

Teacher Fabiana's resources to teach affine functions in a field high school

Recursos de la profesora Fabiana para enseñar funciones afines en la educación secundaria en una escuela de campo

Ressources de l'enseignante Fabiana pour enseigner la fonction affine dans un lycée en zone rurale

Recursos utilizados pela Professora Fabiana para ensinar função afim no ensino médio em uma escola do campo

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Abstract

The article is part of a master's dissertation that falls within the domains of the documental approach to didactics (DAD) and field education. The aim is to present an analysis of a teacher's resources to teach affine functions in a field high school and the relationship between these resources and the local farmers' productive activities. The research adopts the reflective research methodology within the framework of the DAD to produce data with the teacher, whom we call here Fabiana, through semi-structured interviews, video recording, and the creation of a map, where she presents the resources available at the field school to teach affine functions, analysis of the teacher's lesson plan, and observation of the planned lesson. To characterize the farmers' productive activities developed in the municipality, a survey of agricultural and livestock production was carried out in the IBGE Automatic Recovery System (Sistema IBGE de Recuperação Automática - Sidra) and semi-structured interviews with residents of the community where the school is located. The resources the teacher selected, constructed, and used were mostly concrete material and, in part, digital. However, non-material resources were identified, such as her reference to articles the students produced associated with their realities. The research results point to some needs, for example, to

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experience initial and continuing teacher education –which is based on the documentational approach to didactics and the principles of field education– to establish better relationships between the realities of students who live and work in the fields and the teaching of mathematics.

Keywords: Documentational approach to didactics, Resources, Field education, Farmers' productive activities, Affine function.

Resumen

El artículo forma parte de una disertación de maestría que se enmarca en los dominios del enfoque documental de lo didáctico (EDD) y de la educación de campo. El objetivo es presentar un análisis de los recursos de una profesora para enseñar funciones afines en una escuela secundaria de campo y la relación entre estos recursos y las actividades productivas de los agricultores locales. La investigación adopta la metodología de investigación reflexiva en el marco del EDD para producir datos con la profesora, a quien llamamos aquí Fabiana, a través de entrevistas semiestructuradas, grabación de video y creación de un mapa, donde presenta los recursos disponibles en la escuela de campo para enseñar funciones afines, análisis del plan de su plan de clase y observación de la clase planificada. Para caracterizar las actividades productivas de los agricultores desarrolladas en el municipio, se realizó un levantamiento de la producción agrícola y ganadera en el Sistema IBGE de Recuperação Automática - Sidra y entrevistas semiestructuradas con habitantes de la comunidad donde se ubica la escuela. Los recursos que la profesora seleccionó, construyó y utilizó fueron, en su mayoría, materiales concretos y, en parte, digitales. Sin embargo, se identificaron recursos no materiales, como la referencia a artículos producidos por los(as) estudiantes asociados a sus realidades. Los resultados de la investigación apuntan a algunas necesidades, por ejemplo, la de experimentar la formación docente inicial y continua –que se basa en el enfoque documental de lo didáctico y en los principios de la educación de campo– para establecer mejores relaciones entre las realidades de los(as) estudiantes que viven y trabajan en el campo y la enseñanza de las matemáticas.

Palabras clave: Enfoque documental de lo didáctico, Recursos, Educación de campo, Actividades productivas del campo, Función afín.

Résumé

L'article fait partie d'une recherche développée dans le cadre d'un master qui s'ancre dans les domaines de l'Approche Documentaire du Didactique (ADD) et de l'« Educação do Campo ».

Il vise à présenter une analyse des ressources utilisées par une enseignante pour enseigner la fonction affine dans un lycée en zone rurale et les relations entre ces ressources et les activités productives de la région. Il adopte la méthodologie de l'investigation réflexive, dans le cadre de l'ADD, pour produire les données avec l'enseignante, en utilisant: entretiens semi-structurés ; enregistrement vidéo et construction d'une carte dans laquelle l'enseignante présente les ressources disponibles au lycée pour enseigner la fonction affine ; analyse d'un plan de cours et observation de la leçon planifiée. Afin de caractériser les activités de production menées dans la municipalité, une enquête sur la production agricole et animale a été réalisée grâce au Système de Récupération Automatique de l'IBGE (Sidra) et des entretiens semi-structurés avec des résidents de la communauté. Les ressources sélectionnées, construites et utilisées par l'enseignante sont principalement matérielles, en partie numériques. Cependant, des ressources non matérielles ont été identifiées, comme la référence qu'elle fait aux usines de vêtements faisant partie de la réalité des élèves. Les résultats de la recherche mettent en évidence un certain nombre de besoins, dont une formation initiale et continue des enseignants basés sur l'ADD et les principes de l' « Educação do Campo », afin de promouvoir un enseignement qui explore les relations entre la réalité des élèves et l'enseignement des mathématiques.

