

The Democratization of Technical Education from the Point of View of the Affective Dimension of Mathematics Learning: an Outset Reflection

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ABSTRACT

The article offers a reflection stemming from the elaboration of a doctoral research project, which involves the students enrolled in the first year of the Integrated Technical Secondary Education, at the Instituto Federal de Educação, Ciência e Tecnologia do Mato Grosso (IFMT). Aiming to illustrate the main research study, we present a section of a qualitative pilot study carried out in the mathematics subject. The broader study involves students at risk of failure in mathematics and seeks to bring the students' voice into the discussion of their failure in the discipline. The main purpose of the study is to understand how first-year students experience situations of failure and difficulty in mathematics that put them at risk of dropout and/or retention. It is expected to contribute to the improvement of mathematics learning, to a better understanding of students' evasion and retention, and to the design of policies and actions that may improve the quality of technical education and promote its democratization.

Keywords: School failure. Mathematics. Affective dimension. Evasion and retention. Democratization of technical education.

A Democratização da Educação Técnica do Ponto de Vista da Dimensão Afetiva da Aprendizagem Matemática: uma Reflexão de Partida

RESUMO

Este artigo oferece uma reflexão, a partir da elaboração de um projeto de pesquisa de doutorado que envolve os alunos matriculados no primeiro ano dos Cursos Técnicos Integrados ao

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Nível Médio, no Instituto Federal de Educação, Ciência e Tecnologia do Mato Grosso (IFMT). Com o objetivo de ilustrar o principal trabalho de pesquisa em curso, apresentamos uma seção de um estudo piloto qualitativo realizado na disciplina de matemática. A pesquisa mais alargada envolve estudantes em risco de fracasso em matemática e procura trazer a voz dos alunos para a discussão de seu insucesso na disciplina. O objetivo principal do estudo é entender como alunos do primeiro ano vivenciam situações de fracasso e dificuldades em matemática que os colocam em risco de abandono e/ou retenção. Espera-se contribuir para a melhoria da aprendizagem da matemática, para uma melhor compreensão do problema da evasão e retenção dos alunos, e para o desenho de políticas e ações que possam melhorar a qualidade do ensino técnico e promover a sua democratização.

Palavras-chave: Insucesso Escolar. Matemática. Dimensão Afetiva. Evasão e Retenção. Democratização da Educação Técnica.

INTRODUCTION

The democratization of public education in Brazil faces the challenge of including all socioeconomic classes and supporting students in achieving success in school (OECD, 2016). To ensure democracy in the public school, it is necessary to guarantee all students access and permanence in a quality education system by considering the specific characteristics of the students who are attending the school (Romão, 2004). In this regard, the democratization of education also means the expansion of vacancies, by taking into account social, economic, ethnic and regional inequalities. The creation of the Federal Institutes is in line with the policies for expanding the number of places in technical courses in order to favour local socioeconomic and cultural development (Silva & Ventura, 2017).

In the context of such expansion, the Federal Institutes in Brazil have faced the intensification of a high rate of student grade repetition and/or dropout in the first year of the Integrated Technical Secondary Courses. Due to a rapid expansion, many of the recent campuses located in the inner regions of the country have not yet had time to be recognized and valued by the local or regional community, which results in low demand to admission. More precisely, at the Campus de Primavera do Leste of the Instituto Federal de Educação, Ciência e Tecnologia do Mato Grosso (IFMT), despite the selection process for entrance into the Integrated Technical Secondary Courses, there is no actual filtering, since the institution accepts all the applicants and there is even the need to make several application calls for the full filling of the vacancies offered. In this way, the institution receives a diversity of students revealing great heterogeneity regarding their school backgrounds, social and economic conditions, motivations, future expectations, etc.

In this sense, the Federal Institutes (FIs) policy of favouring the inner country by democratizing the access of people to further education has challenged the logic of meritocracy and of selective enrolment processes, which means receiving students often from restricted cultural environments, with fragile schooling, who need quality education and formation. Therefore, the expansion of technical education in Brazil represents a response to a desire of inclusion of the country's youth in the school, in a scenario where the integrated technical secondary education has become an important asset for Brazilian families who aspire to a quality public secondary education for their children. At the same

time, this means a significant effort to the FIs regarding the quality of their teaching and the permanence of young people in school.

The challenge in welcoming and keeping all the admitted students is to find ways to minimize failure and subsequent dropout while respecting individual diversity. This requires, in particular, the identification of the students who present the most difficulties and insufficient knowledge, that is, those who have the weaker school grounding, namely in mathematics.

At the Campus de Primavera do Leste, in the first year of the Integrated Technical Secondary Courses, the mathematics presents critical barriers that are difficult to overcome and which compromise the desired targets. As such, the overall results of these courses represent an obstruction to the success of the institution itself. It is important to emphasize that mathematics plays a central role in this situation both because it is a key subject of the general core curriculum and because it has a strong application in the various technical disciplines of the vocational areas. This problem is restricted to the first year of the course, since the students who progress to the following grades almost fully remain until the end of the course.

Failure in mathematics learning is an issue that has been approached by the research in mathematics education throughout the years and in several studies that present very diverse methodological and conceptual characteristics. The most recent research has favoured a qualitative approach to the study of failure in mathematics, by stressing its affective dimension instead of reducing it to the cognitive dimension of learning (Amado, Carreira, & Ferreira, 2016, Amado & Carreira, 2018, Zan, Brown, Evans, & Hannula, 2006, Evans, Morgan, & Tsatsaroni, 2006).

