

LA INSPECCIÓN DE EDUCACIÓN COMO FACTOR CLAVE EN LA IMPLEMENTACIÓN DE ESTRATEGIAS INNOVADORAS PARA LA ENSEÑANZA STEAM EN LOS CENTROS EDUCATIVOS

EDUCATIONAL INSPECTION AS A KEY FACTOR IN THE IMPLEMENTATION OF INNOVATIVE STRATEGIES FOR STEAM TEACHING IN SPANISH SCHOOLS

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Resumen

En el contexto actual, el sistema educativo se enfrenta al reto de preparar a los estudiantes para un mercado laboral en continua transformación. La creciente demanda de profesionales en el ámbito STEM (Ciencias, Tecnología, Ingeniería y Matemáticas) contrasta con la disminución del interés del alumnado por estas disciplinas, generando una brecha preocupante entre la formación y la empleabilidad. Para intentar corregir dicho desajuste, son muchos los agentes que pueden verse implicados. Este artículo analiza el papel clave de la Inspección de Educación (IE) en la promoción de la innovación educativa en los centros, con un enfoque particular en el asesoramiento para el desarrollo de la competencia STEM.

Mediante una revisión sistemática de la literatura nacional e internacional basada en el método PRISMA, se realizó un recorrido exploratorio sobre el asesoramiento de la IE entendido como factor esencial para impulsar procesos de innovación en competencia STEM en los centros educativos.

Las conclusiones sugieren que una implicación más proactiva y cercana al asesoramiento de la IE, puede ser un factor determinante en la mejora de los centros educativos, y en la creación de un entorno que promueva el interés por las vocaciones STEM desde las primeras etapas. Se necesita una inspección que actúe como un impulso y apoyo para la adaptación de experiencias innovadoras a la normativa vigente, en lugar de mantener el rol inhibitor que ha ejercido hasta ahora. Se proponen diversas recomendaciones, como el fomento de la asesoría pedagógica personalizada y la creación de redes de colaboración para la difusión de buenas prácticas en STEM.

Palabras clave. *STEM, inspección educativa, asesoramiento pedagógico, innovación educativa, mejora escolar, competencia STEAM.*

Abstract

In this context, the educational system faces the challenge of preparing students for an ever-evolving labor market. The growing demand for professionals in the STEM fields (Science, Technology, Engineering, and Mathematics) contrasts with the declining interest among students in these disciplines, creating a concerning gap between education and employability. To address this mismatch, many stakeholders can be involved. This article analyzes the key role of the Education Inspection (EI) in promoting pedagogical innovation in schools, with a particular focus on advising for the development of STEM competencies.

Through a systematic literature review based on the PRISMA method, national and international studies exploring the function of the EI in educational advising and its impact on the implementation of STEM strategies were identified.

The findings suggest that a more proactive and supportive involvement from the EI can be a determining factor in improving educational institutions and creating an environment that fosters interest in STEM careers from early stages. There is a need for an inspection that acts as a catalyst and support for adapting innovative experiences to regulations, rather than maintaining the inhibiting role it has played so far. Several recommendations are proposed, such as promoting personalized pedagogical advising and creating collaborative networks for the dissemination of best practices in STEM.

Keywords. *STEM, educational inspection, pedagogical counselling, educational innovation, school improvement, STEAM skill.*

1. INTRODUCTION

STEAM education, which integrates artistic disciplines with science, technology, mathematics and engineering, has gained popularity internationally in recent years. This synergy between seemingly disparate fields not only fosters innovation and motivation, but also combines logical reasoning with creativity, thus arousing greater interest in science among students (Meza and Duarte, 2020).

In our country, Organic Law 3/2020, of 29 December, which amends Organic Law 2/2006, of 3 May, on Education, includes eight key competences, understood as areas in which a specific level of performance must be acquired during the period of compulsory schooling, and one of them is the STEM competence (art was not yet included). These competences are an adaptation to the Spanish education system of those established in the Recommendation of the Council of the European Union. Their acquisition is considered essential in order to progress with guarantees of success both in the field of training and in the labour market, and thus be able to face the main global and local challenges that our society is facing (LOMLOE, 2020).

