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STEAMCat: the results of the implementation of a STEAM-based innovation program at an all-through school (3-16)

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STEAMCat: the results of the implementation of a STEAM-based innovation program at an all-through school (3-16)

Abstract. *This article examines the impact of the STEAMCat educational innovation program in a Catalan all-through school, Spain. This study uses a mixed-methods approach, combining a validated questionnaire and a focus group carried out with the team responsible for implementing the program. The study explores the perceived changes in teaching practices, school organization and student motivation after the implementation of the program. The results point to a widespread adoption of project-based learning, improved teacher coordination, and increased student interest in science and technology. However, the findings also highlight disparities in how the STEAM approach is applied across different educational stages, as well as limitations in the use of specialized learning spaces. The article concludes by underscoring the importance of fostering a shared school culture, strengthening teacher training, and ensuring the availability of sufficient resources and of time for coordination, all in order to ensure the long-term sustainability of the program.*

Keywords: *Educational development; educational technology; teaching methods; STEAM; digital literacy.*

El programa de innovación STEAMCat: Resultados de su implementación en un instituto escuela (3-16)

Resumen. *El presente artículo analiza el impacto del programa de innovación educativa STEAMCat en un instituto escuela de Cataluña. A través de una metodología mixta, que combina un cuestionario validado y un grupo de discusión con el equipo impulsor, se identifican los cambios percibidos en la práctica docente, la organización del centro y la motivación del alumnado. Los resultados muestran una implementación generalizada del aprendizaje basado en proyectos, una mejora en la coordinación docente y un aumento del interés del alumnado por las ciencias y la tecnología. No obstante, también se evidencian desigualdades en la aplicación del enfoque STEAM según las etapas educativas, así como limitaciones en el uso de espacios especializados. El artículo concluye destacando la importancia de consolidar una cultura de centro compartida, reforzar la formación docente y garantizar recursos y tiempo de coordinación para asegurar la sostenibilidad del programa a largo plazo.*

Palabras clave: *Innovación educativa; tecnología educativa; método de enseñanza; STEAM; competencia digital.*

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Introduction

In recent years, education systems have had to face new challenges as they prepare students for a world in constant transformation, driven not only by scientific and technological advances but also by rapidly accelerating, globally interconnected social changes.

The STEAM approach (Science, Technology, Engineering, Arts, and Mathematics), introduced by Yakman (2008), represents an attempt to meet these challenges. In the past two decades, STEAM education has gained ground as a strategic framework for fostering critical thinking, creativity, problem-solving, teamwork, and meaningful learning through active and interdisciplinary methodologies (García-Fuentes et al., 2023).

To support this educational transformation, in the 2018-2019 academic year the Catalan Department of Education launched the STEAMCat program, an educational innovation initiative aimed at promoting scientific, technological, and maker culture in schools. The program offers support, training and mentoring to teaching teams in the design and implementation of interdisciplinary STEAM-based learning proposals. It also provides specialized learning spaces and encourages collaboration with local associations.

The program has been implemented gradually throughout Catalonia, but empirical evidence is still needed to assess its real impact on teaching practices, school culture and student learning. It is also important to gain deeper insights into how core implementation teams perceive the program and how it is transforming educational projects and classroom methodologies.

The aim of this study is to analyze the impact of the STEAMCat program on a Catalan all-through school using a mixed-methods approach. Data were collected through a validated questionnaire and a focus group carried out with the core team. The research tools were designed to explore perceived changes resulting from the program in teaching practices, the use of specialized spaces, digital competence, student motivation and the internal organization of the school.

Definition and foundations of the STEAM Model

STEAM is presented as an educational approach that integrates scientific and artistic disciplines to foster creativity, critical thinking and the ability to solve real-world problems. This interdisciplinary framework seeks to connect theoretical learning with practical applications, promoting active and meaningful learning experiences.

Yakman's (2008) contribution is key to understanding the conceptual origins of the STEAM model, as it provides a systemic view of the disciplines involved and their interconnections in learning contexts. Elsewhere, Aguilera and Ortiz-Revilla (2021) emphasize that the inclusion of the arts within the STEM model not only enhances student motivation and engagement, but also supports the kinds of creative processes that are essential to 21st-century education by reinforcing the central role of creative thinking.

Educational innovation and maker culture

Maker culture has become a prominent locus of educational innovation, given its focus on active learning, design, and the creation of products using technology and diverse materials. According to Blikstein (2018), maker spaces encourage curiosity, experimentation and collaboration, and they hold great potential for STEAM education.

