographic perspective to explore the in-time and over-time discursive and social constructions of identities (19,20) of students who participated in InvenTeams in the 2016-2017 academic year.

Interactional Ethnographic Epistemology

Our ongoing program of research on invention education is driven by Interactional Ethnography (IE) and is currently in its third year of development. In this article, we present an early analysis from the first year of the study. This work informed our subsequent research development and our ongoing interactional ethnographic goals to construct emic understandings of developing social processes, practices, and identities (19,21). IE, as an epistemology (19), draws on anthropology, sociology, sociolinguistics, and critical discourse analysis to examine how people in and through interaction construct patterned ways of being, acting, interacting, and knowing in particular social groups. Interactional ethnographers utilize a variety of methods and tools as they seek to understand insider/emic perspectives about aspects of complex social, cultural, and discursive phenomena (22) of human activity and interaction. As an epistemology, not method (19,21), IE has been taken up in longitudinal ethnographies as well as studies of a shorter duration that utilize an ethnographic perspective but do not constitute a full ethnography. Adopting an ethnographic perspective, as proposed by Green and Bloome (23), requires researchers to examine particular social and/or cultural phenomena in depth, either as part of full-scale ethnographies or as telling case studies (24) that utilize multiple methods to construct understandings of bounded phenomena of interest. The "interactional" aspect of IE focuses on discourse and ways people in interaction discursively construct social actions, meanings, and identities for themselves and others (18,25,26).

Our examination of the identities InvenTeams students chose for themselves and how they described the meanings of the chosen identities required us to draw on student experience surveys, interviews, and program records. The use of multiple records and forms of data enabled us to follow the interactional ethnographic logic as we traced back from the choice-of-identity appellations on a survey selected by six students in our telling cases to their discursive inscriptions of identities in interviews. This led us to further analysis of the social, biographical, academic, and invention-opportunity contexts that shaped how and in what ways the six students did or did not construct self-identities as inventors. We collected and analyzed multiple sources of data to construct multifaceted understandings of the bounded phenomena, as is consistent with our interactional ethnographic perspective and take-up of ethnography as epistemology. Our triangulation of information from program data, student surveys, and interview responses provided the data needed to uncover individual and contextual factors that influenced the ways youth self-identified as inventors after participating on InvenTeams.

LEMELSON-MIT INVENTEAMS AS CONTEXT FOR THE STUDY

This study examines the ways young inventors relate to the term inventor as a way of describing themselves at the end of their year-long work with the Lemelson-MIT (LMIT) Program's InvenTeams initiative. The program, housed within the School of Engineering at the Massachusetts Institute of Technology, focuses on inspiring, supporting, and fostering the work of young inventors from diverse backgrounds across the U.S. (27). The joint work of LMIT staff and educators over the past 15 years has enabled almost 230 teams of students to develop working prototypes of inventions that were designed to address community-based problems. Historical records depicting the demographics of each InvenTeam indicate that there were 2,403 youth participants between 2008 and 2018. An average of 35% of InvenTeams participants have been female across the ten-year period, representing a number higher than the national average of women involved in inventing activity that leads to patents (11.7%) (28).

DATA SOURCES

For this study, we used two primary sources of data available in our larger ethnographic archive, which includes program records, pre- and post-InvenTeam surveys with teachers and students, video and audio recordings and interviews with staff, educators, and students, as well as related documents. To address our first research question, *Do high school students identify themselves as inventors after participating* *on an InvenTeam?* our primary source of data was a voluntary experience survey of the 2017 InvenTeams participants, which was administered online to 196 students. One hundred forty-seven returned responses were analyzed using descriptive statistics methods to identify student choices of identity descriptors. Semi-structured interviews with six focus students constituted the second primary source of data and enabled us to explore the second and third questions, *How do the students explain their choice of identity descriptions?* and *What prior experiences with science, technology, engineering, and mathematics (STEM) do students have that may influence their take-up of an "inventor" identity?* Tracing from student discourse within the interview, we also drew on the InvenTeams program records to make connections between student identity inscriptions and the contexts in which their self-identifications occurred. Utilizing the surveys and the interviews as primary sources of data and linking analyses to the program records enabled us to explore individual and social factors that students discursively proposed as influencing their developing identities as inventors. The use of multiple sources of data was consistent with an interactional ethnographic perspective and its goals to uncover insider perspectives and to locate them in the academic, social, and other contexts that support and constrain student opportunities for learning and identity development.

Survey Data

The experience survey data for the 2016–2017 InvenTeams cohort was collected at the end of students' year-long participation in the InvenTeams program. Seventy-three percent of the 196 students responded to the 184 survey questions. For the analysis of our first research question, we focused on the survey item that explicitly asked students to select self-identifiers from a number of potential descriptors. Students' responses offered a beginning point for seeing student preferences in identity choices. We compared the prevalence and differences in identity choices between young women and men. Analysis of the survey enabled us to identify the potential identities students constructed within the context of their participation in the InvenTeams program. However, the survey did not allow us to understand how or why particular identities were chosen and what the identity appellations used on the survey meant to individual students.

Interview Data

In an effort to delve deeper into understanding how students constructed particular identities for themselves and what they meant when they selected particular professional appellations, we utilized transcripts from semi-structured interviews with six students who participated in the program during the same school year. We chose three men and three women to reflect diversity in gender, race, and ethnicity. This paper builds on our prior work that addressed the experiences of three young women (29) and adds a focus on identity construction for the same three women, along with the addition of three men who were not included in the previous paper.