For the last two decades, in mathematics education research, there has been a significant increase in the number of empirical studies that address a range of emotional phenomena, mainly focusing on educational contexts. But there is still a shortage of studies that investigate mathematics failure in terms of daily, contextual, emotional, representational and also biographical factors (Viveiros & Lopes, 2010). From the point of view of school dropout, when considering failure as a process and not just a moment in the trajectory of the student, one may see the school evasion as the culmination of a dynamic and cumulative process of disengagement from the school. In this sense, it is necessary to implement a set of prevention strategies that must be initiated in advance, in order to avoid problematic attitudes and behaviours that can lead students to evasion.

Understanding how students feel and the emotions they experience in relation to their failure in the integrated technical secondary education becomes imperative for a deeper and broader knowledge of the at-risk student from which new approaches to school failure may be devised. Taking the above general concern, and in order to fine-tune the guiding questions of the research study that will take place in the academic years of 2018 and 2019, a pilot study was carried out, at the end of 2017, with students attending their first year, which allowed settling and defining the development of the broader research. In

this article, a partial report of this preliminary study is presented, involving two students of the first year of the Integrated Technical Secondary Course in Electromechanics.

LITERATURE REVIEW

In Brazil, for some time, through social and intellectual movements, the concern about the democratization of education has become apparent. At the National Education Conference (CONAE) held in 2010, the “Final Report”, resulting from a rich process of collective construction, was triggered by the political decision of launching a social debate on the ideas and proposals surrounding the construction of the National Education System, as to ensure the articulation between educational institutions and the civil society. In this document (Brazil, 2010) it is emphasized that democratization is not just a matter of access to the educational institution but it must also guarantee the successful permanence of all individuals. “Thus, the democratization of education is made of all individuals’ access and permanence in the educational process within which school success is a reflection of quality” (p.63). The document also highlights that the conception of school success in a democratic proposal of education is not limited to student performance. “Rather, it means guaranteeing the right to education, which implies, among other things, an uninterrupted school trajectory, respect for human development, diversity, and knowledge” (p.62). As such, accomplishing success in school entails overcoming a vision that imputes the responsibility for school performance exclusively to the individual. “That accomplishment will be achieved through integrated actions that imply the understanding of the educational phenomenon in its pedagogical, institutional, relational, cultural and social dimension” (Brazil, 2010, p.63).

According to Dore and Lüscher (2011, p.778), the conditions of student access and permanence in technical education, in particular, “are defined to a great extent by the educational policy focused on this type of education and its relation to the secondary education”. In order to obtain the diploma of technical education in Brazil, the completion of secondary education is required, either concomitantly or subsequently to vocational education. The authors note that the educational policy of the early 2000s sought, in some measure, to “reduce the old dichotomy by creating a new possibility for articulating secondary education with the technical education through an integrated modality” (p.779). The authors also acknowledge that the expansion of technical education at the secondary level enables a greater degree of democratization of education because it promotes the opening up of new opportunities for access to vocational training and the insertion of young people in the workplace.

The expansion policies, which included the creation of the Federal Institutes in 2008, brought new demands to the Brazilian educational system. According to Ferreira, Costa, Araújo, and Oliveira (2013), new mechanisms are currently needed to monitor students’ performance in the different subjects of the curriculum, as well as the teachers and administrators. The authors justify their observation with the fact that a goals agreement was signed with the Secretariat of Professional Education, in which a commitment was

made to improve the outcomes related to the effectiveness and efficiency of the Federal Institutes.

In 2013, an official recommendation dictated the establishment of a plan for reducing the evasion rates in the Federal Network of Professional Education (Brazil, 2013). For the implementation of this determination, guidelines were given to the Federal Institutes on the construction of a Strategic Plan of Actions for Student Permanence and Success. The official informative document considers that evasion consists of a student's withdrawal from a course, characterized by various situations, such as: dropout, cancellation of enrolment, and internal or external transfer. Grade repetition, in turn, means not completing the course in the expected period, which is a contributing factor to increased evasion. Both evasion and retention are phenomena involving pedagogical, cultural, social, institutional and individual factors. According to the document, those phenomena have repercussions on the fulfilment of the social function of the Federal Network, whose purpose is to promote the inclusion of a diversified public that, for the most part, is socioeconomically vulnerable and arriving from public educational settings of regions with low educational development. For the analysis of evasion and retention, it is necessary to know and evaluate the complexity of factors that intervene in student learning, since they have an effect over the success or withdrawal of the course. In this perspective, understanding evasion as a process involves examining evasion, retention and completion rates as a whole, by addressing the various factors of the problem and adopting pedagogical and institutional measures, with a view to resolving them (Brazil, 2015).

Dore and Lüscher (2011) emphasize the complexity involved in identifying the possible causes of dropout because, similarly to other processes linked to school performance, it is caused by a set of factors that relate both to the student and his/her family, the school, and the community to which he/she belongs. The authors refer that the two main research approaches to school evasion are: the individual perspective, which involves the student and the circumstances of their experience in school; and the institutional perspective, which takes into account family, school, community, and groups of friends. At the individual level, Dore and Lüscher (2011, p.776) consider the values, behaviours and attitudes that favour "a greater or lesser engagement of the student with (or sense of belonging to) school life". They underline the existence of different theories about school evasion, emphasizing that most of them affirm the existence of two main types of school engagement: "the academic or learning engagement and the social engagement or interaction between the student, colleagues, teachers and the other members of the school community". Based on the studies of Rumberger (2004), the authors assert that the way in which the student relates to these two dimensions of school life has a fundamental influence in the individual's decision to evade or remain in school.

