CHALLENGES AND POSSIBILITIES OF CURRICULAR INTEGRATION: AN ANALYSIS OF THE MATHEMATICS TEACHING IN AN AGRICULTURE AND LIVESTOCK TECHNICIANS TRAINING

DESAFIOS E POSSIBILIDADES DA INTEGRAÇÃO CURRICULAR: UMA ANÁLISE DO ENSINO DE MATEMÁTICA NA FORMAÇÃO DO TÉCNICO EM AGROPECUÁRIA

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ABSTRACT

The present work analyses the teaching of mathematics in the technical professional mid-level education program integrated to high school in the process of training agriculture and livestock technicians in a campus of the Federal Institute of Espírito Santo. We performed a documentary research and observations of classes and pedagogical meetings, applying a qualitative method to analyse the data. The results suggest the importance of mathematics for the training of agricultural technicians, from its abstract and intuitive use to its applied use as basic mathematical concepts necessary for problem solving and execution of projects and practices related to the program field. In this context, we find that mathematics is intrinsic to the vocational courses and, thus, participates in and favours the process of curricular integration. However, we observed a unidirectional movement of pedagogical practices for curricular integration between vocational courses and High School Mathematics courses. Interdisciplinarity of mathematical knowledge occur in vocational courses, but mathematics courses do not integrate vocational courses knowledge. We believe in the search for pedagogical practices that allow students to develop abilities to operate, apply, and reflect on ideas, algorithms and mathematical procedures, not just for their practical application to market demands.

Keywords: Curriculum. Mathematical education. Professional education. Curricular integration. Pedagogical practices.

RESUMO

O presente trabalho analisa o ensino da matemática na educação profissional técnica de nível médio integrada ao ensino médio no processo de formação do técnico em agropecuária em um campus do Instituto Federal do Espírito Santo. Com abordagem qualitativa, utilizou-se de pesquisa documental e observações de aulas e reuniões pedagógicas. Os resultados revelaram a importância da matemática para a formação do técnico em agropecuária, fazendo-se presente desde a sua utilização mais abstrata e intuitiva, até a necessidade de aplicação de conceitos matemáticos necessários à resolução de problemas e execução de projetos e práticas relacionadas à área do curso. Nesse sentido, constatou-se que a matemática é intrínseca às disciplinas técnicas, e, portanto, participa e favorece o processo de integração curricular. No entanto, verificou-se um movimento não recíproco de práticas pedagógicas em direção à integração curricular, ocorrendo um fluxo unidirecional de construção da interdisciplinaridade do ensino técnico para com os conhecimentos matemáticos e que não ocorre da matemática

para o ensino técnico. Assim, acredita-se na busca por práticas pedagógicas que permitam desenvolver nos alunos habilidades para operar, aplicar e refletir sobre as ideias, algoritmos e procedimentos matemáticos, não se limitando apenas à sua aplicação prática para atender à demanda mercadológica.

Palavras-chave: Currículo. Educação matemática. Educação profissional. Integração curricular. Práticas pedagógicas.

1. Introduction

In recent years, mathematics has gained important space in the field of curriculum as either a discipline or an area of knowledge. In the professional technical mid-level education integrated to high school, this space is increasingly broader as it allows the dialogue between disciplines, in the development of projects as well as a discipline that has its own language, assisting the construction of abstraction skills and logical reasoning.

In the field of agricultural education, we see the increasing incorporation of scientific-technological resources and new models of production management, which requires technical but also political and social training of professionals in order to meet these new demands. In this context, we see mathematics as the science that permeates the different fields of knowledge and has become the basis for science, technology, and communication. It constitutes an important knowledge that generates worldviews, education, work training, work design, science, and technology, which contributes highly for the agro-technical education process.

Given that, one of the major challenges facing the Federal Institutes of Education, Science and Technology (FIs), especially the former Federal Agrotechnical Schools, is to promote the relationship between the various fields of knowledge in order to enable human development and emancipation. This leads to the appropriation and mastery of scientific and technological knowledge, which goes beyond knowing how to make things.

To address these questions, we will take a campus of the Federal Institute of Espírito Santo (Ifes), located in the city of Alegre, as scenario. Since its establishment, this school has undergone several political, social, and economic changes that happened in the country. These educational reforms raised studies, debates and discussions at the school environment, aiming to comply with several rules such as the precepts of Decree-Law No. 9,613/1946, denominated "Organic Law of Agricultural Education", and the LDBEN nº 9.394/1996, in force until the present date.

With the enactment of Law No. 11.892/2008, the Ifes - Alegre Campus went through another period of changes and ruptures, starting from a new denomination and novel structure, practices, and experiences by students, teachers, administrative and pedagogical staff. And more, in order to comply with Decree 5,154/2004, the school started to offer technical courses integrated to high school. With this new pedagogic proposal, the program plans were elaborated based on the conception that the integral training should overcome pedagogic practices and professional qualification with the reduced vision of an operational, immediatist and segmented training, and concentrate on the work and citizen development by students.

