SEVEN publicações acadêmicas
EM PARCERIA COM: IEMS UNIASSELVI

STEM Project: Students in the teaching role for mathematical learning

Lucio Garcia Veraldo Junior[1], Douglas Carlos Vilela[2], Alex Sandro Marques[3].

ABSTRACT

STEM (Science, Technology, Engineering, and Mathematics) Education is an integrated approach that promotes interdisciplinary teaching by encouraging the use of materials, practical and collaborative work, discussion, research, and problem-solving. Based on active learning, this approach provides students with the opportunity to learn by doing, creating, manipulating, and experimenting, while simulating, conjecturing, and validating. In addition, it allows the mathematical analysis of the properties of objects and phenomena through work with concrete materials, enabling more realistic and contextualized approaches.

Keywords: STEM education, Integrated teaching, Problem solving.

INTRODUCTION

An integrated teaching perspective that embraces the interdisciplinary teaching of Science, Technology, Engineering, and Mathematics is known as STEM Education (acronym for *Science, Technology, Engineering, and Mathematics*) in which it allows and promotes the use of materials and equipment, encourages hands-on work, cooperative learning, discussion and research, questioning, and conjecture, the production of justifications, the preparation of reports, the problem-solving activity, including the use of technologies (BAIOA & CARREIRA, 2019). Also according to the authors, the possibility of seeing experimental activities based on real objects as a particular type of mathematical modeling activities is based on the following assumptions: (1) students have the opportunity to "learn by doing" (while creating, manipulating and experimenting, simulating, conjecturing and validating); (2) working with concrete materials is a way of mathematically analyzing the properties of objects and phenomena, allowing more realistic approaches.

In today's society, the relevance of the integration and use of digital technologies in human activities, both personally and professionally, is undeniable. This integration also occurs in the educational context, affecting the teaching-learning processes and making traditional teaching, based solely on the oral transmission of information, increasingly unfeasible. Faced with this reality, institutions and teachers face the challenge of educating and forming critical and up-to-date citizens, capable of applying scientific

[1] Infinity Academy 3D – SP
[2] Sphere International School – SP
[3] Sphere International School – SP

knowledge in their personal and professional conduct, guiding their ability to act in society (TEONES et al., 2020).

By working in this way with STEM disciplines, the student is also able to develop leadership; teamwork; improve the relationship with the teacher and classmates, in addition to being the protagonist of their own learning. Because the student needs to seek such concepts to solve the proposed problem, and who does this is the student himself, the teacher acts as a mentor or facilitator of the process, which in the end characterizes the student as the main author of the learning. (BRIGHENTI et.al., 2015).

According to a report by the European Parliament, according to Caprile, Palmén, Sanz, & Dente (2015) the rate of jobs in STEM professions is expected to increase significantly by 2025. Thus, it is necessary to train more highly qualified individuals in STEM, and the challenge falls on teachers to make these areas appealing to students. To this end, it is necessary to rethink the role of everyone in the learning process in the digital age (COHEN & PATTERSON, 2012), prioritizing innovative and active teaching methodologies, such as project-based learning, which provide students with authentic and contextualized experiences in order to develop skills in STEM areas (CAPRARO & SLOUGH, 2013).

One of the justifications for the implementation of education from the STEM perspective, in the world and in Brazil, is that the labor market is changing exponentially due to the use of technologies, requiring people literate in STEM, both to pursue technological careers and to live in this society (Freitas, 2019).

OBJECTIVE

The general objective of this article is to describe the development of a STEM project by high school students to create a mathematical knowledge journey.

As specific objectives, there are:

- Define the learning needs in the target audience;
- Establish the expected outcomes of the STEM project;
- Present the content proposals to be developed.

THEORETICAL FOUNDATION

STEM content integration is an educational approach that aims to connect the disciplines of science, technology, engineering, and mathematics to highlight the fundamental ideas of these knowledge areas. There are several approaches to achieve this integration, with different terminologies being used by different authors. Some authors differentiate between multidisciplinary and interdisciplinary approaches. Other authors differentiate interdisciplinary approaches from integrated approaches (Thibaut et al., 2018).

