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Interdisciplinarity and professional education in the context of the mathematics fairs in Espírito Santo

Interdisciplinaridade e formação profissional no contexto das Feiras de Matemática no Espírito Santo

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ABSTRACT

The Mathematics Fairs have been held in Brazil for more than thirty years. Throughout these years, they have become a productive locus of teacher and student education, providing a space for the exchange of experiences and socialisation of practices that occur in the classroom, triggering new meanings for teaching and learning mathematics. Considering the possibilities of integrating curriculum components of middle level professional technical education, also known as career education, from experiences with mathematics fairs projects, this research studies projects presented in Espírito Santo between 2015 and 2017. For the research, we consider the curriculum documents and theoretical assumptions that deal with the articulation between general and professional formation, the concept of interdisciplinarity and the landscapes of investigation. In the end, although we understand that the construction of a curriculum matrix requires that the knowledge is organised in disciplines, we conclude that the interdisciplinarity proposed in mathematics fairs projects promotes the reconstitution of the totality of scientific knowledge from the relationship between concepts of different curriculum components, basic education and professional education.

KEYWORDS: Mathematics fairs, Professional education, Integrated curriculum, Interdisciplinarity.

RESUMO

As Feiras de Matemática já são realizadas no Brasil há mais de trinta anos. Ao longo destes anos, têm se constituído em um profícuo lócus de formação de professores e alunos, propiciando um espaço de troca de experiências e de socialização de práticas que de fato ocorrem em sala de aula, provocando novos sentidos para o ensinar e o aprender Matemática. Considerando as possibilidades de integração de componentes curriculares da Educação Profissional

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Técnica de Nível Médio a partir de experiências com projetos de Feira de Matemática, esse estudo analisa projetos apresentados no Espírito Santo, entre 2015 e 2017. Para análise, consideramos os documentos curriculares e pressupostos teóricos que tratam da articulação entre formação geral e profissional, do conceito de interdisciplinaridade e dos cenários de investigação. Ao final, apesar de entender que a construção de uma matriz curricular exige a organização dos conhecimentos em disciplinas, concluímos que a interdisciplinaridade proposta nos projetos de Feiras de Matemática promove a reconstituição da totalidade do conhecimento científico a partir relação entre conceitos de diferentes componentes curriculares, da formação básica e da formação profissional.
PALAVRAS-CHAVE: Feiras de Matemática, Educação Profissional, Currículo Integrado, Interdisciplinaridade.

Introduction

In December 2018, the Federal Network of Professional, Scientific and Technological Education (RFEPCT) completed a decade of existence. Instituted by President Lula from Law No. 11.892/2008, the RFEPCT, also known as Rede Federal/Federal Network, represents a milestone in the expansion, internalisation and diversification of professional and technological education in Brazil. Currently, the network consists of 38 units in all states and 644 campuses in operation, offering qualification courses, integrated high-school education, technology courses and undergraduate degrees. Among the participating institutions are the Federal Institutes of Education, Science and Technology (IFs), the Federal Technological University of Paraná (UTFPR), the Federal Centers of Technological Education (CEFET-RJ and CEFET-MG), Technical Schools linked to Federal Universities and Colégio Pedro II, in the state of Rio de Janeiro (BRASIL, 2008).

Besides the scope of the Federal Network and the celebration of its first decade, our study focusing on professional education is also justified from other studies of mathematics education in this modality (GONÇALVES; PIRES, 2014), which also point to a shortage of specific research. As an example, the former Working Group n.3 of SBEM, Mathematics Education in High School, aimed at developing "research on the roles and effects of mathematics education in the different teaching modalities – such as the one integrated to professional education, youth and adult education (EJA), rural education, indigenous people's school education, quilombolas' school education. However, among the publications of the WG in the previous editions of the International Seminar on Research in Mathematics Education - Sipem, only four papers discussed the professional education modality, one in the third (2006) and three in the fourth edition (2009). In the last edition of the event, in 2018, we had another publication on the theme, now in WG 2.[4] We were the authors of the text that analysed practices

[4] Due to the renaming of WG 3 for "Currículo e Educação Matemática/Curriculum and Mathematics Education", discussions about educational experiences in high school in their different modalities were directed to WG 2,

communicated by students of technical courses integrated to high school during the IV National Mathematics Fair, in 2015 (SÁ; GONÇALVES; TURI, 2018).

