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ARTICLE

AFFIRMATIVE ACTION IN BRAZILIAN HIGHER EDUCATION:PATHWAYS FOR THE PROGRESS AND CONTINUANCE OF STUDENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) PROGRAMS[1]

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ABSTRACT: The purpose of this work is to understand factors that contribute to the retention and academic progress of students in science, technology, engineering, and mathematics (STEM) programs available at universities through affirmative action policies. Using a qualitative research approach, the data were obtained from semi-structured interviews with affirmative action students and faculty in STEM programs at two federal Brazilian universities. Data were organized and analyzed using content analysis and the theoretical perspective of critical inquiry. This process was supported by a broad framework and provided clues to understanding significant factors in the university trajectory of these students, which can be summarized in five themes: initial academic preparation, social integration, academic integration, the role of the teaching staff, and issues beyond pedagogy.
Keywords: Social and Academic Integration. Retention. Microaggressions. Affirmative Action. Mathematics Education.

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AÇÕES AFIRMATIVAS NO ENSINO SUPERIOR BRASILEIRO: CAMINHOS PARA A PERMANÊNCIA E O PROGRESSO ACADÊMICO DE ESTUDANTES DA ÁREA DAS CIÊNCIAS EXATAS

RESUMO: Este estudo aborda a questão do acesso e da permanência de estudantes pertencentes a grupos sub-representados no ensino superior. Seu propósito é compreender aspectos que contribuem para a permanência e o progresso acadêmico de estudantes beneficiados por ações afirmativas de cursos das ciências exatas. Utilizando-se de uma abordagem qualitativa, os dados foram produzidos a partir de entrevistas semiestruturadas com estudantes de cursos superiores de exatas de duas universidades federais brasileiras, ingressantes por meio de ações afirmativas. Para a organização e análise dos dados, utilizaram-se ferramentas da análise de conteúdo, tendo como perspectiva teórica o inquérito crítico. A análise respaldou-se em um amplo referencial e forneceu indícios para compreender aspectos significativos da trajetória dos estudantes, os quais podem ser resumidos em cinco temas: preparação acadêmica inicial; integração social; integração acadêmica; o papel do corpo docente e elementos que transcendem o espaço pedagógico.

Palavras-chave: Permanência. Integração Social e Acadêmica. Microagressões. Equidade. Educação Matemática.

INTRODUCTION

In the field of higher education, many theories and much research have explored possible factors that contribute to a student's continuance at their university (Berger, 2001; Terenzini et al., 1994; Tinto, 1975, 1988, 1997). In the 1970s, Vincent Tinto developed a model to examine student integration process within academic and social systems of higher education institutions (Tinto, 1975). Tinto sought to understand how social and academic interactions affect a student's continuance at their university. His work enabled the introduction of a new area of inquiry in higher education and influenced much of the subsequent research in this area. For Tinto, when students enroll in universities, they possess formal and informal attributes they have developed within their familial and educational contexts that influence their goals, commitments, workforce, and place in the student society. After admission, this background, as well as the new formal and informal experiences that they acquire over their courses at the university, can influence their integration into the

institution, both socially and academically. According to Tinto, such a level of integration has a significant impact on the student's goals and objectives and can directly affect their decision of whether or not to persist in their courses, especially when adversity arises. In this way, Tinto suggests that the student's decision to continue at the university is a direct result of his or her integration influenced by the experiences acquired along the university trajectory.

At the end of the 1980s, Vincent Tinto expanded this model to include a three-stage process: separation, transition, and incorporation (Tinto, 1988). Through a parallel with Van Gennep's social anthropological theory, Tinto compared the movement of individuals from one group to another in tribal societies with the departure of students from their homes and their incorporation into new university communities. The separation stage refers to the student's disassociation, in varying degrees, of their habits and patterns from previous associations. In order for the student to be considered part of their university community, they somehow abandon their previous communities. After this separation, the student undergoes a transition stage during which they learn to deal with the tension of leaving their family context while they have not yet understood the characteristics of the university environment or even fully integrated themselves within it. Finally, during the incorporation stage, the student acquires the necessary skills to become an effective member of their new community. Tinto states that during this stage, the student, in a sense, becomes a new individual. According to Tinto (1988), the students face many types of difficulties in this last stage. For example, the lack of social and academic integration may lead them to fail to separate from previous associations and materialize their transition into the new community. This can contribute to the student not making the progress that is necessary and leaving their courses.

In the last decades, the Tinto model has been criticized, revised, and improved upon by several researchers (Bean & Eaton, 2000; Cabrera, Nora, Terenzini, Pascarella, & Hagedorn, 1999; Rendon, Jalomo, & Nora, 2000; Tierney, 1999). According to Tierney (1999), for example, the model does not consider how Black students experience the racial climate of the campus. In addition, in agreement with Yosso, Smith, Ceja, and Solórzano (2009), students from underrepresented groups, who attend universities that are outside their immediate community, rarely enjoy the same level of "fit" in their new environment as their White colleagues do. To survive and resist the racism they encounter, they use the cultural resources from their

previous communities. Even considering the differences, there is a consensus within the research that social and academic integration, as well as certain institutional practices, significantly impact a student's willingness to remain at their university. Nevertheless, many studies have been concerned with discussing aspects that contribute to (and also interfere with) the continuance of traditionally underrepresented students at their university, who generally belong to racial and/or ethnic minorities, socioeconomically vulnerable individuals, and those from the "first generation." These studies discuss formal and informal strategies for their material and academic survival on campus, as well as institutional practices that impact their university progress (Santos, 2009; Solórzano, 1998; Terenzini et al., 1994).