The implementation of disciplinary integration requires a change in mindset on the part of educators, as well as the adoption of innovative pedagogical strategies and the creation of collaborative learning environments. In addition, the authors recommend promoting interdisciplinary research projects and developing partnerships between educational institutions and business sectors to strengthen disciplinary integration in STEM education (Aguilera et al., 2021).

According to Moreira (2018), the basis of STEM involves the integration of the themes studied, breaking the fragmented structure and making connections with the real-world context in an innovative education with meaningful learning. According to the author, practice involves the learner in solving a set of tasks or problems that are challenging, but feasible, and that explicitly involve the practice of reasoning and scientific performance.

Considering specifically mathematical knowledge, according to Godoy (2016), the contribution of mathematics to the general purposes of education is positive and beneficial, since its knowledge helps in the development of reasoning capacity and has the function of an auxiliary instrument for various disciplines and areas. In addition, mathematical knowledge at least serves as the basis for several technological advances, and is therefore ubiquitously present in STEM careers.

In this approach, the teaching of mathematics needs to provide the student with forms of learning that go beyond the disciplinary contents of the curriculum, emphasizing the contribution and influence that mathematical knowledge has in the formation of the individual, as well as its contribution to citizenship, technology and scientific advances in a contextualized way. This action, according to some authors, is fundamental to give relevance to school mathematics, so that the option for STEM careers can be more representative in a future technological scenario (GESSER; DIBELLO, 2016; GODOY, 2016).

In this context, there is a need to review methodologies in Brazilian schools, and it is important to invest in multidisciplinary learning programs based on projects focused especially on science teaching or STEM subjects. Investments in STEM disciplines awaken in students an interest in scientific disciplines, as these challenges relate to everyday life and arouse the curiosity to know the reason for events. (ROSS, 2017).

In the classroom, this becomes a great challenge for the educator, since the teacher of another generation needs to understand this divergence of priorities and help students to build their own way of learning. For this, active learning methodologies seek to serve this generation, since they intend to change the way of learning and teaching, making teaching more dynamic and fun, with classes being more interesting for students. (LIMA, 2016).

This motivation is facilitated because the purpose of STEM disciplines is to work from something students' daily life so that they can propose solutions and innovate in the solutions of these conflicts, and in this way, have the opportunity to learn in a meaningful way. (PAVÃO & FREITAS, 2008).

As the world becomes increasingly technological, these new jobs will have a direct link to new technologies. To meet this future demand and ensure innovation and economic growth, it is necessary to encourage young people to study disciplines related to technology in an interconnected way. (HECK, 2017). Also according to the author, it is essential that the new generation of students learn STEM content in an integrated way. This current educational model seeks to offer students a view of the phenomena that make up these areas in relation to everyday life.

Many students develop attitudes and skills compatible with the STEM methodology, especially in relation to digital games, where the demand is intense in the appreciation and participation of being part of a list of members focused on that area of interest. According to Ishak (2021), the number of digital games for STEM continues to increase as a result of the development of the gaming industry. According to Correia & Batista (2021), STEM Education has been in the spotlight in recent years due to its potential for the development of diverse skills and for encouraging the pursuit of careers in related areas, especially due to the transformations that have occurred in the contemporary era.

The scientific, technological, and economic development of a nation depends on a society capable of technological innovation. In the same way, in order to ensure meaningful and integrative learning in current times, we need to develop a critical view of discussions about educational processes. Critical knowledge is part of science, as well as ideas transformed into projects that are capable of changes in the human being in social terms in the educational sphere (SEDLACEK, 2021).

METHODOLOGY

The classification of this research is a case study and defined as follows (MIGUEL et al., 2018): how much nature is APPLIED because it is characterized by its practical interest; as for the objectives, it is DESCRIPTIVE, as it describes the development of a project of mathematical learning solutions; and when the approach is defined as QUALITATIVE, because its results consider that there is a relationship between real and subjective in the interpretation of phenomena and the attribution of meanings. For Yin (2014), the case study is an investigation of contemporary phenomena in the context of real life.