Mots-clés : Approche documentaire du didactique, ressources, Education rurale, fonction affine

Resumo

O artigo é parte de uma dissertação de mestrado³ inserida nos domínios da abordagem documental do didático (ADD) e da educação do campo. Objetiva apresentar uma análise dos recursos de uma professora para ensinar função afim no ensino médio em uma escola do campo, as relações entre tais recursos e deles com as atividades produtivas camponesas desenvolvidas na comunidade em que a escola está situada. Adota a metodologia de investigação reflexiva, no quadro da ADD, para produzir os dados com a professora, por meio dos seguintes instrumentos: entrevistas semiestruturadas; produção de vídeo e mapa de recursos nos quais a professora apresenta os recursos para ensinar a função afim disponíveis na escola em que atua; análise do planejamento de uma aula fornecido pela professora; e observação da aula planejada. Para caracterizar as atividades produtivas camponesas desenvolvidas no município em que está a comunidade, realizaram-se um levantamento –no Sistema IBGE de Recuperação Automática (Sidra – da produção agrícola e pecuária e entrevistas semiestruturadas com moradores(as) da comunidade. Os recursos selecionados, construídos e utilizados pela professora são em sua

³ A pesquisa foi financiada pela Fundação de Amparo à Ciência e Tecnologia de Pernambuco (Facepe).

maioria materiais, dois quais parte são recursos digitais. Contudo, identificaram-se recursos não materiais, a exemplo da referência que ela fez aos fabricos de confecções associados às realidades dos(as) estudantes. Os resultados da pesquisa apontam para algumas necessidades relacionadas às escolas do campo, como a necessidade de vivenciar formações –iniciais e continuadas– de professores(as) referenciadas na ADD e nos princípios da educação do campo, para melhor estabelecer relações entre as realidades dos(as) estudantes camponeses(as) e o ensino de matemática.

Palavras-chave: Abordagem documental do didático, Recursos, Educação do campo, Atividades produtivas camponesas, Função afim.

Resources used by teacher Fabiana⁴ to teach affine functions in a field high school

The dissertation from which this article comes is part of a set of research that has been developed at the Center for Research, Extension, and Education in Field Education (Núcleo de Pesquisa, Extensão e Formação em Educação do Campo - Nupefec) of the Federal University of Pernambuco (UFPE), and at the Research Group on Teaching, Learning, and Educational Processes (Grupo de Pesquisa Ensino, Aprendizagem e Processos Educativos - Gpenape). Among the topics researched is mathematics teaching in field schools (Lima et al., 2020; Medeiros & Lima, 2021; Silva, 2017; Sousa et al., 2023), the context in which the dissertation is inserted.

Life in the rural environment involves several situations in which mastering mathematical concepts worked on at school can help solve everyday problems –for example, calculating the area of a portion of land, calculating the perimeter of a fence, or estimating the production of a given plantation based on the area and value of the inputs. In developing the research, we were particularly interested in the concept of affine functions, as we understand that it can be associated with situations experienced in the daily lives of men and women who live and work in rural areas. For example, it can be used to graphically represent the grain production of a given crop in relation to the area used for planting or the profit obtained from the sale of a specific type of grain. Farmer students can also create graphs that help them observe and understand the production of vegetables or grains during a predetermined period.

In this context, and assuming that this concept is consolidated in high school, we focus specifically on the resources used by a teacher who teaches the concept of affine functions at this level of education, Fabiana.

Guidance documents for the teacher's work, such as the National Curriculum Parameters for Secondary Education [*Parâmetros Curriculares Nacionais do Ensino Médio*] (Ministério da Educação, 2000, p. 42), indicate the relevance of the concept of functions and its internal connections with mathematics:

The concept of functions also plays an important role in describing and studying, through reading, interpreting, and constructing graphs, the behavior of certain phenomena in everyday life and other areas of knowledge, such as physics, geography, or economics.

⁴ The name in the text is fictitious to preserve the participant's anonymity, following the ethical guidelines established for scientific research.

In turn, the Parameters for Basic Education in the State of Pernambuco [*Parâmetros para a Educação Básica do Estado de Pernambuco*] (Secretaria de Educação de Pernambuco, 2012, p. 129) state that “functions play a central role in secondary education, mainly due to their role as a mathematical model for studying variations between quantities in phenomena of the natural or social world.” Among the skills recommended by the *Common National Curriculum Base* [Base Nacional Comum Curricular – BNCC] (Ministério da Educação, 2018, p. 536) on functions, we have: “Solving and developing everyday problems in mathematics and other areas of knowledge, involving simultaneous linear equations, using algebraic and graphical techniques.” Thus, from a teaching point of view, the concept of functions is considered relevant to help people solve everyday problems in different sociocultural contexts – among them, we turn our attention to the contexts of field education.

