Effects of a Steam and Physical Education Integrated Curriculum on Middle School Students' Scholastic Well-Being

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Abstract
The promotion of well-being in schools is becoming increasingly central. This experimental study examined the effects of an integrated curriculum combining STEAM and Physical Education on scholastic well-being in lower secondary school students. Scholastic well-being was assessed using the tool developed by Tobia and Mazzocchi (2015). A total of 120 students were randomly divided into two groups: an experimental group, which took part in the integrated program, and a control group, which followed the traditional curriculum. The findings revealed a significant improvement in interpersonal relationships, academic self-esteem, and sense of belonging among students in the experimental group compared to those in the control group. These results support the effectiveness of a holistic and interdisciplinary approach—centered on STEAM and Physical Education—in enhancing students' overall scholastic well-being.

Keywords: *STEAM, Physical Education, Secondary School, School Well-Being*

Introduction

In recent years, the educational landscape has shown a growing focus on interdisciplinary approaches aimed at promoting the comprehensive development of students' cognitive, emotional and social skills. In this direction, STEAM disciplines (Science, Technology, Engineering, Art and Mathematics) have established themselves as effective tools for addressing the complexity of contemporary reality, promoting critical and creative thinking through educational experiences that intertwine different areas of knowledge.

At the same time, physical education is widely recognised for its positive effects on physical, emotional and cognitive well-being, contributing not only to improved concentration and stress reduction, but also to the development of socio-emotional skills.

Despite the recognised value of both approaches, the scientific literature still presents a limited number of studies dedicated to the systematic integration of STEAM and physical education in the school context. This study aims to fill this gap, at least in part, by investigating

the effects of an integrated educational intervention between these two areas on students' perception of well-being at school.

Well-being was assessed using the test developed by Tobia and Mazzocchi (2015), a validated tool that measures fundamental dimensions such as the quality of interpersonal relationships, academic self-efficacy and sense of belonging to the educational community.

The central hypothesis is that an educational model combining physical activity and STEAM interdisciplinary learning can have a positive and significant impact on school well-being, surpassing the effects of a traditional curriculum. This hypothesis is based on extensive literature highlighting the effectiveness of multidimensional and participatory educational experiences that simultaneously engage the body and mind.

1. Research structure

The study involved 120 students (average age: 12.5 years, range: 11-14 years) from three lower secondary schools located in an urban area of the city of Caserta (Italy). The division into two groups was made randomly: the experimental group (N=60) participated in the integrated programme, while the control group (N=60) continued to follow the traditional curriculum. To ensure the representativeness of the sample and the validity of the results, specific criteria were defined for the selection of participants in this study. The inclusion criteria were as follows:

- Age: Students had to be enrolled in lower secondary school (11-14 years old). This age group was chosen as it is crucial for the development of cognitive, social and emotional skills and coincides with a time of significant change in terms of school well-being.
- Continuous school attendance: Only students with school attendance of more than 80% in the six months prior to the start of the study were included. This criterion was adopted to ensure that participants had a relatively stable and consistent school experience, which is essential for measuring the impact of the intervention.
- Absence of significant intellectual or physical disabilities: To prevent particular conditions from substantially influencingthe results of the integrated intervention, students with intellectual or physical disabilities that could have interfered with full participation in the proposed STEAM andmotor activities were excluded. However, students with special educational needs (SEN) and specific learning disorders (SLD) were included, as the intervention did not exclude these categories but rather aimed to create an inclusive environment.
- Informed consent: Participation in the study required informed consent from the students' parents or legal guardians, as well as the consent of the students themselves. Consent included authorization for the collection and analysis of data relating to school well-being, as well as participation in the integrated programme activities.
- Motivation and willingness to participate: Only students who had shown willingness and interest in participating in the project and who had agreed to be randomly assigned to the experimental or control group were included. This criterion was implemented to ensure the active participation of students, a key factor in the success of the programme.
- No involvement in other parallel experimental programmes: Students who were participating in other experimental programmes or extracurricular activities that could influence the results related to school well-being (e.g., tutoring, after-school programmes, extracurricular activities) were excluded.
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- No involvement in other parallel experimental programmes: Students who were simultaneously participating in other experimental programmes or extracurricular activities that could influence the results related to school well-being (e.g., science workshops, intensive sports programmes) were excluded to avoid interference in the results.
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These inclusion criteria were chosen to ensure that participants were representative of the target school population while maintaining the integrity of the data collected and the accuracy of the measurement of the effects of the intervention. The integrated educational intervention "STEAM-Physical Education" lasted a total of 12 weeks, with three sessions per week: two STEAM lessons and one physical education lesson. Each lesson lasted 90 minutes. The STEAM sessions focused on practical and creative learning, integrating scientific, technological and mathematical concepts with artistic activities, while the physical education lessons incorporated physical activities aimed at promoting collaboration, coordination and problem-solving through movement.