The potential of this approach is further reinforced by a recent systematic review conducted by Davies and Seitamaa-Hakkarainen (2024), which analyzes international research on maker education during the early 2020s. The findings show that educational environments incorporating maker culture support the development of practical skills, computational thinking and programming abilities. Moreover, these spaces foster an active relationship with knowledge and promote student autonomy and motivation through hands-on experimentation and the creation of artifacts linked to real-life situations.

Implementation of STEAM programs: international and national contexts

In recent years, STEAM has gained increasing visibility as a pedagogical model that promotes integrated learning. Indeed, it is being implemented in educational systems around the world, including in the United States, Europe, Asia and Australia (Herro et al., 2019). This global expansion is driven by educational policies that support interdisciplinary integration. For example, in the United States, new standards now include engineering in the science curriculum; in the United Kingdom, integrated STEM projects are being promoted both inside and outside schools; and in countries such as Germany and South Korea, national plans have been launched to incorporate the STEAM approach across all educational levels (Kang, 2019).

In the Spanish context, STEAM programs have also gained momentum as a pedagogical innovation strategy in both primary and secondary education. One notable initiative is the STEAM Alliance for Female Talent: Girls on the Front Line of Science, launched by the Spanish Ministry of Education, Vocational Training and Sports in 2021. This alliance brings together public administrations, companies, schools, and organizations to challenge gender stereotypes, strengthen girls' confidence from an early age, and foster their interest in science and technology (Ministerio de Educación, Formación Profesional y Deportes, 2021).

In Catalonia, as mentioned above, the STEAMCat program promotes interdisciplinary school-based projects from early childhood to lower secondary education, offering teacher training and collaboration with external stakeholders (Departament d'Educació i Formació Professional, 2023). In Andalusia, an ini-

tiative called STEAM: Applied Aerospace Research in the Classroom links science to real-world contexts such as space exploration and has reached over 125,000 students (Junta de Andalucía, 2023). In Madrid, the STEMadrid program promotes science and technology learning in English through active projects, reaching more than 35,000 students (Comunidad de Madrid, 2024).

These experiences demonstrate that, despite challenges related to teacher training and resource management, the implementation of STEAM programs can foster creativity, critical thinking, and students' interest in scientific and technological disciplines (Spyropoulou & Kameas, 2024).

Method

This investigation takes the form of a case study. It follows a descriptive mixed-methods approach in an effort to analyze the impact of the STEAMCat educational innovation program on a Catalan all-through school. The case study design enables in-depth exploration of specific and contextualized educational settings that can shed light on how certain dynamics and changes unfold within the school environment (Yin, 2014). The combination of quantitative and qualitative data provides a detailed view of the perceived changes in the school resulting from its participation in the program.

Objectives of the study

The main objective is to analyze the impact of the STEAMCat program in a Catalan all-through school (3-16), based on the results of a validated questionnaire and a focus group conducted with the core implementation team.

From this general objective, the following specific objectives are derived:

To examine perceived changes in teaching practices and school organization, with a particular focus on the integration of STEAM methodologies, the use of specialized spaces and interdisciplinary work.

To assess the program's impact on students, particularly in terms of their motivation and engagement, and their interest in science and technology.

To collect data on the teaching staff's overall evaluation of the program, in order to identify strengths and challenges, and to arrive at suggestions for improvement.

Context and participants

The research was conducted at an all-through school participating in the STEAMCat program, involving teachers from early childhood, primary, and secondary education. A total of 48 teachers took part in the study: 44% from primary education (n=21), 29% from secondary (n=14), and 27% from early childhood (n=13). Women made up most of the participants from all of these educactional stages, and they were especially predominant in early childhood education, where 100% of participants were women. Among the primary and secondary school teachers, the proportion of male participants reached 24% and 29%, respectively, while female participation was 76% and 71%.

It is worth noting that although there were a total of 76 teachers at the school this academic year, 20 of them joined the teaching staff either this year or the previous one and were therefore not considered eligible to participate. Thus, the study population was 56 teachers, meaning that the approximate participation rate was 86%. Moreover, all respondents had also taken part in the school's internal training linked to the FAIG innovation program (Fent per Aprendre, Imaginant Globalment), which promotes meaningful learning through a maker perspective and the use of digital fabrication.

Questionnaire

The questionnaire was designed by the research team and validated by six experts in educational technology and teaching methodologies. These experts represented diverse academic fields (Table 1) and rated the suitability and relevance of the items on a Likert scale. The overall average score was 3.60 out of 4, with ratings of 3.51 for suitability and 3.69 for relevance.