Specifically, in what concerns the integrated technical courses, Egre and Lopes (2015), in their study, sought to identify what leads the student to remain or to abandon these courses. In relation to those who remain what motivated their permanence was the quality of the education and the no costs involved. For the students surveyed, quality involves mainly the school infrastructure, the teachers and the administrative sectors. For

those who thought about leaving the course and also those who left, the main reasons given were the lack of identification with the area of study and the difficulty of the content. The authors highlight the first year as the phase that presents the highest failure rate in the integrated technical courses and consider this period as critical and vulnerable. This is consistent with the literature, that is, failure or low consecutive performance make the student a strong candidate to leave the course, especially in the first phases (Gazo & Torrado, 2012).

In some of the studies on student evasion and retention in integrated technical secondary courses of the Federal Institutes, researchers who embrace the individual perspective identified factors related to the student difficulties in previous school grades (lack of knowledge foundations), that is, difficulties related to content learning (e.g., Araújo & Santos, 2012, Ferreira, Costa, Araújo, & Oliveira, 2013, Egre & Lopes, 2015, Souza, 2016). Implicitly, this factor is related to the subjects of mathematics and Portuguese language, which constitute the knowledge base of students at the end of elementary school. In fact, the difficulties in mathematics are shown to be a reality in most of the FIs.

In some of the aforementioned studies, it was verified that in addition to the required adaptation to the secondary level and to the technical training, the students of the integrated technical courses are faced with considerable mathematical formalism that appears in some specific subjects of the course and also in others of the common curricular base, such as physics, chemistry, and mathematics itself. Ferreira et al. (2013), in their study, note the shortcomings in elementary mathematics knowledge as a decisive factor for the difficulty of learning the contents covered in other subjects, and emphasize the need to retrieve such contents through actions that make possible their revision, such as remediation classes and tutoring.

In the study by Carvalho, Nacarato and Reinato (2016) it is pointed out the challenge of teaching mathematics to students who, at the same time, aim to acquire a vocational education and aspire to proceed to higher education. The authors characterize the majority of the students as those who are coming from public schools and who see the FI as an opportunity of a high quality secondary education that is simultaneously propaedeutic to university studies. However, many of the students have great deficiencies in mathematical knowledge, which the authors confirmed by the high failure rate in this subject.

Cerda, Ruiz, Casas, del Rey and Pérez (2016) describe mathematics as a discipline in which many students express a negative predisposition or even rejection, for various reasons, such as the teaching methods or the teacher kind of person, people's expectations, and also the influence of stereotypes based on social and cultural factors. In this context, the authors also include the students' own expectations of success as well as their perception of self-efficacy. For Akin and Kurbanoglu (2011), these unfavourable attitudes and beliefs are strongly linked to school failure.

There are several studies where it has been shown that beliefs and emotions can favour or hinder attitudes towards learning mathematics (Zan et al., 2006, Di Martino & Zan, 2001, 2007, 2010, Hannula, 2012, Goldin, 2014). More specifically, there are studies

that link emotions, such as anxiety and blockage, to academic performance or achievement in mathematics. Pekrun, Elliot and Maier (2009) found that there are certain emotions, both positive and negative, that are accentuated in the learning processes. Emotions such as pleasure, curiosity, satisfaction, boredom, anger, hope, pride, anxiety, despair and shame play a relevant role in the cognitive processes involved in school learning. Those emotional nuances can act as mediators of the relationships between achievement goals and performance level in mathematics, some of which have a significant negative impact on school disengagement processes and lead to school failure (Cerdeira et al., 2016). Likewise, the positive effect that a good predisposition for mathematical tasks has on the reduction of anxiety in learning was pointed out (Akin & Kurbanoglu, 2011).

Di Martino and Zan (2011) argue that mathematicians and mathematics teachers have always experienced in their own practice the deep interaction between cognition and emotions and the role that this interaction plays in mathematical behaviour. The authors cite renowned mathematicians, such as Hardy, Hadamard and Poincaré, who described mathematical activity as being characterized by a strong interaction between cognitive and emotional aspects, attributing to the latter a leading role in the creative phase of mathematics. The authors state that, on the other hand, teachers are aware that, among all school subjects, mathematics is the one that triggers the strongest negative emotions, which can be striking and even lead to avoidance or block the thinking processes.

Keys and Fernandes (1993) refer to a series of factors associated with students' dissatisfaction and disengagement: disappointment and dislike of school; lack of interest and effort in class and homework; boredom with school and school work; aversion to certain teachers or kinds of teachers; resentment of school rules; belief that the school does not improve career prospects; low educational aspirations; low self-esteem and poor academic performance. Nardi and Steward (2003), in their study, also denote the silent dissatisfaction of students in the mathematics classroom. The authors identify such students as those with little involvement in learning tasks, those who perceive the tasks as having no relevance to the world outside of school and to their own needs, interests and experiences, and those who routinely perform but do not substantially engage with the tasks. The rescue of those students is therefore of strategic importance because they are often a large number whose mathematical potential remains inert. The authors emphasize that in order to investigate students' silent discontent in mathematics it is necessary to integrate the cognitive and the affective perspectives on mathematics learning, one that combines students' attitudes and achievements in mathematics.

