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MINDS OF THE FUTURE: ENTREPRENEURIAL, INNOVATIVE AND TECHNOLOGICAL EDUCATION

MENTES DEL FUTURO: EDUCACIÓN EMPRENDEDORA, INNOVADORA Y TECNOLÓGICA

MINDS OF THE FUTURE: ENTREPRENEURIAL, INNOVATIVE AND TECHNOLOGICAL EDUCATION

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ABSTRACT

This article presents partial results of a Brazilian entrepreneurial education project named Minds of the Future. This project is aimed at low-income high school students from public schools in the city of Juiz de Fora, Minas Gerais State, Brazil. Developed through a collaboration between Federal University of Juiz de Fora and Minas Gerais Education Department, the project aims to contribute for a transformative education, focused on training young people to cope with new life realities, social relationships, and work through the stimulation of critical, creative, technological and entrepreneurial thinking. This project is justified both by the need for young people's engagement in the rapid advances in systems and data automation and by the educational reality of the country, which has a high dropout rate during the transition between elementary and high school.The proposed approach to knowledge transfer and sharing is STEAM. In the first stage, Lego® Education robotics

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materials were used, which combine Lego® construction elements and intuitive programming language in a 12-hour module of lessons and playful activities offered to 135 students distributed in eight classes during 2024. This and other modules involving 3D modeling, soft skills, financial education and sustainable development will be offered in the second semester of 2024. The project includes professors from different areas and 14 scholarship holders from different undergraduate courses at the Federal University of Juiz de Fora - physics, engineering, computer science, business administration, accounting, law, nutrition and pedagogy - who acted as facilitators during the classes and activities developed. To evaluate the results of this initial experience with the application of the Lego programming and robotics module, a qualitative and quantitative research was conducted. Questionnaires with objective questions were administered to the students via Google Forms at the beginning of the first class and at the end of the last class of the module. Additionally, questionnaires with both objective and open-ended questions were given to the project scholarship holders. Minds of the Future project demonstrated significant positive impacts both among the students and the participating scholarship holders perceptions and skills. The results indicate improvements in various dimensions, from the relationship with teachers to the development of technical skills and increased interest in technology and innovation.

Keywords: Innovative education, technology education, entrepreneurial education.

RESUMEN

Este artículo presenta resultados parciales del proyecto brasileño de educación emprendedora "Mentes del Futuro". El proyecto está dirigido a estudiantes de secundaria de bajos ingresos de escuelas públicas en la ciudad de Juiz de Fora, estado de Minas Gerais, Brasil. Desarrollado a través de una colaboración entre la Universidad Federal de Juiz de Fora y la Secretaría de Educación de Minas Gerais, el proyecto busca contribuir a una educación transformadora, enfocada en la capacitación de jóvenes para afrontar las nuevas realidades de la vida, las relaciones sociales y el trabajo mediante el estímulo del pensamiento crítico, creativo, tecnológico y emprendedor. Este proyecto se justifica tanto por la necesidad de involucrar a los jóvenes en los rápidos avances en la automatización de sistemas y datos como por la realidad educativa del país, que presenta una alta tasa de deserción escolar durante la transición entre la educación primaria y la secundaria. El enfoque propuesto para la transferencia e intercambio de conocimientos es STEAM. En la primera etapa, se utilizaron materiales de robótica Lego® Education, que combinan elementos de construcción Lego® y un lenguaje de programación intuitivo en un módulo de 12 horas de clases y actividades lúdicas ofrecido a 135 estudiantes distribuidos en ocho grupos durante 2024. Este y otros módulos que incluyen modelado 3D, habilidades blandas (*soft skills*), educación financiera y desarrollo sostenible se ofrecerán en el segundo semestre de 2024. El proyecto cuenta con la participación de profesores de diferentes áreas y 14 becarios de diversas carreras de grado de la Universidad Federal de Juiz de Fora - física, ingeniería, informática, administración de empresas, contabilidad, derecho, nutrición y pedagogía - quienes actuaron como facilitadores durante las clases y actividades desarrolladas. Para evaluar los resultados de esta experiencia inicial con la

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aplicación del módulo de programación y robótica Lego, se realizó una investigación cualitativa y cuantitativa. Se administraron cuestionarios con preguntas objetivas a los estudiantes a través de Google Forms al inicio de la primera clase y al final de la última clase del módulo. Adicionalmente, se aplicaron cuestionarios con preguntas objetivas y abiertas a los becarios del proyecto. El proyecto "Mentes del Futuro" demostró impactos positivos significativos tanto en las percepciones como en las habilidades de los estudiantes y de los becarios participantes. Los resultados indican mejoras en diversas dimensiones, desde la relación con los docentes hasta el desarrollo de habilidades técnicas y un mayor interés en la tecnología y la innovación.