This article will resume the contribution of researchers who investigate mathematics education of professional education students and will encourage reflections in order to explore possibilities of curriculum integration from projects of the mathematics fairs held in the state of Espírito Santo. The project to which this text is associated aims to analyse the mathematics education of students from technical courses integrated to high school participating and exhibiting works in mathematics fairs (SÁ; SILVA, 2016; TURI; SÁ, 2017; SÁ; GONÇALVES; TURI, 2018), which have been carried out in Brazil for more than thirty years, increasingly becoming a scenario for teachers and students' training, as they "play a role in triggering new meanings for teaching and learning mathematics" (HOELLER, *et al.*, 2015, p. 4), as we discuss below.

Mathematics Fairs in Brazil and Espírito Santo

The first Brazilian mathematics fair was held in the state of Santa Catarina, in 1985. Coordinated by professors José Valdir Floriani and Vilmar José Zermiani, the fair was instituted to be "a program to encourage students from all stages of schooling to study and research under the guidance of teachers in school spaces and periods and share those studies and research with the community through an exhibition" (BIEMBENGUT; ZERMIANI, 2014, p.52). Since then, the event has taken place annually in Santa Catarina and has gradually expanded to other units of the Federation. The following chart presents a summary of the fairs in national territory.

which was called "Educação Matemática nos Anos Finais do Ensino Fundamental e Ensino Médio/Mathematics Education in the final years of Elementary Education and High School ".

Chart 1 - Capillarity of Mathematics Fairs

STATE	EDITIONS
Acre	02 state editions
Amapá	05 state editions
Bahia	11 state editions
Ceará	01 edition
Federal District	01 edition
Espírito Santo	04 editions
Mato Grosso	01 edition
Minas Gerais	01 state edition, 05 regional editions
Pará	01 regional edition, 01 school edition
Pernambuco	01 school edition
Rio Grande do Sul	02 regional editions
Santa Catarina	34 state, regional and municipal editions
Tocantins	01 regional edition

Source: National Standing Committee of Mathematics Fairs, 2019.

In the state of Espírito Santo, the first mathematics fair was held in 2015, after the first author of this work was contacted by the fairs national movement, fostered by the technical cooperation agreement signed by the Federal Institute Catarinense, State University of Bahia, Regional University of Blumenau and Brazilian Society of Mathematics Education. Due to logistic issues, the general coordinators of the 4th Mathematics Week of the Federal Institute of Espírito Santo (Ifes), professors Lauro Sá and Sandra Fraga chose to develop the fairs during Semat, which is held annually in May.

In the first Ifes mathematics fair, we registered 10 papers presented by groups from 5 municipalities of the state of Espírito Santo. The second edition counted on 28 exhibitions from 5 other cities. In 2017, there were 24 projects presented from 8 municipalities. In this history, it is important to register the participation of different regions of Espírito Santo, beyond the metropolitan region of Greater Vitória, which assigns the mathematics fair a state status, although this was not the initial goal.

Besides being a space to socialise classroom practices, Silva (2014, p.189) argues that mathematics fairs are "a space for the training of teachers and students, insofar as the participants conceive, elaborate, execute and present works, explaining in them and through them the conceptions that govern their school practices". One of the differentials of this event is that it prioritises the participation of basic education actors. But, in our view, what makes mathematics fairs extremely important events for mathematics education is that "mathematics fair must enable to display to the external public the mathematics activities normally undertaken in or outside the classroom by the internal public of the school" (FLORIANI; ZERMIANI,

1985, p.1). In other words, the works are not developed for the fair; they are, on the contrary, scholarly experiences to be shared in that movement.

As an opportunity to socialise a normal classroom practice, mathematics fairs are organised into eight categories (Special Education, Early Childhood Education, First Years of Elementary School, Middle School, High School, Higher Education, Teacher and Community), according to the level of schooling that students are attending at the time the experiment is completed. In terms of modalities, there are:

I) Materials and/or educational games: this item comprises works on the use of any material that allows concepts and mathematical properties to be studied. In this case, materials and games are educational resources through which - through exploration, discussion and analysis - concepts are elaborated, conclusions are drawn, and mathematical knowledge is constructed. In the following figure, we have, as an example, the work "A Matemática na trilha das compras/The Mathematics in the shopping trail", carried out with students of the Special Education category.