Based on the studies and contributions of the aforementioned researchers who have been investigating the problem, there is evidence that failure in the mathematics subject can lead students to situations of school dropout. It is also realized that the affective and emotional experiences of the individuals involved in this process can become preponderant factors in that decision. Thus, it is necessary to get a deeper and broader knowledge of the student who is recognized at risk of evasion and/or grade retention, which may move beyond a single focus on the remediation of learning and performance.

METHODOLOGICAL PROCEDURES

In this section, we present a fragment of the pilot study, developed in September and October 2017. Five meetings were developed, lasting 90 minutes, in a context of remedial classes where students were given the opportunity to revise and acquire the mathematical content on affine and linear functions, already taught in the regular mathematics classes.

Students of the first year of the Integrated Technical Courses of Electrotechnics and Electromechanics were invited. The choice of the participants was based on their school performance in mathematics, aiming at the students who showed unequivocal difficulties and low attainment in this subject. The purpose of the pilot study was to involve students with difficulties in solving rich mathematical tasks that would allow them to improve their learning.

Out of the eleven invited students, only eight attended the first session. The proposed activity for that session consisted of a “sea battle” style game, intended to work on ordered pairs in a Cartesian system. In this context, while students were solving the task it was possible to perceive some of their difficulties that could not be easily identifiable in the larger regular class. In the course of the experiment, it became apparent that it would not be possible to develop too demanding mathematical tasks, because as soon as a mathematical situation involved a more complex reasoning, students were embarrassed, got stuck and wanted to give up. It was then decided to organize the classes within a low level of demand, by working on the basic concepts that would be needed for the understanding of the given content. Also, little by little, the work in pairs was encouraged, in which the students solved, presented and discussed the tasks among themselves, and then a discussion was made within the whole group.

During the development of the pilot study, the teacher was able to interact with the students individually and so it was possible to notice their feelings and some of their attitudes in the face of mathematical situations. It was then evident the importance of giving a privileged attention to the affective aspects involved in the way those students reacted and behaved when having difficulties in mathematical questions. The affective aspects strongly overlaid any attempt to invest on cognitive issues, given the extent of the difficulties revealed by the students. From the observations and interactions, it was considered important and timely to invest on a better awareness of the affective dimension, based on the emotional experiences of those students who present difficulties in learning mathematics and who are potential students at risk of evasion and/or retention.

The data for this initial study were collected through participant observation in the remediation classes, questionnaires to the participants and two narratives produced by the students; the first at the beginning of the study and the second that was delivered in the class before the last. The use of narrative production as a data collection tool is based on the fact that it is an instrument that is consistent with an interpretative approach, capable of capturing students’ relationship with mathematics, giving students a voice through the possibility of talking about the aspects that they consider relevant in their

own experience with mathematics (Di Martino and Zan, 2010). Narratives 1 and 2 had the titles, respectively: “My relationship with mathematics up to the present is...”; “For me to succeed in mathematics it is necessary...”. All the remedial sessions were audio and video recorded. Here we will present some fragments of the data from the observation and the two narratives produced by the students participating in the pilot study, which allowed us to examine and analyse, in an exploratory way, the affective components of the students’ experiences of failure in mathematics.

In official terms, this investigation respects the indications of the Charter of Ethics in Education and Training (CEIEF), through opinion n° 1493, of the Ethics Commission of the Institute of Education of the University of Lisbon. Also, an appropriate request was made for parental permission for student participation and for the governing board of the institution to implement the pilot study. The confidentiality of the data and the anonymity of the participants were guaranteed. In this article, due to space limitations, only data for two of the students will be presented.

DATA PRESENTATION AND ANALYSIS

In this section, the profiles of two students of the Integrated Technical Course in Electromechanics, participating of the pilot study, are sketched. The profiles were structured through participant observation, as well as from the data that emerged from the students’ productions in the classes and the two narratives made by them. In the presentation of the data, the names of the two students, Carla and Paulo, are fictitious, as well as other student’s names that participated in the study.

CARLA

Carla is 15 years old, shy and sensitive; she is afraid of communicating in the classroom, does not interact and when invited to participate she gets nervous and cannot speak. For instance, on one occasion, in the classroom, there was an attempt to involve her in the discussion of the lesson; at that point, she was very nervous, refused to speak and began to cry. In a conversation with the student’s mother, in a parents meeting, she reported that her daughter had not achieved high grades in elementary school, but still she had never failed a year. The parents showed concern about their daughter’s results in mathematics and in some of the technical subjects at the FI. When the invitation to participate in the project was made to the student, she showed satisfaction.

Carla participated in all of the five sessions. In the first session, she developed the activity together with a student who did not continue in the project. She started the task in a messy way, could not understand the rules, but gradually progressed. At the end of the class, when asked to talk about her impressions of the lesson and the proposed assignment, Carla quickly said: “I have nothing to say”. This was the common attitude she held in the classroom, consistent with her difficulty in expressing herself in public.

In the second session, only four students participated and Carla worked together with Raquel, who had not participated in the previous session. In this session, which took place in the computer lab, Carla was more communicative, perhaps because the group was very small. She was asked to help her classmate and it was possible to observe her effort, despite the difficulty in organizing her reasoning and in verbalising it.