Regarding this last topic, some studies discuss, in particular, the specificities of science, technology, engineering, and mathematics (STEM) programs and corroborate arguments on the importance of social and academic integration but also highlight the existence of factors demanded by this area (Foltz, Gannon, & Kirschmann, 2014; Hrabowski & Maton, 2009; Hurtado, Newman, Tran, & Chang, 2010; Museus & Liverman, 2010; Palmer, Maramba, & Dancy, 2011; Seymour & Hewitt, 2000). In this sense, this article seeks to enlarge such discussions regarding the Brazilian university scenario, which is in a time of expansion of opportunities of access for these students, especially after the promotion of affirmative action policies. On the other hand, such insertion has raised challenges for universities related to issues about the continuance and academic progress of these students.

In the scope of mathematics education, new possibilities and challenges are being demanded, such as the opportunity to think of different forms of scientific production from the entry of groups that were previously outside the university and to discuss, in some way, questions that were already challenging for the institution, even before such insertion, mainly related to the high failure rates and the withdrawal of mathematics disciplines from these courses. In addition, Brazilian research in this area has generally favored comparative performance among student groups (Bezerra, 2011; Cavalcanti, 2015; Mendes Junior, 2014; Pinheiro, 2014) or factors linked to the issue of material survival on campus (Bello, 2011; Heringer, 2014; Paixão, Rossetto, Monçores, & Sant'Anna, 2012). However, other factors directly affect the permanence of students who belong to underrepresented groups in the university (Silva & Skovsmose, 2019), and for many of them, mathematics education can make important contributions.

METHODOLOGY

This article presents the results of research whose objective was to understand how mathematics education can contribute to the continuance and academic progress of affirmative action students in STEM programs (Silva, 2016c). Using a qualitative approach, the data were obtained from semi-structured interviews with 21 affirmative action students (13 males and 8 females) in STEM programs from two federal Brazilian universities (UFA and UFB, pseudonyms). All of them had completed at least 1 year of college and had completed their high school education at public schools. In total, 10 students identified as Black, 10 as White, and one as Indigenous. Six entered the university through places held for students based on income, four based on race, seven based on both income and race, and four for having studied in public schools, regardless of income. This division follows the Brazilian "Quotas Law" of affirmative action used in all public federal universities ("Law n. 12.711 of August 29," 2012).

Interviews were conducted individually, with an average duration of 1 hour, and were audio recorded and transcribed later with permission of the participants. In addition, notes and summaries of the conversations were recorded in a field notebook. The interviews were conducted with the purpose of determining, based on the students' experiences, possible factors of their university trajectories indicated as significant in their continuance and academic progress, as well as the main difficulties that they faced in this course. Data were supplemented by interviews with managers and teachers of these courses, as well as a review of official documents on institutional programs of financial and pedagogical support from both universities. For the organization and analysis of the data, we used tools of content analysis and critical inquiry as the theoretical perspective (Apple, Au, & Gandin, 2011; Crotty, 1998). Critical inquiry is concerned with power relations and oppression, questioning values and assumptions, challenging conventional structures, engaging in social issues, and exposing the forces of hegemony and oppression present in society. Research using this perspective generally seeks to challenge more than understand, reading a situation in terms of conflict and oppression, rather than in terms of integration and community, and discussing change more than accepting the status quo. From the perspective of critical inquiry, research is not viewed as a discrete part of an action that, when achieved, ends. Indeed, it is

assumed that for every modified action or situation, we must criticize our assumptions again. In this way, critical inquiry emerges from a continuous project through reflection and action (Crotty, 1998).

After organizing all the data obtained, a deep reading of and immersion into them were carried out. Keywords were initially emphasized that highlight the exact sequence as they appeared in the data. The goal was to search for important ideas, thoughts, or concepts that could be repeated to contribute to the emergence of new ideas and insights about the data obtained and the first sketches of how to discuss them. After this process, codes were created that were named based on context and were obtained through possible connections and groupings between keywords that presented ideas and similar situations. Then, based on the relationships between different codes and how they connected to other codes, several "categories" were created. Of course, this did not occur linearly. As the analysis was done, categories were created and deleted and then transformed into subcategories and categories again in a constant "come and go" movement. Finally, "themes" were constructed based on the relationship between categories that were connected by similar issues or that could be discussed together. The discussion of the analysis process was supported by a broad theoretical framework and provided insights for understanding significant factors of the students' academic trajectory regarding their continuance and academic progress at the institutions, which can be summarized in five themes: initial academic preparation, social integration, academic integration, the role of the teaching staff, and issues beyond pedagogy.