Interviews with the six selected students took place during a culminating event for all InvenTeams. The interviewer (third author) had previous interaction with the six students as an LMIT Program staff member, so a level of familiarity was established with interviewees prior to the interviews. Students were invited to select their own pseudonyms. Each interview lasted approximately 60 minutes, was videotaped, and was transcribed by an outside company in a pragmatic way to match the content-focused research purpose (30). The interviewer asked each student the same specific open-ended questions related to their experiences on InvenTeams and followed a semi-structured interview format (31) that was also responsive (32) to student propositions and related discussions, which could provide more in-depth explanations of the students' discursive choices. The interviews focused on students' identities as InvenTeams members and as participants in the national invention education program, as opposed to the many other identities students may hold in other contexts (such as sister, friend, or student). We analyzed the interviews to explore the ways students talked about their identities in relation to invention and how they explained experiences that influenced their developing identities as inventors, innovators, leaders, or other identity appellations to which they referred in the interviews. Using student discourse as an anchor, we also referred to program records to explore the connections students made between their identity choices and the opportunities offered within and beyond the Lemelson-MIT InvenTeams program.

ANALYSES

The first layer of analysis focused on responses to nine optional identity descriptors on the year-end survey: leader, engineer, creator, innovator, maker, scientist, inventor, technologist, and entrepreneur. Students could select more than one option. Our analyses revealed that 32.2% of survey respondents self-identified as inventors. We also extracted the responses to this question for the six students we interviewed. Three of the six focus students selected inventor as one of their self-identification choices. Given that the students spent an academic year working on an invention and were referred to as InvenTeam members by the LMIT Program staff, these results created a frame clash for us (33). We wondered why students who had worked as inventors did not identify as inventors. We turned to the interviews with the six focus students to transform this frame clash into a rich point (33,34). This was an opportunity for learning—for us and potentially for students themselves, as they explored their identity constructions with the researcher during the interviews (35).

Our quest to uncover insider perspectives from InvenTeams participants about why only 32.2% of InvenTeams members selected inventor identities on the survey constituted the second layer of research and centered on work with the six focus students' interview transcripts. The interview transcripts were analyzed through multiple analytic passes (22), each of which focused on a separate aspect of students' discursive constructions of their identities. Examining the interviews through the multiple analytic passes allowed us to zoom in on specific parts that later could be (re)connected to construct the telling cases of student developing identities. The first analytic pass through the interview data consisted of reading the transcripts of the semi-structured interviews. This initial analysis revealed instances in which students inscribed particular identities for themselves. We focused on their discursive choices in talking about themselves as inventors, scientists, engineers, leaders, innovators, or other identities related to participation in InvenTeams. We selected interview excerpts for each student and aligned the inscriptions of self in the interviews with those marked on the survey.

Our second analytic pass through the interview transcripts examined the ways each of the six students answered two specific questions: 1) whether they considered themselves to be an inventor and 2) how they were like or unlike an inventor. Analyzing the transcript in the third pass, we examined students' conceptions of inventors and the reasons students gave for not describing themselves as inventors. The fourth pass explored students' references to experiences prior to InvenTeams that may have influenced the ways that the students described themselves. In the final pass, we examined the students' accounts of their interactions and engagements with the community during their InvenTeams experience. We sought to understand the ways in which community engagements may have been consequential for students' take-up of inventor identities. These analytic passes followed an interactional ethnographic abductive, iterative, and recursive logic (19) of examining discursive choices in particular moments of interaction. It also involved tracing the roots, routes, and potential larger influences for those discursive choices involved in the construction of social (4), epistemological, and ontological (13) identities-in-the-making.

FINDINGS: STEM EXPERIENCES AND IDENTITIES AS INVENTORS

Identification Choices on the Survey

The InvenTeams end-of year student experience survey included one specific question in which students were to "mark all that apply" for nine self-descriptors. Survey respondents, on average, selected 3.54 terms as descriptors of self from the nine possibilities. Responses, ranked from most to least chosen, appear in Table 1 and reflect that the leader, engineer, creator, innovator, and maker self-descriptors were chosen the most. Inventor ranked seventh out of ten choices.

Table 1 shows that only one self-identifier, leader, received over 50% of responses. Engineer, creator, innovator, and maker were selected by over 40% of respondents, while scientist and inventor were chosen

Table 1. Self-Descriptors Selected by 2017 InvenTeams Participants

Self-Descriptor	Number of Responses	% of Total Responses	% of Respondents
Leader	74	14.3%	50.7%
Engineer	66	12.8%	45.2%
Creator	62	12.0%	42.5%
Innovator	62	12.0%	42.5%
Maker	61	11.8%	41.8%
Scientist	55	10.6%	37.7%
Inventor	**47**	**9.1%**	**32.2%**
Technologist	40	7.7%	27.4%
Entrepreneur	34	6.6%	23.3%
No response	16	3.1%	11.0%
Total	517	100%	

by one-third of all respondents. The ranking of terms from the most chosen (leader) to the least (entrepreneur) makes visible that, of the top five choices, only engineer is a descriptor that is associated with a STEM profession, while leader, creator, innovator, and maker are more general descriptors that can be utilized across a variety of social, academic, and professional contexts. Scientist and inventor, the choices that received 37.7% and 32.2% of responses, respectively, are terms usually used in research and/or STEM disciplines. Scientist represents a more general term with the potential for the inclusion of social scientists in addition to STEM professionals. Inventor, the focal term of interest for our study, is seen as a transdisciplinary term (27,36), though it is more likely to be considered as being associated with STEM-related endeavors.

The term inventor received only 32.2% of student choices even though students had worked as inventors for nearly a year. This led us to examine the choices made by the interviewees. Descriptors selected by the six focus students show that the women—Celaena, Magdalena, and Chelly—marked terms that were among the top four answers given by all respondents, as did the men—Alec, Jacob, and George (Table 2).

Table 2 makes visible that Celaena, Magdalena, and Jacob were the only three of the six focal students who identified with the term inventor and were among the 32.2% of all respondents who chose this self-identifier. Inventor was one of seven choices for Celaena, and Magdalena selected inventor as one of six choices. Jacob was the only man who chose inventor; it was one of his six descriptors. Table 2 shows that the other two men and one woman not identifying as inventors chose fewer indicators (one for Chelly and Alec, and three for George). All three of the men marked engineer as an identity descriptor, while none of the women did. These results puzzled us and led us to the interview records to explore how the students talked about their identities in relation to the InvenTeams experience.