Field education (Caldart et al., 2012; Lima et al., 2021) has its origins in the demands of rural social movements and has been consolidated in recent years in teaching and research, including in mathematics education (Lima et al., 2020; Silva, 2017). One of the main demands of the Movement for Field Education [Movimento por uma Educação do Campo] is access to quality, socially-referenced education that meets the needs of the people of the countryside, waters, and forests. The movement opposes rural education, which has among its characteristics the exploitation of the labor of people who live and work in rural areas, considering the countryside a place of backwardness, lack of knowledge, and lack of culture. Field education demands human emancipation, rethinking the conception present in society, and reflection on the relevance of the knowledge and culture of rural residents as subjects capable of transforming their social environment.

In this broad problem, we are mainly concerned with mathematics teaching in field schools. For Lima et al. (2021, p. 9), the field school “is characterized, primarily, by the protagonism of its educational subjects with their histories, their knowledge and their cultures, as well as by the characteristics of the territory where it is located.” Therefore, the mathematical content taught in this school must be addressed from a perspective that seeks to strengthen culture, ways of life, work, and production, among other aspects that characterize the local rural workers. To this end, teachers must relate school knowledge to routine situations, which becomes possible when they (re)cognize the characteristics of the community expressed by the biomes and the productive activities developed by the rural workers, the local culture, and the role the school plays in society.

Regarding resources for teaching mathematics, the *BNCC* (Ministério da Educação, 2018, p. 276) advises, for example, that the use of “grids, abacuses, games, books, videos,

calculators, spreadsheets, and dynamic geometry software” can help students understand mathematical notions. In addition to these resources mentioned in the BNCC, teachers who teach in field schools can integrate resources –both in their planning and in their classes– originating from different rural realities, such as agricultural practices, livestock activities, or others linked to new ruralities.

Indeed, the relationship between the content taught at school and everyday needs will only be explicit to students if the teaching provides an understanding. One way for this to happen is to use their realities as a reference for the development and experience of mathematical activities. From this perspective, we are interested in the resources that high school teachers select, build, and use to teach affine functions and the relationships they establish with the productive activities developed by rural workers in the communities we chose to carry out the research. This article presents only a section of the dissertation, which is still in press. Our objective is to present an analysis of teacher Fabiana’s resources for teaching affine functions in a field high school, the relationships between such resources, and their relationship with the rural productive activities developed in the community.

To this end, after this introduction, we present the structuring theoretical elements of the documental approach to didactics (DAD) that supported the research. Below, we detail the methodological path and highlight the main results obtained from analyzing teacher Fabiana’s work.

Structural elements of the DAD

To teach, teachers use, based on lesson planning, several resources ranging from textbooks to access to various Internet websites. Understanding the selection, production, and use of these and other resources available for teaching is complex, but it can contribute to their work.

The DAD proposed by Trouche and his collaborators (Gueudet & Trouche, 2010) has been dedicated to studying this theme. This approach has as its primary source the instrumental approach developed by Rabardel (1995), which treats the notions of scheme, artifact, and instrument as central concepts. According to the researcher, the artifact refers to what is material or symbolic. The instrument arises from the interaction of the subject with the artifact, and this interaction involves the usage schemes that the subject makes of the artifact. Bittar (2011, p. 160) says:

In the instrumental approach, an artifact can be a material medium, such as a hammer, a hoe, or a symbolic medium, such as a symbolic language (algebraic language, vector

symbols, etc.). The instrument consists of the artifact plus one or more schemes for using this artifact, which are schemes constructed by the subject.

The DAD is interested in selecting and using resources –teachers’ documentary work– and how this influences teaching-learning and improves teaching work (Gueudet & Trouche, 2010).

The DAD revisits the studies of Adler (2000), who considers the term “resource” as a verb (*resource*), which means “to nourish again from the source” –and thus makes the meaning of the term “resource” more comprehensive. The author proposed the following classification: **human resources**, which concerns teachers’ decision-making, their guidance, and professional knowledge; **material resources**, which can be school books, educational software, calculators, and notebooks, among other everyday objects; and **cultural resources**, which are linked to language –verbalization, informal conversation, and exchange of experiences– and time (class period, planning, and time organization). For her, “the resources function as an extension of the mathematics teacher in the teaching-learning process” (Adler, 2000, p. 207).

Within the framework of DAD, Bellemain and Trouche (2019) defend the broad notion of resources proposed by Adler (2000); however, they propose some restrictions, as in the following quote:

What is external to the teacher: teacher knowledge is not considered here as a resource, instead, what guides the work with the resources, being constantly renewed by this work; what is material: human beings – for example, the teacher’s colleagues – are not considered resources. On the other hand, advice, messages, and proposals from colleagues as material or materializable entities are taken as resources. (Bellemain & Trouche, 2019, p. 117)

Trouche (2018) classifies teachers’ resources into **material** and **non-material** resources. As examples of material resources, we cite a laptop, games, websites, books, and curriculum matrices; and as non-material resources: a piece of advice from a fellow teacher, a reference to rural productive activities, or a student’s idea.