Table 1. Profile of validation experts

	Specialty / Position
Expert 1	Researcher and lecturer in Science Education.
Expert 2	PhD in Educational Technology and primary school teacher.
Expert 3	Lecturer in the Department of Pedagogy, specialising in research methods, evaluation, and data collection and analysis tools.
Expert 4	PhD candidate in Educational Technology and teacher trainer in the "maker movement".
Expert 5	Lecturer in the Department of Pedagogy. Researcher in Digital Teaching Competence (DTC) and digital inclusion.
Expert 6	Lecturer in the Department of Pedagogy. Researcher in Educational Technology.

A table summarizing the proposed and implemented modifications was created. These revisions included the rewording of certain items, the incorporation of Likert scales into some items, the addition of examples in some open-ended questions, and the inclusion of new items to complete the information gathered.

The aim of this instrument was to collect data on the use of STEAM methodologies and of specialized spaces (such as the FAIGLab, robotics classroom, or science lab), as well as on organizational changes and the program's perceived impact on students. The questionnaire was administered via an online form and consisted of four sections: biodata; STEAM methodologies and spaces; impact on students and the school; and digital competence and technologies.

The questionnaire included both single-choice and multiple-choice questions to gather information on teachers' profiles and the methodologies they used. It also featured Likert-scale items to assess the impact of teaching strategies and digital tools, as well as open-ended questions to collect additional insights and suggestions.

Focus group

To carry out the focus group, the research team first analyzed the questionnaire data to identify the most relevant areas for discussion. Based on this analysis, a discussion guide was developed, addressing topics such as challenges in implementing methodologies across different educational stages, teacher coordination for interdisciplinary work, and perceptions of the program. The same dimensions used in the questionnaire were adoped in order to complement and enrich the data collected.

A face-to-face session was then held with the program's core implementation team, consisting of eight teachers. The focus group included representatives of all the school's educational stages, as well as a member of the management team. The session was moderated by the researcher, recorded with prior consent, and subsequently transcribed. The contributions were analyzed, and a detailed report was drafted, including conclusions and suggestions for program improvement. This document was later shared with the school's management team.

Data analysis

Quantitative data from the questionnaire were processed using Excel, including counts, percentage calculations, and means, with the aim of identifying general trends and response patterns among the teaching staff.

The qualitative data obtained from the questionnaire's open-ended responses served to complement and enrich the quantitative results. These responses provided practical examples that helped support and contextualize the numerical findings. Each qualitative item was directly linked to the corresponding quantitative results to make it possible to offer specific examples to illustrate the data more effectively. A coding system was used to classify responses into two categories: factors that hindered (barriers) or that facilitated (enablers) program implementation.

Regarding the focus group, each teacher's contributions were labeled with an identifier code (Table 2) and analyzed using the same coding system applied to the questionnaire's open-ended responses. The transcribed input from the focus group was used to further support and deepen the data analysis, reinforcing the conclusions drawn from the survey. Direct quotes, along with the corresponding teacher codes, were included to provide a qualitative perspective.

Table 2. Classification of the teachers participating in the focus group

Code	Stage of education
T1	Early childhood education teacher
T2	Primary education teacher
T3	Secondary education teacher
T4	Early childhood education teacher
T5	Primary education teacher
T6	Secondary education teacher
T7	Primary education teacher
T8	Secondary education teacher and member of the management team

Results

This section presents the results obtained from the questionnaire and the focus group, structured to correspond with the various objectives defined in the study. The analysis combines quantitative data with teachers' qualitative perceptions to understand the impact of the STEAMCat program on teaching practices, school organization and students' learning experiences.

Perceived organizational changes in teaching practice and STEAM methodological integration

This subsection relates to the first specific objective of the study, which was to analyze perceived changes in teaching practices and school organization, with special attention paid to the integration of STEAM methodologies and interdisciplinary methods of work.

The results (Table 3) show a high degree of implementation of project-based learning (PBL), with 85% of teachers reporting regular use of this approach. When broken down by educational stage, the figure is 90% for primary education, 85% for early childhood and 79% for secondary education.

Table 3. Percentage of teachers by educational stage implementing different STEAM approaches in the classroom

Approach	Early childhood	Primary	Secondary	Total
Project-based learning	85%	90%	79%	85%
Computational thinking	0%	0%	14%	4%
Scientific method	0%	0%	0%	0%
Critical thinking/ problem solving	0%	10%	7%	6%
Tinkering	0%	0%	0%	0%
Other	15%	0%	0%	4%

Other approaches such as computational thinking, use of the scientific method, or tinkering appear much less frequently, particularly in early childhood, where no such practices were reported. In secondary schools,

14% of teachers report using computational thinking, and 7% use critical thinking and problem-solving strategies. In primary, the rates are 0% and 10%, respectively.