RESULTS

INITIAL ACADEMIC PREPARATION

Traditionally, over the years, mathematics has worked as a gatekeeper for higher education and better jobs, creating an uneven distribution of income, skills, and power (Martin, Gholson, & Leonard, 2010; Moses & Cobb Jr., 2001; Stinson, 2004). For reasons strongly related to race, gender, ethnicity, religion, language, and social class, a variety of groups have been excluded from social contexts in which mathematics predominates. Moses and Cobb Jr. (2001) point out that the domain of a high level of mathematical knowledge can contribute to modifying the life situation of these students because it works to overcome social inequalities, allows them access to universities and

prestigious courses, and, consequently, occupies important decision-making posts. In addition, equipping students with mathematics skills could enable them to gain tools that allow them to move in society and expand their future horizons.

There is no question that Moses and Cobb Jr. are correct, even though we have in mind that other factors are involved in overcoming social inequalities. However, of course, failing to master mathematics has been strongly linked with stratification issues.[2] The results of this study provide evidence that affirmative action students understand mathematics to be a challenge in their academic career. It has not been a barrier to access, but it has directly impacted their lives at the university, "selecting," for example, those chosen for academic research and social project scholarships and "filtering" those who graduate, functioning as what Moses and Cobb Jr. call a "gatekeeper."

In this sense, especially in the beginning of the trajectory at the university, this study provides evidence for the existence of a feeling of unpreparedness for the affirmative action students in relation to the mathematics disciplines. This fact was even more evident when compared to fellow students from private high schools. Even those who studied at high-quality public high schools, such as federal high schools and technical schools, and at high schools of application of public universities said they did not feel prepared to face the initial courses, such as Calculus I and Analytical Geometry. Even those who took preparatory courses claimed that their study of mathematics had been very brief and only helped them to improve their performance in the institution's selection process. As Seymour and Hewitt (2000) point out, this feeling of initial unpreparedness has a very negative bearing on the student's continuance at the university as it profoundly undermines their self-confidence. Carlos, a third-year mechanical engineering student at UFA who had begun using affirmative action based on income, looked back and reflected on his experiences from his first school year and stated the following:

> **Carlos:** "In the first disciplines, which are Calculus I and Analytical Geometry, some of those from better schools already came with an initial idea of the subjects, so they did not have much difficulty. Then, with them, it did not seem like the class started and they took notice. Because, for example, I had studied linear arrays and systems extensively in high school and also in pre-university preparatory course. By the way, I've never studied linear systems, either in pre-university preparatory course or in high school. These people studied these in high school. So, we came here, and in Analytical Geometry, the difference was stark among the quota holders who came from 'normal' public schools and non-quota holders who came from good private schools, at least this was that I

> realized. When we started Calculus II, which was something new for everyone, there was no difference. It was difficult for everyone. In the first disciplines, the difference was great. I had friends who had studied differential calculus in pre-university preparatory course. So, they did not get scared in the beginning. I always did very well at school. So, it was even a disappointment because we get here and only get beaten in the beginning."

Like other students who participated in the research, Carlos pointed out that the initial impact caused by mathematics generated many dropouts in the disciplines and that many colleagues who were affirmative action takers abandoned the courses after the first evaluation. Of course, this did not only occur with affirmative action students. Despite this, the students who participated in the study had the feeling that theirs colleagues who had studied in the private high school system were better suited for the turbulent situation at the beginning of the courses. However, Carlos showed a perception that public school students who persisted and overcame the difficulties related to mathematics disciplines at the beginning of the program "matched up" to the others. This perception also appeared in interviews with other students and teachers. However, one fact that stood out was that, regardless of the form of admission, there was a discourse among the teachers who teach mathematics subjects that most of the students enter universities unprepared. A common perception among the teachers interviewed was captured by the following commentary of Anderson, a professor of engineering courses at UFB:

> **Anderson:** "There was a time when the entrance exam would not allow this student to enter. But the expansion of the university system allows the presence of this student in the university community. This student is in fact totally lost because, despite having passed the first barrier, which charges something he does not possess, the second barrier, which is the permanence, makes his life totally hellish inside. The culture practiced in high school is very different from the culture practiced here in the university. Because of this, it turns out that, regardless of whether the student entered by quota or not, almost all students have enormous difficulties in mathematics disciplines."

The transition between high school mathematics and higher education mathematics is generally viewed as an obstacle. For students from underrepresented groups, this transition tends to be even more difficult because going to college is usually not part of the expectations and tradition of their families. In addition to the usual subject-related difficulties that all students face, attending university presents additional challenges for these students in terms of multiple transitions related to academic, social, and cultural aspects (Terenzini et al., 1994). In

other words, when entering higher education, the new student must "discover the routines, the evidences, the rules, the new codes of the university" (Coulon, 2017, p. 1243). According to Coulon (2017), students who fail to join this new world can be driven to failure. For this transition to be successful, Coulon states that first-year students need to learn their trade as a student. In particular, this study suggests that for many students entering through affirmative action, the initial unprepared feeling can also be related to this transition.