The STEAM lessons were based on project-based learning (PBL) models, which promote active and interdisciplinary learning.

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which promote active and interdisciplinary learning. Some of the activities included:

- Building Robots with Recycled Materials: This activity integrated concepts of engineering and technology, with a focus on the sustainable reuse of materials, while developing students' creativity
- Maths and Movement: Lessons in which students were asked to solve maths problems during physical activities that stimulated physical and mental coordination, inspired by research showing how movement can facilitate conceptual understanding in maths.
- Applied Physics Experiments: During these sessions, students performed experiments on physical concepts such as gravity and motion, building and testing simple machine models. The integration with physical education was evident when students replicated physical principles through physical activities such as jumping and throwing objects.

Physical education lessons were structured to promote peer cooperation, self-control and physical awareness. Some of the activities included are listed below:

- Cooperative games: Activities such as "human rope" and "friendship ball", which required collaboration to achieve common goals, while promoting the development of social and communication skills
- Agility Courses: Students participated in physical circuits that combined motor exercises with intellectual challenges, stimulating problem solving while performing physical activities
- Physical Problem Solving Activities: During these sessions, students had to face motor challenges that also required the application of STEAM concepts, such as transferring an object from one point to another using tools they designed themselves.

School well-being was measured using the Tobia and Mazzocchi test (2015), which divides school well-being into three macro-dimensions:

- Interpersonal relationships: This scale measures the quality of interpersonal relationships.
- Academic self-esteem: The test assesses students' perceptions of their effectiveness in the school context, including confidence in their learning abilities.
- Sense of belonging: This scale measures how much students feel they are an integral part of the school community and their level of emotional involvement.

The test was administered before the start of the intervention and at the end of the 12 weeks for both groups. It was administered anonymously and in the presence of an external mediator to ensure the transparency and sincerity of the responses. The data collected were analysed using a repeated measures analysis of variance (ANOVA) to verify the differences between the pre- and post-intervention scores within each group and to compare the two groups with each other. The Bonferroni post-hoc test was also applied to account for

2. Data Analysis

The assessment conducted through the School Well-being Test made it possible to evaluate the changes in the twogroups in the three specific areas investigated by this assessment tool, allowing us to compare the changes between the two groups. The results for each individual area are analysed below.

• Interpersonal relationships

Students in the experimental group showed a significant improvement in interpersonal relationships, with an average increase of 15% compared to the pre-intervention score ($p < 0.05$). This suggests that the integration of STEAM activities with physical education created a collaborative environment in which students were able to develop better social and communication skills. Previous studies have shown how group activities, especially in physical contexts, can promote greater social cohesion among students7. In particular, cooperative games and activities requiring physical problem-solving seem to have fostered positive interaction and mutual support.