In the third session, Carla no longer revealed the initial shyness, now communicating and speaking very naturally and not as quietly as in the regular classroom. Although she was more at ease, she continued with a disorganized speech when she needed to explain her thinking, which could be an indication that she had not yet understood the mathematics involved and therefore did not feel sure of what she was saying.

In the fourth session, she continued to work in pair with Raquel and led the dyad. At the beginning of the class, along with the classmates, she asked if they would present the solutions of the tasks to the others, indicating satisfaction with that possibility. She communicated well with the group, was not afraid to say she did not understand and that she needed help. She justified her difficulty in expressing herself in public, in saying: "That's the way it is; if I know what I'm talking about, then I can explain it well, but now I've just spoken and I feel a little lost, I lose myself".

In the last session, during the work on a proposed problem, Carla related it to other tasks; she questioned her classmates when they made suggestions that were senseless, proving to be very concentrated. What was notorious was that Carla did not show discouragement in solving that problem, contrary to what other colleagues showed. She initially seemed not to know very well how to do it, but kept trying to find the solution. This attitude of facing a situation that seemed insurmountable to others suggests that Carla may have improved her self-ability perception. She also stressed the opportunity to discuss the resolution of the tasks, considering that at those times what happened was: "...

We were explaining". Despite her difficulties, she stated that resolution and willingness to learn are fundamental: "The important thing is that we dedicate ourselves. I get up early, I'm going there; I want, I can; then with time we open ourselves to understand more". In terms of shyness, Carla showed evolution in the course of the sessions and to the end she already seemed to express herself naturally; however, in the regular classroom she kept her reserved attitude and when invited to interact she still preferred not to speak.

From the narratives produced by Carla it is possible to see that, due to her difficulties in the discipline, she presents a negative attitude towards mathematics:

I do not say that mathematics is my favourite subject. People say that anyone who has difficulties in a subject ends up not liking it. I have to agree, I have difficulties in mathematics and I have a lot! When the content is presented, I even understand it, but when I have to do it in practice, I get lost; I get it wrong... But after I learn it, I can do it right. (Narrative 1)

In this excerpt, Carla describes two of the three affective dimensions referred by Di Martino and Zan (2010): the emotional disposition, the vision of mathematics and the perception of competence. The emotional dimension and perceived competence are two dimensions that appear to be strongly connected. For example, there is a transition from the emotion (not liking) linked by the connective “but” to a perceived competence (after I learn it, I can do it). This link between an emotional disposition and the perceived competence in mathematics is very complex, also because the perceived competence is linked to the idea of success in mathematics. Success in mathematics does not have a shared meaning among the students; it may be identified with good grades or with understanding the material. In the first case, from the students’ point of view, it is up to the teacher to recognize success, whereas, in the second case, the student can be the one who recognizes his or her own success (Di Martino & Zan, 2010). In the Narrative 2, which referred to achieving success in mathematics, Carla wrote:

Mathematics is like other subjects, if you do not work, you will not learn. But for those who have difficulties in mathematics the secret is to strive and to strive hard. For me to succeed in mathematics, it is necessary to try harder, to sit, to study, to practice, to read and reread, to see where I am wrong. I know I can, I know that I am capable, and to succeed it takes me dedication and much effort. But just talking is very easy. Maybe some would say – all you need to do is to sit down and study. But no, we really try; at least, in my case, I try, but sometimes I fail, I lose myself. But I’m trying to improve more and more. (Narrative 2)

In the above excerpt, Carla has the perception that mathematics is a subject that requires dedication and effort. From our perspective, her vision of mathematics is relevant in relation to her emotional disposition (I know I can, I try) and perceived competence (sometimes I fail).

PAULO

Paulo is 17 years old, has a restless and deconcentrated behaviour, and he is not able to stay still much time. He is repeating the school year and tends not to do the activities proposed in the classroom; he often tries to copy the work of his colleagues during the assessment tests. When a group work activity is proposed he does not effectively participate, but he maintains a good relationship with his classmates and is accepted in the group. Paulo has participated in all the sessions of the project.

On the first day, his participation in the proposed activity was similar to his behaviour in the normal classroom, that is, he did not get involved in solving the task, leaving the work to his partner. He would say, for example, “Pick any number...” in referring to the ordered pairs chosen to devise a strategy to win the battle. The task did not motivate his participation and he felt that the lesson was too long.

The second session involved the use of the computer, which seems to have aroused the interest of Paulo who actually participated in the lesson. He led the pair work with Walter and he was always ahead of the others in solving the activities. He asked questions, discussed things and justified his answers. Unlike the first class, he did not stray at any time and made no comments regarding the duration of the session. At the end, when he said good-bye, he suggested: "You could make our assessment here (in the computer lab), what do you think?". This could be an indication that the use of the technology motivated his participation in the class.

As in the previous one, in the third session, Paulo became effectively involved in solving the proposed activities. He thought, argued, elaborated, and reworked, quite enthusiastically. He could not stay very still, but he behaved well in that regard. Like his colleagues, he found difficult to develop a good mathematical reasoning and keep it organized. When he apparently understood something, he got lost again. However, Paulo became interested in the class.

In the fourth session, he performed the task, discussed it with his classmate, quickly finished the solution and right immediately wanted to present it to his colleagues. He was told and advised that he needed to temper his distress because he should respect the time of his colleagues. When he finished the activity, he could no longer sit in his place, began to circulate around the room and to draw on the board. But his interest and what he contributed to the discussions were remarkable (a different attitude from the one in the regular classroom, where he does not participate in the discussions and generally does not bother to develop the proposed activities). At the end of the session, when he said goodbye, he declared: "The class was really cool" and "I'm really enjoying it".