The students that participated in the research were enrolled in very concurrent STEM programs, and they needed high scores on the admission exam to attend UFA and UFB. Many of them said they had higher grades than their colleagues who did not join affirmative action. Even so, they carried a feeling of unpreparedness about the content of mathematics. They argued that their trajectory at the university would have been less arduous if they had participated in a "pre-college" course, which covers the basic content of the initial subjects of mathematics they had learned as soon as they entered higher education. Some universities have been concerned with this issue and developed so-called "mathematics leveling courses," which often generate clashes in the university environment. Teachers generally argue that such action should not be done at the university. On the other hand, students emphasize their importance.[3]

The feeling of unpreparedness has clearly influenced the life of students benefiting from affirmative action in STEM programs. The same feeling could have led to disapproval in the initial period of the program. Despite this, these factors did not lead the students participating in the research to leave the university. Of course, most of them were progressing in the course when they were interviewed. In this sense, they indicated important issues that, until that time, were contributing to their progress at the institution, and many of them were related to their social and academic integration into the university.

SOCIAL INTEGRATION

Social integration is linked to the level at which students believe they have established meaningful relationships with their peers and with the university community (Nora, 1993; Pascarella & Terenzini, 1983). In this sense, the atmosphere and climate on campus, reflected in the way the institution treats and assists the student and the positive nature of their relationships with others, are important for

their self-esteem and confidence (Swail, Redd, & Perna, 2005). For students belonging to underrepresented groups, emotional, personal, and family problems, in addition to feelings of isolation, non-adaptation, and discrimination on campus, become strong barriers to continuance, which are usually ignored by institutions (Santos, 2009; Solórzano, Ceja, & Yosso, 2000; Torres, 2003).

Foltz et al. (2014) conducted a survey of students from underrepresented groups in STEM programs at a university in the United States. According to the researchers, the social integration of these students manifested in different ways and, corroborating the research, was pointed out as fundamental for continuance in the courses. Among the possible paths for this integration, Foltz and colleagues placed a great prominence on the exchange of experiences among students who shared university housing. According to the researchers, this relationship created a sense of "it in together" throughout the students' university life.

Several students who participated in the research resided in the housing provided by the university. Most of them had entered using the vacancies reserved for students based on income and race. All of them were from distant cities and rarely traveled to visit their relatives. In this way, they created a relation of identification between themselves and those who were familiar. In addition to academic support, they found mutual support in times of stress and pressure, especially during exams. They distributed academic materials, such as photocopies and books, and shared food. A strategy of similar material continuance was also identified by Santos (2009): from their daily experiences at the university, affirmative action students observe that if they do not unite, they will not be able to remain and succeed in the course. In this way, mutual support between peers has proved to be a fundamental factor for these students in overcoming many of the obstacles that they encounter throughout university life. This may be even more evident for those students from lower income families. As Swail et al. (2005) observed, the development of friendly relationships among these students can help them alleviate the trauma of the initial weeks and provide support throughout the course at the university.

In addition, the analysis of the data presents indications of possible contributions of university extension projects[4] to foment the social integration of affirmative action students. Many students who participated in the research were engaged in some project. In one way or another, they pointed out that such engagement was a positive factor in them remaining at the university, more for the

contact network and friendships that developed over time as part of the project than for the contact with the academic content required by the project activities. For example, Manoel, a fourth-year mechanical engineering student at the UFA, who entered the university through racial affirmative actions, reported his 3-year experience in an aero-design extension project as follows:

> **Manoel:** "You would get your hands dirty, build something. When I joined college, most of the weekends I stayed in the project, you know, there was the team, and you did a lot of things together. We went out together and things like that. It was pretty cool. It was a family relationship, especially for me, who was from a far city. It was kind of tiring to stay with that obligation to go every week and build a part of the plane. But in a way, it was cool. It had an influence over my permanence. I do not know if it would be different if I had not participated in that. I do not know if the motivation would be different, but today I can say that it was essential for me to stay here on the course, to get involved in this project in my first 3 years."

Thus, in the Brazilian context, university extension has proved to be a vehicle for the social integration of affirmative action students. Those who participated in this research were open to this and became involved in various projects. Engineering students engaged in designing and building electric cars and model airplanes for competition; mathematics, science and technology, and engineering students worked as teachers and mathematics tutors in a community preparatory course targeting public school and low-income students. Students of mechanical engineering and materials engineering programs were involved in robotics projects; students of the electrical engineering program participated in projects that encouraged high school students to enter the science programs. In short, the engagement took place in a variety of ways and in varied projects, but what the students' reported was similar: they developed lasting friendship with their projects' colleagues and teachers. As pointed out by some studies, these relationships are fundamental for the student to remain at the university because, in addition to mutual support, they contribute to the creation of a sense of belonging to the institution (Seymour & Hewitt, 2000; Swail et al., 2005).