• Academic self-esteem

Academic self-esteem improved significantly in the experimental group, with a 12% increase compared to the pre-intervention score ($p < 0.05$). The STEAM approach, with its focus on project-based learning and the practical application of concepts, seems to have increased students' confidence in their ability to solve complex problems. This is consistent with existing literature, which highlights how active and engaging learning can foster a positive perception of one's academic abilities. The integration of physical activity further reinforced this effect, thanks to the cognitive benefits of exercise on concentration and working memory.

- Sense of belonging

The sense of belonging also increased significantly in the experimental group (+10%, $p < 0.05$). Students who participated in the integrated programme reported greater identification with the school community and a stronger sense of being part of a cohesive group. This result confirms previous research showing that participatory and collaborative activities, especially those that combine physical and cognitive learning, can increase students' affective involvement in school.

- Comparison with the control group

In the control group, no significant changes were found in any of the three dimensions of school well-being, suggesting that the traditional curriculum did not have a significant impact on the improvement

in students' perceived well-being over the 12 weeks. This further reinforces the idea that an interdisciplinary and dynamic teaching approach is more effective in promoting school well-being than traditional methods.

3. Discussion

The data emerging from the study clearly confirm the effectiveness of an integrated teaching approach that combines STEAM disciplines with physical education in promoting pupils' well-being at school. The increase in interpersonal relationships observed in the experimental group is consistent with the literature on the positive effects of cooperative and problem-solving activities carried out in physical contexts[11]. At the same time, a significant improvement in academic self-esteem was recorded, attributable to the use of project-based methodologies. By allowing students to apply complex concepts in practical situations, these approaches strengthened their perception of personal effectiveness[12]. The sense of belonging to the school community also increased, in line with previous studies emphasising how active and participatory learning methods can strengthen students' emotional bond with the school environment.

These results not only confirm the validity of interdisciplinary teaching, but also highlight the importance of considering school well-being as a fundamental component of the educational experience, an issue that has gained increasing relevance in contemporary pedagogical debate. As highlighted by Tobia and Mazzocchi (2015), school well-being represents a state of psychophysical balance that allows students to approach their education in a calm and effective manner, facilitating learning and personal growth. The central aspects of this well-being include the quality of interpersonal relationships, academic self-esteem and a sense of belonging, all dimensions that the educational intervention considered contributed to improving.

Numerous theoretical contributions highlight how a school environment focused on well-being promotes not only academic performance but also students' emotional and social engagement. In particular, Fredricks, Blumenfeld and Paris (2004) emphasise that emotional and cognitive participation is a determining factor for educational success. An environment that values well-being allows students to feel safe, motivated and supported, facilitating the development of socio-emotional skills that are essential for their future.

This work is part of a broader framework of growing attention to school well-being in Italy. In recent years, in response to increased stress among students and signs of psychological distress, accentuated by the COVID-19 pandemic, many Italian educational institutions have begun to promote initiatives aimed at well-being and mental health. However, these interventions are often fragmented and not always organically integrated into the curriculum. The results of this study show that structured integration of wellbeing into the educational context can bring tangible and measurable benefits, as evidenced by an increase in the quality of relationships, self-confidence and sense of belonging among the students involved.

In Italian lower secondary schools, teaching continues to be organised into separate subjects, with little room for interdisciplinary approaches or practical and physical experiences. However, recent educational guidelines promoted by the Ministry of Education and Merit (MIM, 2022), through the new “National Guidelines for the Curriculum”, emphasise the importance of interdisciplinarity, personalised learning and active student participation.

The integration between STEAM disciplines and physical education proposed in this study responds precisely to these demands for methodological innovation. Previous research has shown that multisensory, practical and collaborative learning promotes the development of cognitive, physical and social skills. For example, Gresalfi et al. (2009) emphasise the value of meaningful teaching contexts that stimulate active student engagement, while studies such as those by Biino (2021) and Tomporowski et al. (2008) document the cognitive benefits of

physical activity, with positive effects on attention, working memory and problem-solving skills.