Palabras clave: Educación innovadora, educación tecnológica, educación emprendedora.

RESUMO

Este artigo apresenta resultados parciais do projeto brasileiro de educação empreendedora "Mentes do Futuro". O projeto destina-se a estudantes do ensino médio de baixa renda de escolas públicas na cidade de Juiz de Fora, Minas Gerais, Brasil. Desenvolvido em colaboração entre a Universidade Federal de Juiz de Fora e a Secretaria de Estado de Educação de Minas Gerais, o projeto visa contribuir para uma educação transformadora, com foco na capacitação de jovens para lidar com as novas realidades da vida, as relações sociais e o trabalho, por meio do estímulo ao pensamento crítico, criativo, tecnológico e empreendedor. Este projeto justifica-se tanto pela necessidade de engajamento dos jovens nos rápidos avanços da automação de sistemas e dados quanto pela realidade educacional do país, que apresenta alta taxa de evasão escolar durante a transição entre o ensino fundamental e o médio. A abordagem proposta para a transferência e compartilhamento de conhecimento é STEAM. Na primeira etapa, foram utilizados materiais de robótica Lego® Education, que combinam elementos de construção Lego® e linguagem de programação intuitiva em um módulo de 12 horas de aulas e atividades lúdicas, oferecido a 135 estudantes distribuídos em oito turmas durante 2024. Este e outros módulos, que abrangem modelagem 3D, *soft skills*, educação financeira e desenvolvimento sustentável, serão oferecidos no segundo semestre de 2024. O projeto conta com a participação de professores de diferentes áreas e 14 bolsistas de diversos cursos de graduação da Universidade Federal de Juiz de Fora – Física, Engenharias, Ciência da Computação, Administração, Ciências Contábeis, Direito, Nutrição e Pedagogia –, que atuaram como facilitadores durante as aulas e atividades desenvolvidas. Para avaliar os resultados dessa experiência inicial com a aplicação do módulo de programação e robótica Lego, foi realizada uma pesquisa qualitativa e quantitativa. Questionários com perguntas objetivas foram aplicados aos estudantes via Google Forms no início da primeira aula e ao final da última aula do módulo. Adicionalmente, questionários com perguntas objetivas e abertas foram aplicados aos bolsistas do projeto. O projeto "Mentes do Futuro" demonstrou impactos positivos significativos tanto nas percepções quanto nas habilidades dos estudantes e dos bolsistas participantes. Os resultados indicam melhorias em diversas dimensões, desde o relacionamento com os professores até o desenvolvimento de habilidades técnicas e o aumento do interesse por tecnologia e inovação.

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Palavras-chave: Educação inovadora, educação tecnológica, educação empreendedora.

INTRODUCTION

The OECD (Organization for Economic Co-operation and Development), in its March 2020 publication "Strategic Vision and Direction for Science" addressing the scope for PISA 2024, reinforced the need for the interdisciplinary nature of sciences and the importance of young people's understanding and engagement in rapid advances in data systems and automation, as well as in the ways scientific knowledge is acquired and applied. Among other points, it also emphasized that these young people should be encouraged to be fluent in digital, integrative, and sustainable-based studies.

The rapid technological advancement, with the increasingly frequent use of artificial intelligence for developing solutions, has demanded new competencies to deal with constant and disruptive changes. Entrepreneurial, innovative and technological education has become an essential factor in developing the skills required in this new living and working environment (OSTERWALDER and PIGNEUR, 2010; HOROWITZ and KENERLY, 2014). With the advancement of innovation and the emergence of new technologies, the formation of young entrepreneurs with critical, reflective, and creative thinking to propose innovative, technological, and sustainable solutions has become a paramount factor.