In this sense, several reports, such as the one developed by the Immune Technology Institute & Randstad Digital (2024), point to the tendency of the labour market to require an increasing number of professionals in fields related to science, technology, engineering and mathematics. Despite this trend, the number of students interested in orienting their professional future towards these areas is decreasing (DigitalES, 2019). The reasons for this deviation are varied, but behind many of them lies the need to implement educational strategies that promote interest in STEAM competence from the earliest stages of development (Baelo et al., 2018). This situation is not unique, and many governments in Western

countries have shown their concern and launched initiatives aimed at increasing students' interest in this field.

At the national level, education administrations have implemented policies aimed at improving students' academic performance. These initiatives promote and support the adoption of innovative practices and more efficient school models. In relation to STEAM education, our education system has traditionally approached STEAM education in a segmented way. This approach has hindered the approach to scientific, mathematical and technological problems from a global perspective, ignoring the fact that the application of a holistic approach to STEAM learning favours the acquisition of these skills by students (Becker and Park, 2011).

Today, most authors agree that the functions of educational inspection should go beyond mere supervision and control, and also encompass advisory and support tasks (López Menéndez, 2014; Alcalá Ibáñez, 2016; Bravo et al., 2021; and Estefanía Lera, 2021). In this regard, Zulueta (2020) pointed out the influence that EI has on the development of innovation processes. The author considers it at three levels: macro, participating in the elaboration, development and evaluation of innovation programmes developed by educational administrations; at the meso level, collaborating with schools in the evaluation and assessment for the development of pedagogical innovation proposals; and at the micro level, identifying and evaluating innovative practices developed in the classroom in order to advise on their development and disseminate them. In this way, analysing the role played by this group in the promotion of innovation proposals that reduce the gap between training and employability is an essential aspect.

In reference to the above, and despite the marked tendency of the Administrations to develop actions aimed at improving the performance of the professional body that makes up EI, there is little research that addresses the

need to promote organisational strategies in this area that can contribute significantly to improving academic results. The lack of results from research contrasts with the recommendations of experts, who highlight the importance of investigating the actors directly involved in schools, and of promoting research in this field (MEC-CIDE, 2000; Gairín and Antúnez, 2008; and Manzanares, 2010; Tébar Cuesta, 2017; Sóler Fierrez, 2019; Castán Esteban, 2021; Marrodán Gironés, 2024).

Our research is presented as a proposal for analysis of the conclusions found about the relevance of educational inspection in the implementation of pedagogical innovation proposals, specifically in the development of STEAM competences. In this sense, the results of this analysis will allow decisions to be taken in line with the results, providing objectivity and systematicity to the whole process.

1. LITERATURE REVIEW

Several studies show that the support and collaboration of EI is essential to promote innovation processes in schools. Moreover, it has been shown that when there is effective coordination with management teams, the progress of improvement actions is significantly greater (Silva García, 2012).

At the same time, at the social level, there is a clear need to verify that the innovations introduced in the education system lead to improvements in the system. For this to happen, the inspectorate needs to focus its actions on established criteria based on improvement, change and innovation, strengthening its commitment to schools.

Authors such as Estefanía Lera (2021) suggest that the EI model should evolve from the current bureaucratic approach, focused on regulatory control

and isolated tasks, towards a pedagogical approach that is more in line with schools, contributing in a realistic and contextualised way to improving their organisation and functioning. Such a model would favour the implementation of the plans and projects that schools have in the use of their autonomy and would help to improve the teaching-learning processes in the classrooms.

In general, the EI community is not making important contributions in the area of educational innovation. There is a widespread feeling that the inspectorate not only does not encourage innovation, but also slows it down. Different authors point out that EI hinders both the development and the establishment of a culture of innovation in schools (Esteban, Sarasúa, Serentill and Zulueta, 2016; Alcalá Ibáñez, 2016; Estefanía Lera, 2017; Zulueta, 2020).

However, a review of the existing international literature shows a growing interest in innovation in the field of EI, with several recurring ideas being highlighted, such as:

- That the factors leading to the success of education are included among the actions of EI.
- That advice to improve the quality of teaching is established as one of the fundamental pillars of the new inspection model.
- That the advice and guidance provided by the inspectorate is seen as a good starting point for the development and improvement of schools.
- That the implementation of educational networks coordinated by EI is shown to be an effective practice.
- That strengthening the autonomy of schools promotes the proliferation of innovations.

These ideas reflect a positive trend towards a more collaborative, mentoring and capacity-building approach for schools to foster innovation in this area.