The results observed in the experimental group, in terms of school well-being, indicate that an educational approach combining cognitive and motor activities may be an effective strategy for addressing the current challenges facing Italian schools. Lower secondary school is a key moment in students' development, characterised by significant physical, emotional and social changes. A school environment that neglects these aspects risks amplifying school discomfort, with negative consequences on performance and a possible increase in early school leaving.

4. Practical implications, recommendations and challenges

Based on the results obtained, some useful operational guidelines can be drawn for the introduction of educational programmes aimed at school well-being in lower secondary schools in Italy:

• Integrated STEAM–Physical Education Curriculum: It is desirable for schools to promote greater synergy between cognitive and motor activities, as demonstrated by the effectiveness of the experimental model presented. Project-based learning, which combines practical and motor activities, allows students to acquire fundamental transversal skills, such as the ability to cooperate, creativity and problem-solving. Such proposals should be structured within the curriculum and not treated as optional or extracurricular activities, so as to ensure equal access for all students.

• Professional training for teachers: A key factor in the effectiveness of integrated STEAM-motor skills programmes is teacher training. Educators must be able to design and deliver interdisciplinary courses that combine science, technology, art and movement. Johnson, Zhang and Kahle (2011) emphasise that continuing education is essential to equip teachers with the skills they need to successfully guide interdisciplinary teaching experiences. The launch of specific professional development programmes could be a strategic lever for improving the quality of teaching.

• Psychological support and mental health care: The results indicate a close relationship between increased social relationships, academic self-esteem and the combination of active learning and physical activity. However, these benefits cannot replace a focused attention to students' psychological well-being. Schools should therefore invest more in professional figures such as school psychologists and in the promotion of social and emotional education programmes that can address pupils' inner needs in a structured way.

• School inclusion and active participation: The increase in the sense of belonging recorded in the experimental group highlights the inclusive potential of the integrated approach. Well-planned physical and collaborative activities can reduce isolation and promote greater participation, even among students with learning difficulties or special educational needs. This confirms that a holistic teaching approach can support the creation of a more equitable and welcoming school environment for all.

• Continuous assessment of school well-being: It is essential that educational institutions adopt systematic tools for monitoring student well-being. The questionnaire developed by Tobia and Mazzocchi (2015), used in this study, has proven effective in detecting changes in the various dimensions of school well-being. However, the introduction of a system of continuous observation and assessment would allow for the early identification of any critical issues and the activation of appropriate support measures.

The current context of Italian lower secondary schools presents numerous critical issues that could be addressed through the adoption of innovative and multidisciplinary teaching methods. The COVID-19 health emergency, in particular, has exacerbated phenomena such as social isolation, school anxiety and a decline in motivation. After experiencing distance

learning, many students have found it difficult to readjust to the traditional school routine, resulting in increased stress levels and a decline in interest in school. In this scenario, educational interventions such as those analysed in the study can be a concrete resource for restoring the balance between learning and physical and emotional well-being. At the same time, the growing focus on the development of transversal skills – such as critical thinking, teamwork and emotion management – calls for a review of traditional educational models. The integration of STEAM subjects and physical activity can provide students with practical and cognitive tools to face the challenges of a constantly changing society, promoting authentic, engaging and meaningful learning.

Conclusions

The integration of STEAM subjects and physical education has shown positive effects on the well-being of secondary school students, contributing to improved interpersonal relationships, academic self-esteem and a sense of belonging. These findings highlight the value of interdisciplinary teaching approaches that simultaneously engage the physical and cognitive dimensions of the educational process. The combination of physical activity and STEAM content not only promotes the acquisition of academic skills but also supports the construction of a more inclusive school environment that is attentive to the overall well-being of students. In the future, it will be useful to investigate the impact of similar interventions over longer periods of time, in different geographical areas and with larger samples of students, in order to assess the possibility of generalising the results and to provide further guidance for the development of innovative educational practices.

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