Data from the Instituto Unibanco Observatory (2022) shows that Brazil has a high dropout rate in high school, which is also the reality in the State of Minas Gerais. In 2023, 6.8% of students in Minas Gerais dropped out in the 1st year of high school, 5.9% in the 2nd year, and 4% in the 3rd year. Furthermore, the state's basic education development index was 4.2 in the same year, indicating low learning levels, far from the target of 6 points. Although issues related to learning and school dropout worsened during and immediately after the Covid-19 pandemic, when families faced a significantly critical period of school suspensions, they cannot be specifically attributed to this period as they had already been occurring over the past decade.

The Minds of the Future project proposes to reduce the gap between the needs pointed out by the OECD and what is observed in the country's educational reality through complementary digital, entrepreneurial, and integrative training of teachers and students in the public system, with the potential to positively impact sustainable economic and social development. Using the STEAM (SAWYER, 2014) and active learning methodologies (ARALDI ET AL, 2022), the project seeks not only to develop technical skills in areas such as robotics and programming but to promote the construction of broader competencies, such as critical thinking and problem-solving ability.

Thus, the objective of this article is to evaluate the project's first impacts on student training, both in terms of developing technical skills and the ability to apply these competencies in practical situations. One of the premises of the project is that the success of entrepreneurship is not necessarily in individual characteristics, but in the methodologies used, such as experimentation, creation, and reflection, pillars that the project uses to connect theory to practice.

The article is structured as follows: beyond this (1) introduction, we present a (2) literature review; (3) methodology background; (4) results analysis; (5) final considerations and further directions; (6) acknowledgements.

LITERATURE REVIEW

This section is structured in three main themes: entrepreneurial education, innovative education and technological education. As follows, each one will be developed in the next sections.

ENTREPRENEURIAL EDUCATION

The growth of entrepreneurship and innovation as fields where career opportunities, individual achievement, and contribution to social and economic development manifest, has transversally impacted numerous professions and areas of knowledge, stimulating the demand and supply for entrepreneurial education based on innovation and technology in the context of higher education worldwide (HOROWITZ and KENERLY, 2014). In parallel, universities, especially public ones, recognize entrepreneurship as a vehicle capable of bringing innovations and technologies developed by academic research to society, and contributing to the socioeconomic development of the territories where they operate (AGUIAR, 2013; SILVA AND PATRUS, 2017; COSTA ET AL, 2019; EVERED and ROGERS, 2022).

Neck, Greene, and Brush (2011) argue that the great turn in the demand for entrepreneurial and innovative technology-based education occurred from the moment academic research in the field of entrepreneurship debunked myths about the phenomenon - such as the idea of the entrepreneur as a predestined individual, endowed with luck or even capital - demonstrating that the success of entrepreneurial activity resided less in the

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characteristics of individuals and more in the process and methods of developing new businesses and projects. Works such as Shane's (2003) contributed to the understanding of entrepreneurship as a process in which an individual recognizes an opportunity and decides to exploit it, paving the way for a series of research that culminated in the creation of models and methods to support the development of entrepreneurial activity, such as business modeling (KURATKO, 2005; DA SILVA and PATRUS, 2017), lean startup methodology (RIES, 2011) (HOROWITZ and KENERLY, 2014), customer development (HOROWITZ and KENERLY, 2014) and approaches to obtaining venture capital for financing entrepreneurial projects (ARALDI ET AL, 2022).

The set of this new knowledge promoted the growth of the offer of short and medium-duration entrepreneurial education programs in various institutions, both in free courses or even in regular disciplines offered in undergraduate courses (NECK, GREEN & BRUSH, 2011). However, this growth posed a challenge for teachers, since entrepreneurial education, which has practical and technical objectives, requires pedagogical approaches that transcend the instructional expository model (SAWYER, 2014). Thus, in the midst of discussions about university pedagogy (KURATKO, 2005; AGUIAR, 2013; ARALDI ET AL, 2022) we observe teachers who develop didactic-pedagogical experiences that aim to bring the practical reality of entrepreneurship closer to the classroom environment. In addition, NECK et al (2011) also identified the importance of cultural factors in entrepreneurial education, allowing characteristics of regional and local economies to be highlighted in educational experiences.