Identification Choices in the Interviews: Inscriptions of Self as an Inventor in Relation to the InvenTeam Experience

Although the survey data revealed that three of the six students selected for our case studies self-identified as inventors, the survey data did not offer information about why the students selected the term (or not). Our first analytic pass (22) over the interview data involved identifying segments in which the interviewer asked each student directly if they were an inventor and what being an inventor meant for them. Following student emic inscriptions of what being an inventor meant to them, we conducted semantic analyses (37) to construct the domain of actions students made visible as important to the identity of an inventor (Table 3). We also explored reasons the students provided for not identifying as an inventor (Table 4), prior experiences (Tables 5 to 8), and the community engagement aspect of the InvenTeams experience itself (Tables 9 and 10).

Celaena, the first of two female InvenTeams students who chose inventor as a descriptor, was

Table 2. Self-Descriptors Selected by All 2016-2017 InvenTeam Respondents and the Six Focus Students

Self-Descriptors	**Number and % of All Respondents**	**Women**			**Men**		
		Celaena	**Magdalena**	**Chelly**	**Alec**	**Jacob**	**George**
Leader	74 (50.7%)	X	X				
Engineer	66 (45.2%)				X	X	X
Creator	62 (42.5%)	X	X			X	
Innovator	62 (42.5%)	X	X	X			
Maker	61 (41.8%)	X	X			X	
Scientist	55 (37.7%)		X			X	X
Inventor	**47 (32.2%)**	**X**	**X**			**X**	
Technologist	40 (27.4%)					X	X
Entrepreneur	34 (23.3%)	X					
No response	16 (11%)						
Total	517						
Terms per respondent	3.54 average	7	6	1	1	6	3

asked whether she saw herself as an inventor. She responded, "I would say yes. I think a lot of people can consider themselves as an inventor." She then proceeded to draw a distinction between an inventor and a "well-known, established inventor who actually helps people and actually created something that people can use." She went on to say she wouldn't "say that yet, but I'm hoping I can say that in the next year or two." The interviewer went on to ask how Celaena was like (or different from) an inventor and whether she knew an inventor. Celaena cited everybody who goes to her [STEM] school and then qualified the statement by saying, "I feel like that term is very loose. I feel like everybody can feel the term 'inventor' in some way. I feel like it's about expressing creativity in a different way that somebody else hasn't thought of expressing their creativity before. So, I think it's a broad, awesome term that can be used."

Magdalena, the second of the two female InvenTeam students who chose inventor as a descriptor and who attended the same STEM school as Celaena, answered "yes" when asked whether she considered herself an inventor. She explained, "I think an inventor is able to come up with solutions, some creative innovative solutions to problems, and I think I'm able to do that, even if I don't always display the technical skills to work that out."

Chelly had chosen only innovator as a descriptor on the survey. In the interview, we asked her if she considered herself an inventor. She responded, "Honestly? No. Even though I did this project I don't feel like I am. I don't know why."

Following the analyses of the women's responses about why they considered or did not consider themselves inventors, we proceeded to analyze the transcripts of the three men. Alec, like Chelly, did not select inventor as a descriptor on the survey. When asked in the interview if he would consider himself an inventor, Alec offered that he viewed inventor as a "broad definition." He described an inventor as "someone who enjoys inventing and thinking of ways to solve problems maybe through the use of a new product or a new invention." He indicated he was an inventor using this definition. He went on, however, to say, "I don't know if I would call myself an inventor because that's something that has a bit more weight to it," and "I would definitely say that I err more on the side of a problem solver than an inventor."

George was the third student who did not select inventor as a descriptor; he also was asked by the interviewer if he would consider himself an inventor. He indicated "somewhat" and qualified the statement by adding, "maybe inventing comes with experience and that I just need more experience before I can invent things more easily."

Jacob, who identified as inventor on the survey, responded "yes" during the interview when asked if he considered himself an inventor. He explained that "being able to create something out of scratch, and knowing that your technology, your invention,

Table 3. Analysis of Students' Comments about Actions Undertaken by Inventors

x is a Type of Action Undertaken by Inventors	Described by
1. Helping people	Celaena
2. Creating something that people can use	Celaena
3. Benefiting others by making a product	Jacob
4. Having a purpose	Jacob
5. Starting with an idea	Chelly
6. Not knowing what they are doing	Chelly
7. Testing the waters	Chelly
8. Looking at problems	Alec
9. Looking for new ways, new solutions	Alec
10. Problem solving	Alec
11. Doing research	George
12. Thinking of ways to solve problems … through the use of a new product or new invention	Alec
13. Creating something out of scratch	Jacob
14. Coming up with brand new ideas, brand new concepts	George
15. Coming up with solutions	Magdalena

can actually help somebody, and help a problem" was the reason he considered himself an inventor. When asked how he was similar to an inventor, Jacob described actions taken by inventors. "To be an inventor, you have to make something that your product will actually benefit," he said. He went on to qualify the statement about making and the product in three ways: "Your project has to have an audience," "and a purpose for what your [*sic*] doing," and "so people can actually benefit off your project." He went on to note, "So I think that's what makes me an inventor, my InvenTeam, all of them inventors, because we were able to make something that actually could make an impact on our community, and make an impact in people's lives."