According to Trouche et al. (2020, p. 5), “Teachers’ work always incorporates a conscious/deliberate act of conception, of creating ‘something new,’ for example, the combination of existing and new elements, to achieve a specific didactic objective.” In this context, the notion of scheme proposed by Vergnaud (2009) plays a crucial role in DAD insofar as two or more teachers –even with the same didactic intention –can use the same resource in different ways to, for example, teach affine functions in a class of first-graders of high school. This will depend on the schemes they use as a result of their teaching experiences, the

characteristics of the class, their identification with the school, and their education, among other factors.

Thus, taking Vergnaud's studies (2009) as a reference, a scheme within the DAD framework is described based on four components: activity objectives, action rules, operational invariants, and possibilities of situation inferences. The teacher-resources relationship is permeated by the processes of **instrumentation** and **instrumentalization** that come from the instrumental approach (Rabardel, 1995). According to Trouche et al. (2020), the instrumentation process is characterized by the influence of resources on the teacher's work, whose activity is then guided by resources. In the instrumentalization process, the teacher appropriates the resource and makes modifications and/or adaptations to it, transforming it for teaching. The authors represent the process of documentary genesis as it appears in Figure 1 below.

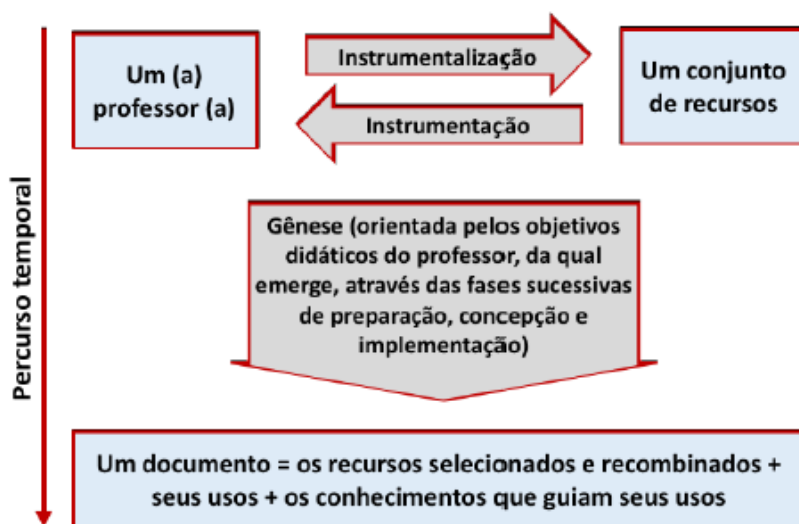


Figure 1.

Schematic representation of the documentary genesis (Trouche et al., 2020, p. 4)

Bellemain and Trouche (2019, p. 118) emphasize that “A teacher’s resource system is a living entity, structured in relation to his/her activity (according to teaching levels, types of activity, etc.).” The resource system comprises all the resources whose functionalities and characteristics –which may evolve over time– the teacher has already acquired.

Hammoud (2012), in turn, names the recombined resources that are part of the construction of a document. She classifies as **mother-resources** the set of initial resources that the teacher reserves for a class or course and as **child-resources** those already adapted or modified that will be implemented at the end of the class or course. In this way, child-resources are the product of mother-resources. Aligned with the author, Assis and Trouche (2021) deal

with the dialectic that involves the resources teachers have available, the mother-resources; and the resources that result from their adaptation, child-resources, as shown in Figure 2 below.

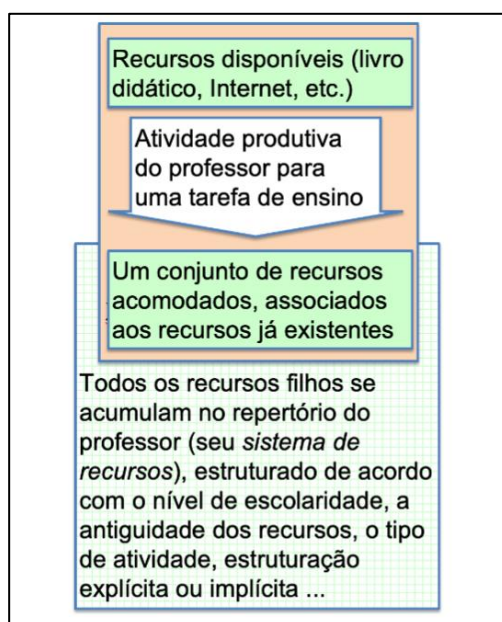


Figure 2.