At the 5th session, Paulo said that he was sad and happy at the same time because that would be the last one. His words were: "I'm happy because I can sleep late on Mondays and sad because I'm enjoying attending these classes and it's going to end". While solving a problem, Paulo could not organize his reasoning, he was very agitated, and he wanted to discuss the problem with the whole group. He was told that he and his mate should together try to understand the problem and then discuss it. He remained agitated; he was given some clues, but it took time for him to understand what was being asked in the problem. In the end, he claimed that the problem was very difficult, and although he was able to solve it, he still had doubts. Solving a mathematical problem is a situation where the student has a goal, but does not immediately envisage how to achieve it, therefore experiencing some kind of dead end or obstacle, or some cognitive incongruity not easily solved, so this dead end is likely to evoke a spectrum of emotions, which can range from anxiety to increased interest and curiosity (Goldin, 2014). In Paulo's case, he felt anger, anxiety, frustration, and tension. Goldin (2014) refers that during problem solving, frustration and tension often occur.

In his final statement, Paulo told that he understood the subject better in the remediation classes than in the classroom and attributed it to the fact that "it was not always the same thing, it changed every week, sometimes it was on the computers and

other times...”. He highlighted the classroom environment in which the students presented and explained to the whole group and he added that the students did not feel insecure to speak because “one of the things that was very good was that our degree of difficulties was almost the same but if it were in the [regular] classroom, some people would know more and some would know less, so that thing of explaining to the others...”.

In his Narrative 1, Paulo expressed his relation with mathematics and described how he feels about his difficulties in this discipline.

My relationship with mathematics is very difficult. In elementary school, up to the 8th grade, I did not have any kind of difficulty, but in the 9th grade, when I came to school in Primavera do Leste, I already felt difficulties. All the material that the teacher explained did not get into my head, no matter how hard I tried. I did not understand any of the material that the teacher taught, so I got discouraged and gave up participating in many activities. In the first year of secondary school things just got worse, and with all my disappointment I preferred not to study maths. So I'm like that until today. (Narrative 1)

In speaking of his relationship with mathematics, Paulo describes a history of change, providing some insight into the factors that may have influenced his relationship with this discipline. It reveals a negative perception (a very difficult relationship) and gives a description of the moment in which this relation changes from positive to negative (in the 9th year... I already felt difficulties). From grade 9, he develops a blockage in relation to the subject and makes the option of not engaging with mathematics classes, and developed an avoidance attitude regarding mathematics. He reinforces his negative history with mathematics, saying that by attending his first year of secondary school, things have gotten worse. This discourse from Paulo allows us to verify how delicate the transition between school levels is, especially for students who experience learning difficulties.

As for succeeding in mathematics, Paulo wrote:

I have to pay more attention to the teacher, to the clarification and help. Well, I have problems with mathematics, which have come from the 8th grade, but with this project, and the support of these classes I feel that I will overcome all those difficulties. I would like to thank you for all the opportunities you are giving me and for believing in me. (Narrative 2)

In this excerpt, the student restates the school grade in which his problem with the discipline began and considers that to be successful it is necessary to pay attention to the classes. The interesting point of his narrative is that he believes in a possibility of changing from a negative attitude towards mathematics to a positive one, which means

that his participation in the project may represent a turning point in his relation with mathematics.

SYNTHESIS

In order to understand the emotions, beliefs and attitudes of the students who present difficulties in mathematics, we sought, in this section, to capture the affective aspects of two students participating in the pilot study who were at risk of evasion and/ or retention.

Carla, a shy and sensitive girl, revealed her involvement in the project. Due to her effective participation, it was possible to observe the construction of a positive disposition during the solution of the tasks, as well as the development of an attitude that was different from that she had in the regular classroom. Little by little, she gained confidence and there were clear improvements in her communication with the other students of the group. When she spoke about her relationship with mathematics, she indicated a negative attitude toward the subject. Carla declared that although she tries sometimes she fails. She stressed that commitment together with effort is needed to succeed in mathematics.

Paulo has a history of grade repetition and some attitudes that reveal his disinterest and which hinder his learning of the content. In the course of the project, he became involved in the solution of the tasks. From the second meeting he was interested in the activity because he enjoyed the fact that the work was developed with the use of technology in the computer lab. At the fifth meeting when confronted with the solution of a mathematical problem, he showed attitudes of discouragement, tension and frustration.

Like Carla, Paulo showed a behaviour that was different from that he had in the regular classes. According to him, in the remedial lessons, the degree of difficulties among the students in the group was similar, which facilitated the communication between them. This means that he did not feel intimidated in explaining his reasoning because he knew that he would not be judged by his colleagues. In describing his relationship with mathematics, he said that it was very difficult. He narrated a negative history with mathematics from the 9th year of elementary school that worsened in the first year of secondary school, at the time of his grade failure. As for success in the discipline, Paulo considered the importance of participating in the work during the class and saw his participation in the project as a positive fact that could provide a change in his relationship with mathematics.