These results reflect the strong presence of PBL as a cross-cutting methodological approach, but they show an uneven degree of implementation of other STEAM approaches. As noted in the focus group, this imbalance can be partially attributed to the difficulties involved in adapting approaches like computational thinking and the scientific method to earlier stages, as well as to the lack of specific training and clear models to support the application of these methods.

The presence of interdisciplinary projects, learning-environment-based activities and learning boxes was also confirmed during the focus group. As one participant (T6) put it: "When we share projects and methodologies across school levels, you really notice a transformation in the school."

This integration is also reflected in the data, as 44% of teachers reported that between 26% and 50% of their classes' weekly activities include interdisciplinary tasks, while another 23% reported said that over 75% of their sessions incorporated such tasks (Table 4). This approach is reinforced in turn by certain organizational changes, such as the creation of STEAM time blocks, the reorganization of spaces, the dedicated use of the science lab and improved scheduling coordination to support interdisciplinary work.

The responses to the open-ended items on the questionnaire provided concrete examples that illustrate the diversity and creativity of STEAM proposals that have been implemented at the school. In secondary education, for example, the project "Our little place" involved building an interactive model using robotics, programming, and 3D printing. Tools such as Microbits, Makey Makey, Scratch, and GeoGebra have also been used to explore computational thinking, electricity, and the graphical representation of mathematical systems.

Table 4. Frequency of STEAM implementation by educational stage (% of weekly activities)

% of implementation	Early childhood	Primary	Secondary	Total
0 -25%	8%	19%	21%	17%
26-50%	15%	67%	36%	44%
51-75%	23%	10%	21%	17%
76-100%	54%	5%	21%	23%

In primary education, the project "Which elements of the city reflect our past?" combined local history, science, and technology through activities such as cleaning public spaces, creating laser-cut models and designing electrical circuits.

In early childhood, notable examples of activities include the use of BeeBots and TaleBots in math activities and learning corners, as well as the "Solidarity Paw Prints" project, linked to an animal shelter. In this initiative, young children actively participated in maker-style product creation for a charity fundraiser. This project represents an early introduction to maker culture, aimed at connecting learning with real-world contexts.

STEAM methodology is employed with varying degrees of frequency at different levels. Most early childhood teachers (84%) make only occasional use (1-2 times per week) of these methods. At the primary level, there is more variation among teachers, as 33% report using these methods 3-4 times per week, while 19% say they do so more than seven times. Among secondary teachers, 57% report using STEAM methods just 1-2 times per week, while 14% do so more than seven times in the same period (Table 5).

Table 5. Percentage of weekly lessons by educational level that include STEAM methodologies

Lessons	Early childhood	Primary	Secondary
0	0%	0%	8%
1-2	84%	48%	57%
3-4	8%	33%	21%
5-6	0%	0%	0%
7+	8%	19%	14%

This variation was also discussed in the focus group, where teachers linked it to the internal organization of each educational stage. In early childhood, the structure of daily routines and activity-based learning limits the implementation of STEAM proposals. "In early childhood, it is much harder to set aside time. Routines take up most of the morning, and many activities already have a set structure that doesn't always fit with these approaches" (T1). In contrast, primary and secondary classes benefit from dedicated time blocks for more interdisciplinary learning, which facilitates integration. As a result, participants suggested expanding the use of "FAIG projects" across all grade levels and gradually adapting some early childhood environments to better align with STEAM and maker education.

Finally, the data indicate a generally positive perception of the organizational changes associated with the implementation of the STEAMCat program (Table 6). About 46% of teachers reported that coordination and networking within the school had improved "quite a bit" or "a lot," and 63% noted improvements resulting from the creation of new learning spaces. In addition, 39% of respondents stated that STEAM activities were "well" or "very well" integrated into timetables and curriculum planning.