From mother-resources to child-resources (Assis & Trouche, 2021, p. 407)

When a teacher plans a lesson or a course for a group of students from field schools and selects a game or a list of problems to teach affine functions, for example, we can consider the game and the list of problems as the mother resources used by the teacher. When the teacher uses knowledge of the school's context and modifies the game and the problems to bring them closer to the students' reality, we have child resources.

Among the elements and processes that make up the theory and structure our research, we are interested in the notion of material and non-material resources proposed by Trouche (2018) and the classification of mother and child resources coined by Hammoud (2012). These elements provide theoretical support and are relevant to analyzing the resources used by teacher Fabiana and the relationships she could establish to teach affine functions to students at the field school. Such relationships can tell about her initial education, knowledge of the countryside, identification with the field school, professional experience, and the productive rural activities of the community.

Methodological procedures

The research was conducted in three field schools of the state education network located in three municipalities from the Agreste region of Pernambuco. To select the schools, we had

the help of the Field Educational Policy Management (Gerência de Políticas Educacionais do Campo - Gepec) of the Pernambuco Department of Education and Sports, which provided a list of field schools that offer high school education. We first contacted the three schools on the list to present the research proposal to the principals, who showed interest in participating. Teacher Fabiana taught mathematics in the first and second grades of high school and youth and adult education (Educação de Jovens e Adultos - EJA), also at the high school level, at one of the three schools.

To select the three teachers participating in the research – including teacher Fabiana –, we used the following criteria: having a degree in mathematics, working in secondary education in field schools, and having experience as a teacher in this area of knowledge. First, we gave a brief presentation of the research objective to the principal and then to the teachers, to whom we explained our intention to conduct interviews, monitor a class planning, and observe that class. At this point, we delivered the letter to the principal, requesting access to the school with their signature. We then asked the teachers to sign the *Research Participation Consent Form*. In this term, we also assumed the ethical commitment to guarantee the anonymity of the school and participants and to use the data collected exclusively for academic purposes.

At the same time, we sought to characterize the rural productive activities developed in the three municipalities that host the three schools. To this end, as the first instrument, we surveyed the IBGE Automatic Recovery System website⁵ (Sistema IBGE de Recuperação Automática - Sidra) to identify agricultural and livestock production in the last three years. We established this time frame to observe some stability in the productive activities in the municipalities. Finally, we conducted semi-structured interviews with ten farmers, primarily residents living near the investigated schools –to this end, we had the help of teachers' and the schools' management team. Most respondents were students' parents, and conducting the interviews was important to confirm and complement the information obtained through Sidra about the productive activities developed in those municipalities.

To organize data production with teacher Fabiana – and the other participating teachers –, we used the reflective inquiry methodology, which originates in the DAD (Trouche et al., 2020). This methodology has principles such as: long-term monitoring; monitoring anywhere, with extensive data collection on the resources produced and used by the teacher; reflective monitoring of documentary work; principle of confrontation; and principle of methodological contract. We did not use the first principle, as its implementation required long, which we could

⁵ Sidra website is available at <https://sidra.ibge.gov.br/home/pnadcm>

not afford during data production with the teacher. Regarding the second principle, corresponding to monitoring anywhere, our boundaries were the school environment, according to the availability of the participating teachers.

In this context, the second instrument was a semi-structured interview with the teacher to understand her academic background, experience with mathematics teaching, identification with the field school, and knowledge of her students' rural activities. The third instrument consisted of recording a video with a mobile, where the teacher presented the resources available at the field school to teach affine functions. As the fourth instrument, we asked the teacher to build a resource map –based on examples we provided– explaining how she used these resources, a construction process we recorded on video.

The fifth instrument was analyzing a lesson plan –delivered by the teacher– to teach affine functions. She also orally explained details, such as class time and resources used. The sixth and final instrument consisted of observing the planned class, which had been recorded on audio and video, to identify how the teacher related the resources she had selected and the relationships she eventually established between the concept of affine functions and the rural productive activities the first instrument had indicated.

To organize the data and carry out the analysis, as announced, we used the assumptions of the DAD based on the principles of field education.

Analysis and discussion of results

Teacher Fabiana holds a teaching degree in mathematics from UFPE and a *lato sensu* specialization in mathematics teaching. At the time of the research, she had been working as a teacher for 11 years in public and private schools, but most of the time in the public system. She taught mathematics in the first and second grades of high school and YAE at the high school level in one of the field schools. At some point, the teacher had also taught sociology, arts, philosophy, biology, and chemistry. When asked if she knew the history of the school, she replied:

So, it was a primary school with only two classrooms and a cafeteria. I studied in that primary school. Later, as time went by and governments changing, the school became state-owned and was expanded. (Teacher Fabiana)

At that time, the teacher lived in the same community where the school she worked at was and where she received her basic education. When asked about the productive rural activities of the community, she commented: “*The community has many traders, few farmers,*

most are seamstresses, factory owners, or sew for others.” She also reported that most students who studied at night worked as seamstresses in those factories. Teacher Fabiana’s speech aligns with the data we collected at Sidra about the reduction in agricultural and livestock production in the municipality and confirms the data collected in interviews with farmers about clothing manufacturing as one of the main productive activities. Therefore, we can see that the teacher was well aware of the activities carried out by the community’s residents, including the students.