Another point has to do with the students' involvement in cultural/ethnic organizations. Studies demonstrate that the participation of students from underrepresented groups in these organizations significantly collaborates in reducing the sense of isolation and alienation that many students acquire when they enter higher education, especially during the transition between high

school/university and work. In addition, this involvement favors the individual's identification as a member of the institution; the support and strengthening of the group also work as a point of confrontation against situations of racism and prejudice present on the campus (Hall, 1999; Terenzini et al., 1994; Yosso et al., 2009). At UFA, for example, there is a nucleus of Afro-Brazilian studies and an Indigenous coexistence center. Besides one Indigenous student in the agricultural engineering program, none of the other 14 students at this institution who participated in the research had engaged in activities of these organizations. Many did not even know about them. Through interviews and conversations with the faculty, program coordinators, and members of these organizations, we observed that, apparently, students from STEM programs have little involvement in this type of activity when compared to students in the humanities, for example. Understanding the reason for this non-involvement could be important when discussing the continuance of the affirmative action students in STEM programs, especially when we understand the importance of social integration in his or her university career.

ACADEMIC INTEGRATION

Academic integration is linked to the development of affiliations with the university's academic environment, both inside and outside the classroom. This integration involves the level of academic relationship and connection of the student with the faculty, the pedagogical team, and the colleagues (Nora, 1993; Pascarella & Terenzini, 1983). In addition, the level of student participation in different contexts of university life, such as research programs, institutional projects, monitoring and academic tutoring, and specialized care, among others, can also be considered part of academic integration.

According to Foltz et al. (2014), academic integration plays a significant role in the progress of undergraduate students belonging to underrepresented groups. The researchers showed that mentoring and academic support programs, as well as involvement in research programs, were key determinants in the progress of the students who participated in their study. Corroborating the work of Foltz and his colleagues, affirmative action students who participated in this study and who engaged in any of these actions placed great emphasis on such participation. For example, in relation to the research projects traditionally called "scientific initiation" at Brazilian universities, they

pointed out the connection between mathematics content studied in the disciplines and the research subjects as an important factor in their academic progress. In addition, the fact that they were engaged in these projects provided academic experiences that they would hardly have been exposed to during the program courses, even contributing to their autonomy in their studies. José, a White mechanical engineering student at UFA who entered through affirmative action based on income, highlighted how important it was for his training to have participated in a scientific initiation project right at the beginning of his graduation. He stated that all students should be able to do research work during graduation. However, he pointed out that, mainly due to test failure at the beginning of the course, many lose this opportunity because the students' overall average grade directly influences those who are chosen to participate in a project:

> **José:** "I think scientific initiation is that point inf college when you can choose what you want. We have no way of escaping from the obligatory disciplines, but the initiation is the place where you want to improve your knowledge in something particular. I believe it is an activity that should not be mandatory for everyone, but it would be so good if every student had a chance to take a scientific initiation, even having some failure or problems of grades because sometimes scientific initiation teachers like to pick up only those students who have a very good IRA [academic performance index]. So I think it should not be restricted, but, rather, if the person wants to do scientific initiation, regardless of anything, even if it is voluntary, he or she should have the chance to do it because it really helped me grow."

Research has shown that students in STEM programs have a better chance of progressing at the university if they participate in scientific initiation projects at the beginning of their courses (Foltz et al., 2014). On the other hand, research also shows that students belonging to underrepresented groups tend to participate less in these actions in relation to other students (Hurtado et al., 2010). Several reasons may contribute to this fact. Hurtado et al. (2010) point out that the question of finances is one of them. Often, they must worry about miscellaneous issues, usually related to material survival on campus (Santos, 2009). In addition, as already mentioned, the "turbulent" beginning at the university, which is usually associated with failures in mathematics subjects, can influence this participation because it reduces the chances of joining a project, especially those offering scholarships and financial aid. Of course, it is not just students benefiting from affirmative action who face early academic difficulties in their courses. As already mentioned, the interviewed

teachers reported that the issue of disapproval was a general problem, regardless of the student's admission form. Despite this, the students who participated in the research, with a few exceptions, were unanimous about the initial lack of preparation in mathematics as the main difficulty in the academic course.

There are many possibilities for the development of actions aimed at the academic integration of the student. As Tinto (1997) points out, institutional commitment to this issue is the first and most important condition for the student to remain at the university. Many institutions develop programs that aim to collaborate in this direction. For example, they create programs of academic development, mentoring, study groups, ethnic centers, financial support, etc. These actions are important for students, especially during their first year at the university (Swail et al., 2005). For affirmative action students, these actions can make the difference between persisting in and abandoning college. UFA and UFB have developed some programs that were attended by students who participated in the research. Both institutions implemented, for example, a counseling program that helped students set up their hourly grades and create study schedules. The UFB had a specialized team of psychologists and pedagogues who organized workshops and university entrance courses, as well as encouraged faculty to become tutors for freshmen students. In addition, these institutions had specialized sectors for dealing with affirmative action issues by providing care and financial support. Interviewed students who had participated in any of these actions indicated they were positive for their progress in the courses.

There is no doubt that institutions can collaborate to help the social and academic integration of students in a general way. In this sense, this study praises the importance of taking special care of students entering through affirmative action. Generally, these students do not learn required guidelines related to academic life in their family context and need support from the institution. In this sense, the institution plays a unique role in ensuring that affirmative action policies are not limited in access at the university but, rather, to a cycle that involves access, continuance, and training. The more the university contributes to the completeness of this cycle, the more it collaborates so that the social, economic, and underrepresentation inequalities in the decision-making sectors of society can be combated. Nevertheless, other factors can directly influence the social and academic integration of the student. The results of this study show that the faculty may be one of them as they play a unique role in the continuance and academic progress of these students.