Nonetheless, the focus group also highlighted challenges, particularly regarding uneven participation among staff, which results in inconsistencies in implementation. "Some subjects still follow a very closed-off, traditional model. Even if there are projects, not everyone is equally involved" (T3). Difficul-

Table 6. Teachers' perceptions of organizational changes associated with the implementation of the STEAMCat program

	None	Few	Some	Several	Many	Mean*	Deviation	Mode
Coordination and networking within the school	0%	2%	52%	42%	4%	3.48	0.84	3
Creation of new spaces	0%	0%	38%	48%	15%	3.77	0.81	4
Greater integration of STEAM activities into timetables and the curriculum	0%	2%	58%	29%	10%	3.48	0.75	3

Note. *Mean score on a 5-point scale

ties were also noted in aligning schedules and tasks, and in ensuring coherence between projects, technologies, and methodologies to ensure a meaningful impact on student learning. As teacher T6 pointed out: "What we also lack is time. Not just time to carry out the activities, but to plan them together. It's hard to innovate when you do it alone." Overall, however, these findings point to a clear trend toward school-wide transformation in support of interdisciplinary and active learning, as envisioned by the STEAM model.

Use and perception of specialized learning spaces

This section also relates to the first specific objective, which was to analyze changes in teaching and organizational practices, with a particular focus on the use and evaluation of the school's specialized spaces linked to STEAM methodology.

Although the school's STEAM spaces (such as the robotics classroom, the FAIGLab, and the science lab) are considered key resources for implementing competence-based learning, their use varies significantly across educational stages. Questionnaire data show that nearly half of the teaching staff (48%) said they had not used these spaces with students during the past month, and only 8% had used them more than five times (Table 7).

Table 7. Monthly frequency of use of STEAM spaces by educational stage

	Early childhood	Primary	Secondary	Total
None	85%	48%	14%	48%
1-2 times	8%	43%	57%	38%
3-4 times	8%	10%	0%	6%
5 or more times	0%	0%	29%	8%

Among early childhood education teachers, 85% reported not using these spaces at all. On average, they rated their use of the spaces below 2 on a scale from 1-to-5 (Table 8). Primary teachers had slightly more positive perceptions of the spaces (2.5 for the FAIGLab and 1.8 for the robotics space), but nearly half of the teachers at this level still report not using them. Secondary teachers tend to use the FAIGLab used more regularly, with 29% of them doing so more than five times per month. This space gets an average rating of 3.4 from teachers at this level.

Table 8. Assessment of the use of STEAM spaces in teaching practice by educational stage

	Early childhood	Primary	Secondary	Mean	Deviation	Mode
Robotics classroom	2.08	1.8	2	1.96	1.34	3
FAIGLab	1.7	2.5	3.4	2.54	1.41	3

Participants acknowledged the educational potential of these spaces, but noted that their use is mainly concentrated at the secondary level and among a few specific teachers. In contrast, the participation of early childhood and primary education is significantly lower. As one kindergarten teacher (T1) explained: "In early childhood, honestly, we hardly ever use it. It feels like a space designed for older students, with materials we don't really know how to use with young children."

This disparity is attributed to a lack of specific training and unfamiliarity with how these spaces function and what they offer. Participants also emphasized the need for clear usage protocols and support materials to facilitate access for all teachers. As another teacher (T4) put it, "I went there once with my group and felt a bit lost. Maybe we need some support sessions or someone to guide us." The absence of guidance makes it difficult for some teachers to use these learning environments confidently and independently.

In response, the group proposed several actions, including appointing contact persons for each space, creating infographics or short guides, and establishing collaborative dynamics to encourage shared use of these resources. This approach aligns with the suggestion made by a member of the management team (T8): "We're considering creating brief visual guides or tutorials with activity proposals for each educational stage. That would help democratize access to the space."

In this regard, the group agreed on the need for stronger and broader promotion of these spaces to ensure that all students benefit and become a part of both the STEAMCat program and the school's educational project.

Impact of the program on students' motivation, engagement, and learning

This subsection relates to the study's second specific objective, which was to assess the impact of the STEAMCat program on students in terms of motivation, engagement, and interest in science and technology.

The questionnaire results indicate that participation in STEAM activities (such as Science Week, Retotech, Recerkids and the Cangur math competition) has led to increased student interest and engagement. Overall, 52% of teachers reported observing a slight increase in interest in science and technology-related activities, while another 25% stated that this interest had increased significantly. Meanwhile, 44% of respondents noted a moderate improvement in student participation, and 38% reported a higher degree of improvement (Table 9).

Table 9. Teachers' perceptions of the improvement in students' interest and participation in science and technology

	Early childhood		Primary		Secondary		Total	
	I(*)	P(*)	I	P	I	P	I	P
None	46%	38%	5%	0%	0%	0%	15%	10%
Little	0%	8%	0%	5%	14%	0%	4%	4%
Some	46%	23%	62%	52%	43%	50%	52%	44%
Quite a lot	8%	31%	24%	33%	43%	50%	25%	38%
A lot	0%	0%	10%	10%	0%	0%	4%	4%

Note. * I- Interest ; P- Participation

This positive trend is particularly evident in primary and secondary education, where over 90% of teachers observed improvements in students' interest and participation. In contrast, early childhood education showed more uneven results, suggesting a need for further implementation efforts at that level.