The practical aspect of entrepreneurial and innovative technology-based education does not represent the absence of theory, on the contrary. The effective doing of entrepreneurship and innovation requires a series of practices, which are solidly based on theory (NECK, GREEN & BRUSH, 2011). Corbett and Katz (2012) state that students do not see theory in the foreground, since it is hidden in practice. Neck et al (2011) state that the entrepreneurial and innovation environment is endowed with a character of unpredictability, uncertainty, and ambiguity, in an evident contrast to the classroom environment. Thus, the need for pedagogical practices that bring the real context of entrepreneurship and innovation closer to the academic experience of students is configured in an important way. Neck et al (2011) propose 5 dimensions of practice for teaching entrepreneurship, as a guiding path for teachers' pedagogical choices: 1) practice of experimentation; 2) practice of creation; 3) practice of empathy; 4) practice of play; 5) practice of reflection. Such practices should subsidize choices and didactic creations by teachers who teach entrepreneurship, allowing the educational environment to approach the practical challenges mentioned in the literature on the subject.

INNOVATIVE EDUCATION

The teaching of innovation has gained prominence in academic literature, particularly for its relevance in developing essential skills to tackle the challenges of the global economy and contemporary society. Studies highlight that teaching innovation is not limited to the transmission of technical knowledge but includes fostering a creative mindset, problem-solving skills, and interdisciplinary collaboration. Authors like Schumpeter (1934) already pointed to innovation as a driver of economic progress, but more recently, pedagogical approaches have emphasized active methodologies such as design thinking, project-based learning, and educational hackathons that bridge theory and practice. These strategies aim to engage students in creative and collaborative processes that simulate real-world innovation contexts.

Moreover, the role of educational institutions in fostering innovation ecosystems has been widely discussed. Research indicates that universities and schools can function as innovation hubs, promoting interaction among students, entrepreneurs, businesses, and governments. This perspective aligns with the concept of the "entrepreneurial university" proposed by Etzkowitz (2008), which emphasizes the triple helix of innovation—university, industry, and government. However, challenges persist, such as resistance to curriculum changes and the need to train teachers to act as facilitators of creative learning processes. Thus, the teaching of innovation remains a dynamic and interdisciplinary field, crucial for preparing leaders and change agents in society.

The Innovation Pedagogy, developed by Finnish researchers, is an educational approach designed to systematically integrate innovation into teaching and learning. Conceived at the Turku University of Applied Sciences, this methodology fosters interaction across different fields of knowledge and emphasizes experiential and collaborative learning as pillars for developing innovative competencies (Kettunen, 2011). Innovation Pedagogy aims to align academic education with the needs of the market and society, encouraging students to transform knowledge into creative and practical solutions.

A central aspect of this approach is its focus on interdisciplinarity and co-creation, manifested through projects where students, teachers, and external partners—such as companies and communities—collaborate to solve real-world problems. According to Kairisto-Mertanen et al. (2012), *Innovation Pedagogy* also stands out by explicitly integrating innovation competencies—such as critical thinking, communication, and teamwork—into curricula. The application of this methodology has proven successful in preparing students to act as transformative agents in an increasingly complex and dynamic world, contributing to the dissemination of innovative practices in higher education.

TECHNOLOGICAL EDUCATION

Education for technology has established itself as a strategic area for developing 21st-century skills, equipping individuals to thrive in an era of rapid digital transformation. This approach goes beyond teaching technical skills, incorporating the promotion of critical thinking, complex problem-solving, and creativity. Papert (1980), in his work *Mindstorms*, emphasized the importance of constructivist learning mediated by technology, highlighting how technological tools can enhance students' intellectual development, transforming them into creators of knowledge.

Another theoretical milestone is the concept of "Education for the Digital Age" by Jenkins et al. (2006), which introduces media and technological literacy skills as essential for contemporary citizenship. These skills include online collaboration, navigating information networks, and the ethical use of technology. Sawyer (2014) argues that educational innovation must be grounded in the learning sciences, promoting pedagogical practices that integrate emerging technologies with the development of socio-emotional and cognitive skills.

Furthermore, the Situated Learning Theory, proposed by Lave and Wenger (1991), provides a foundation for understanding how technology can be integrated into learning through communities of practice, where students actively participate in real-world problem-solving contexts. These perspectives underscore that education for technology should not be limited to instrumental teaching, but must be embedded in broader contexts that foster innovation and adaptation to the demands of an ever-evolving society.