In the present work, we will analyse the teaching of mathematics for agricultural technicians at the Ifes - Alegre Campus, from 2008 to 2016. We conducted fieldwork through documentary research and observation of classes and pedagogic meetings. We analysed data qualitatively, using three codification categories: pedagogical practices; curriculum integration; and mathematics education.

2. Mathematics teaching and curricular integration with a focus on integral human development

Mathematics may be defined as a strategy developed throughout human's history to explain, understand, manage, and coexist with reality, within a natural and cultural context. In this context, learning occurs at any moment and in any environment. This affects the concept of school, especially of mathematics education, strongly influenced by the hierarchization of learning (D'Ambrosio, 1993; 2013).

There are three ways to look at mathematics: as a way of understanding nature; as an invaluable resource for the development of science and technology; and as pure rationality. These three ways of looking at mathematics operates in the development of a concept called "modern mathematics education" (Skovsmose, 2014, p.74), an indispensable tool for understanding nature, carrying out technological projects, and valuing mathematics in its pure form. In this sense, the word mathematics does not refer only to advanced mathematics, or to applied mathematics. Mathematics is part of the sociotechnological actions and everyday contexts. Through mathematics, it is possible to create situations, analyse them in detail, and understand the hypothetical state of occurrences arising from such situations, relating knowledge, action, and reflection (Skovsmose, 2007).

In addition to an educational perspective, mathematics should be considered from the philosophical and sociological point of view, considering that it represents a giant variety of cultural techniques integrated in routines of daily life, science, technology, economy, business, and industries worldwide. In this scenario, one of the roles of the school is to give access to the sources of knowledge that are important for the maintenance and improvement of the mechanism that supports globalization and the economy associated with it. Furthermore, it is essential that students develop the skills to interact and act in economic, social, and political situations structured by Mathematics, which Skovsmose (2007, 2014) calls "mathemacy".

Understood as support for the development of critical citizens, mathemacy concerns the ability to calculate and use mathematical techniques, but it is also a skill associated with reflection to act in a world strongly structured by mathematical models. Mathemacy refers to a competence that can be discussed in terms of the ability to understand and operate ideas, algorithms, and mathematical procedures; in terms of skills to apply all these ideas, algorithms, and procedures in a variety of situations; or in terms of skills to reflect and reconsider the reliability of all such applications (Skovsmose, 2007, 2014).

In this context, we observe mathematics with a focus on a citizen training, which is called individual integral human development in the curriculum field of a professional technical mid-level education integrated to high school. This training must be understood from three structuring concepts: a) work, as a principle that organises the unitary basis of high school education; b) science, which presents the knowledge that underlies the techniques; and, c) culture, synthesis of general and specific development through the different forms of creation existing in the society (Frigotto & Ciavatta, 2004). These three structuring concepts - work, science, and culture - must be embedded in all dimensions of life.

Mid-level education, the last stage of basic education, constitutes a social and subjective right, linked to all spheres and dimensions of life, and should help students to understand in a critical way the society in which they live and their relation to nature (Frigotto, 2005). It's not just about mastering the scientific and technological knowledge, it is also necessary that mid-level education contributes to the formation of ethical, critical, creative and conscious citizens of the world in which they live, in such a way that they are able to act in a responsible manner in society.

The integrated articulation between technical vocational education at the high school level and high school suggests that general education becomes an inseparable part of professional education in all fields where work is prepared, focusing on it as an educational principle (Ciavatta, 2005). Thus, a high school project integrated with technical education, concentrating on work, science, and culture, should seek to overcome the duality between general education and vocational training, shifting the focus from labour market objectives to human, labour, cultural, and technical-scientific development (Ramos, 2005; Ciavatta & Ramos, 2012).

The development of critical citizens is also a concern of critical mathematics education, which recognizes that the teaching and learning of mathematics happens in the world in the most diverse conditions and in many different ways, which can impact the concepts and theories that are developed and imposed on society (Skovsmose, 2007).

Thus, mathematics as a science that crosses the different fields of knowledge, the basis for science and technology, can contribute to the construction of an integrated curriculum. This strengthens the articulation between mathematical and professional-technical knowledge, with a view on ethical training and intellectual improvement of students, so that they can act in all fields, i.e., in the society, business world, or continuing with their studies.

3. The year 2008 ends: from EAFA to Ifes - Alegre Campus

At Ifes - Alegre Campus, the first decade of 2000 was a period of continuing ruptures regarding the concepts of professional-technical education at the secondary level. At first, they tried to adapt to the actions proposed by Decree nº 2.208/1997, which conceived a professional education with its own independent curricular organization from high school. Next, following the repeal of this decree and the actions proposed by Decree 5.154/2004, high school and technical education were integrated, aiming at consolidating the basic, unitary, and polytechnical training centred on work, science, and culture, in a mediate relation with professional training (Frigotto, Ciavatta, & Ramos, 2005, pp. 43-44).