Figure 4 - Presentation of work in the modality materials and/or educational games.

Source: Collection of the National Standing Committee of Mathematics Fairs, 2018.

II) Applied mathematics and/or interrelationship with other disciplines: in this modality, mathematics is seen as a tool to obtain concrete results, within a context, through algorithms and methods. Below, we have a record of the work " Matemática, vida e saúde relacionada ao Índice de Massa Corporal/Mathematics, life and health related to the body mass index", presented in this modality by students of the Middle School category.

Figure 5 - Work in the modality applied mathematics and/or interrelationship with other disciplines.

Source: Collection of the National Standing Committee of Mathematics Fairs, 2018.

III) Pure mathematics: brings together works that deal with mathematics concepts, operations and properties. An example of experiences of this modality is " Matemática – o momento da beleza/Mathematics - the moment of beauty", performed with students of the High School category.

Figure 6 - Presentation of work in the Pure mathematics modality.

Source: Collection of the National Standing Committee of Mathematics Fairs, 2018.

Thus, if the works presented in the mathematics fairs report practices developed in the classroom, we believe that it is an interesting space to investigate how the experiences of professional education (also called career education) institutions promote interdisciplinarity and carry out the integration between general and professional education. More specifically, we focus on productions presented in the modality "Applied mathematics and/or interrelationship with other disciplines" that could associate mathematics with disciplines of a professional nature. We analyse the mathematics fair projects presented in Espirito Santo, based on theoretical assumptions that comprise the articulation between general and professional

formation, the concept of interdisciplinarity in different landscapes of investigation (SKVSMOSE, 2000).

Mathematics Education and Professional Education: some approximations

From the point of view of mathematics education, we have found different Brazilian studies focused on professional education, including the history of education (PINTO, 2006), the integrated curriculum (GONÇALVES, 2012), interdisciplinarity (FERREIRA, 2018), production of educational materials (FREITAS, 2010), the relationship between curriculum and teaching (AUGUSTO, 2019) and teacher training (JORDANE, 2013).

Since 2014, the Research Group on Mathematics Education and Professional Education - EMEP, of which we are part, has also developed different research work in this area. In a diagnostic work, we analysed the practices presented by teachers who teach mathematics in professional education during events such as national meetings of mathematics education and mathematics fairs. From an interventionist perspective, we explore the relationships between mathematics content and the vocational core, following classes, projects and activities in non-formal spaces (such as technical visits and olympiads of knowledge), producing specific didactic materials and performing interventions in the classroom. In all those studies, we deal with issues such as curriculum integration, correlation between the fields of mathematics and the vocational/professional axis of technical courses, and the appropriation of mathematics education trends in professional education classes, especially in the modality integrated to high school.[5]

When it comes to a school curriculum in a technical course integrated to high school, the articulation between the general formation and the professional formation is what characterises that modality. Therefore, it has the mission of providing students with the basic education at the same time, and in an integrated way, obtaining a professional qualification (IFES, 2019). For this training that aims at full human development, training for work and preparation for the exercise of citizenship, political, social, professional, historical and cultural aspects must be considered, as Ciavatta (2005: 84) points out:

> In the case of integrated training or high school integrated to technical education, we want general education to become an inseparable part of the professional education in all fields where there is education for work: whether in productive processes or in educational processes as initial training, as technical, technological or higher education. It means that we seek to focus work as an educational principle, in order to

[5] To know about these EMEP studies, go to http://emep.ifes.edu.br

> overcome the dichotomy of manual/intellectual work, to incorporate the intellectual dimension into productive work, to train workers capable of acting as leaders and citizens.

Complementing the above, we mention Saviani (2008), to point out that whereas the presentation of scientific concepts (intellectual work) unrelated to practice is configured as contemplation, the reciprocal practice - unrelated to theory (manual work) - is spontaneity. It is important, then, that theory enlightens practice as much as practice gives meaning to the theory. "It is a movement that is primarily practical but theoretically grounded, feeds on theory to clarify meaning, to give direction to practice" (SAVIANI, 2008, p. 142). Hence, it is necessary to go beyond the simultaneity between disciplines of general formation and of the professional nucleus, both formations must be worked in an integrated way. But how can these goals be achieved in mathematics? How to get the activities closer to the professional reality of the students?