After determining students' explanations for why they chose or did not choose inventor as a self-identifier, we analyzed information about what the students thought inventors did. Following Spradley's semantic relationship of "strict inclusion," *x* is a kind of *y* (37), we included terms used by students. We explored the terms (*x*) as a type of action (*y*), as described by a particular InvenTeam student. We adapted Spradley's graphic representation of domain analyses to include a column in Table 3 for participants who indicated the actions. Our process of identifying inventor actions from the students' discourse included writing student names next to identified actions in order to maintain visibility for potential links between student conceptions of the work of inventors and the ways these conceptions could impact their inventor identity. The actions represented in Table 3 are not linear by student but rather reflect analyses of what students made visible about inventor actions, as described below.

We added numbers to the actions to facilitate analyses. When reviewing the domain of inventor actions students identified, we noticed that actions 1 to 4 focused on having a purpose and seeking to benefit people. These actions were emphasized by Celaena and Jacob. Actions 5 to 9 focused on problem-seeking processes and were emphasized by Alec and Chelly. Alec, George, and Jacob also made visible the actions of problem solving (actions 10 to 13), while in actions 14 and 15, Magdalena and George made visible that "coming up with solutions" is an important outcome of invention. Focusing on the kinds of actions students associated with the work of inventors enabled us to start understanding what the term "inventor" meant for the students; however, we still did not have sufficient evidence to see whether and how students' choices of identities were related

Table 4. Analysis of Reasons Three Students Did Not Self-Identify as Inventors

x **is a Reason for Not Identifying as Inventor**	**Described by**
Just because it was one thing maybe	Chelly
Because it was just this project	Chelly
That's something that has a bit more weight to it	Alec
There's a distinction … between an inventor and a problem solver … easier to be a problem solver because anyone that actively has to create new solutions would fall into the category of a problem solver	Alec
Professional inventor would be an inventor	Alec
I invented a few things, but I've came up to solutions for minor problems	George
I think maybe inventing comes with experience and that I just need more experience before I can invent things more easily	George

to their understandings of the work of inventors.

Our next analytic pass involved returning to the transcripts of the three students who did not self-identify as inventors (Chelly, Alec, and George) in order to explore their reasons for this choice. We chose the "rationale" semantic relationship, *x* is a reason for *y* (37), to construct a domain analysis of the students' reasons for not identifying with the inventor appellation. Table 4 makes visible the reasons the three students cited.

Chelly emphasized her limited experience in invention as the primary reason for not self-identifying as an inventor. She acknowledged that she worked as an inventor on the InvenTeam, but, to her, "it was just this project" and "one thing maybe," which were not sufficient reasons to develop her identity as an inventor. Alec saw the identity of inventor as having "a bit more weight to it," as in being a "professional inventor." Making a distinction between being a problem solver and an inventor, Alec self-identified as a problem solver who "actively" seeks "to create new solutions" to problems. George, on the other hand, acknowledged that he "invented a few things," but he did not see himself as an inventor yet because his inventions addressed "minor problems" and "inventing comes with experience." George did not mark inventor as a self-identity choice on the survey; yet, in the interview, he made visible that he is already on the pathway to becoming an inventor and "just needs more experience before I can invent things more easily."

All three students emphasized their limited experience as the primary reason for not self-identifying as inventors, but, at the same time, their responses to how they were or were not like an inventor indicated that they had constructed the potential for taking up the inventor identity. For example, while Chelly answered "no" to identifying herself as an inventor, she explored this possibility by talking about "it's kind of I guess mixed feeling," and having now done this "one thing" on an InvenTeam, she sees that other inventors started with one thing, too. Through this exploration, Chelly made visible the potential for developing her inventor identity.

Similarly, while saying "no" to seeing himself as an inventor at the time of the interview, Alec was open to exploring ways of seeing the inventor appellation. He explained, "If I am going to take it broadly as someone who enjoys inventing and thinking of ways to solve problems … I would suppose I would say yes." Introducing the potential of "yes" to seeing himself as an inventor, he added that he already engages in processes and practices of invention: "In robotics and the inventing you spend a lot of time looking at problems in a sort of … you have a process, I guess, when you see a problem in which you just look for new ways, new solutions, and I guess I could call that inventing." Drawing parallels between his prior experiences in robotics and his recent experience on the InvenTeam, Alec acknowledged that "anyone that considers themselves a problem solver could also be considered in broad terms an inventor, and I guess that's what I'd consider myself." Even though Alec qualified that he would see himself as an inventor only

Table 5. Analysis of Students' Descriptions of Family STEM Backgrounds

x is a kind of STEM expertise	Held by	Referenced by
Chemical engineer Mechanical engineer	Dad Brother	Alec (Grade 12)
Accountant Works on planes Aerospace engineer Coding	Mom Dad Uncle Uncle	Jacob (Grade 12)
Engineering company	Dad	George (Grade 11)
n/a	n/a	Chelly (Grade 12)
n/a	n/a	Magdalena (Grade 11)
In STEM	Nine family members	Celaena (Grade 10)

if the term was seen "in broad terms" and related to problem solving, Alec, like Chelly, was consciously exploring the possibility of self-identifying as an inventor.

The third student who did not identify as an inventor on the survey, George, also was open to the inventor identity. He answered "somewhat" when asked if he considers himself an inventor. Asked further whether he would see himself like an inventor, George reiterated the uncertainty in "maybe." He explained, "I wouldn't say I invented a few things, but I've came up with solutions for minor problems." Although George had not marked inventor as a self-descriptor on the survey, his interview responses of "maybe" and "somewhat" indicated that he opened the door to considering the possibility of an inventor self-identity. George, along with Alec and Chelly, cited the InvenTeams experience as important but not quite sufficient for them to label themselves as inventors. Despite saying "no" to the inventor appellation, the three students demonstrated an open and fluid process of exploring and constructing the new identity.

Given that George, Alec, and Chelly emphasized the importance of repeated experience with invention in forming the new identity, in our next analytic pass through the interview transcripts, we explored student references to science and invention-related experiences prior to the students' work on InvenTeams.