The National Common Curriculum Base (BNCC) is a document that defines all the essential learning that must be developed by students throughout all stages and modalities of Basic Education. Essential learning should ensure that students develop ten general competencies, among them is the competence that refers to Digital Culture (BRASIL, 2018, p. 9). Digital culture is an important tool for the student because it makes him the protagonist of his own learning, strengthening autonomy and being able to interact critically with different knowledge that will improve teaching and learning.

Mathematical knowledge, on the other hand, is very important because it has great application in society, forming critical and reflective citizens, in the area of mathematics, elementary education must be

committed to developing mathematical literacy, which is fundamental "for understanding and acting in the world", favoring the development of logical and critical reasoning, stimulating research (BRASIL, 2018, p. 266). It adds that the national guidelines indicate that the area of Mathematics should ensure that students relate empirical observations of the real world to representations (tables, figures and schemes), relating them to a mathematical activity, making inductions and conjectures, thus developing the ability to identify opportunities to use mathematics to solve problems.

The object of study is the students of the second year of high school of a private institution that has as one of its purposes to develop a Technological Education in the teaching-learning process.

DEVELOPMENT

The proposed STEM project aims to create multiple solutions in the teaching-learning process for mathematical knowledge. These solutions occurred from the evaluation of the deficiencies in the learning of Mathematics (Elementary I) defining the theme of knowledge.

The initial stage was an unstructured interview by the students to the elementary school teachers about which were the contents of greatest need in mathematical learning, thus meeting an internal educational demand, enabling the application and validation of the proposed learning solution.

The definition of the learning content for each of the teams was designed through an active learning methodology called World Café. According to Da Silva (2023), a relevant characteristic of the World Café is the agility and fluidity between the teams, in order to allow participants to move through several other groups, having the opportunity to look at a certain content from different perspectives. Thus, the groups defined at the beginning of the activity will diversify throughout the course of the proposal, ensuring the circulation of ideas.

The results established by the groups and shared among all were:

- Writing: stimulation of fine motor coordination;
- Sums of units and tens,
- Multiplication;
- Geometric shapes.

As expected results for the development of teaching-learning solutions in mathematical knowledge, students will have the following deliverables:

- **Learning Activity Roadmap:** content, practice (include use of VR), assessment. Succession;
- **Learning Contents and Media:** abstract content, media (dynamics, practices and virtual reality);

- **Development of solutions:** guide the programming of the proposed content in virtual reality (immersive);
- **Validation of the proposed solution:** apply the Learning Path (target class).

As for students, the project is expected to promote:

- Stimulate the teaching process (teaching);
- Understand mathematical learning deficiencies;
- Evidence scientific research and writing;
- Develop skills: teamwork, leadership, communication, creativity, systems thinking, among others.

FINAL CONSIDERATIONS

The proposal to transform second-year high school students into teachers for elementary school students in mathematical content is the main pillar of the project established and in execution. For Ninow, from Assis Olgin & Groenwald (2022), the development of projects, in which the student acts with challenging, innovative activities that integrate STEM areas is a path for the development of the aforementioned skills.

The objectives of this article were achieved with the process of defining the content to be developed through interviews with teachers and discussion between groups through active methodology. The deliverables during the development of the STEM project were presented, from the learning path to the validation of the target audience.

The process of involving Mathematics and Technology, pillars of STEM with the use of virtual reality in the learning process, promotes an educational transformation with a greater capacity to understand certain content. Thus, this project can bring significant contributions to establish a disruptive education that is more appropriate to the current reality and, preparing for the future.

As a proposal for future research:

- Evaluate projects with other areas of knowledge: Sciences;
- Include content associated with Lean Thinking and Analysis Tools (Quality).

REFERENCES

Aguilera, D., Lupiáñez, J. L., Vílchez-González, J. M., & Perales-Palacios, F. J. (2021). In search of a long-awaited consensus on disciplinary integration in STEM education. Mathematics, 9(6), 1–10.

Baioa, A. M., & Carreira, S. (2019). Modelação matemática experimental para um ensino integrado de STEM. Educação e Matemática, (152), 9-12.

Brasil, Ministério da Educação. (n.d.). Portal da Base Curricular Nacional. Available at: http://basenacionalcomum.mec.gov.br/images/BNCC_EI_EF_110518_versaofinal_site.pdf. Accessed on: March 3, 2024.