METHODOLOGY

To evaluate the results achieved in this first stage of the Minds of The Future project, qualitative and quantitative research was conducted. A structured questionnaire based on the Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), was used to measure students' perception regarding different aspects of their educational and personal development. The applied questionnaire was developed by the project's research team, based on previous studies on the impact of educational programs and assessments of technological and entrepreneurial skills. Data collection was carried out at two moments: in the first and last class of the project activities execution. 107 of the 135 students who participated in one of the 8 classes of this first module answered both questionnaires.

The dimensions evaluated on both questionnaires included quality of relationships in the school environment, preparation and support for the academic and professional future, competence and comfort in the use of technology, and development of critical thinking and problem-solving skills. Specific questions were also included about learning robotics and programming concepts, interest in technology and innovation, and students' confidence in their own ability to face professional challenges. The first questionnaire also included questions related to age, type of school (state, municipal, or private), and socio-economic status. The second included questions related to the students' perceptions of the experience: lesson structuring, instructor clarity, teaching materials and support for questions, collaborative learning environment, opportunities for classroom practice and development of thinking skills, positive experience with robotics kits, learning in robotics and programming, engagement and motivation, interest in technology and innovation, confidence in using advanced technologies, preparation to face future professional challenges after the project and positive Impact of the project on school performance.

The data were analyzed through descriptive statistics to identify variations in students' perceptions before and after participation in the project activities. The responses were organized according to the scales and the percentages of responses for each category were calculated. The focus of the analysis was to identify significant changes in the highest evaluations (grades 4 and 5), reflecting improvements in the studied dimensions.

To evaluate the scholarship holders' perceptions regarding the effects of this stage of the project on the students and on their own personal and professional development, a questionnaire with objective and open-ended questions was administered for the 14 scholarship holders of the project. The dimensions used to assess the scholarship holders' perceptions regarding the effects of this first module on the students were: student engagement level, challenges faced by the students, interactions and group dynamics, student progress, feedback received, use of robotics materials and effectiveness of the

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activities performed, responses to the STEAM methodology. Questions about their perceptions of personal and professional growth during this stage of the project covered challenges, skills developed, interdisciplinary teamwork, views on the teaching-learning relationship, use of active methodologies, practical application of theoretical knowledge, and preparation to face future professional challenges.

The responses were analyzed through data coding, creation of categories, frequency analysis of responses, identification of patterns and relationships, and interpretation of the findings in relation to the research objectives.

RESULT ANALYSIS

In this section the results of both quantitative and qualitative methods will be presented, through analysis that connect the main findings with the general aspects of our research stream.

QUANTITATIVE ANALYSIS

107 students, aged between 13 and 19, answered both questionnaires, which were administered in the first and last class of the module. Among the respondents, 39% were in their last year of middle school and 61% were in high school; 72% attended state schools, 21.5% attended municipal schools, and 6.5% attended private schools.

Table 1 below presents the variables considered in the two questionnaires to assess the students' relationship with the school and with technologies, according to their perceptions, and the questions associated with each of these variables.

Table 1: variables and questions

Variable	**Associated Question**
Skills for Solving Technical Problems	Do you agree with the statement: "I have good skills for solving technical problems"?
Preparedness for Facing Market Challenges	How prepared do you feel to face the challenges of the job market?

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Relationship with Teachers	On a scale of 1 to 5, how do you rate your relationship with your teachers this year?
Preparedness for Professional Challenges	How prepared do you feel for professional challenges after high school?
Confidence in Career Choice	How confident are you about your career choice?
Frequency of Using Technological Devices	How often do you use technological devices (computer, tablet, smartphone)?
Quality of Education	How do you rate the quality of education at your school so far in 2024?
School Support for Academic Choices	How supported do you feel by the school regarding your future academic choices?
Comfort Using New Technologies	Do you agree with the statement: "I feel comfortable using new technologies"?
Motivation to Study	How do you rate your motivation to study so far in 2024?
Employment Opportunities in the Field	On a scale of 1 to 5, how do you feel about employment opportunities in your field?
Technology as Essential for Professional Future	Do you agree with the statement: "Technology is essential for my professional future"?
School Infrastructure	How do you rate your school's infrastructure (classrooms, laboratories, library, etc.)?
Regular Use of Technological Devices for Study	Do you agree with the statement: "I regularly use technological devices to study"?
Importance of Technological Innovation for Society	Do you agree with the statement: "Technological innovation is important for society"?
Relationship with Peers	On a scale of 1 to 5, how do you rate your relationship with your classmates this year?