According to Resolution No. 6/2012 of the National Council of Education, which defines the National Curricular Guidelines for Professional Technical Education at the Middle Level, the principles of this modality include "interdisciplinarity ensured in curriculum and pedagogical practice, aiming at overcoming the fragmentation of knowledge and segmentation of the curriculum organization" (BRASIL, 2012, Art. 6º, item VII). CNE Resolution No. 6/2012 also recommends the contextualisation and interdisciplinarity in the use of educational strategies, because they are "favourable to the understanding of meanings and the integration between theory and the experience of professional practice, involving the multiple dimensions of the technological axis of the course and of the sciences and technologies linked to it" (BRASIL, 2012b, Art. 6º, item VIII).

To implement this interdisciplinarity recommended in CNE Resolution 6/2012, we propose establishing some of the landscapes of investigation defined by Skovsmose (2000). In this case, those landscapes of investigation are presented as possible responses to the challenge of practicing critical mathematics education in the middle level technical professional education classroom. In a total of six, the milieus of learning are the result of combining three reference types (pure mathematics, semi-reality, reality) with two paradigms (exercises and landscapes of investigation), as illustrated below.

Table 1 - Milieus of learning.

	Exercise Paradigm	Landscapes of investigation
References to Pure Mathematics	1	2
References to Semi-reality	3	4
References to Reality	5	6

Source: Skovsmose (2000).

In elaborating the above table, Skovsmose (2000) considers that pure mathematics refers to primitive concepts, operations, and exclusively mathematical procedures. The semi-reality associates mathematics with hypothetical situations based on real situations. Reality, in the strict sense of the word, refers to real situations. In the exercise paradigm, milieu of learning (1) refers to pure mathematics exercises and can be exemplified by math exercises whose command of the statement is "find the value of X" or "solve according to the model". Milieu (3), with reference to the semi-reality, deals with problems contextualised by hypothetical situations, and that present objective resolution, for example, calculating the height of a pole from the height measures of a person and the shadows of the person and the pole. Finally, milieu (5), with reference to reality, can be represented by a mathematics class in which exercises are carried out with true data and information conveyed by the media.

From the perspective of the landscape of investigation, milieu of learning (2), referring to pure mathematics, deals with a problem with several possibilities of approach and resolution involving arithmetic, algebra or geometry, but without contextualisation or application in other areas other than mathematics. Milieu (4), concerning semi-reality, represents a problematisation to be explored based on a hypothetical situation and that does not have a unique solution. In this milieu, interventions and questions are valued, but may be limited to speculative hypotheses, since it is a fictional situation. And milieu of learning (6), concerning reality, differs from milieu (4) regarding the context of the problematisation to be investigated, considering that, in this milieu, contextualisation is not a hypothetical situation. And it is in milieu of learning (6) that we guide our research work, since we seek to provide the young students with possibilities to know the course and area of action beyond the description of the curriculum components, so that they can overcome the high school - technical school dualism, constructing an integral education.

Methodological paths

Regarding the methodological format, we developed a research of qualitative nature, of the exploratory type. We analysed the mathematics fair projects presented in Espírito Santo

between 2015 and 2017. In this period, we identified 62 projects, of which 5 were produced by elementary school students, 42 by high school students and 15 by undergraduate students, as shown in the following table.

Table 2 - Works by level and stage of teaching

Education level	Teaching stage	1st edition (2015)	2nd edition (2016)	3ª edition (2017)	Total
Basic education	Elementary school	1	1	3	5
	High school	9	24	9	42
Higher education	Undergraduate studies	0	3	12	15
Total		**10**	**28**	**24**	**62**

Source: Researchers' collection, 2018.

Of the 62 papers exhibited at the mathematics fairs, 42 were produced with high school students, 39 of which were by students of technical courses integrated to high school. If we used the categorization of the National Mathematics Fairs, we would associate 22 of these 39 to the modality "Applied mathematics and/or Interrelationship with other disciplines", of which, specifically, 6 mobilised contents of mathematics and disciplines of the vocational core. This was, therefore, our second research focus.