The LOMLOE (2020) includes the development of competences in science, technology, engineering and mathematics, which has traditionally been identified with the STEM competence. However, the need for a global approach to this competence has led to the popularisation of the STEAM concept. This concept involves the incorporation of the arts into the competence in science, technology, engineering and mathematics. This integration gives a more innovative nuance and generates an increase in motivation, while associating logical thinking with creativity, making science more attractive to students.

Although this study may be transferable to other key competences, we have chosen this one because of the worrying lack of interest among young people in developing their careers in these areas (DigitalES, 2019). In other words, when assessing the relationship between training and employability, there is a significant gap between the growing need for STEAM professionals and the decline in the number of students choosing to train in this area. Among the main causes of this situation, DigitalES (2019) mentions academic difficulty and lack of guidance and knowledge.

Correcting this mismatch requires the intervention of various actors, including EI. Therefore, our working hypothesis argues that the actions of the inspectorate, aimed at making visible, advising and supporting innovation processes, are fundamental for the effective implementation of these processes. In this way, these actions are key to promote initiatives that promote knowledge and the approach to the STEAM field.

It is important to specify that, when considering the term counselling, this study takes into account the evolution that the concept has undergone in recent years. In this sense, EI counselling should not be interpreted as a training activity; the role to be assumed by the inspectorate is not that of providing training to schools in this area, since this is not its function and there are other professionals

responsible for carrying out this type of counselling and training. From this perspective, the role to be played by EI is closer to the current concept of counselling linked to facilitation, mentoring and collaboration. In the same vein, Gerver (2016) also states that inspection should be a catalyst and not an inhibitor of change and innovation.

Among the possible forms of EI consultancy, the following can be found:

- To report on the implementation of innovative proposals in schools, and to grant recognition from the Administration for work well done.
- Facilitate the atmosphere of trust and support for schools that is required for the proliferation of innovative experiences.
- Generate collaborative work by disseminating successful experiences in other schools, with the macro vision that inspectors have as they have access to the different schools.
- To consider duly justified proposals from schools, based on their autonomy, analysing the regulatory limits.
- Participate directly in the monitoring of projects, the creation of working groups, the holding of meetings or conferences, the dissemination of good practices, etc.

At the policy level, the main education laws consider counselling and pedagogical guidance as inherent functions of the inspectorate. However, these functions have not been a priority focus of inspection practice. Thus, we can see how they are mentioned both in Organic Law 3/2020 of 29 December, which modifies Organic Law 2/2006 of 3 May on Education (LOMLOE) and in most

regional regulations. By way of example and given the geographical context in which the authors work, we can point out that in the autonomous community of Castile and León, Decree 92/2004 of 29 July 2004, which regulates educational inspection in Castile and León, refers to the following.

FUNCTIONS OF THE EDUCATION INSPECTORATE RELATED TO COUNSELLING	
LOMLOE (art 151)	DECREE 92/2004, CASTILLA AND LEÓN (art 2)
a) To control, supervise and advise , from a pedagogical and organisational point of view, on the functioning of educational centres, programmes and services, both public and private, as well as to coordinate the external support actions carried out in the centres.	a) To control, supervise and advise from a pedagogical and organisational point of view, on the functioning of educational centres, programmes and services, both public and private, as well as to coordinate the external support actions carried out in the centres.
b) Monitor teaching practice, the management function and collaborate in its continuous improvement .	b) Supervising teaching practice and collaborating in its continuous improvement and in that of the functioning of the centres, as well as in the processes of educational reform and pedagogical renovation, teacher training and improvement..

If we assume the paradigm shift towards competency-based learning that is taking place in the general education field, it is imperative that the educational inspectorate rethinks its functions and the role it must assume.

2. RESEARCH OBJECTIVES

Based on the above, the present study aims to conduct a literature review of studies related to STEAM competence in order to show the importance of the

counselling function of EI. This general objective is specified in a series of specific objectives, as follows:

1. Analyse the results obtained in relation to EI's advisory role in national and international studies, projects and research articles.
2. Analyse the conclusions reached in national and international studies, projects and research articles on the development of STEAM competence.
3. Identify potential benefits of increased EI involvement in the implementation of innovative teaching strategies for STEAM education.

3. METHODOLOGY

This work has been carried out by conducting a systematic review of the literature using the criteria of the PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). In this sense, a systematic review of the existing literature on the importance of the role of counselling in EI and STEAM competence was carried out.