Source: Formulated by the Authors (2024)

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Considering the Likert scale used, Table 2 below presents the results of the sum of responses 4 and 5 (good or very good, partially or completely agree) for each question and the comparison of responses in the two applications of the questionnaire.

Table 2: comparative results

Variable	Q1 (%)	Q2 (%)	Difference (%)
Skills for Solving Technical Problems	63.55	71.96	8.41
Preparedness for Facing Market Challenges	49.53	52.34	2.81
Relationship with Teachers	75.70	77.57	1.87
Preparedness for Professional Challenges	46.73	48.60	1.87
Confidence in Career Choice	75.70	77.57	1.87
Frequency of Using Technological Devices	74.76	75.71	0.95
Quality of Education	64.49	65.42	0.93
School Support for Academic Choices	39.26	39.25	-0.01
Comfort Using New Technologies	85.05	82.24	-2.81
Motivation to Study	51.40	47.67	-3.73
Employment Opportunities in the Field	65.42	61.68	-3.74
Technology as Essential for Professional Future	82.25	78.51	-3.74
School Infrastructure	42.06	37.38	-4.68

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Variable	Q1 (%)	Q2 (%)	Difference (%)
Regular Use of Technological Devices for Study	77.57	71.97	-5.60
Importance of Technological Innovation for Society	87.85	82.25	-5.60
Relationship with Peers	78.51	71.96	-6.55

Source: Formulated by the Authors (2024)

Analyzing Table 2, we observe that the most significant positive difference perceived by the students was regarding their ability to solve technical problems. At the beginning of the project, 63.55% of the students rated their skills for solving technical problems as "good" or "very good." By the end, this perception increased to 71.96%, representing a growth of 8.41 percentage points. This result demonstrates that the project had a significant impact on the development of problem-solving skills, which is a skill closely related to entrepreneurship. This evolution reflects the program's success in empowering students to seek solutions to technical problems by promoting a more confident and proactive approach.

Regarding preparedness for the job market, the data shows that initially, 49.53% of the students felt prepared for future challenges. By the end of the project, this number rose to 52.34%, indicating an increase of 2.81 percentage points. Although modest, this growth reflects that the project introduced elements that helped students feel more capable of facing the job market. However, the relatively small impact suggests the need to incorporate more specific activities to develop skills directly applicable to professional demands, which is already being prepared for the upcoming modules.

Students' perception of their relationship with teachers at their schools started high, with 75.7% rating it as positive, and experienced a small increase of 1.87 percentage points. This increase, although small, indicates that the project demonstrated the possibility of strengthening educational bonds by promoting a collaborative environment during the module and valuing the role of the teacher in the teaching process. However, improving students' relationship with their school teachers depends on establishing the same collaborative environment.

The same increase of 1.87 percentage points occurred in students' perception of their preparedness for professional challenges after high school. Although positive, there is still much to be done before students are truly prepared, and they understand this. Students' confidence in their career choice remained high, starting at 75.7% and reaching 77.57%, also a growth of 1.87 percentage points. This small improvement suggests that the project contributed, albeit initially, to encouraging students to reflect more thoughtfully on their possible choices.

The frequency of using technological devices increased from 74.76% to 75.71%, a slight rise of 0.95 percentage points. However, the perception of regular use of technological devices for study decreased from 77.57% to 71.97%, a reduction of 5.6 percentage points. This decline likely reflects the discrepancy between the use of technology throughout the project and the difficulty schools face in promoting this same use, either in the classroom or autonomously for other extracurricular activities.

The perception of the quality of teaching at the school where the students study increased from 64.49% to 65.42%, an increase of 0.93 percentage points, indicating no significant change. In the continuation of the project, modules are proposed for preparing public school teachers to utilize these methodologies, which may contribute to improving the quality of teaching. However, this can only be confirmed after the implementation of this new phase. Similarly, the perception of the limited support offered by the school for academic choices remained stable, a topic that can be included in the teacher training module.

Analyzing the results of other variables directly related to the school, such as motivation to study, school infrastructure, and relationships with peers, it is observed that this module does not reach the school and, in a way, highlights its weaknesses.

Regarding students' perception of the importance of technology for their professional future and for society itself, the results are concerning. After the project, there was a reduction in these perceptions. This decline, coupled with increased discomfort in using technologies, may indicate that students face difficulties in understanding how to apply the technologies presented in the project to their future careers and in associating technological innovation with direct social impact. This highlights the importance of reinforcing this connection in future editions.