Below, we present the resources the teacher cited for the teaching of affine functions, the classification into mother resources and child resources, and also the relationship between the resources and their relationship with the identified rural productive activities.

Teacher Fabiana’s resources for teaching affine functions

- Material resources: textbook, education management (Gerência de Educação - GRE) handouts with questions from the Pernambuco Educational Assessment System (Sistema de Avaliação Educacional de Pernambuco - Saepe), whiteboard, A4 sheet of paper, cardboard⁶, Twister, notebook, mobile, Graphs of the Galaxy, projector⁷, Google Maps, summaries, calculators, and exercise lists.
- Non-material resources: students’ ideas and contexts of their realities.

As we can see, the teacher mentioned several resources, including the game Twister, which she modified to teach affine functions. When asked whether using this resource helps students’ learning, she replied: *“Yes, because they learn while playing. They don’t feel like they are studying, but they are studying... They are there putting into practice what they have learned, and even reinforcing it so they can remember it for the tests.”* The teacher also said that she used Google Maps to present a notion of Cartesian coordinates. When asked whether she uses the same resources to teach affine functions every year, she answered that she makes changes depending on the class’s performance.

⁶ Game that involves physical skills and consists of using a carpet with markings where players occupy the spaces.

⁷ <https://maps.google.com>

Teacher Fabiana explained that the GRE of the Education Department sent booklets to the school about the descriptors of the Basic Education Assessment System (Sistema de Avaliação da Educação Básica - Saeb) and Saepe, which contained questions involving affine functions. She also produced exercise lists based on research on the Internet and textbooks and used the whiteboard to construct graphs of the functions.

We classified most of these resources as materials, but she mentioned the use of “student ideas” –which we classified as non-material– to create games to meet their didactic intention.

She explains:

It happens that I get the student’s idea... the student was playing UNO, which they bring to school and play during the break, so I came up with the idea of using UNO. I am currently developing a game based on UNO to teach algebraic expressions. (Teacher Fabiana)

Teacher Fabiana claims that she does not remember having used an idea or strategy from a colleague to present the concept of affine functions; however, she ponders: “I still use many of the ideas from the investigations we did in the Didactics classes I had at college, so I can still bring and apply them.”

We also consider the **contexts of students’ realities**, which the teacher cited, as a non-material resource used to work on affine functions. She described:

When I work with affine functions, for example, I present a problem situation for them to write the function expression. So, in the clothing manufacturing part... They work with a fixed value and a production share. When they are sewing, each piece has a value, and they can roughly calculate their income using the affine function. (Teacher Fabiana)

In this situation, the teacher mentions data inherent to clothing manufacturing, one of the community’s productive activities, to teach affine functions. Therefore, we classify “contexts of the students’ realities” as a non-material resource.

Mother resources and child resources

The teacher handed us a written lesson plan to introduce the content of affine functions and explained how each stage of the lesson would occur during the interview. Based on the planning and the observed class, we identified the main resources the teacher used to introduce the concept of affine functions to a second-grade high school class. She highlighted that the

class had already had very brief contact with the content on affine functions the previous year due to the COVID-19 pandemic. Moreover, she said that many students had not followed the classes remotely. Therefore, she planned an introductory class on the concept of affine functions to highlight its main elements.

The first child resource we identified was a **summary** built by the teacher for the students on the history of the concept of affine functions, citing the leading mathematicians who contributed to formalizing the concept of functions. Through research on the Internet and in textbooks, she summarized the relevance of the work of mathematicians such as Leibniz and René Descartes in the evolution of the concept of functions.

At one point in the class, before dealing with the graphical representation of the affine function, the teacher revisited the concept of the Cartesian plane and emphasized its main elements. Considering that some students had difficulty relating the points on the Cartesian plane, she drew a representation of a **minefield** –about the minesweeper game, which the students were familiar with– to relate it to the Cartesian plane. We consider the teacher’s representation of the game on the board a child resource.

The teacher asked the students to use Google Maps on their mobiles at a given point. She instructed them to enter the school’s name in the search field and record the geographic coordinates given –the students showed interest when they realized they could see the school and their homes through the app. Then, the teacher asked them to locate the school’s geographic coordinates on the Cartesian plane, where the x-axis would correspond to the equator and the y-axis to the Greenwich Meridian. Hence, she established a relationship between geographic coordinates and the Cartesian plane to facilitate the location of ordered pairs on the plane. We consider this case as another child resource built by the teacher –from using the mobiles, the Google Maps app to the context of the students’ realities– to explain the location of ordered pairs on the Cartesian plane.