FINAL COMENTS

From the reflection on the positive aspects and the obstacles encountered during the collection of data in the pilot study and through the observation of the participating students, it was possible to perceive their difficulties and anguishes in performing mathematical tasks, as well as their feelings and attitudes. Those issues were decisive to

highlight the importance of understanding how students experience situations of failure and difficulties in mathematics learning. In a more specific way, it is important to know more, from the individual's perspective, about the process that leads the student to feel in a situation of failure, about the difficulties that have an emotional impact on the student and become obstacles to their mathematical learning, thus putting him or her in a situation of risk of retention and/or evasion. In short, we need to get a deeper knowledge into the ways in which students find themselves in a situation of failure in mathematics.

Research results that relate the school performance and the students self-concept indicate that some students experience difficulties and failure in mathematics not because of low intellectual aptitude or lack of other abilities, but because they perceive themselves as incapable of learning or doing things well (Veiga, 2006); students with a history of failure in mathematics may have poor performance, because they do not believe that they are capable and that they have competence or aptitude for learning mathematics (Piscarreta & César, 2004). Likewise, when experiencing some difficulties in the beginning of their learning of mathematics, the students tend, sooner or later, to disengage from that learning, as they get convinced that the knowledge required in the discipline becomes unattainable, thus leading to the intensification of failure in mathematics (Almeida & Mourão, 1994). In this sense, students with "low achievement may not be aware of their implicit, inadequate representations about mathematics, or see themselves as not capable of modifying them" (Veiga, 2006, p.38). Such representations therefore negatively contribute to their learning and achievement. Thus, the affective factors involved in the teaching and learning of mathematics may be indicative of success or failure in student's learning, just as attitudes toward mathematics can be understood through the individual's experiences with the discipline (Brito, 2011).

Based on the literature and on the analysis of the data that emerged in this pilot study, we claim to be relevant to deepen our knowledge on the students' visions of mathematics as well as on the emotions and attitudes that are linked to those. From the interaction with the students, and from the feelings and attitudes they demonstrated and reported, we may better understand how they are framed in a condition of risk of failure in mathematics. This seems to be crucial if we aim at generate new ideas and/or strategies that allow planning educational actions in the classroom, or institutional actions, to progressively change "the inadequate representations about the nature and the acquisition of knowledge in mathematics" (Veiga, 2006, p.38).

Regarding the learning difficulties in mathematics and their repercussions in the student's decision to remain or evade the integrated technical secondary courses in the Federal Institutes, there is still a shortage of studies focusing on this problem. We note the lack of research in line with the main questions guiding our research study, which addresses, in vocational education, the failure in mathematics from the perspective of the affective dimensions. The shortage of studies on this issue may be related to the fact that the process of democratization of the vocational secondary school in Brazil is quite recent. And if the democratization of education means students' access to school and their permanence in school, then a crisis in one of these two terms proves to be a problem.

Therefore, it is extremely important to seek answers to the problems that are taking place at this level and modality of education, in order to contribute with preventive measures, policies and/or actions that contribute to the permanence and success of students and, consequently, to their full education.

REFERENCES

- Akin, A. & Kurbanoglu, I. N. (2011). The relationships between math anxiety, math attitudes, and self-efficacy: a structural equation model. *Studia Psychologica*, 53, 263-273.
- Almeida, L. S. & Mourão, A. P. S. (1994). Os alunos face à Matemática: Relevância na formação de professores. *Educação em Debate*, 16(27-28), 5-12.
- Amado, N. & Carreira, S. (2018). Students' attitudes in a mathematical problem solving competition. In N. Amado, S. Carreira, & K. Jones (Eds.), *Broadening the Scope of Research on Mathematical Problem Solving – A Focus on Technology, Creativity and Affect*. (Research in Mathematics Education Series), (pp.401-434). Cham, Switzerland: Springer International Publishing.
- Amado, N., Carreira, S. & Ferreira, R. T. (2016). *Afeto em competições matemáticas inclusivas: a relação dos jovens e suas famílias com a resolução de problemas*. Belo Horizonte: Autêntica.
- Araújo, C. F. & Santos, R. A. (2012). A educação profissional de nível médio e os fatores internos/externos às instituições que causam a evasão escolar. In *Proceedings of the 4th International Congress on University – Industry Cooperation* (pp.1-17). Taubaté, Brasil: Unindu.
- Brasil. (2010). Documento Final – Conferência Nacional de Educação (CONAE). Brasília: MEC. Disponível em: http://conae.mec.gov.br/images/stories/pdf/pdf/documentos/documento_final_sl.pdf
- Brasil. (2013). Acórdão 506/2013. Brasília: Tribunal de Contas da União (TCU). Disponível em: <http://www.ifto.edu.br/portal/docs/dae/permanencia/acordao-506-2013.pdf>
- Brasil. (2015). *Nota Informativa Nº 138/2015*. Brasília: SETEC e MEC. Disponível em: <http://proen.ifpa.edu.br/documentos-1/documentos-gerais/2015/1234-nota-informativa-n-138-2015-dpe-ddr-setec-mec/file>.
- Brito, M. R. F. (2011). Psicologia da educação matemática: um ponto de vista. *Educar em Revista*, 1, 29-45.
- Carvalho, R. M., Nacarato, A. M. & Renato, R. A. O. (2016). Educação matemática e o ensino técnico profissionalizante em nível médio: uma análise curricular. *Revista Eletrônica Pesquisa Educa*, 8(15), 25-44.
- Cerda, G., Ruiz, R. O., Casas, J. A., del Rey, R. & Pérez, C. (2016). Predisposición desfavorable hacia el aprendizaje de las Matemáticas: una propuesta para su medición. *Estudios Pedagógicos XLII* (1), 53-63.
- Di Martino, P., & Zan, R. (2001). Attitude toward mathematics: Some theoretical issues. In M. Van den Heuvel-Panhuizen (Ed.), *Proceedings of the 25th conference of the IGPME* (Vol. 3, pp.351–358). Utrecht, The Netherlands: PME.