References to Experiences Prior to Work on InvenTeams

Returning to the transcripts, we analyzed the prior experiences students referenced when describing their invention pathways. Using Spradley's domain analysis logic (37), we constructed three domains of student prior-experience contexts: 1) family, 2) school, and 3) out-of-school settings. Individually and collectively, each of these contexts affected how students constructed their self-identities, which ones they marked on the surveys, and how they explained the identities they selected.

Family Context

We asked students to describe themselves and their backgrounds, and many chose to include information about their parents or relatives. Four of the six focus students talked about family members who had STEM knowledge or worked in STEM-related fields. Table 5 lists the kinds of STEM expertise held by family members of the students we interviewed. The three men, Alec, Jacob, and George, were specific about the people and their expertise, while only one of the three women, Celaena, mentioned that nine family members were in STEM, but she did not specify the people or their expertise. Neither Chelly nor Magdalena mentioned STEM experiences in the family.

Listing the expertise and family members for each

Table 6. Analysis of Students' Experiences with STEM in School-Based Settings in Grades K-12

***x* is a Type of STEM Experience**	**Of Student**	**That Offers**
Freshman year … robotics team [School's] maker space	Alec (Grade 12)	n/a Our space … maker space gang … time there working on personal projects in robotics or whatever
[School] since third grade … a STEM school [School] Engineering since eighth grade Two years of engineering	Jacob (Grade 12)	Basically science, technology, arts, mathematics. so it's the basic Fundamentals of technology is oriented in the school environment Fundamentals and skills Projects such as we built a playhouse for a nonprofit organization
AP stats class Software for engineering program and hardware [class options for junior and senior year at school] [Parents] got me into technology at a young age	George (Grade 11)	Unspecified [Engineering class] projects where the design process was applied Build computers
[Before InvenTeam] I didn't really know anything about engineering I had absolutely no idea what STEM was	Chelly (Grade 12)	n/a [no knowlege of engineering] [no knowlege of STEM]
STEM School Favorite class is STEM three Biology project	Magdalena (Grade 11)	Helped me … become a more critical thinker, more of a problem solver … problem-based learning at ninth grade Where we do all our project-based learning Involved a water treatment experiment
[reference to math as weakest subject in middle school and strongest subject now at the STEM school] Three pillars at STEM school: critical thinking, innovation, and collaboration Project-based learning at STEM … Those are very intensive projects that we do	Celaena (Grade 10)	n/a Practiced those things every day We based all of our curriculum off of

student in Table 5 made visible that four of six students had immediate or extended family members with STEM expertise. Students did not explicitly state how the family members influenced their own paths in science and invention, yet the choice to name family backgrounds in introducing themselves during the interview signifies the potential links between student self-identifications and their prior experiences with STEM at home. This finding aligns with research that indicates that having a family member who is an inventor or STEM professional enables young people to engage in conversations and work related to STEM over time, thus fostering their potential interest in choosing STEM-related pathways (36). Family experiences may be important in shaping young people's developing identities, but, for students like Chelly and Magdalena, who did not have family members in STEM, school can provide learning opportunities to develop invention and STEM-related identities.

School Context

Five of six students we interviewed talked about participating in STEM-oriented school programs prior to engaging in InvenTeams. All three men reported engagement in STEM-oriented activities during both their K–8 years and in high school. Two of the three women, Magdalena and Celaena, cited experiences with STEM once they entered their STEM high school—including their experience on the InvenTeam—but not before that time. The third woman, Chelly, stated that she had no prior STEM experience. Celaena and Magdalena, the two women who identified as inventors, attended the same STEM school and had numerous experiences with STEM. Jacob, the one male who identified as an inventor, also attended a STEM school. Jacob noted, "I've been in [my school] since third grade, and since [my school] was a STEM school, basically science, technology, arts, mathematics."

Seeking to analyze the kinds of STEM experiences the students encountered in school prior to InvenTeams, we used Spradley's strict inclusion semantic relationship, *x* is a kind of *y*, and placed the included terms for the kinds of experiences into the first column of Table 6. We noted the student and his or her grade level in the second column. The last column includes student statements about what the experiences in column one offered.

Analysis of the experiences in the first column of Table 6 made visible that the three men were more specific than the women in explaining the STEM-related opportunities they had in school. Alec participated in robotics and utilized maker spaces, Jacob had engaged in engineering since 3rd grade, and George built computers and took an AP statistics class as well as classes in software and hardware for engineering. Magdalena mentioned a biology project, and both Magdalena and Celaena talked about project-based learning and opportunities at their STEM school as important experiences prior to InvenTeams participation. Chelly was the only one of the six InvenTeams students we interviewed who had no prior STEM-related experiences: "I didn't really know anything about engineering.… I had absolutely no idea what STEM was."

Analysis of STEM opportunities offered by students' schools prior to InvenTeams makes visible that those experiences enabled students to develop fundamental understandings about science and engineering (Jacob), engage in and understand design processes (George, Magdalena), invest time and personal interest in conducting a project (Alec), develop critical thinking and problem-solving capacities (Magdalena, Celaena), practice problem-solving skills by working on projects (Celaena, Alec), and to experience building things for others (Jacob, Magdalena). These skills, processes, practices, and dispositions are all aspects of the invention and innovation practices in STEM and other fields (27,36,38).

Out-of-School Context

Identity construction is a process that is contingent on various encounters and relationships in multiple settings (1,3,8). Out-of-school contexts, in addition to family and school, have the potential to shape student identities and pathways in invention and STEM. Therefore, in our next analytic pass, we examined the interview transcripts for discursive references to out-of-school STEM-related experiences the students may have encountered. Again, following Spradley's strict inclusion semantic relationship, *x* is a kind of *y* experience, in the first column of Table 7, we listed the out-of-school STEM experiences students mentioned; the column on the far right indicates the time frame during which this experience occurred.