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Considering the Likert scale used, Table 3 below presents the results of the responses 4 and 5 for each question related to the variable about students' perceptions about the project.

Table 3: students' perceptions

Variable	SUM of 4 and 5 (%)
Project Recommendation	99
Clarity of Instructors	97.2
Didactic Material	97.2
Lesson Structuring	96.3
Collaborative Learning Environment	95.3
Learning in Robotics and Programming	94.4
Interest in Technology and Innovation	94.4
Positive Experience with Robotics Kits	94.4
Support for Questions	94.4
Exceeding Expectations	93.4
Engagement and Motivation	92.5
Development of Thinking Skills	88.8
Opportunities for Practice in the Classroom	86.9

Confidence in Using Advanced Technologies	79.4
Preparation to Face Future Professional Challenges	72
Positive Impact of the Project on School Performance	71

Source: Formulated by the Authors (2024)

As shown in Table 3, the main positive outcome is the project's recommendation rate, at 99%, indicating that the students were satisfied with the experience. The instructors' clarity, which fostered engagement and understanding of the content being taught, along with the use of interactive teaching materials, received 97.2% positive evaluations. The careful planning and organized execution of activities, as well as the creation of a collaborative learning environment, were also perceived very positively, with 96.3% and 95.3% of responses scoring 4 or 5, respectively.

94.4% of the students positively evaluated their learning in robotics and programming and the use of robotics kits, reinforcing the effectiveness of the project's practical and technical approach. They also expressed interest in technology and innovation, demonstrating the project's success in sparking curiosity and student engagement, fostering a strong alignment with technological and innovative themes.

Further positive feedback included the support provided by the scholarship holders, with a 94.4% satisfaction rate. Moreover, 93.4% reported that the project exceeded their expectations, and 92.5% felt engaged and motivated for the majority of the time. The students perceived the project as contributing to the development of their critical thinking and problem-solving skills, essential for both personal and professional success.

The students also felt that the project provided opportunities for practical application in the classroom (88.8%) and increased their confidence in using technology (79.4%). To a lesser extent, students believed the project contributed to their preparedness for changes in the world of work (72%) and positively impacted their school performance (71%).

QUALITATIVE ANALYSIS

The 14 scholars of the project responded to the two blocks of questions in the open questions forms: (a) students in the classroom and (b) personal growth. Based on the

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scholars' responses to questions regarding the student experience block, we created five categories of analysis: 1) student engagement in activities; 2) challenges faced; 3) interaction and communication; 4) suitability of methodology and materials; and 5) student development.

For the scholars, student engagement was significant, especially during moments of greater interaction and challenge. Competition was highlighted as one of the most attractive activities, providing enthusiasm and greater participation. The use of LEGO kits was also a relevant factor, particularly in practical activities where students could experiment and apply learning in a more interactive way. An important observation made by the scholars is that younger students were more engaged than older ones.

Several challenges were identified, mainly related to students' insecurity and difficulties with programming, as this was most students' first contact with basic programming language. Insecurity about their own abilities was an initial obstacle, but students managed to overcome this challenge as they progressed through the activities, likely due to the support received from facilitators and the practical format of the tasks.

Interaction among students varied according to the group, with some teams standing out for effective collaboration, while others faced difficulties due to challenges in working collaboratively, requiring intervention to help resolve internal conflicts. Overall, there was a positive trend towards the formation of natural leaders within groups, contributing to the organization and effectiveness of team activities.

The STEAM methodology was well-received by students, particularly for the practical and interdisciplinary integration of concepts. The approach helped students develop logical and creative thinking skills. The methodology provided a more dynamic learning experience, and the playful materials contributed to a more accessible and interactive approach to programming and robotics. They also helped maintain student focus by making activities more fun and engaging, ensuring that learning was both educational and enjoyable.

In the scholars' perception, student progress was visible throughout the project. Evolution in interpersonal communication was one of the main indicators of success, with students becoming more confident and improving their interaction with peers and facilitators. A significant advance in practical skills was also observed, especially in the use of LEGO kits and in solving robotics-related problems. This improvement reflected the constant enhancement of the students' technical and social skills, as they became more autonomous and communicative as the project progressed.