Table 4 - Works that articulated mathematics and professional training

Title	Area of the technical course and institution	Area integrated to mathematics
The golden ratio in logos that are operating in Brazil	Management *Ifes Linhares campus*	Marketing
Verifying inflation rates and price indexes in the city of Venda Nova do Imigrante - ES	Management *Ifes Venda Nova do Imigrante campus*	Statistics
Rate of change of prices of essential products in the district of Kaikan	Management *IF Baiano*	Statistics
Abusive conduct in interpersonal relationships: A Statistical analysis with Ifes students - Linhares *campus*	Management *Ifes Linhares campus*	Intrapersonal relationship
Mosaic based on the concept of proportion	Electrotechnology *Ifes Vitória campus*	Proportionality and technical drawing
Graph theory for high school: Possibilities from the use of electronic models	Industrial Automation *Ifes Linhares campus*	Graph theory, finite state machines and programming

Source: Researchers' collection, 2018.

As this is an investigation based on the works published in the proceedings of the event, it can be characterised as a bibliographic research (FIORENTINI; LORENZATO, 2006). The research stages included a preliminary survey, reading the material, taking notes on the reading, organizing the subject and writing the text (Gil, 2008). The first stage - preliminary survey -

was carried out from the proceedings of the Semanas de Matemática/Weeks of Mathematics held by Ifes, an event comprising the mathematics fairs in Espírito Santo.

By reading the material, we realised that the reduced number of pages required for the submission of written works jeopardised the in-depth description of those experiences. For this reason, and unlike the work that we presented in Sipem,[6] we limited our corpus of analysis even further, to works that were associated with a stricto sensu postgraduate research, leaving us with only two texts. In this case, we focused our research on both the project "Mosaico baseado no conceito de proporção/Mosaic based on the concept of proportion", linked to Marques's research (2016), and "Teoria de Grafos para o ensino médio: Possibilidades a partir do uso de maquetes eletrônicas/Graph theory for high school: Possibilities from the use of electronic models", associated with Sá's research (2016).

When taking notes on the readings, we sought to answer the following questions:

- How was the experience inserted into the scope of the knowledge fairs and, more specifically, of the mathematics fairs?
- What is the paradigm that guided the practice: the exercises or the landscapes of investigation? Why?
- What was the reference established: to pure mathematics, to semi-reality or to reality? Why?
- To which subjects was mathematics related during the mathematics fairs project? How did this process take place?

Results and reflections

The first mathematics fair project we brought to discussion was "Mosaico baseado no conceito de proporção/Mosaic based on the concept of proportion", developed by students of the Electrotechnology Technical Course Integrated to High School in Ifes, Vitória campus. This work was linked to Marques's research (2016), who presented a proposal for the teaching of technical drawing, mediated by the history of architecture and mathematics. The research investigated how studying those relationships can contribute to the elaboration of a proposal of interdisciplinary, attractive and contextualised, teaching that gets closer to the students' reality and adds to the already existing didactics.

[6] In Sá, Goncalves and Turi (2018) we developed our analysis exclusively from those works published in the proceedings of the IV National Mathematics Fair, which restricted the analysis of the experience.

The work presented at the mathematics fair consists of a mosaic based on the concept of proportion and was developed by students in a workshop held by a research group in technical drawing. According to Marques (2016), from mathematical concepts and manual drawing, the students constructed several rectangles obeying the Fibonacci sequence. With the squares of the sequence obtained, they traced the logarithmic spiral, located in the center of the mosaic, made three copies of the golden spiral and rotated them. The drawing was then scaled, printed and transferred to a base on which the participants scratched, cut and glued ceramic tesserae, using the appropriate tools and the necessary safety equipment.

Figure 7 - Mosaic made by students

Source: Marques, 2016, p. 140.

The elaboration of the materials and the presentation of the project during the mathematics fair proved to be precedents for the realisation of the synthesis of scientific knowledge. The presentation made possible to return to the beginning of the proposal promoted by the researcher in a dialectical and enriched way, since the dialogue between mathematics, history of architecture and technical drawing, contextualising them and providing with an integrated formation, ensured meaning to the mathematics existing in the practical applications of students' professional life.

If we think about full professional education, we perceive students' development in relational skills, necessary for the world of work (CIAVATTA, 2005), whose importance has been re-dimensioned since the introduction of the concept of emotional intelligence in studies on multiple intelligences (GOLEMAN, 2011). Among some principles of emotional intelligence, we highlight, in the following section, aspects related to recognising and controlling emotions and the ability to relate interpersonally:

> Students Samarone and Vitor noted that attending Semat contributed to improving their ability to speak in public. They overcame their own limits, overcame shyness and nervousness and performed very well the task they set out to do. They pointed out as positive the knowledge acquired, the importance of participating in the event for curriculum and acquisition of experience. (MARQUES, 2016, 152)

Figure 8 - Students presenting their work at the mathematics fair.