To delimit the search, keywords related to the research were selected, such as: educational inspection, STEAM, counselling, among others. These words were translated into English to broaden the search in databases such as WOS, ERIC, Dialnet, Scopus and Google Scholar.

After having the selection of the keywords, the search string was used in which we related the words with the logical connectors "AND" and "OR". It was considered appropriate to elaborate the search string in English and Spanish, in order to maximise the number of possible documents and thus increase the quality of the work. The search strings used were the following):

Chain in Spanish: (Inspección educativa) AND (función de asesoramiento OR apoyo) AND (STEAM OR ciencia, tecnología, ingeniería, artes y matemáticas).

Chain in English: (School inspectors OR educational inspectorates) AND (supporting OR advising) AND (STEAM OR Science, Technology, Engineering, Arts and Mathematics).

The timeframe used to delimit the results was 2010 to 2023. This limit was set in order to focus on the most recent publications and to avoid an excessive number of results. After excluding articles not considered relevant to the research, a total of 130 articles were obtained. From the final selection, 18 were discarded as they were not valid for the work, so the final result was 112 scientific articles and legislative references, all of them coming from a wide variety of sources, most of them related to the field of education, indexed in different journals, most of them with an impact. For each of the articles, the data was completed in an Excel table for subsequent analysis, comparison and drawing of conclusions.

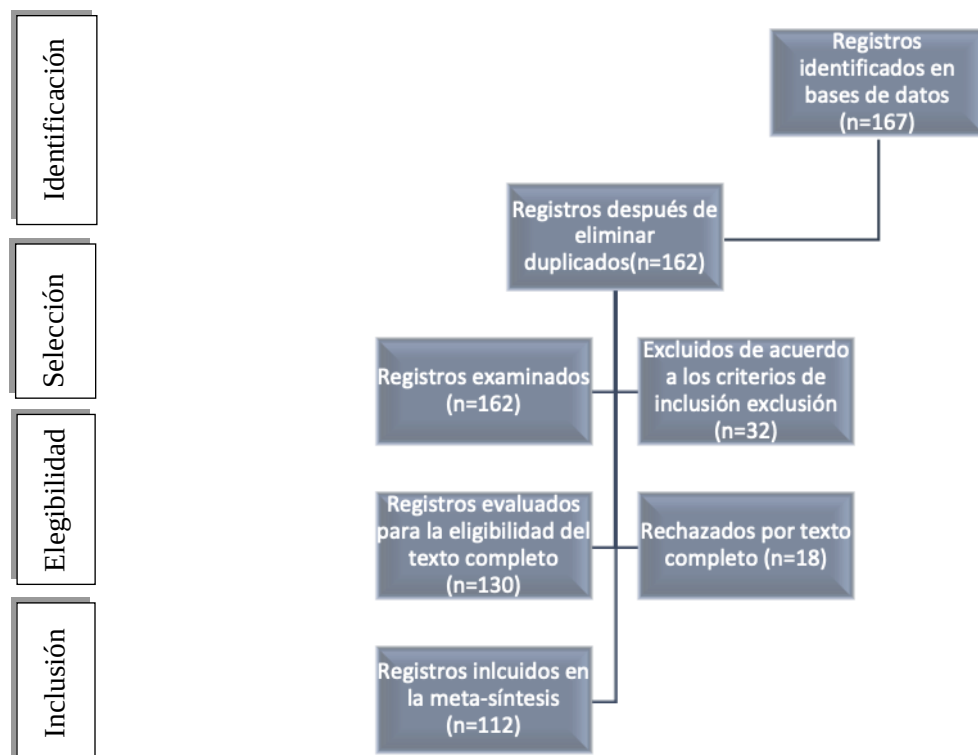


Figure 1. PRISMA flowchart for systematic literature review and article inclusion.

4. RESULTS AND CONCLUSIONS

The main findings from the literature review are presented below, organised according to the specific objectives set out in this study.

Objective 1: To analyse the results obtained in relation to EI's advisory role in national and international studies, projects and research articles.

The analysis of the texts reviewed reveals a consensus on the importance of innovation as a key indicator in the evaluation of schools. The inspectorate should integrate innovation as a positive aspect within its assessment model, encouraging each school to set its own strategic objectives based on its

educational vision and values. The ability to analyse and solve problems from an external perspective, as well as the identification of weaknesses and potential, are tasks that educational inspectorates carry out in their daily work.