Meanwhile, 83% of teachers believe that STEAM activities at the school have encouraged students to pursue further studies in science and technology, with 35% considering this motivation significant. Active participation was identified by 58% of teachers as the clearest indicator of increased interest, while other signs, such as participation in science fairs (19%) and the development of specific projects (4%), were less common but still relevant. However, as noted in the focus group, it is still too early to determine whether the program has led to an actual rise in scientific or technological vocations. It is clear, though, that teachers believe that access to specialized spaces supports student motivation. The FAIGLab received an average rating of 3.06 and the robotics room 3.08 out of 5. In secondary education, these spaces received the highest scores (3.64 and 3.21, respectively), confirming their motivational value, particularly at upper educational levels.

Teachers' perceptions of how STEAM methodologies influence their students also reinforce the idea of student motivation (Table 10). The participants were likely to believe that STEAM leads to "increased motivation and engagement in hands-on activities," as this item registered the highest average score (4.05 out of 5), with particularly strong results among early childhood (4.31) and secondary (4.07) teachers. Teamwork (3.96) and the development of critical thinking and problem-solving skills (3.86) were also rated positively. These results suggest that hands-on methodologies enhance student engagement across all educational stages. In contrast, the cross-curricular application of STEAM content received lower scores (2.46), as did the development of digital creativity (2.64), pointing to areas in need of reinforcement.

Table 10. Teachers' perceptions of the impact on students of work in learning environments, learning corners and STEAM learning boxes.

	E. child.*	Pri.*	Sec.*	Mean	Deviation	Mode
Understanding and applying the scientific method	3.85	3.67	4.07	3.86	0.20	4
Motivation and engagement in hands-on tasks	4.31	3.76	4.07	4.05	0.28	4
Critical thinking and problem-solving	3.92	3.71	3.93	3.86	0.12	4
Creativity and use of digital tools	2.38	2.67	2.86	2.64	0.24	3
Cross-curricular STEAM application	2.31	2.29	2.79	2.46	0.28	3
Collaboration and teamwork	4.15	4.10	3.64	3.96	0.28	4

Note. *Early childhood, Primary and Secondary

This overall positive perception of student motivation and engagement is further supported by evaluations of the impact of digital tools on the teaching and learning process (Table 11). With a weighted average of 3.77 out of 5, digital tools are seen to foster motivation (4.0 in primary), increase classroom interactivity (4.1 in secondary), and support hands-on learning (4.1 in early childhood). Other aspects also received favorable, albeit slightly lower, ratings—such as the improvement in managing digital content and resources (between 3.5 and 3.8, depending on the stage) and support for the inclusion of students with special educational needs, with an overall average of 3.3. This consistency across educational levels (3.8 in early childhood and primary, 3.7 in secondary) reinforces the idea that the digital approach not only boosts motivation but also enriches and diversifies teaching practices.

Impact of the STEAMCat program on teaching practice and digital competence

This section addresses the third specific objective of the study, which was to gather teachers' overall assessment of the STEAMCat program, identifying stren-

Table 11. Impact of digital tools on the teaching and learning process in the classroom

	E. child.*	Pri.*	Sec.*	Mean	Deviation	Mode
Increased student motivation	3.9	4.0	3.9	3.9	0.06	4
Greater class interactivity	3.8	4.0	4.1	4.0	0.15	4
Facilitated hands-on learning	4.1	4.0	3.8	4.0	0.15	4
Improved management of digital content and resources	3.5	3.8	3.5	3.6	0.17	3
Promoted inclusion of students with special needs	3.5	3.4	3.1	3.3	0.21	3

Note. *Early childhood, Primary and Secondary.

gths, challenges, and areas for improvement, particularly regarding teaching practice and the development of digital competence.

The STEAMCat program has significantly impacted teachers' self-perceived Digital Teaching Competence (DTC). As shown in Table 12, there has been a decrease compared to three years ago in the percentage of teachers identifying with only a basic level dropped from 52% to 18%. Meanwhile, over the same period the percentage of teachers at the intermediate level rose from 27% to 63%. The prevalence of advanced profiles, such as expert and transformative teachers, also increased. The proportion of teachers who considered themselves experts rose from 6% to 13%, and while three years ago few if any labeled themselves transformative, now 6% do so. This progress is reflected in the rise of the average DTC self-assessment score from 2.25 to 3.06.