After defining affine functions and their main characteristics, the teacher used a game (Cf. Figure 3), which she built inspired by Twister, which, according to her, would help students “fix” the content. The teacher explained that she used this resource –made with cardboard and A4 sheets of paper– because something different sparked students’ interest.

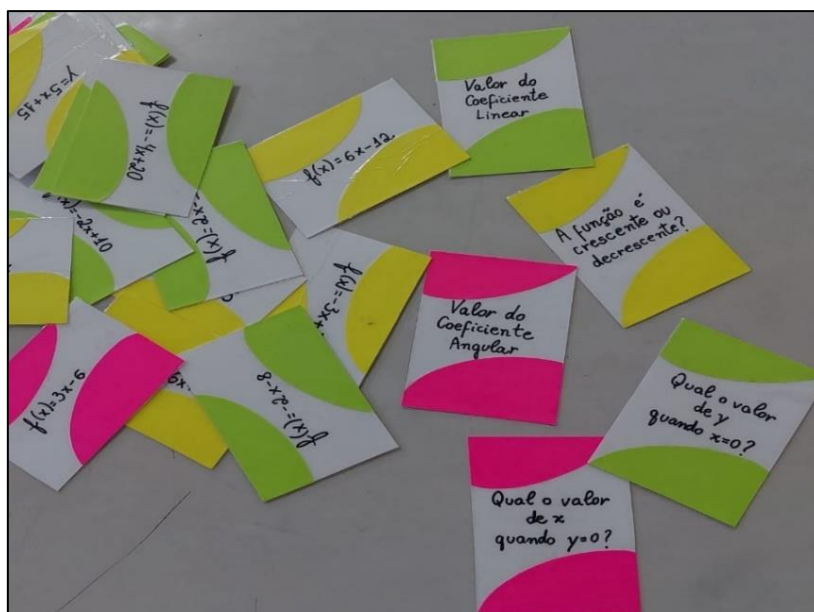


Figure 3.

Child resource used by teacher Fabiana

At the end of the class, the teacher announced to the students that, due to time constraints, she would use the game with them in the following class –so, we did not have access to the resource.

Relationship between resources for teaching affine functions and their relationship with rural productive activities

In Figure 4, teacher Fabiana presents a schematic representation (map) of her resources for teaching affine functions.

We consider that the larger arrows connecting one frame to another indicate the order of the moments planned by the teacher, and the shorter arrows, which start from each frame outwards, indicate the resources that she uses in each of these moments. In addition to material resources –such as a projector, textbook, board, exercise list, content summary, and games –, the teacher included in her map the use of non-material resources, such as **informal conversation**. About this, she says: “*I take into account almost everything they say in class... I take it and take advantage of it... they are being ‘pulled’ into a line of reasoning.*” This resource seems central to organizing the class because, before conceptually defining affine functions, it promotes a conversation with the students – and with each other– about everyday situations.

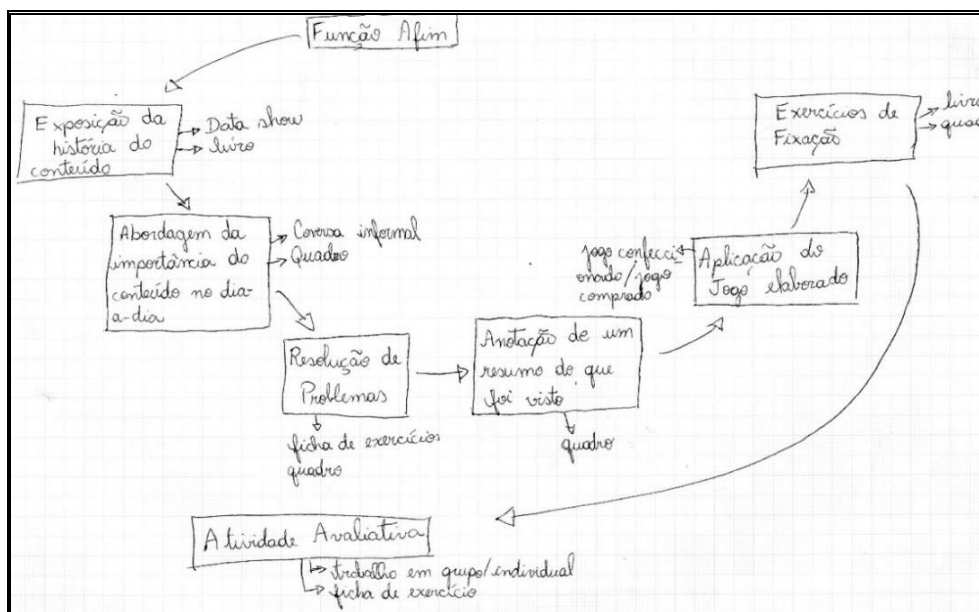


Figure 4.