Analysis of male and female interviewees' accounts of STEM experiences in out-of-school settings, as shown in Table 7, revealed that the three men engaged in numerous STEM learning opportunities in informal education settings from a young age. Their exposure and participation in STEM activities continued throughout their lives into the high school years. Jacob, for example, "started playing with LEGOs at seven or eight," and George was "big into computers" from a young age. Alec mentioned the TV show *Myth Busters* and the building of potato cannons as activities continuing from a young age into high school. George talked mostly about his elementary and middle-school years, whereas Jacob outlined the whole trajectory from age six or seven to high school. Only one of the three women, Magdalena, talked about being engaged in a STEM program in an out-of-school setting prior to InvenTeams. Her engagement in the Science Olympiad program did not take place until high school. Chelly mentioned that she "never really looked into robotics teams" or other science activities as possibilities for out-of-school engagement. Meanwhile, Celaena did not mention any out-of-school STEM experiences at all.

Jacob provided the most detailed account of his out-of-school experiences with STEM. He was also the only man who self-identified as an inventor on the survey. Jacob described his learning opportunities through a local university during middle school as well as engagement in the maker space and engineering festival in high school. He took a STEM class offered by a local university in the summer, where he "learned how buildings were formed," and later enrolled in a coding class at another technical university. He also described work in a maker space in the community where "we have this design sort of festival …[;] it's sort of like this big engineering festival." Jacob's account of out-of-school STEM experiences throughout his life led us to wonder whether the number and richness of the out-of-school and in-school experiences were factors in helping him develop and stabilize (7) his identity as an inventor over time.

Table 7. Analysis of Students' Experiences with STEM in Out-of-School Settings

***x* is a Type of STEM Experience**	**Of Student**	**Time Period**
Watching *Myth Busters* and building potato cannons	Alec (Grade 12)	Went on through most of my childhood and into high school
Playing with LEGOs STEM program … [at a local technical university] … learned how buildings were formed Coding class at [local technical university] Maker space … engineering festival	Jacob (Grade 12)	At seven or eight In seventh grade Unspecified High school
Big into computers … technology … building computers Solidworks … 3D modeling FIRST LEGO League Competition at LEGOLAND Big into games	George (Grade 11)	At a young age Unspecified Elementary School Sixth grade Unspecified
I never really looked into like robotics teams	Chelly (Grade 12)	
I was in Science Olympiad	Magdalena (Grade 11)	High school
n/a	Celaena (Grade 10)	n/a

Table 8. Student Descriptors of Self and Prior STEM Experiences

Student	Identity: Inventor	Identity: Innovator	Identity: Engineer	STEM @ Home	STEM @ School	STEM in Out-of-School
Alec			X	X	X	X
Jacob	X		X	X	X	X
George			X	X	X	X
Chelly		X				
Magdalena	X	X			X	X
Celaena	X	X		X	X	

We constructed Table 8 to explore the possible relationships between identity self-descriptor choices and prior STEM experiences in the family, at school, and out of school.

Table 8 displays the STEM experiences in relation to the three self-descriptors of identity: inventor (common to one male and two females), engineer (common to all three males), and innovator (common to all three females). The significant number and duration of STEM-oriented experiences described by the men in their homes, schools, and out-of-school activities did not appear to relate to a higher propensity for the males to take up the identity of inventor. All three did, however, identify with the appelation engineer—a descriptor that aligns with the prior experiences they cited. Magdalena and Celaena, in contrast to the men, took up the identity of inventor despite their limited experiences in STEM at home and after school. However, both of them attended a STEM school for two years or more and thus had multiple opportunities to engage in various activities in high school. The third woman, Chelly, cited the InvenTeams experience in an out-of-school program in her senior year as her main STEM-related experience.

InvenTeams' Mid-Grant Technical Review as an Opportunity for Community Support in Inventing and Developing Inventor Identities

Our findings that all three males had similar prior experiences with STEM, and that all three also identified as engineers, led us to wonder what may have supported the take-up of an identity as an inventor by only one of the three males (Jacob). We revisited the transcript of the interview with Jacob and conducted a semantic analysis to identify supporting factors beyond STEM experiences at home, in school, and in out-of-school contexts. We analyzed the kinds of people Jacob and his team encountered and feedback they received in their work as inventors. We discovered that Jacob talked about the Mid-Grant Technical Review event as key to helping him and his InvenTeam see their invention as important and needed in the community. To explore what was afforded in the Mid-Grant Technical review, we drew on LMIT program records.

As described in the InvenTeams Handbook that each team is sent upon being awarded the grant, InvenTeams are required, midway through the grant year, to present their work to roughly one hundred members of the community for feedback. This event is called the Mid-Grant Technical Review, which Jacob described as a high point in his InvenTeams experience due to the feedback received from numerous types of actors, including CEOs, parents, teachers, and people from the community. The kinds of feedback they provided were "try to patent our product," "get rid of all the bugs," and "make sure it was working functionally" in order to "actually sell our product to market so we could actually make an income or money off of this." Jacob noted that "their advice, and the information they gave us actually helped us make this project more efficient, and more suitable for customers and community."

Table 9 lists the different actors and the kinds of support they provided to help Jacob's InvenTeam continue the work of inventing. A news channel and CEOs of businesses were actors Jacob cited as helping his team overcome a low point in trying to raise travel funds to attend the culminating event for all InvenTeams. A technical advisor was an actor who helped overcome another low point by helping to "make our invention work again." A patent attorney provided technical information about how the patent system works and how to patent the team's product. Jacob's mom, an accountant, was "the biggest influence that we had that wanted us to get this patented, and actually make a profit off this." Jacob credited "parents that deal with numbers" and "other parents [that] deal in accounting, and different aspects like engineering, mathematics, and technology" as having offered advice, input, and expertise to "help us with this project." He also mentioned an uncle who "deals with coding" who helped him "know a little bit about the technical aspect." Analysis of the kinds of actors, support, and effects of support revealed the importance of community as a factor in helping high school students develop their inventions and maintain their engagement in the invention process.