Regarding the personal development of the scholars, four categories of analysis were created: personal and professional development, challenges and successes, use of active methodologies, and application of knowledge. In the first category, the scholars highlighted the development of communication skills (especially the ability to teach clearly and adapt to the audience), teamwork, creativity, empathy, patience, and adaptability. The experience of teaching and learning simultaneously was mentioned as a significant achievement, along with building bonds with colleagues and students, which enhanced confidence and a sense of belonging. Many responses mentioned the perception that participants were needed and could make a difference. There was also an emphasis on increased empathy, especially when dealing with different realities and working with audiences of various ages and backgrounds.

The main challenges involved adapting to a new area (such as programming), maintaining students' attention, and managing differences of opinion within the group. However, the successes were evident, particularly in student engagement, the growth of the scholars' self-esteem, and the positive impact on teaching skills. Positive feedback from students was a key source of motivation, especially comments on the scholars' availability and support.

The use of active methodologies was considered a transformative factor, as it allowed scholars to practically apply their theoretical knowledge and interact more effectively with students. The methodology was also seen as an important tool for making learning more engaging and efficient. It was crucial for adapting teaching to the individual needs of students, facilitating the understanding of complex concepts. In various responses, scholars mentioned how they learned alongside students, emphasizing the exchange of experiences and the encouragement of reflection and innovation in the teaching-learning process.

Although not all scholars had direct applicability of their undergraduate knowledge in the practical classes, many were able to integrate their training in areas such as physics, technology, and project management, which facilitated the execution of various tasks. The scholars also highlighted the importance of interdisciplinarity in academic and professional training. The project challenged previous views on teaching, leading many to realize that

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the practice of teaching goes beyond the mere transmission of knowledge, requiring adaptation and flexibility.

In the scholars' perception, the project served as preparation for future academic and professional challenges, helping them develop proactivity, self-confidence, and the ability to work in collaborative and interdisciplinary environments.

As we already find in the literature of STEAM and active learning (SAWYER, 2014), our results are intertwined with the same understanding: the experience of learning through practical experiences in a tech and innovation context, provide to students the opportunity to develop no jus cognitive skills, but also (and mainly) behavioral competencies.

That is why the connection between content and format, forges the nature of the learning experience in the context of Minds Of The Future Projects. As we intend to elaborate in the next section, despite the fact that we are just at the beginning of the research, it is possible to foresee positive implications in terms of pedagogical practices in developing countries and educational public policies towards entrepreneurial, innovative and technological education.

FINAL CONSIDERATIONS AND FURTHER DIRECTION

Minds of the Future project demonstrated significant positive impacts on the participating students' perceptions and skills. The results indicate improvements in various dimensions, from the relationship with teachers to the development of technical skills and increased interest in technology and innovation.

The increase in confidence in using advanced technologies and the perception of being better prepared for future professional challenges are particularly noteworthy. These results suggest that the project is achieving its goal of bridging the gap between the needs pointed out by the OECD and the educational reality observed in the country.

The project's approach, which combines STEAM methodology with active learning, seems to be effective in developing not only technical skills but also broader competencies such as critical thinking and problem-solving. This aligns with Neck and Greene's (2011) perspective that the success of entrepreneurship education lies in the methodologies used, such as experimentation, creation, and reflection.

However, it's important to note that this is an initial analysis, based on a relatively small sample and a short period of intervention. Future studies could benefit from a larger sample, a longer intervention period, and the inclusion of control groups to more robustly assess the project's impact, even qualitative approaches in the search of more contextual understandings.

Despite these limitations, the initial results are encouraging and suggest that initiatives like "Minds of the Future" can play a crucial role in preparing students for the challenges of the 21st century, fostering entrepreneurship, innovation, and technological fluency.

As we already detached in the last section, despite the fact that we are at the beginning of the research, our findings allow us to glimpse how pedagogical practices can influence learning environments, teachers training, and curricula. Models of learning that engage low income students in school practices, improving the relationship between them and the educational institutions is something that has the potential to turnaround the current scenario that educational professionals are facing in countries like Brazil.

Our initial results could provide inputs to support new public policies in terms of entrepreneurial, innovative and technological education in developing countries. In parallel, could also contribute to improvements in pedagogical practices in general, helping teachers to find solutions to engage their students in the daily routine of the schools.

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