Schematic representation of resources for teaching affine functions

We observed an important correspondence between the schematic representation (map) and its planning, which includes child resources, such as the “elaborate game” –inspired by Twister–, the “exercise list” and the “summary.” To prepare the list of exercises, the teacher consulted the “Saepe curriculum matrix” and selected questions from “books.” Finally, to build the summary, she researched “Internet websites” and “books.” Therefore, those are mother resources insofar as they were used as a basis for constructing other resources.

At the beginning of the observed class, the teacher sought to encourage students to talk about the activities they carried out daily, aiming to relate them to the concept of affine function. She asked: “*Does anyone here work in retail? How do you know if you are making a profit or a loss?*” A student replied that she worked selling slices of cake. Based on this answer, the teacher created a hypothetical situation involving selling slices of cake and wrote it on the board, relating it to the affine function. In this situation, she brought elements of local commerce and productive activities to the classroom.

The teacher then asked the class about the manufacture of clothing, which is the main productive activity in the municipality. Below is an excerpt from the observed class. First, however, it is important to emphasize that we do not intend to analyze the teacher’s choices or

her teaching methodology. Our interest is in the resources she uses and the relationships she seeks to establish with the students' realities.

Teacher Fabiana: *Does anyone work sewing?*

Student: *Yes!*

Teacher Fabiana: *Do you work on a production basis?*

Student: *Yes.*

Teacher Fabiana: *How much do you earn per piece produced?*

Student: *I earn three reais a piece.*

Teacher Fabiana: *So if she makes a hundred pieces, how much does she earn?*

Class: *Three hundred reais.*

Teacher Fabiana: *If she produces ten pieces?*

Class: *Thirty reais.*

Teacher Fabiana: *So, three reais is the value of one piece, it will vary in relation to the number of pieces produced. How many pieces do you sew per month?*

Student: *There, I produce about three hundred pieces every fortnight.*

Teacher Fabiana: *So, let's calculate per fortnight. Is there a fixed amount that you earn?*

Student: *No.*

Teacher Fabiana: *So, the function will be $f(x) = 3x$, where the value of x refers to the quantity of parts you produce. So, in a fortnight you get $f(300) = 3 \times 300 = 900$, that is, nine hundred reais. If you produce less, you will receive less.*

At that moment, the teacher used the board to write the function and interact with students. For us, the relationships she sought to establish between the concept of the affine function and the productive activities of the municipality were evident based on the students' knowledge. We consider this situation in class a rich resource used by the teacher.

Final considerations

In this article, we present an analysis of the resources teacher Fabiana –who taught mathematics at a field school in the Agreste region of Pernambuco– selected and/or used to teach the concept of affine functions in high school. We also sought to analyze the relationships established between such resources and the productive rural activities of the municipality. For this purpose, we relied on studies on field education and DAD.

To better support the research, we carried out a study to identify the main productive activities developed in the municipality where the field school is based, and the data indicated that the main activities were clothing manufacturing and commerce.

The data production steps carried out with teacher Fabiana showed that she had various resources available to teach affine functions. The resources were mostly characterized as

material resources, including digital ones: textbook, GRE handouts with Saepe questions, whiteboard, A4 sheet of paper, cardboard, exercise list, summary, calculator, Twister game, laptop computer, Graphs of the Galaxy, projector, Google Maps, and mobile. Less frequently, the teacher presented non-material resources –such as the contexts of the students’ reality, their ideas and informal conversations about their daily lives– to introduce affine functions teaching.

Some of the child resources constructed by the teacher demonstrated her concern in relating the municipality’s productive activities (clothing manufacturing and commerce, in particular) with the concept of functions. In the resource map (cf. Figure 4), she highlighted the moments when she intended to use them and the relationships she sought to establish between them and with the realities of the rural students, which also occurred in the class we observed.

At the time of the research, teacher Fabiana had more than 11 years of teaching experience, mostly in public schools, field schools, and private institutions. At the time of the research, she was teaching mathematics in the first and second grades of high school and YAE at the high school level at a field school. She highlighted that in her teaching practice, she worked on some ideas and strategies learned in didactics classes during her initial education and sought to adjust them to meet students’ specific needs.

We recognize the effort made by the teacher to bring the teaching of mathematical concepts closer to students’ realities and the rural area where the school is. However, the results pointed to some needs of the field schools, among them, the need to experience initial and continuing education for teachers based on DAD and the principles of field education to support better teaching work based on the resources that teachers select, modify, construct, and use to teach mathematics.

We also consider that carrying out new research in different educational and sociocultural contexts –based on these theoretical approaches– emerges as pertinent to deepen further the understanding of the relationships that can be established between the resources selected, constructed and used by the teacher to teach mathematics and the real needs of schools and, above all, of students.

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Data supporting the research findings will be made available by the first author, [ACB], upon reasonable request.