Given the importance Jacob attributed to the Mid-Grant Technical Review and community engagement as factors supporting student work as inventors, we sought to confirm or disconfirm this finding and returned to the transcript of another student. A review of George's interview transcripts revealed that George also credited the Mid-Grant Technical Review with an increase in his confidence. He said, "I realized that it was not better than I thought it was, but I didn't think people were going to react so positively to it. So, that gave me confidence." His reference to the event, however, was very short. He did not elaborate on the experience, the range of individuals, or its impact to the degree that Jacob did. Alec made no reference to the Mid-Grant Technical Review nor did he refer to engagement with community partners.

Jacob's articulation of ways that community members supported his work as an inventor—experiences not emphasized by the other men—was consistent with a finding in our prior study (28), in which the two women taking up an identity as inventor cited

Table 9. Actors and Support Provided to Jacob's InvenTeam

Actors	Support Provided	Result
News Channel4	Show ourselves to the media … people actually knew what we were	Overcome a low point … having to do with funding to get here [the culminating event for InvenTeams]
CEOs of different businesses, e.g., MoonTrust	Funding Help	Overcome a low point … having to do with funding to get here [the culminating event for InvenTeams] Get a market for our invention
Mr. [Adult Mentor]	Technical advice	Overcome a low point by fixing "something wrong with the wiring of the device"
Patent attorney	Technical information	Patent our product
Mom	Influence	Get this patented, and actually make a profit off of this
Parents that deal with numbers … accounting, and different aspects like engineering, mathematics, and technology	Advice input and expertise	Get this patented, and actually make a profit off of this
Uncle	Coding expertise	Teach Jacob "a little bit about the technical aspect"

their engagement with the community as a factor that supported their work as inventors. This finding made visible the importance of community engagement and how the InvenTeams initiative provides a framework for developing connections between student inventors and the community. In turn, community members' support enables students to see the importance of their work and thus enhances students' developing identities as inventors.

CONCLUSION: THE DEVELOPING NATURE OF INVENTOR IDENTITY AND THE INFLUENCE OF SCHOOL-BASED STEM AND INVENTEAM EXPERIENCES

The end-of-year experience survey data suggested that only one-third of InvenTeams students (roughly equal percentages of men and women) self-identified as inventors at the end of their experience with the Lemelson-MIT InvenTeams grant. Our analysis of six students' discursive constructions of self-identities as inventors revealed the complexities associated with all six students' ways of thinking about inventor identity during this early phase of work as inventors. One of the three men took up the identity of inventor and attributed it to his InvenTeam experience as well as to his prior home, school, and out-of-school experiences in STEM. Two of the three women, Celaena and Magdalena, who were on the same team and attended the same STEM school, also took up identities as inventors even though they did not cite STEM experiences prior to high school. One of the two (Magdalena) attributed her ability to call herself an inventor to her InvenTeam experience, while Celaena attributed her capacity to invent to her STEM school.

The three remaining students stopped short of calling themselves inventors but did not reject the term entirely. They explored the meaning of the term and offered examples of ways they are like inventors, suggesting that they remained open to the potential of calling themselves inventors in the future. The state of fluidity in students' willingness to call themselves inventors stemmed partly from their limited experiences and/or their perceptions of the significance of their inventions and problem-solving work to date—not from an inability or unwillingness to embrace the term as a reflection of self. One student described his decision of whether to embrace the identity of inventor as being contingent on how broadly the term "inventor" was conceptualized.

Students' responses raise questions about whether a person is an inventor if they are working as an inventor or if the term "inventor" is only applied retroactively after one has invented a solution to a problem—possibly, solutions and problems that achieve a particular level of impact on society. Student insights suggest that the potential to see oneself as an inventor at some point in the future is present in all six students even if only three were confident enough to identify as inventors at the end of their InvenTeams year.

The references Jacob made to his school experiences with STEM across time, and the STEM-rich environment in high school described by the two women who took up the inventor identity (despite their lack of experiences in the early years), suggest that STEM offerings in school-based settings are consequential to the take-up of an inventor identity. Student references to the community engagement aspect of their InvenTeams experience suggest that the opportunity to present as an inventor and have their inventions considered by people in the com-munity is also consequential for students developing inventor identity potentials.

REFERENCES

1. De Fina A, Schiffrin D, Bamberg M. Discourse and identity. Cambridge (UK): Cambridge University Press; 2006.
2. Thompson J. Engaging girls' sociohistorical identities in science. J Learn Sci. 2014;23(3):392–446.
3. Bucholtz M, Hall K. Identity and interaction: a sociocultural linguistic approach. Discourse Stud. 2005;7(4-5):585–614.
4. Bloome D, Carter SP, Christian BM, Otto S, Shuart-Faris N. Discourse analysis and the study of classroom language and literacy events: a microethnographic perspective. Mahwah (NJ): Lawrence Erlbaum Associates; 2005.
5. Ivanič R. Writing and identity: the discoursal construction of identity in academic writing. Amsterdam (NL): John Benjamins Publishing Company; 1998.
6. Bauman R, Briggs CL. Poetics and performance as critical perspectives on language and social