In many of the articles analysed, the importance of a balanced training in knowledge, skills and values is emphasised in order to carry out support and advisory functions, both in relation to the processes to be used and those referring to specific content (in relation to the curriculum, school organisation, teacher training and professional development, group dynamics and functioning, processes of change and school improvement, etc.).

Increasing the participation of the educational community in schools appears as an aspect that should be a priority for the inspectorate. This is an indicator of institutional health in schools. In general, the need for a counselling model that addresses the real problems of schools, especially those related to student processes and results, and whose solution requires the participation of all educational actors, is highlighted.

The development of innovation projects that impact on educational practices and bring about a change in the way schools operate requires a proactive and cooperative mentoring model. Coaching makes sense if it contributes to improving school practices, organisation and student learning.

A large group of the reviewed articles focuses on the challenges that educational inspection will have to face in the coming years, among which the following stand out:

- Search for models close to advice, support, dynamisation and implementation of improvement actions in schools.

- Analysis of the models of access to educational inspection with new approaches and functionalities.
- To achieve greater autonomy, a reduction in the bureaucratic workload, and adequate training for all education inspectors, both at the time of initial or entry into the Corps and, subsequently, through ongoing training.
- To achieve a professional, transparent, critical, investigative and analytical model of inspection of the system, in the search for professional independence.

Objective 2: Analyse the conclusions reached in national and international studies, projects and research articles on STEAM competence development.

One of the most evident challenges in STEAM education, due to its recurrent presence in the works reviewed, is to reverse the situation of a lack of STEAM vocations. This situation is particularly alarming among under-represented groups, such as women. For this reason, it is essential to design a quality pedagogical framework that takes into account the needs of all actors involved in the teaching and learning process, including students, teachers, families and employers.

In view of the results obtained by the reviewed studies, a variety of reasons why students tend to drop out of STEM studies have been identified. Likewise, these studies provide possible measures that would contribute to retaining students in STEM studies. Many of these measures include an early introduction to technology, programming or computational thinking.

Another group of studies has focused on the reasons students indicate for choosing to pursue STEM degrees. In this respect, teachers report a positive influence on students' achievements in academic maturity with respect to the

implementation of STEM programmes in the first years of schooling. These gains are linked not only to increased interest in STEM disciplines, but also to the development of their convergent thinking, creativity and problem-solving skills (Monkeviciene, Autukeviciene, Kaminskiene, & Monkevicius, 2020).

As for the reasons that lead students to choose their degrees, the results underline the influence of issues such as the environment, family support, knowledge of references, overcoming stereotypes, identification of professional opportunities related to the field of study, or the self-perception of the subjects about their ability to develop these careers. These conditioning factors have a greater weight when it comes to students belonging to under-represented groups or from lower socio-economic strata.

Some proposals, shown in the reviewed works, to motivate students towards STEM degrees are:

- Convey a positive and inclusive image of science and technology.
- To become aware of the professional opportunities that these studies offer.
- To have references and role models. To focus education in a more practical way.
- Increase relationships and partnerships with industry to provide internships and real-world learning opportunities.

These proposals are shown to have key elements to foster vocations among young people, reduce the gender gap, improve the training of teachers and students, and favour the updating of the educational curriculum. In terms of counselling, the most common proposals focus on:

- Highlight the importance of the teacher as a motivational agent towards STEM disciplines.

- Emphasise the importance of advice and feedback from employers in the training of STEM graduates to meet the needs of the labour market. Give greater prominence to the development of soft skills, collaboration between educational institutions and industry to provide internship opportunities, the development of STEM mentoring programmes, and the development of STEM mentoring programmes.
- Emphasise the relevance of a participatory approach to counselling through collaboration between institutions, teachers, researchers and other stakeholders in the evaluation of the STEM curriculum.
- The need to tailor counselling and training to the specific needs of teachers and students, rather than offering a generic solution.
- Guidance, in an appropriate way, for students to understand the career options available and the skills to succeed in them in order to choose STEM degrees.
- Emphasise the relevance of a participatory approach to counselling through collaboration between institutions, teachers, researchers and other stakeholders in the evaluation of the STEM curriculum.
- The need to tailor counselling and training to the specific needs of teachers and students, rather than offering a generic solution.
- Guidance, in an appropriate way, for students to understand the career options available and the skills to succeed in them in order to choose STEM degrees.