Source: Marques, 2016, p. 151-152.

To recognise one of the landscapes of investigation defined by Skovsmose (2000), we sought to understand which paradigm guided the practice performed and to identify the reference established in the project presented at the mathematics fair.

Regarding the paradigm that guided the work, we believed that the scenario consisted of a landscape of investigation (SKOVSMOSE, 2000), in which students were invited to engage in exploration processes, asking questions and seeking explanations. This is because, as registered by Marques (2016), the students worked collectively all the time, investigating, planning, sharing tasks, studying beyond the mathematical concepts. The work showed to be collaborative, since the students acted as action researchers, through debates promoted by the teacher about which would be the best way to deepen the studies within the chosen content and what could be added to the proposal of the project.

Regarding the reference established in the project, we identified a practice related not to a reality that we "actually" observed, but to a constructed one; therefore, it would be a semi-reality (SKOVSMOSE, 2000). Within the context of the professional education of which the students are a part, the work contributed to the construction of a proposal of a more attractive and emancipating technical drawing learning, which, according to the researcher, was hitherto "sectioned":

> As a teacher of this area, I have noticed the need to reformulate the teaching of technical drawing, since in the technical courses this has been done in a "sectioned" way, that is, totally disconnected from the history of architecture and mathematics. The students do not have the opportunity to know how and when the techniques that they are using were discovered, in what way they were and are applied in great works

> of architecture. This lack of contextualisation can discourage the students. (MARQUES, 2016, p. 13)

The teacher's report reproduced above is in line with what Ramos (2005) argues by saying that it is from knowledge in its most contemporary form that one can understand reality and science itself in its historicity. According to the researcher, the working processes and technologies correspond to moments of the development of the material forces of production and can be taken in the classroom as a historical and dialectical starting point for the pedagogical process:

> Historical, because the fruitful pedagogical work is concerned with highlighting, together with the concepts, the reasons, problems, needs and doubts that constitute the context of knowledge production. The apprehension of knowledge in its most elaborate form allows to understand the previous foundations that led to the current stage of understanding of the phenomenon studied. Dialectic, because the reason for studying a production process is not in its aparent normal and procedural structure, but aiming to grasp the underlying concepts and the relationships that constitute them. (RAMOS, 2005, 120)

The second mathematics fair project we discuss is "Teoria de grafos para o ensino médio: Possibilidades a partir do uso de maquetes eletrônicas/Graph theory for high school: Possibilities from the use of electronic models", developed by students of the Industrial Automation Technical Course Integrated to High School in Ifes, Linhares campus . This work was linked to Sá 's (2016) research, which investigated how students of professional education integrated to high school learn during the construction or use of electronic mockup for teaching graphs together with students from the state education network. The research supported the thesis that contents are concepts and theories that constitute syntheses of the historical appropriation of the material and social reality by the human being. The mathematics fair is inserted in Sá's research (2016) as the event that the teacher chose to promote his project.

In the project, students and teachers built a model with electronic components for the teaching of graph theory, in order to enhance the study of this content considering the history of mathematics. Student-researchers used electronic devices such as LEDs (light emitting diodes), pulsating buttons and an electronic prototype board (Arduino), so participants could interact while trying to solve the problem. In the mockup, there would be a button in each region and a LED on each bridge. Thus, when the participant chose to cross a certain bridge, he/she should press the button of the initial region and then press the second button, of the destination region. This would light the bridge LED linking those two regions, indicating that the bridge was crossed. Then, the participant would continue to follow the path to try to solve the proposed puzzle.

Figure 9 - Mockup exhibited at the mathematics fair

Source: Sá, 2016, p. 66.