Brighenti, E., et al. (2015). Metodologias de ensino-aprendizagem: uma abordagem sob a percepção dos estudantes. Revista GUAL, 8(3), 281-304. Florianópolis.

Capraro, R. M., & Slough, S. W. (2013). Why PBL? Why STEM? Why now? An introduction to STEM project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach. In STEM project-based learning (pp. 1-5). Brill.

Caprile, M., Palmén, R., Sanz, P., & Dente, G. (2015). Encouraging STEM studies: labour market situation and comparison of practices targeted at young people in different member states. Policy Department A, 12.

Cohen, C. A. R. O. L. Y. N., & Patterson, D. G. (2012). The emerging role of science teachers in facilitating STEM career awareness. Northwest Association for Biomedical Research, Seattle, WA, USA.

Correia, M., & Baptista, M. (2021). The effects of a STEM approach on Pre-service elementary teachers' subject matter knowledge about sound. Acta Scientar-Revista de Ensino de Ciências e Matemática, 6(23), 179-208.

Da Silva, J. N. (2023). Estratégias pedagógicas norteadas por metodologias ativas no ensino de ciências. Editora Dialética.

Freitas, D. (2019). Indústria 4.0 e Educação em Ciências no Brasil: perspectivas STEM e Freire-PLACTS no horizonte de disputas por suas afirmações. Anais do XII Encontro Nacional de Pesquisa em Educação em Ciências–XII ENPEC.

Gesser, V., & DiBello, L. (2016). Educação para Ciência, Tecnologia, Engenharia e Matemática e as Relações com a Política de Avaliação em Larga Escala na Educação Básica. Educação, 81-94.

Godoy, E. V. (2016). Currículo, cultura e educação matemática: uma aproximação possível?. Papirus Editora.

Heck, C. (2017). Integração de tecnologia no ensino de física na educação básica: um estudo de caso utilizando a experimentação remota móvel. Available at: https://repositorio.ufsc.br/bitstream/handle/123456789/179798/348092.pdf?sequence=1. Accessed: March 3, 2024.

Ishak, S. A., Din, R., & Hasran, U. A. (2021). Defining digital game-based learning for science, technology, engineering, and mathematics: a new perspective on design and developmental research. Journal of Medical Internet Research, 23(2), e20537.

Lima, V. V. (2016). Espiral construtivista: uma metodologia ativa de ensino-aprendizagem. Interface-Comunicação, Saúde, Educação, 21, 421-434.

Miguel, P. A. C., et al. (2018). Metodologia de Pesquisa em Engenharia de Produção e Gestão de Operações. Rio de Janeiro: Elsevier Editora Ltda. (3rd ed.)

Moreira, M. A. (2018). O ensino de STEM (Ciência, Tecnologia, Engenharia e Matemática) no século XXI. Revista Brasileira de Ensino de Ciência e Tecnologia, 11(2).

Ninow, V., de Assis Olgin, C., & Groenwald, C. L. O. (2022). Educação STEM no Ensino Médio. UNIÓN-REVISTA IBEROAMERICANA DE EDUCACIÓN MATEMÁTICA, 18(66).

Pavão, A. C., & de Freitas, D. (Eds.). (2008). Quanta ciência há no ensino de ciências. SciELO-EdUFSCar.

Sedlacek, G. B. (2021). Projetos STEAM: controvérsias e ideologias no Ensino de História e Filosofia das Ciências. Khronos, (11), 20-54.

Teones, A., Santana, L., Ribeiro Da Silva, R., Leal Do Prado, J., & Fortes Quintino, J. (2020). Inovação no ensino: a aplicação da metodologia STEM no IFS. Anais Semana Nacional de Ciência e Tecnologia (SNCT), 2(1), 725–730.

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van Petegem, P., & Depaepe, F. (2018). Integrated STEM Education: A Systematic Review of Instructional Practices in Secondary Education. European Journal of STEM Education, 3(1), 1–13.

Yin, R. K. (2014). Case Study Research: Design and Methods (5th ed.). London: Sage.