- Di Martino, P., & Zan, R. (2010). 'Me and maths': towards a definition of attitude grounded on students' narratives. *Journal of Mathematics Teacher Education*, 13, 27-48.
- Di Martino, P., & Zan, R. (2011). Attitude towards mathematics: a bridge between beliefs and emotions. *ZDM Mathematics Education*, 43, 471-482.
- Dore, R. & Lüscher, A. Z. (2011). Permanência e evasão na educação técnica de nível médio em Minas Gerais. *Cadernos de Pesquisa*, 41(144), 772-789.
- Egre, P. & Lopes, A. M. (2015). Permanência e abandono no ensino técnico integrado – Instituto Federal de Santa Catarina. *Anais do VI Simpósio Nacional de Ciência, Tecnologia e Sociedade* (p.1-16). Rio de Janeiro, Brasil: CCMN/UFRJ.
- Evans, J., Morgan, C., & Tsatsaroni, A. (2006). Discursive positioning and emotion in school mathematics practices. *Educational Studies in Mathematics*, 63(2), 209-226.
- Ferreira, M. F., Costa, J. J. L., Araújo, M. S. T. & Oliveira, L. N. (2013). Investigação sobre fatores de sucesso e insucesso na disciplina de Física no ensino técnico integrado na percepção dos alunos e professores do Instituto Federal de Goiás – Campus Inhumas. *HOLOS*, 5(29), 347-368.
- Gazo, F. P. & Torrado, M. (2012). La adaptación y la persistência académica en la transición em el primer año de universidad: el caso de la Universidad de Barcelona. *I Congreso Internacional e Interuniversitario de Orientación Educativa y Profesional: Rol y retos de la orientación en la Universidad y en la sociedad del siglo XXI* (p.1-17). Málaga, Espanha: Facultad de Ciencias de la Educación, Universidad de Málaga.
- Goldin, G. A. (2014). Perspectives on Emotion in Mathematical Engagement, Learning, and Problem Solving. In: R. Pekrun & L. Linnenbrink-Garcia (Eds), *International Handbook of Emotions in Education*, (pp.391–414), New York: Routledge.
- Hannula, M. S. (2012). Exploring new dimensions of mathematics-related affect: embodied and social theories. *Research in Mathematics Education*, 14(2), 137-161.
- Keys, W. & Fernandes, C. (1993) *What Do Students Think about School?* Slough, Berkahire, England: National Foundation for Educational Research.
- Nardi, E. & Steward, S. (2003). Is Mathematics T.I.R.E.D? A profile of quiet disaffection in the Secondary mathematics classrooms. *British Educational Research Journal*, 29(3), 345-367.
- OECD (2016). *Brazil. Country Note – Results from Pisa 2015*. Disponível em: <https://www.oecd.org/pisa/PISA-2015-Brazil.pdf>.
- Pekrun, R., Elliot, A. J., & Maier, M. A. (2009). Achievement goals and achievement emotions: Testing of a model of their joint relations to academic performance. *Journal of Educational Psychology*, 101, 115-135.
- Piscarreta, S. & César, M. (2004). Desafinado... ou o meu primeiro amor: a construção das representações sociais da Matemática. *Vetor NETECLM*, 2, 31-51.
- Romão, C. (2004). *Didática e democratização do ensino*. Disponível em: <http://www.cesarromao.com.br/redator/item24091.html>.
- Silva, M. T. R. & Ventura, A. C. (2017). A democratização do ensino nos Institutos Federais de Educação, Ciência e Tecnologia: um modelo de análise da qualidade da Educação a Distância. *Cadernos de Ciências Sociais Aplicadas*, XIV(23), 1-15.
- Souza, P. S. D. (2016). *A reprovação e seus fatores no primeiro ano dos cursos técnicos integrados do Instituto Federal do Sudoeste de Minas Gerais – Campus Juiz de Fora*. (Dissertação de Mestrado). Universidade Federal de Juiz de Fora, Brasil.

- Veiga, F. H. (2006). Que falta aos alunos para serem bons a Matemática? Uma abordagem Psico-Educacional. *Psicologia, Educação e Cultura*, IX (2), 35-53.
- Viveiros, J. & Lopes, A. (2010). O (in) sucesso escolar a Matemática na transição para o 10º ano – um estudo de caso. In C. Leite, A. F. Moreira, J. A. Pacheco, J. C. Morgado & A. Moraz (Orgs.). *Debater o currículo e seus campos: políticas, fundamentos e práticas. Atas do IX Colóquio sobre questões Curriculares/V Colóquio Luso-Brasileiro*. (pp.2247-2263). Porto: Universidade do Porto.
- Zan, R. & Di Martino, P. (2007) Attitude toward mathematics: overcoming the positive/ negative dichotomy. *The Montana Mathematics Enthusiast*, 3, 157-168.
- Zan, R., Brown, L., Evans, J., & Hannula, M. (2006). Affect in Mathematics Education: An Introduction. *Educational Studies in Mathematics*, 63(2), 113-121 (Special Issue).