Based on our readings, we can say that the mathematics fair "was the context for the creation of the electronic mockup" (idem, p. 48). In this sense, we perceive the use of the fair as a space to identify potentialities of the electronic model based on the use of the resource by the participants of the event. When Sá (2016) identified the learnings of students-researchers of the professional education in the action-research movement, he realised that they occurred in three instances: technical conceptual learnings; interaction with the areas of science and technology; and development of the students in their social and emotional dimensions, which, in turn, reverberated in the way they deal with knowledge, in an emancipated and autonomous way. That is, there is a dialogue between the research and the movement of the knowledge fairs, which, according to Moura (1995, p.7), is characterised as a "space of interaction between the areas of science and technology; teaching and learning opportunities for teachers and students; and student development in their social, emotional, cognitive and psychological dimensions".

This emancipated and autonomous way of dealing with knowledge meets the opinion of the Ministry of Education when it comes to research as a pedagogical principle. The document understands that school research in projects such as fairs, motivated and guided by the teachers, implies identiying a problem, selecting information, interpreting and elaborating this information, as well as organising and reporting on the knowledge constructed:

> Far beyond the knowledge and use of equipment and materials, research practice fosters the development of scientific attitude, which means contributing, among other things, to the development of conditions for interpreting, analysing, criticising, reflecting, rejecting closed ideas, learning, seeking solutions and proposing alternatives, reinforced by the research and the ethical responsibility assumed in the face of political, social, cultural, and economic questions. (BRASIL, 2012a, p.17)

As we did in Marques's experiment (2016), we sought, in Sá (2016), to recognise one of Skovsmose's (2000) landscapes of investigation in the execution process of the project at the mathematics fair. We tried to understand the paradigm that guided the practice performed and to identify which was the reference established in the project exposed in the event.

Like the mosaic project, the work of the electronic mockup was also guided by the research paradigm (SKOVSMOSE, 2000). In the moments narrated by Sá (2016) and in the messages transcribed from WhatsApp[7] in the research, we perceive the students' involvement in all the stages, from the research to the construction of the model, with contents that extrapolated much the mathematics, going to the area of programming. We also note an openness of the teacher-researcher to the interests and reality of the students, as follows:

> Although the research experience of one of the advisors, author of this dissertation, was in history of mathematics, the group started to negotiate a methodological approach, which could be with applications of theory, its history or games associated with content [..] (SÁ, 2016, p. 52)

Based on Sá's (2016) considerations, we can say that the work included situations with reference to semi-reality (SKOVSMOSE, 2000). The mockup that guides the research was based on a historical problem in Königsberg, Prussia. Although the representations do exist, they were not part of the daily life of the students, like the problem of the horses presented in Skovsmose (2000).

Final considerations

In their 30 years of existence, the mathematics fairs habe been an event for the socialisation of classroom practices that differs from others due to its free-of-charge, public character, and to its way of network management, in a collective and collaborative work. These characteristics, to our thinking, make mathematics fairs a unique event within mathematics education.

We realised that the projects analysed, "Mosaic based on the concept of proportion" and "Graph theory for high school: Possibilities from the use of electronic models", were both guided by the research paradigm, with reference to the semi- reality. Thus, we can associate the milieu of learning of the mathematics fair with the research scenario number 4 of Skovsmose (2000). Certainly, it is not our goal to label an experiment according to the landscapes of investigation established by our theoretical framework. On the contrary, we seek, from the barema indicated, to identify interdisciplinary potentialities that can favour the integrated and full education of the students of technical courses integrated to high school.

[7] WhatsApp is a cross-platform application for instant messaging and voice calls to smartphones. In addition to text messaging, users can send pictures, videos and PDF documents, as well as make free calls through an internet connection. The application was used by Sa (2016) as an instrument for producing and collecting research data.

The report of the teachers who advised, authors of the postgraduate research works, showed that the mathematics fairs, in fact, are presented as spaces where experiences with interaction between the sciences and technology areas of the technical professional education of middle level are communicated. In the end, although we understand that the construction of a curriculum matrix requires to have knowledge organised in disciplines, we conclude that the interdisciplinarity proposed in the mathematics fairs projects promotes the reconstitution of the whole of scientific knowledge from the relationship between concepts of different curriculum components, basic education and professional education.

Through this research, we tried to foster the reflection on the mathematics schoolwork with students of the middle-level professional education. Besides this work, we are carrying out a more in-depth study on the subject,[8] also including interviews with the teachers who acted as advisors of projects in mathematics fairs. Based on these reflections, we hope that the mathematics teaching plans can be updated to further explore the existing relationships between mathematics and the world of work, evidenced in this text from the production of works from mathematics fairs.

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