THE ROLE OF FACULTY

In their study, Foltz et al. (2014) showed that academic integration that is provided through established connections with the faculty was a factor that students belonging to underrepresented groups placed great emphasis on. The authors state that the students identified themselves with teachers who influenced them, both in their commitment to the course subjects and in their academic progress. To corroborate this fact, the results of the research discussed in this article show that students who have benefited from affirmative action place great importance, with respect to their continuance and academic progress at the university, on the positive relationship that they had with some faculty members. Students who were "closest" to teachers during the initial mathematics disciplines pointed this out as significant, emphasizing that they could progress more easily in the subjects and that they were better served by them, given the support and encouragement they received from their teachers, both inside and outside the classroom. For instance, Jonas, an affirmative action student from the civil engineering program at UFA, highlighted this point as follows:

> **Jonas:** "In mathematics courses, for example, there are two teachers who constantly talk to them, and so if I have any questions, I have the freedom to walk into their classroom and say, 'Look, teacher, I do not know how to do this exercise. Where can I begin?' (...). At least with these two teachers, I have a good relationship, and that motivates you to continue in the course. They would not look at something or me like I was 'dumb.' I always go over there and talk to them. There's a close relationship, you know? If I want to study something different, they guide me. They are open to talk."

According to Terenzini et al. (1994), this type of relationship makes students feel "accepted" in their new community and offers confirmation signals that they can succeed at the university. In addition, closer contact with faculty members can overcome academic issues through formal and informal conversations about careers, research, and university survival. Especially for students who are the first from their families to enter higher education, the university requires a type of cultural transition for the student (Terenzini et al., 1994). Closer and more sensitive teachers can play a significant role in this transition. The results of this study provide evidence that supports this fact. The faculty, especially of STEM programs, play a role that goes beyond the pedagogical content in the classroom. Being aware of this positive influence becomes an important contribution to the continuance of the incoming affirmative action students, who, as already mentioned, are usually the first from their families to enter the university.

According Tinto and Pusser (2006), students' learning is an important part of their progress in university programs, and the core of this learning lies in the relationships inside the classroom, which are a gateway to their subsequent involvement in social and academic communities. Of course, this also occurs outside the classroom through the students' relationships with the university's academic and social environment. In relation to the faculty, the research discussed in this article provides evidence for the existence of practices that have positively contributed to the integration of the students related to engagement with teachers, such as proximity and support in extra-pedagogical factors. However, this study also indicates the existence of actions related to the faculty that can impair students' continuance. Although many participants made positive statements regarding the attitudes of their teachers, there have also been several situations that worked negatively on the students' willingness to persist in their courses. For example, Maria, a student from UFA, highlighted some possible situations in this sense, which were also reported by other students throughout the interviews. Maria was an Indigenous student of the agronomic engineering course at UFA who entered through an Indigenous entrance exam:

> **Maria:** "As I told you, the teachers are very closed. In relation to my course, there is no teacher who arrives, at least in the exact ones, and says, 'oh, you are in trouble, go to my office that we'll see what you are going to do. We will try to clear your doubts, your difficulties.' In 2 years, no teacher did this. The teachers of Calculus, Botany, and other subjects seem to think that all their students have gone to pre-university preparatory course. So they say, 'I'm going to pass on the subject because I already know that the student will not have much difficulty.' Much of the college entrance is from private school. Teaching in the private school is much more, as it is said, hard, more prepared than a student who comes from a public education without pre-university preparatory course, of the rural zone. So the difficulty is very high. The teacher gives the material, and you must do everything to pass. I tried. I paid a tutor. Some friends helped me, but I had no teacher support, none."

In addition, several students reported situations in which, indirectly, teachers had negative attitudes and behaviors that were linked to their mathematical knowledge. For example, certain positions of some teachers in mathematics have often revealed an attitude of superiority. Students highlighted situations in which the apparent non-mastery of certain mathematical content, which, theoretically, they should know, put them in situations of great discomfort and intimidation, as can be seen in the interview with Aurelia:

> **Aurelia:** "The only different treatment is from what you know. So sometimes you are kind of 'disqualified' by the teachers as a 'stupid student.' It is that student

> that the teacher does not give much confidence because he thinks that he will not grow up in university, will not give cause for pride later. Not because I'm a quota student, but because I do not know some things that he or she [the teacher] thinks are essential and that you should have already learned."

Generally, unconsciously, certain attitudes of faculty members may impair the academic integration of the student, contributing to the student feeling isolated and intimidated to interact with colleagues or teachers themselves and causing them to feel inferior in terms of their level of mathematical knowledge. As much research has pointed out, first-year students in STEM programs who have teachers who are closer to them and more sensitive to their academic needs have a better chance of retention and academic progress at the university (Foltz et al., 2014; Hrabowski & Maton, 2009; Swail et al., 2005; Tinto & Pusser, 2006). In this sense, the students' progress at the university is the work of all involved, including administrators and faculty members, and is not simply a reflection of their own individual attributes, abilities, and motivations.