life. Annu Rev Anthropol. 1990;19:59–88.
7. Wortham S. The objectification of identity across events. Linguist Educ. 2008;19(3):294–311.
8. Reay D. Identity making in schools and classrooms. In: Wetherell M, Mohanty CT, editors. The SAGE handbook of identities. London (UK): Sage; 2010. p. 277–294.
9. Benwell B, Stokoe E. Analyzing identity in interaction: contrasting discourse, genealogical, narrative and conversation analysis. In: Wetherell M & Mohanty CT, editors. The SAGE handbook of identities. London (UK): Sage; 2010. p. 82–103.
10. Bloome D, Carter SP, Christian BM, Madrid S, Otto S, Shuart-Faris N, Smith M. On discourse analysis in classrooms: approaches to language and literacy research. New York (NY): Teacher's College Press; 2009.
11. Castanheira ML, Green JL, Dixon CN, Yeager B. (Re)Formulating identities in the face of fluid modernity: an interactional ethnographic approach. Int J Educ Res. 2007;46(3-4):172–189.
12. Ivanič R. The discoursal construction of writer identity. In: Beach R, Green J, Kamil M, Shanahan T, editors. Multidisciplinary perspectives on literary research (revised edition). Cresskill (NJ): Hampton Press; 2005. p. 391–416.
13. Kelly GJ, Cunningham CM, Ricketts A. Engaging in identity work through engineering practices in elementary classrooms.
14. Bloome D, Beierle M, Grigorenko M, Goldman S. Learning over time: uses of intercontextuality, collective memories, and classroom chronotopes in the construction of learning opportunities in a ninth-grade language arts classroom. Language and Education. 2009;23(4):313–334.
15. Kelly GJ, Green JL. Introduction. In: Kelly GJ, Green JL, editors. Theory and methods for sociocultural research in science and engineering education. New York (NY): Routledge. Forthcoming 2019.
16. Kelly GJ, Licona P. Epistemic practices and science education. In: Matthews M, editor. History, philosophy and science teaching: new research perspectives. Dordrecht (NL): Springer; 2018. p. 139–165.
17. Kelly GJ. Methodological considerations for the study of epistemic cognition in practice. In: Greene JA, Sandoval WA, Braten I, editors. Handbook of epistemic cognition. New York (NY): Routledge; 2016. p. 393-408.
18. Kelly GJ, Green JL. Theory and methods for sociocultural research in science and engineering education. New York (NY): Routledge. Forthcoming 2019.
19. Green JL, Skukauskaite A, Baker WD. Ethnography as epistemology: an introduction to educational ethnography. In: Arthur J, Waring MJ, Coe R, Hedges LV, editors. Research methodologies and methods in education. London (UK): Sage; 2012. p. 309–321.
20. Couch SR. An ethnographic study of a developing virtual organization in education [unpublished dissertation]. [Santa Barbara (CA)]: University of California, Santa Barbara; 2012.
21. Green JL, Bridges SM. Interactional ethnography. In: Fischer F, Hmelo-Silver CE, Goldman SR, Reimann P, editors. International handbook of the learning sciences. New York (NY): Routledge; 2018. p. 475–488.
22. Skukauskaite A. Constructing transparency in designing and conducting multilayered research in science and engineering education. In: Kelly GJ, Green JL, editors. Theory and methods for sociocultural research in science and engineering education. New York (NY): Routledge. Forthcoming 2019.
23. Green JL, Bloome D. Ethnography and ethnographers of and in education: a situated perspective. In: Flood J, Heath SB, Lapp D, editors. Handbook of research on teaching literacy through the communicative and visual arts. New York (NY): International Reading Association & MacMillan; 1997. p. 181–202.
24. Skukauskaite A, Rupšienė L, Player Koro C, Beach D. Rethinking educational ethnography: Methodological quandaries and possibilities. Editorial introduction. Acta Paedagogica Vilnensia. 2017;39(2):9–14.
25. Green JL, Castanheira ML. Exploring classroom life and student learning: an interactional ethnographic approach. In: Kaur B, editor. Understanding teaching and learning: classroom research revisited. Rotterdam (NL): Sense; 2012. p. 53–65.
26. Rex LA, editor. Discourse of opportunity: how

talk in learning situations creates and constrains interactional ethnographic studies in teaching and learning. Cresskill (NJ): Hampton Press; 2006.

27. Committee for the Study of Invention. Invention: enhancing inventiveness for quality of life, competitiveness, and sustainability. Cambridge (MA): Lemelson-MIT Program; 2004 [accessed 2018 Sep 20]. http://lemelson.mit.edu/search-resources/817.
28. Nager A, Hart D, Ezell S, Atkinson RD. The demographics of innovation in the United States. ITIF; 2016 Feb 24 [accessed 2016 Oct 15]. http://www2.itif.org/2016-demographics-of-innovation.pdf.
29. Couch SR, Estabrooks LB, Skukauskaite A. Addressing the gender gap among patent holders through invention education policies. Technol Innov. 2018;19(4):735–749.
30. Skukauskaite A. Transcribing as analysis: logic-in-use in entextualizing interview conversations. SAGE Research Methods Cases. London (UK): Sage; 2014.
31. Brinkman S. Unstructured and semi-structured interviewing. In: Leavy P, editor. The Oxford handbook of qualitative research. Oxford (UK): Oxford University Press; 2014.
32. Rubin HJ, Rubin IS. Qualitative interviewing: the art of hearing data. 2nd ed. Thousand Oaks (CA): Sage; 2005.
33. Agar M. Language shock: understanding the culture of conversation. New York (NY): Quill; 1994.
34. Agar M. An ethnography by any other name … Forum Qualitative Sozialforschung / Forum: Qualitative Social Research. 2006 [2018 Sep 20];7(4). http://www.qualitative-research.net/fqs.
35. Skukauskaite A. Systematic analyses of layered meanings inscribed in interview conversations: an interactional ethnographic perspective and its conceptual foundations. Acta Paedagogica Vilnensia. 2017;39(2):45–60.
36. Bell A, Chetty R, Jaravel X, Petkova N, Van Reenen J. The lifecycle of inventors. Working paper. Chicago (IL): The Society of Labor Economics; 2016 [accessed 2018 Sep 20]. http://www.sole-jole.org/17631.pdf.
37. Spradley J. The ethnographic interview. Long Grove (IL): Waveland Press; 1979/2016.
38. Perez-Breva L. Innovating: a doer's manifesto. Cambridge (MA): The MIT Press; 2016.