In 2008, the Federal Institutes Act was signed, and the former Federal Agrotechnical School of Alegre (EAFA) turns to be called Ifes – Alegre Campus. In the following year, the school began to offer the technical agricultural program integrated to high school. This pedagogical proposal was elaborated from a conception that the integral formation of a student requires overcoming pedagogical practices and professional qualifications narrowed out to a vision of operational, immediatist, and segmented training, having the work and citizen training as articulating axes. The guiding principles were synthesised into flexibility, interdisciplinarity, plurality of knowledge and languages, work and research as educational principles, praxis, and studies continuity.

In the high school mathematics teaching plan for first-year students, the planning aimed at "[...] the integration of mathematical contents with other areas that require their mastery", with indicated teaching procedures and suggestion of work for integrating knowledge through project methods (Ifes - Campus de Alegre, 2009). The said plan also suggested the interdisciplinarity between mathematics and vocational training courses as well as the applicability of mathematics in concrete situations, beyond the technical disciplines. The document proposes the idea of integrating concepts and applications in the curriculum that enable the learner to apply mathematics to everyday situations. In this respect, we corroborate with Ciavatta (2005), who explains:

> […] both the teaching-learning processes and the curricular elaboration must be object of reflection and systematization of knowledge through the basic disciplines and the development of projects that articulate the general and the specific, the theory and practice of the contents [...] (Ciavata, 2005, p. 100).

In this context, mathematics teaching programs bring contents related to elementary education aimed at meeting special requirements of vocational courses while it also proposes the high school contents.

4. Mathematics in the vocational courses

In the exams carried out by the students, we observed the importance of applying mathematical concepts for solving real problems faced by an agricultural technician.

In the assessment of the General Agriculture course (Figure 1), the students were required to apply their knowledge of transforming units of measure and the simple rule of three to resolve the problem.

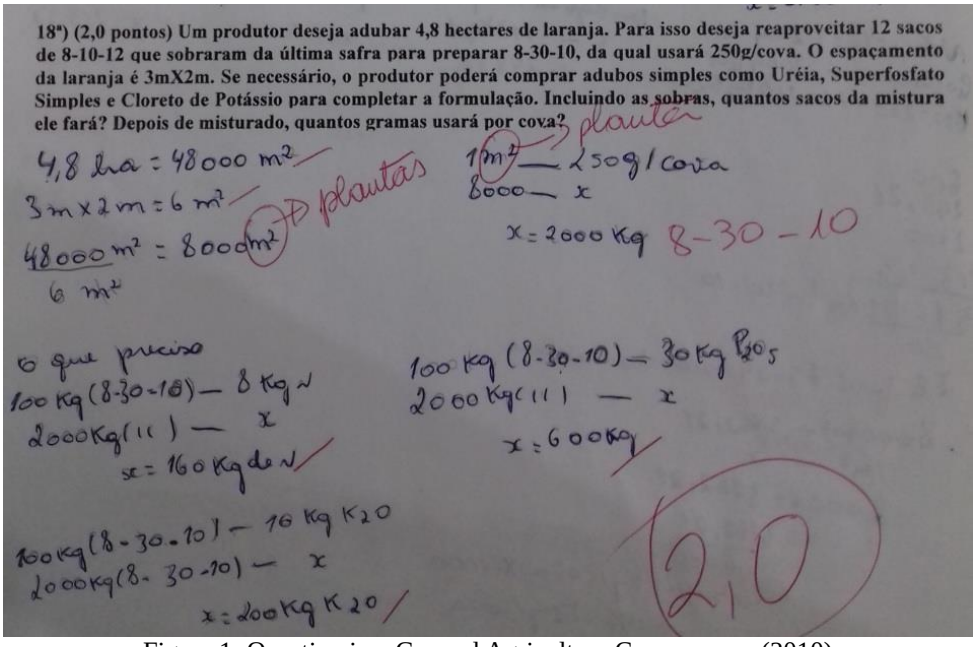


Figure 1: Question in a General Agriculture Course exam (2010)
Source: archives of the teaching coordination (Ifes – Alegre Campus)

In a final exam of Topography and Geoprocessing, it was asked:

> **1st Question** (2,5 points) - Calculate the area of the terrain raised with a scale and show the result in squared meters, hectares, geometric *alqueires*, quarter, and litres.
>
> Note: The survey measurements are on the board
>
> Source: Final Evaluation of Topography and Geoprocessing (archives of the teaching coordination, Ifes – Alegre Campus)

The student presented the following answer to the question (Figure 2):