BEYOND PEDAGOGICAL ISSUES

The results of the research discussed in this article provide indications that in a very similar way, affirmative action students in STEM programs, regardless of the type of quota admission exam, have concerns and yearnings related to their initial academic preparation to deal with mathematics subjects. They place great emphasis on factors related to social and academic integration and are influenced by positive and negative attitudes of the faculty during their university career. However, there are elements that interfere with the continuance and progress of the student that go beyond pedagogical aspects. According to Hall (1999), institutional climate and non-cognitive factors are generally more important in determining the progress of students belonging to underrepresented groups at the university than for other students. The results of this research corroborate this fact. In addition, they show that, depending on the type of quota used by the students, very distinct differences arise regarding non-cognitive elements, especially in relation to strategies for material survival at the university and experiences related to microaggressions and to the attitudes and positioning from affirmative action.

Public federal Brazilian universities use quotas of affirmative action related to admission to their programs through the following categories: broad competition; students from public schools with

a family income greater than 1.5 minimum wages; students from public schools with a family income of less than 1.5 minimum wages; students from public schools with a family income above 1.5 minimum wages and who self-identify as Black or Indigenous; and students from public schools with a family income of less than 1.5 minimum wages who self-identify as Black or Indigenous ("Law n. 12.711 August 29," 2012). Among students who entered through rent-based and race-based quotas or only through an income-based quota who participated in the study, material survival on campus was one of the factors that significantly affected their lives at the university. This fact was even more evident at the UFA. The UFB students claimed that the institution offered a good repertoire of aid, and all the interviewees received some financial aid. Most of them received, during at least a year, a monthly Permanence Scholarship in the amount of R$ 400.00 (approximately $125). This is aid offered by the Brazilian Ministry of Education (MEC) for students who have entered a public federal university through affirmative action. UFA students argued that the engineering programs of the institution did not fit the standards required by the MEC,[5] and therefore they could not request this aid. At the UFA, students from low-income families received food aid, housing, and activity-aid of R$ 180.00 ($57) per month during the first year of the courses. When they could not get a grant of scientific initiation or from an extension program, they were in a complicated situation because the family generally could not send money, and the courses were full-time, so some students worked on weekends, or they attempted to concentrate the disciplines within a single period in order to work on the others. However, this was not always possible. In this way, these students went through very "stressful" situations and needed to spend a lot of energy on issues related to the financial aspect. The interview with Ricardo, from the Materials Engineering Program at UFA, summed up this feeling:

> **Ricardo:** "I believe that one of our main difficulties is related to financial questions. The university gives very low help to pay the rent, and I have to arrange for the rest by myself. This ends up getting heavy on the budget. I think the university should give more support in this matter. And I also find it is very discriminatory the fact just programs with more than a specific number of hours in class load are entitled to provide to students the *Bolsa Permanência* (Financial Support Program) of the Federal Government. I think so, not wanting to relieve the people who do medicine and these programs, but we study much more than 5 hours by day. It's complicated for us to get our stay here because of that. My family cannot help me. I see my friends there in my city. I tell them to try to enter a public university, but they say that even if they manage to pass, they cannot stay here."

According Hurtado et al. (2010), compared to other students, the trajectory of those belonging to underrepresented groups in higher education is more impaired in college due to financial concerns. Tinto and Pusser (2006) emphasize that this situation leads students to take more time to graduate because they need to work at alternative times to obtain resources. This was the case for many students who participated in the survey, especially those who had accessed the university through affirmative action based on social aspects (income).

Another point that goes beyond pedagogical questions concerns the microaggressions that exist in the university context. Microaggressions are like subtle forms of verbal (or nonverbal) insults, with hostile, deprecating, and negative disruptions, directed against individuals due to issues strongly related to race, gender, ethnicity, social class, place of origin, language, etc., which are often practiced unconsciously by the aggressors and which have a profound impact on the life of the assaulted (Minikel-Lacocque, 2013; Solórzano et al., 2000; Sue et al., 2007). Students who entered the places reserved for students based on racial and ethnic criteria reported several cases involving racial microaggressions, a fact that was overlooked by those who used no racial quota. The latter stated that they had never seen, heard, or even witnessed any discriminatory act at the university. This may be due to the subtleness of the microaggressions, corroborating the fact that White individuals are often unaware of their existence.

As research shows, constant exposure to this type of insult, as well as in the racial climate of the campus, can negatively factor in continuance and academic performance as it hinders social and academic integration, causing many students to change universities or simply drop out of college (Minikel-Lacocque, 2013; Rollock, 2012; Solórzano et al., 2000). In this sense, in addition to the pressure of the disciplines and the feeling of initial lack of preparation regarding mathematics and the lack of financial resources for their material survival on campus, these students must manage issues related to racism, sexism, and prejudice in their daily lives at the university.