Finally, since many of these studies are conducted in the COVID-19 pandemic and post-pandemic phase, the need for hybrid learning environments

that combine online and face-to-face learning is highlighted, which would allow students to access quality STEM education from anywhere and at any time. In this line, the creation of a pedagogical framework for the design of STEM learning environments is proposed, enabling students to develop skills and competences relevant to the current and future labour market.

Objective 3: Identify potential benefits of increased EI involvement in the implementation of innovative teaching strategies for STEAM education.

The results of the works reviewed highlight the need to involve the entire educational community in the task of improving the connection between the training received and the knowledge demanded in the labour market. This connection would allow a better match between training supply and demand, as well as the development of strategies to motivate young people towards STEAM vocations.

Numerous studies show that the support and collaboration of the education inspectorate is essential to promote innovation processes in schools. This circumstance indicates that better coordination between the EI and the management teams will make it possible to promote improvement actions and significant progress in the institutional culture of innovation. It is also important to bear in mind that support for innovation processes, which is entrusted to the educational inspectorate, must be backed and supported by other agents, such as training advisors, Educational Guidance and Psychopedagogical Teams and school Guidance Departments.

In this respect, it is essential to modernise educational inspection and focus its actions on improving the education system, schools and teaching-learning processes. In the same vein, it is necessary to rethink its supervision and control functions and to prioritise advisory work.

The results of this work underline the importance of the role of educational inspection as a dynamic agent of innovation in schools, particularly in the development of STEAM competences. The literature review has revealed a consensus on the need for educational inspectorates to go beyond their traditional role of supervision and control, and to become a key actor in pedagogical counselling. This transformation will allow schools to improve their organisation and functioning, as well as to advance in the implementation of innovative educational practices that foster students' interest in STEAM disciplines.

The advice offered by the education inspectorate must be an essential element to reduce the gap between academic training and the needs of the labour market. The education inspectorate should therefore facilitate the design and implementation of educational strategies that stimulate STEAM vocations from the early stages of education, with an emphasis on collaboration with management teams, teachers and other educational agents. Only through this integrative approach is it possible to reverse the decline in the number of students interested in these disciplines.

Generally speaking, and in line with the results found, the following recommendations could be formulated:

- 1. Encourage personalised educational counselling.** EI should adopt a more proactive approach to educational counselling, responding to the particular needs of each school. This implies greater interaction with management teams to identify areas for improvement and propose educational innovation strategies adapted to each context.

2. **Develop STEAM competences from an early stage.** It is essential that the inspectorate works together with schools to progressively integrate STEAM competences from the first years of schooling. This integration should go hand in hand with specific training programmes for teachers, including both initial and in-service training in these competences.
3. **Reduce the bureaucratic burden on educational inspection.** In order for the inspectorate to play a more active role in counselling and innovation, it is essential to reduce the bureaucratic tasks that limit its capacity for pedagogical intervention. A review of administrative procedures is recommended to allow EI to devote more time to the evaluation of educational practices and school improvement.
4. **Promote good educational practices.** EI should play an active role in identifying and disseminating successful educational practices in STEAM. The creation of collaborative networks between schools, promoted and coordinated by EI, can facilitate the exchange of experiences and foster a culture of educational innovation at local, regional and national levels.
5. **Continuous evaluation of counselling.** To ensure the effectiveness of EI interventions, it is recommended that mechanisms for continuous evaluation of counselling actions be established. These mechanisms should include feedback from school management and teaching staff, as well as measuring the impact of the innovations implemented on academic results and interest in STEAM disciplines.
6. **Promote collaboration with other educational agents.** In order to maximise the impact of EI's actions, greater coordination with other educational agents, such as training advisors, guidance counsellors and psycho-pedagogical teams, is proposed. This collaboration will make it

possible to provide a comprehensive response to the needs of the centres and enhance the quality of the advice provided.

In conclusion, the modernisation of EI towards an approach centred on pedagogical advice is an indispensable condition for promoting the culture of innovation and fostering the development of STEAM competences in schools. It is necessary to have an inspectorate that functions as a driving force and support for bringing innovative experiences into line with regulations, rather than continuing to play the restrictive role it has had until now. The recommendations outlined here are key steps to ensure that the education inspectorate becomes the engine of change that the education system requires.

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