Table 12. Self-perception of DTC before and after the implementation of the STEAMCat program

	Level 3 years ago	Current level
Not achieved	15%	0%
Beginner profile	52%	19%
Intermediate profile	27%	63%
Expert profile	6%	13%
Transformative profile	0%	6%

This improvement is more evident among teachers who received specific training (Table 13). Those who had completed training had an average DTC score of 3.27, while those who had not scored 2.72. The focus group emphasized that much of the change stemmed from training and collaboration, as reflected in T7's comment, "Sharing documents, joint projects, and meetings has helped us grow as a team." The participants also highlighted the need to reduce internal disparities through ongoing training, with one (T8) saying that "There are clear differences between those who have received training and those who haven't, and this really shows in interdisciplinary work and technology use."

Table 13. Self-perception of DTC based on training participation

	Without training	With training	Total
Not achieved	0	0	0
Beginner profile	7	2	11
Intermediate profile	9	21	30
Expert profile	2	4	6
Transformative profile	0	3	3
Total	18	30	48
Weighted average (out of 5)	2.72	3.27	

Regarding the use of digital tools (Table 14), the most frequently adopted tool over the past three years include the laser cutter (56%), the 3D printer (38%), BeeBots (29%) and a digital embroidery machine (21%). The adoption of these technologies was supported by better equipment and the promotion of spaces like the FAIGLab. However, the focus group noted that these tools are still used far more often in secondary education. They proposed assigning a reference person for each space and creating visual materials and training support manuals.

Table 14. Use of technological tools by the teaching staff

	Number of teachers	Percentage of usage
Laser cutter	27	56%
3D printer	18	38%
Beebots	14	29%
Digital embroidery machine	10	21%
Vinyl cutter	6	13%
LEGO	5	10%
Arduino	5	10%
Micro:bit	5	10%
Tale bots	5	10%
Makey Makey	3	6%
Codey Rocky	3	6%
Others	4	8%
None	2	4%

The proportion of teachers to take part in training activities varies by stage. The rates were 46% for early childhood, 67% for primary, and 71% for secondary education. A significant gender gap was also noted in the likelihood of enrolling in these activities, as 89% of men participated in training compared to 56% of women. Topics covered included digital competence, the FAIG program, digital tools and machines (plotter, laser cutters), robotics, AI, and gamification.

Overall, the program received a positive assessment, with an average rating of 3.8 out of 5 (Table 15), with the score rising to 3.9 among teachers who had done training. By stage, the scores were 3.8 in early childhood, 3.9 in primary, and 3.7 in secondary. Focus group participants described the program as a catalyst for educational transformation. As one teacher (T5) stated, "It's been a great opportunity, but we need to maintain resources, coordination time, and a strong commitment from the whole staff to ensure quality and continuity."

Table 15. Overall evaluation of the STEAMCat program as a function of participation in training

Educational stage	Overall mean	Without training	With training
Early childhood	3.8	3.8	3.8
Primary	3.9	3.6	4.0
Secondary	3.7	3.3	3.9
Overall mean	3.8	3.6	3.9
Standard deviation	0.10	0.25	0.10
Mode	4	3	4

The participants also stressed the need to strengthen the ties between areas of knowledge to foster meaningful learning. "Interdisciplinary projects like learning boxes or integrated projects are helping students engage and learn in real contexts where different areas come together" (T7). This cross-cutting approach is essential to ensure the program's sustainability and its long-term impact on educational practice.

Finally, Table 16 summarizes the main findings, highlighting key aspects, associated strengths and ongoing challenges.

Table 16. Summary of strengths and challenges in the implementation of the STEAMCat program

Aspect	Key strengths	Main challenges and limitations
Teaching practice	Implementation of active methodologies and interdisciplinary projects.	Uneven implementation across educational levels and teacher profiles.
Student motivation	Increased interest, participation, and cooperative learning.	Ensuring the methodology reaches all students, not only specific groups.
Spaces and resources	Creation and use of innovative spaces (FAIGLab, maker classroom, laboratory).	Underuse of these spaces in early childhood and primary education.
School culture and innovation	Improved coordination among teachers and development of a shared pedagogical approach.	Lack of coordination time and risk of relying too heavily on driving teams or specific leaders.
Teacher training	Active participation by some members of the teaching staff in specific training sessions.	Need for ongoing and tailored training for all profiles.