Finally, another point concerns certain attitudes toward one's own affirmative action. In general, the students who participated in the study were widely favorable to the adoption of differentiated criteria for university access that consider both social and racial aspects. Many stated that they would never have entered a public institution without the use of affirmative action. However, even among the students who entered this way, there were those who did not agree with the use of racial criteria. They only used the criterion

of studying at public schools to enter the university. They supported the use of affirmative action for public school students based on income but were opposed when race was considered. Adriana was one of these students. Adriana is a White student from the mechanical engineering course at UFA. She was admitted through affirmative action for having studied in the Brazilian public school system. In fact, Adriana completed her high school education at a federal school of education. In Brazil, these schools are very different from traditional public schools and are considered to be of high quality. Adriana's parents had superior degrees and good jobs, providing all her financial support, so she could survive in college:

> **Adriana:** "I agree with affirmative action to some extent. I think quotas for high school are cool, but they do not correct the problem. The problem is in the elementary school, not in high school. Now, I'm against quota to Black people. I think the merit is for everyone. I have black relatives who did not get affected by the prejudice, and I think if people were really affected, we wouldn't have so many good examples in the northeast from people who struggled and were better than many White people. In my opinion, from the moment you say, 'there is no race in the human being,' but you create quota, you're creating hypocrisy in the society, so I think that's wrong. I think you must follow a line. No, there is no race. So we're going to have to improve the basics, where most people have access, so they have the same classification in the university."

Despite being favored by affirmative action policies, Adriana disagreed with all those who considered race as a criterion, exemplifying a stance that fits into Rawls's (2003) perspective of "intuitionism," which is understood as a variety of fundamental principles that can enter conflict and offer contrary directives in similar cases. Even though they belong to a sub-represented group at the Brazilian public university, Adriana and at least one other student who participated in the research came from families with good financial conditions, a tradition of receiving higher education, and that were not part of ethnically or racially underrepresented groups. This shows that even with all the effort, affirmative action can still benefit students who, from a racial and social point of view, have the most experience in Brazilian public universities.

FINAL REMARKS

The results of this work suggest that the continuance and academic progress of students benefited by affirmative action involve complex themes. In particular, we consider that research in

mathematics education cannot act with neutrality on this subject. Specially, this article emphasizes some elements that can contribute to this theme, which are related to academic preparation, social and academic integration, student involvement with faculty and institutional programs, as well as the weight of elements that go beyond pedagogical issues, such as financial and microaggression factors. In addition, in keeping with other works (Silva, 2016a; Silva, 2017), we discussed possibilities of the engagement of mathematics education in the access and continuance dimensions of affirmative action, pointing to possible ways of understanding the educational specificities demanded by these policies and the challenges they impose on teaching practice in higher education related to mathematics education. In particular, an example of such specificity is related to microaggressions. As pointed out, microaggressions in terms of race, ethnicity, and gender occurred in the daily lives of students who participated in the study, even after they had overcome prejudices and barriers to accessing the university. However, in some situations, microaggressions were not related to these factors but were linked to their mathematical knowledge level. Certain positions of some teachers have often exposed a superiority attitude through subtle and nebulous offenses. In other situations, they manifested themselves in more direct and purposeful forms of insults. Several students highlighted situations in which the apparent non-domain of certain mathematical content, considered "basics" in the university mathematics context, placed them in situations of discomfort and intimidation. In other situations, in a direct way (consciously or not), teachers and colleagues attributed a "childish" or even "trivial" character to students' questions. We consider that such microaggressions may contribute to students' isolation because they may feel intimidated to interact during classes and assume an inferiority perspective due to an apparent lack of mathematical knowledge. These microaggressions can even cooperate so that students obtain a feeling that they really should not be in that program because they feel that they do not have the academic repertory necessary for that. This situation becomes another obstacle they must face.[6]

Gradually but surely, affirmative actions are changing Brazilian universities, making them more diversified in relation to socioeconomic, racial, ethnic, and cultural aspects (Ristoff, 2014). For instance, this diversity on campuses was pointed out as a positive factor by most of the research participants. However, many felt the number of Black and Indigenous classmates was still very small. According to Ristoff

(2014), although the Black and Indigenous student proportion has been increasing, Brazilian higher education is still a context mostly composed of White students and students from families with higher incomes. Malcon and Tiago, for instance, said they were the only Black students in their mechanical engineering classes. They were admitted by UFA in 2013 just 1 year later through the "Quota Law." They reported they had not seen the same diversity that existed on campus as wholly reflected on the "STEM campus block." This situation reinforces the need for affirmative action maintenance in the Brazilian university context. It may well be that more generations of minority students will need to access, stay in, and graduate from the universities in order for the underrepresentation to be mitigated in this context. In this sense, it is clear that the discussions about affirmative action policies go beyond issues simply related to access to higher levels of education and should be concerned with ways to make the continuance and academic progress of these students at the institutions more effective.

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NOTES

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2 For this question, see Silva (2016b).

3 About this topic, see Silva (2016c) and Silva (2017).

4 In Brazil, projects that engage the university and community are called *Projetos de Extensão* (Extension Projects).

5 To qualify for *Bolsa Permanência* support, students have to be from a family with a per capita income equal to or less than one and one and half the minimum Brazilian wage. Students also have to be enrolled in an undergraduate program with an average hourly load of 5 hours or more daily. At the UFA, only the Medicine Program, Physical Therapy Program, and Occupational Therapy Program fit this last criterion.

6 Microaggressions related to mathematics content are discussed in Silva (2016c) and Silva and Powell (2016).

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