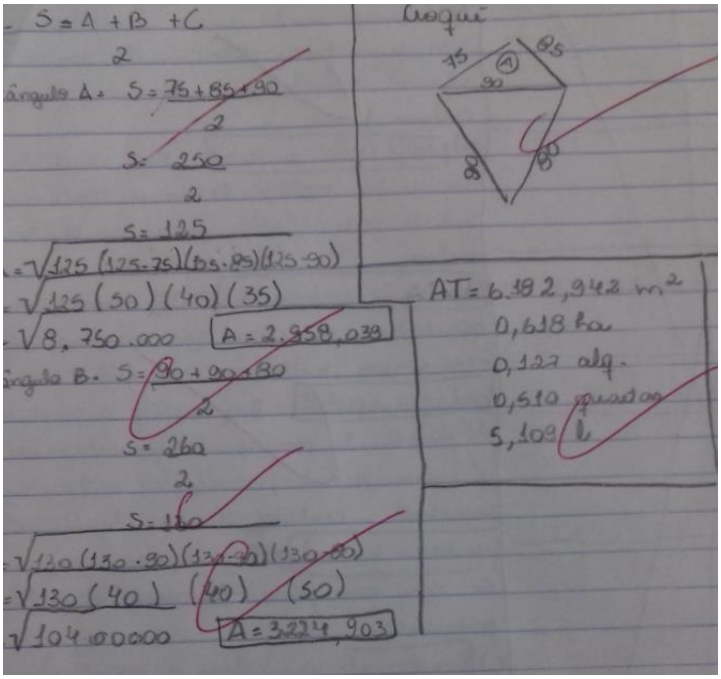


Figure 2: Resolution of a question in a Topography and Geoprocessing exam
Source: archives of the teaching coordination (Ifes – Alegre Campus)

The student calculated the area of each of the triangles according to the measure of the three sides to determine the area of a terrain and then proceeded to the appropriate transformations of units of measure.

In the evaluation of Buildings and Rural Facilities (Figure 3), the student was asked to calculate the actual measure, based on the information contained in an architectural plan, and apply mathematical concepts seized in elementary school.

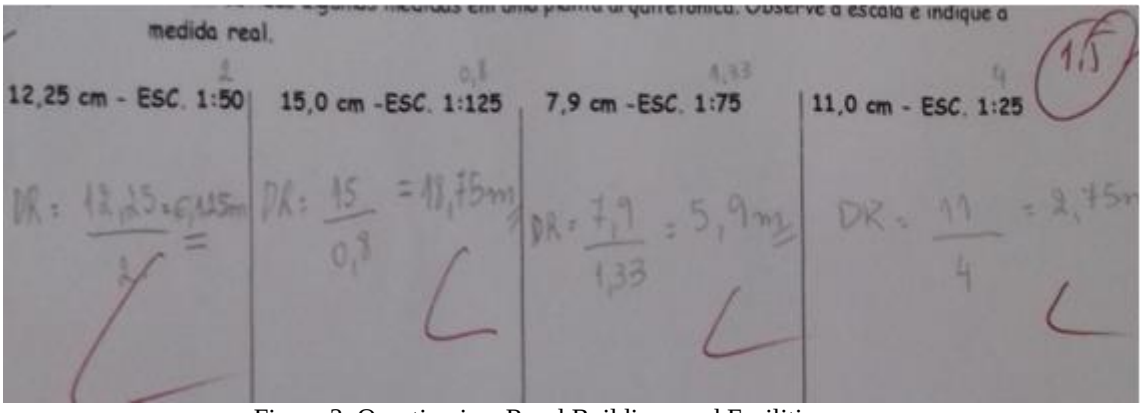
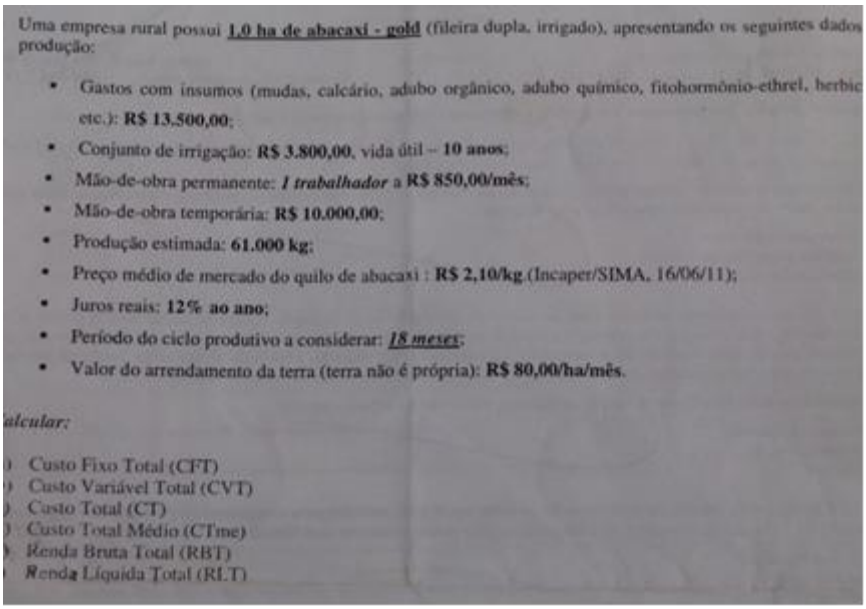