Discussion

The findings of this study confirm the theoretical expectations and align with previous research on STEAM education. Firstly, the results show a transformation in teaching practices arising from the implementation of the STEAMCat program. The adoption of active methodologies such as project-based learning and interdisciplinary collaboration reflects a cultural shift toward a more integrated and reality-connected teaching model. This more interdisciplinary approach addresses the challenge of overcoming subject fragmentation and promotes a more holistic understanding of knowledge (Yakman, 2008).

Student motivation and engagement have also increased, particularly in hands-on and interdisciplinary activities, and increases were found in critical thinking and teamwork during project work. These results support existing literature, which shows that STEAM methodologies enhance student interest and improve learning outcomes. Indeed, a recent systematic review (Amanova et al., 2025) concludes that STEAM programs in schools have a positive impact on academic achievement, emotional factors and skill development.

The STEAMCat program has served as a catalyst for change, promoting a cultural and methodological shift in teaching practices. Teachers emphasized that it not only encouraged the adoption of more active and interdisciplinary approaches, but also redefined how learning is conceptualized within the school community. The creation of new learning environments (such as the lab, the maker classroom, and the FAIGLab) together with the integration of digital tools, have all expanded teaching possibilities and fostered creative and collaborative learning. According to Waters and Orange (2022), collaborative work supported by institutional backing enables schools to develop a STEAM-oriented culture, enhancing creativity and encouraging a growth mindset. In our case, collaboration among teachers has been key to developing a consistent and unified STEAM approach. Experiences have been shared across disciplines and stages, gradually shaping a school-wide pedagogical vision. Boice et al. (2024) also highlight that when educators receive pedagogical support, they are better able to understand the STEAM framework and design context-appropriate activities.

Despite these advances, there have been some limitations. One of the main challenges identified was the lack of time for joint planning and coordination, which is essential for successful project implementation. This concern was echoed by participants in the focus group and is consistent with other studies, which show that integrating STEAM into the curriculum often increases teacher workload and planning demands (Boice et al., 2024).

Another major concern is the unequal level of teacher training and involvement across educational stages, which has led to inconsistent implementation of STEAM initiatives. The use of specialized learning spaces remains largely concentrated in secondary education, while their usage is considerably less frequent in early childhood and primary education. Teachers attributed this gap to a lack of specific training and familiarity with the tools and methods involved. The-

se findings are in line with Silva-Hormazábal and Alsina (2023), who point out that although teachers often show a positive attitude toward STEAM, their initial level of expertise is generally low, and that only continuous and targeted training can build the confidence needed to apply it effectively. Therefore, reinforcing ongoing professional development is crucial to ensuring a more equitable and coherent implementation of the program.

Lastly, the influence of STEAMCat on the school's organizational culture has opened up possibilities for long-term educational innovation. The initial years of participation have prompted a shift toward more inquiry-based, interdisciplinary, and creative learning processes, which have gradually become part of the school's strategic vision. As Gavari-Starkie et al. (2022) suggest, in order to consolidate this transformation, it is necessary to embed the STEAM perspective into the school's long-term planning, capitalize on contextual resources, and ensure the active engagement of both teaching staff and school leadership. This potential was echoed by several participants in the focus group, who viewed the program as a valuable opportunity to move toward a more integrated educational model. However, they also stressed the importance of sustaining coordination time, resources, and collective commitment to ensure the program's long-term impact.

Conclusions

Participation in the STEAMCat program has provided a significant move toward a more active, collaborative, and real-world-connected teaching approach, marking a clear transformation in classroom practices. Despite challenges, the results indicate progress in teaching methods, student motivation, and staff collaboration.

Teachers have begun to implement more interdisciplinary projects, collaborate more regularly, and explore new ways to organize learning. However, notable differences remain in terms of participation and training across educational stages, which must be addressed to maximize the program's impact.

The creation of new spaces such as the laboratory, the maker classroom and the FAIGLab has enriched hands-on learning. Nonetheless, access to and use of these spaces has not been consistent across all levels. Moreover, a lack of coordination time and the additional workload required to develop STEAM projects have limited the program's continuity and broader implementation.

It is also important to contextualize the findings. The study was conducted in a single school with a limited sample, meaning that results should be generalized with caution. Furthermore, the analysis reflects a specific stage of implementation; full consolidation will require time, ongoing monitoring and adaptation.

In summary, the STEAMCat program has enabled progress toward a more integrated and meaningful educational model. To ensure long-term sustainability and deepen the transformation, it will be essential to strengthen teacher training, guarantee coordination time and embed the STEAM approach within the school's strategic plan. These efforts will help consolidate an innovative, equitable, and future-oriented educational culture.

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