Figure 3: Question in a Rural Buildings and Facilities exam
Source: archives of the teaching coordination (Ifes – Alegre Campus)

The exam of the Agribusiness Management course (Figure 4) presents some production data of a rural enterprise:


Uma empresa rural possui **1,0 ha de abacaxi - gold** (fileira dupla, irrigado), apresentando os seguintes dados produção:

- Gastos com insumos (mudas, calcário, adubo orgânico, adubo químico, fitohormônio-ethrel, herbic etc.): **R$ 13.500,00**;
- Conjunto de irrigação: **R$ 3.800,00**, vida útil – **10 anos**;
- Mão-de-obra permanente: ***1 trabalhador*** a **R$ 850,00/mês**;
- Mão-de-obra temporária: **R$ 10.000,00**;
- Produção estimada: **61.000 kg**;
- Preço médio de mercado do quilo de abacaxi : **R$ 2,10/kg** (Incaper/SIMA, 16/06/11);
- Juros reais: **12% ao ano**;
- Período do ciclo produtivo a considerar: ***18 meses***;
- Valor do arrendamento da terra (terra não é própria): **R$ 80,00/ha/mês**.

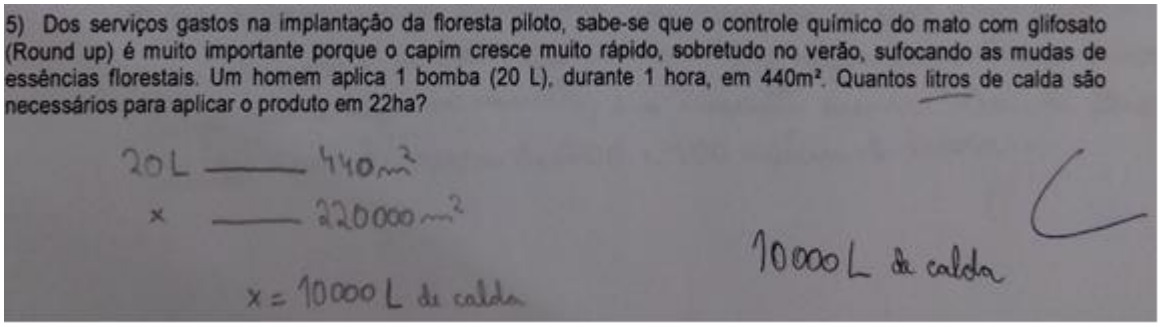
alcular:

) Custo Fixo Total (CFT)
) Custo Variável Total (CVT)
) Custo Total (CT)
) Custo Total Médio (CTme)
) Renda Bruta Total (RBT)
) Renda Líquida Total (RLT)

Figure 4: Question in an Agribusiness Management exam (2011)
Source: archives of the teaching coordination (Ifes – Alegre Campus)

From the data reported in the question, the student should understand the concepts of cost types and incomes to apply them in mathematical formulas, using fundamental operations of addition, subtraction, multiplication, division, potentiation, and radiciation.

In order to carry out the forestry exam, the student was supposed to use his/her knowledge regarding the rule of three (Figure 5):


5) Dos serviços gastos na implantação da floresta piloto, sabe-se que o controle químico do mato com glifosato (Round up) é muito importante porque o capim cresce muito rápido, sobretudo no verão, sufocando as mudas de essências florestais. Um homem aplica 1 bomba (20 L), durante 1 hora, em 440m². Quantos litros de calda são necessários para aplicar o produto em 22ha?

20 L —— 440 m²
x —— 22000 m²

10000 L de calda

x = 10000 L de calda

Figure 5: Question in a Forestry exam (2011)
Source: archives of the teaching coordination (Ifes – Alegre Campus)

In the exams analysed, we identified the need to apply mathematical concepts in order to solve practical situations to be experienced by the agricultural technician, such as rule of three, operations with rational numbers, numerical expressions, transformation of measure units, area and volume calculations, etc. Moreover, many situations were presented based on a semi-reality, i.e., "...it is not a reality that we 'actually' observe but a constructed reality [...]" (Skovsmose, 2000, p. 8).

In the mathematics exams, the contents of operations with numerical sets, function, and roots of the function were selected for the first-year students; matrices, determinants, and spatial geometry, for the second-years; and basic statistics, complex numbers, analytical geometry polynomials, for the third-years. The exams in mathematics courses were then referred as pure

mathematics, i.e., formal mathematical knowledge (Skosvsmose, 2000) without any inference to the applicability of mathematics in the vocational courses.

Based on this, there were concepts of mathematics that served the vocational courses of the program, in which contents related to elementary education were needed, and others that aimed at attending the high school curriculum.

5. The Technical Agricultural Program curriculum: discussions and practices

In the pedagogical meetings, we observed three main topics of discussion: alumni profile, mathematical gap, and the importance of practical classes for the program. In their speeches, teachers expressed their concerns about the alumni:

> *[...] the school mission is to train technicians. We should not misrepresent the school's mission by thinking of ENEM[1]. We do not have students to recommend for regional companies because we are concerned about training them for ENEM. Students wishing to enter higher level programs who take other courses after graduating. We have to think: in three years, who do we want to put out there?*
>
> *We should not focus on propaedeutic training, which means "prepare for."*
>
> *If the student goes well in a technical program integrated to high school since the first year, he/she does not need to get prepared for ENEM.*
>
> *We must invest our pedagogical planning for the technical and technological preparation. We need skilled professionals for our country.*
>
> *You cannot exploit the students, as COAGRI[2] did. But it can lead students to use the chainsaw, weeding [...] How to be a technician without knowing how to sow or use a chainsaw?*
>
> Source: Researcher's field notebook. Registration 05.04.2016.

The students also expressed their opinions regarding the training profile:

> *The school must devote efforts to the technical program [...] The preparation for ENEM should be continuous, and the teacher should bring novelties and reports to contribute to the classes.*
>
> Source: Researcher's field notebook. Registration 05.04.2016.
>
> *There are people in my classroom who want to study gronomy in Ufes[3], but it depends on their ENEM mark. Most people want to get into the Federal University and need those marks.*
>
> Source: Researcher's field notebook. Registration 05.04.2016.

The pedagogical team emphasized the importance of a technical-scientific training of students as citizens:

> *[...] in our scope of training a citizen, we must think about this: the access of our students to higher-level programs.*
>
> *[...] we must find the balance because a good vocational training can prepare a good technician and a good ENEM candidate [...]. We must support our students to continue their studies.*
>
> Source: Researcher's field notebook. Registration 05.04.2016.

[1] ENEM - National High School Examination

[2] COAGRI: National Coordination of Agricultural Education - a government agency with the purpose of providing technical and financial assistance to agricultural and livestock education establishments from 1973 to 1986.

[3] Ufes - Federal University of Espírito Santo – Brazil.

These discussions point out to a scenery in which the training profile of a student, from the teachers' perspective, is seen under different biases. Some believe in an essentially technical training, focused on the business market. For others, the school should, in addition to the technical training, encourage the continuation of studies and contribute to the preparation for ENEM. From the point of view of the pedagogical team and students, the school should contribute to the technical training and continuation of the students' studies.

From this situation in which opinions differ among the school actors, about the type of training that should be provided to students, many schools have "...adopted a conception of misguided education, in which the whole is replaced (integral development) by the part (approval at university)" (Moura, 2007, page 20). Schools should be given an identity that contributes to the integral formation of students, aimed at "...overcoming the structural duality of general culture versus technical culture or instrumental training (for the working class's children) versus academic training (for the mid-upper and upper classes' children)" (Moura, 2007, p.20). Thus, high school education should be oriented towards training citizens who are able to understand the reality in the social, economic, political, cultural, and business contexts, with a view to contributing efficiently, ethically, technically, and politically in favour of social and collective interests (Moura, 2007).

As for the students' lag in mathematics concepts, we highlight some manifestations by class representatives:

> *Our class brings a great deficit from elementary school, mainly in mathematics [...].*
>
> *Former students knew more about technical concepts than us. We do not know how to make a simple liming or fertilizing calculation.*
>
> Source: Researcher's field notebook. Registration 05.04.2016.

The teacher of one of the vocational courses, during a meeting, explains the reasons behind students' low grades in his subject:

> *It's mathematics fault. They do not know math. [...] They have difficulty in basic concepts of mathematics: rule of three, transformation of measure unities. They cannot read what is in the calculator, do not know how to interpret the text.*
>
> Source: Researcher's field notebook. Registration 05.04.2016.

In this context, the way in which contemporary society is organized is the reference for the organization of elementary education. In this sense, the level of development reached by contemporary society places the requirement for a minimum number of systematic knowledge (e.g., written language and mathematics), without which one cannot actively participate in the society. Thus, the basis of the basic education structure is the educational principle of work, and at this basic stage of education, an implicit and indirect relationship between work and education is established (Saviani, 2007).

6. In the class with future Agriculture and Livestock Technicians

The performance of practical activities in the program has undergone substantial changes over the years since students are no longer the agents of production and the productive sectors of the school function as laboratories for the execution of practical classes. Therefore, it is important to notice that the work as an educational principle should not be restricted to "learn working" or "work learning". It is further relevant that, through the educational action, individuals can understand, while experiencing and constructing their own development, that work constitutes a right but also a collective obligation, in which, "from what is produced by everyone, the human existence is produced and transformed" (Moura, 2007, p. 22).

In the Agricultural Mechanization classes, the students performed practices to learn how to use a chainsaw. In that context, the teacher divided the class into small groups that took turns to execute the activity. Students used safety equipment such as leggings, visors, gloves, and an ear tap while operating the equipment. The teacher participated actively, explaining the best position to keep the chainsaw steadier, showing the best point for cut, and best direction for the chainsaw positioning:

> *"Check if the branch has two points of support; if it does, come with it [the chainsaw] from bottom up; otherwise, the chainsaw inverts."*
>
> Source: Researcher's field notebook. Registration 05.04.2016.

The handling of the chainsaw is not simple and requires the student to know how to use it properly and safely. The best position for using a chainsaw in relation to the object being cut. In this sense, the strength applied, the support points, and the best position of the chainsaw should be taken into account. In addition, before cutting the tree, it is necessary to plan to which side the trunk should fall, with a view to preventing accidents. In Figure 6, we recorded the moment when one student used the device under the guidance of the teacher, while the other student removed away small branches and leaves to cut another larger branch.

Figure 6: Practical use of a chainsaw
Source: Researcher's records.

The teacher sought to establish a close articulation between theory and practice, focused on a training that gives students the skills to apply their knowledge in the area. We observed the use of intrinsic mathematics knowledge, which served as support for the activities proposed by the teacher.

In the Project Management classes, the students were led to reflect, interpret, and calculate costs related to rural administration. To perform calculations, expressed through formulas, students should have basic notions of addition, subtraction, multiplication, and division, directly and inversely proportional reasons as well as graph analysis and interpretation. The teacher sought to establish a relationship between the concepts worked in class and their application in the agricultural area. It involved presenting situations related to the financial and economic question of rural properties, examples of the production of the institution itself, and daily issues. In this context, we observed that the limitations the students had for

interpreting proposed activities, in some moments, emerged from a conflict with their realities as many were raised in an urban environment.

In Olericulture classes, the teacher worked on concepts of seedling grafting and hydroponics (Figure 7), seeking to establish a relationship between theory and practice, inside and outside the classroom. As well as in Agricultural Mechanization classes, it was also possible to identify the importance of the correct application of intrinsic mathematics knowledge, which serves as support for the practice's effectiveness.

Figure 7: Presentation of a hydroponic system by the teacher
Source: Researcher's records.

In the classes of Bovine Culture, the students learned about silo, silage, and ensilage. It was possible to verify the importance of applying mathematical concepts into this course, in contents such as relation between volume and amount of silage; minimum height limit of a silo; volume calculation of trapezoidal and cylindrical silos; storage capacity of silos; adequate length of tarpaulins for silage, calculation of silage loss percentage; among others. The teacher discussed with the students about the importance of silo care and silage production and storage; alerting, even, about the correct size for cuts by the forage harvester, which contributes to a longer silage durability. In this sense, we verified that the correct use of mathematical calculations is extremely relevant for the conservation of cattle feed, since the incorrect management for silage production can lead to losses in feeding animals during the dry season.

In the classes of Constructions and Rural Facilities, students should calculate, according to the plan presented and the descriptive memorial, the amount of necessary materials, such as mortar, concrete, tiles, cement, gravel, sand, and gravel for the accomplishment of a work. To perform this activity, students calculated area, volume, rule of three, and scale. Furthermore,

they performed sum, subtraction, multiplication, and division calculations using a calculator. In this sense, it was perceived the application of elementary school mathematical concepts for accomplishing the activity.

From the observations of the vocational courses' classes, we found an intrinsic relation between mathematical knowledge and the training for work (Pinto, 2015). It is worth emphasizing that this relationship occurs even in the face of different conceptions that teachers bring about the concept of work. In this sense, the process of technical and professional training experienced by teachers and students of the program is largely associated with the development of mathematical knowledge and its applicability in the technical activities required in the course (Pinto, 2015).

In Mathematics classes, students worked on concepts related to analytical geometry and, later, statistics. The textbook activities included everyday situations, but we did not observe, at any time, neither in the textbook nor in the examples given by the teacher, questions related to the area of the technical program in agriculture and livestock.

When working statistics, the teacher warned about the manipulation of statistical data and reliability in statistical research. We also observed that, at some moments, the teacher discussed with the class the results found in the calculations, in order to get them to understand the applicability of mathematics in real situations. The teacher, although not addressing specific contents of vocational courses, sought to work the subject in order to apply it to everyday situations.

In the vocational courses' classes, we observed that the application of mathematical concepts is essential for concretizing the practices, requiring the student to master logical-mathematical concepts for the correct execution of activities. In the Mathematics classes, an interdisciplinary approach with the vocational courses was not observed.

7. Discussions and conclusions

The teaching of mathematics in the institutions that offer professional and technological education should not happen in a similar way to the institutions offering only high school, nor, therefore, should only prioritise technical training. It is important that mathematics as well as the other subjects included in the curriculum assist in developing skills that contribute to the concretization of a curriculum that is truly integrated (Santos, 2012).

This way, mathematics brings by itself the concept of integration as it occurs in the most diverse technological resources. It is also important to emphasise its importance as a discipline that has its own language and develops the capacity for abstraction and logical reasoning. In this context, the mathematics teacher must range between these two conceptions, mathematics as a discipline or as an area of knowledge.

This study presented a new approach when analysing the teaching of mathematics, through prescribed curriculum (analysis of the course pedagogical project) and through practiced curriculum (analysis of technical subjects' evaluations, class observations and pedagogical meetings). Considering data collection, we highlight the importance of the teaching of mathematics in the process of training the agricultural technician and its functionality to act on concrete situations, such as handling diverse technological resources, soil management, formulating and mixing fertilizers, calculating the spacing and depth of planting pits as well as planting areas, production costs, etc.; in addition, through mathematics, the agricultural technician will be able to understand reality in a much better way, as well as analyse, reflect

and plan actions that aim at improving the economic, social and environmental farm conditions.

Moreover, it stablishes contributions to professional education by demonstrating the importance of mathematics in training agricultural technicians and its application in diverse activities related to the field, based on three structural concepts, essential for an integral human formation: work, science and culture. By doing so, the following paragraphs present each of these contributions.

Initially, when analysing the participation of mathematics in the technical agricultural and livestock program, we verified that the discipline is intrinsic to the vocational courses. Therefore, it participates and favours the curriculum integration process, being present from its most abstract and intuitive concepts to its real and necessary application for the resolution of problems and for the execution of projects in the agricultural area. Back when the program was created, in the 1960s, mathematics was part of the curriculum as a support for vocational courses, and, over the years, contents were inserted in order to contribute to a broader development of students, considering it should not be limited to supporting activities in the technical area but contribute also to other spheres of knowledge.

The study pointed out to a non-reciprocal movement of pedagogical practices towards curricular integration, occurring a unidirectional movement of interdisciplinarity construction from technical education towards mathematical knowledge that does not occur from mathematics to technical education. In addition, the mathematical knowledge necessary for understanding the contents in the vocational courses of the program come from elementary school, being topic of discussions throughout decades regarding the lags presented by the students.

This study also pointed out the need for students to know how to apply logical-mathematical knowledge to accomplish activities in the vocational subjects. However, the teachers' pedagogical practices in vocational courses, compared with mathematics subjects, take place in an isolated way, which reinforces the relevance of a dialogue between teachers, which may result in interdisciplinary, contextualised, and integrative actions that take the students to reflect better about the proposed situations.

In this perspective, we believe in the search for pedagogical practices that allow students to develop skills in understanding, operating, applying, and reflecting on mathematical ideas, algorithms, and procedures, not just the practical application of it aimed at meeting market demands. Providing students with this way of thinking and understanding the world can contribute substantially to a mathematical education committed to their integral human development.

What is more, this study verified that establishing new laws, regulations, and educational reforms bring to the school a whole movement in order to adjust to the rules, but, at the same time, it does not deconstruct the essence of the school, which is the technical training. The alumni profile is still highly discussed in the school environment. There is a divergence of ideas and points of view about what skills a student should leave the school having. Arguments defend that the school should train a technician with skills and abilities that allow him/her to act immediately in the business world. Others question whether the students should be provided with an understanding of the historical process of knowledge construction. Finally, some defend that the training should prepare students to continue their studies in a higher academic level. For some people, the training should be simple and purely a training for immediate entry into the work market; for others, training should be broader, endowed with knowledge that goes beyond the vocational training.

Thus, this study highlights the importance of a better understanding by all social actors working in the educational process of the concept of work as an educational principle with a view to the student integral human development. This perspective can provide insights for future discussions that consider that training for work is not training only for the job market, but training critical, conscious, ethical, understanding citizens who are empowered with technical, scientific, economic, political, and social knowledge or skills, to act ethically and responsibly for a more fair and equal society.

Finally, we suggest the promotion of moments of study, reflection, and discussion, in order to increase the knowledge about the essence of the pedagogical project of a technical professional mid-level education program integrated to high school. This understanding reinforces the importance of overcoming fragmented and disarticulated pedagogical practices, aiming to train not only technicians but also polytechnicians, as taught by Saviani (2007).

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