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Space related school project to improve digital competences for high school teachers and students: CanSat Spain case study

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SPACE RELATED SCHOOL PROJECT TO IMPROVE DIGITAL COMPETENCES FOR HIGH SCHOOL TEACHERS AND STUDENTS: CANSAT SPAIN CASE STUDY

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1. Introduction

Digital competences refer to the skills and knowledge needed to understand, use, and communicate with digital technologies. In terms of public policies, promoting digital competences has become a priority as it is considered crucial for the economic and social development of countries. In the educational field, digital competences are vital for student learning and training, as well as for teacher training and improving educational quality. Furthermore, the lack of digital competences can perpetuate the digital divide and social exclusion.

Teachers play a crucial role in developing students' digital competences, essential for student success. To this aim, training in digital competences and a proactive attitude towards their use in the classroom must be boosted, as teachers' role in fostering digital competences. In order to meet such demands, professional digital competence is required as an important issue for teacher education to be addressed (Lindfors et al., 2021).

The present study aims to investigate the transformative effects of digital competency development on teachers of secondary education level. Through a comprehensive literature review, this study seeks to provide understanding of how digital competences can positively impact educational outcomes, such as student achievement and teacher performance.

We set the focus on specific teacher training courses, as CanSat school project. By examining the specific context of space-related resources, we will analyse the potential benefits of teacher training process and teacher network learning communities, teaching methods, such as project-based learning, the recognition of teaching activity and the level of student

participation, to optimize educational practices in an increasingly digital world.

Afterwards, we will perform an adaptation of the questionnaire used in "SELFIEforTEACHERS" tool. This will allow us to carry out an analysis of the perception of the level of digital competence used by teachers through a mixed, quantitative and qualitative methodology on a further stage.

The evaluation of teachers' digital skills will allow us to improve and personalize teacher trainings in order to meet their needs properly, in line with what is described in Basilotta-Gómez-Pablos et al. (2022). In addition, as another key objective, we also expect to identify space related content as a suitable and motivational tool to let teachers put their knowledge into practice, addressing the shortcomings identified by Prieto-Ballester et al. (2021).

The remainder of this document is organized as follows, Section 2: Background. This section entails a comprehensive examination of the origins of Information and Communication Technology (ICT), its frameworks of references, the Spanish specific digital normative, and the digital competences base of the study. Moving forward, Section 3 incorporates an extensive literature review, whereas Section 4 comprises of a specific case study, namely, the CanSat Teacher Training. Subsequently, Section 5 summarises the methodology base of the study, followed by Section 6, which unravels the results obtained in this initial phase and appoints expected results of the study, and finally Conclusions at Section 7.

2. Background

The origins of ICT (Information and Communications Technology) skills can be traced back to the early days of computing and the development of the first computers in the mid-20th century. In the early days of computing, individuals who worked with computers needed to have a basic understanding of computer hardware and programming languages. Over time, the scope of ICT skills has continued to expand, involving a broad range of skills related to hardware, software, and digital technologies, from business and finance to healthcare and education. To deal with this challenge, schools must be transformed in ways that will enable students to acquire proper skills (Binkley et al., 2012).

As technology continues to evolve and become more integrated into our lives, the demand for ICT skills continued growing with new skills and abilities becoming increasingly important for success in the modern workforce. ICT skills have evolved into Digital Competences as technology has become more integrated into our lives and work. Digital Competences refer to the ability to use digital tools and technologies to achieve specific goals, solve problems, and communicate effectively in a digital environment.

The evolution of ICT skills to digital competences reflects the changing nature of technology and the need for individuals to be proficient in a wide range of digital tools and technologies in order to succeed in the modern workforce. It is a dynamic context where technology and education mutually adapt (Falck et al., 2021).

Digital Competences emphasize the importance of not only having technical skills, but also being able to use them effectively in various contexts and for different purposes. In an opposite way, not having adequate digital competences can lead to several risks for teachers as ineffective teaching that could reduce student outcomes, inability to adapt to new tools and approaches, putting them at a disadvantage in the classroom, reduce their efficiency, limit job prospects for their pupils, and increase cybersecurity risks, among other potential risks.

This makes education and training in digital competences essential for individuals and organizations looking to stay competitive in the modern economy. Thus, teachers need to be equipped with the skills and competences needed to steer this changing landscape and to help students develop the digital skills they need to succeed. In terms of public policies, promoting digital competences has become a priority as it is considered crucial for the economic and social development of countries.

This is an overview of some of the most common frameworks for digital competences:

- DigComp: The DigComp framework, developed by the European Commission, identifies 21 digital competences across five areas: Information and Data Literacy, Communication and Collaboration, Digital Content Creation, Safety, and Problem-Solving.
- ISTE Standards: The International Society for Technology in Education (ISTE) has developed a set of standards for digital competences in education, which include skills such as creativity and innovation, communication and collaboration, digital citizenship, and technology operations and concepts.
- SAMR: The SAMR model, developed by Dr. Ruben Puentedura, is a framework for evaluating how technology is being used in education. It identifies four levels of technology integration: Substitution, Augmentation, Modification, and Redefinition.
- TPACK: The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Dr. Punya Mishra and Dr. Matthew Koehler, identifies three areas of knowledge that teachers need to effectively integrate technology in their teaching: content knowledge, pedagogical knowledge, and technological knowledge.
- NETS: The National Education Technology Standards (NETS) developed by the International Society for Technology in Education (ISTE) define

digital competences for teachers, students, and administrators across six areas: creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem-solving, and digital citizenship.

There are advantages and disadvantages to implementing either of these approaches at the national level. Therefore, it is essential to establish comprehensive national frameworks that include precise definitions and strategies to facilitate and govern their execution (Voogt & Roblin, 2012).

Finally, a common framework was specified for European countries, the Recommendation of the European Parliament and of the Council of Europe of December 18, 2006 on key competences for lifelong learning (2006/962/CE)¹, which stated that “digital competence entails the safe and critical use of information society technologies for work, leisure and communication. It is based on basic ICT skills: the use of computers to obtain, evaluate, store, produce, present and exchange information, and to communicate and participate in collaborative networks through the Internet”. Based on this recommendation, the Joint Research Center (JRC) developed the DigComp framework for citizen digital competence in 2013, evolving to DigComp 2.1 in 2017 (Redecker C & Punie Y, 2017) and to a more updated version as DigComp 2.2 in 2022 (Vuorikari R et al., 2022).

2.1. Spanish specific normative: National digital skills plan

The Ministry of Economic Affairs and Digital Transformation presented the new Digital Agenda called Spain Digital 2026², on Thursday, July 8, 2022.

This Digital Spain agenda is the roadmap for the digital transformation of the country, an ambitious strategy to take full advantage of new technologies and achieve more intense and sustained economic growth, rich in quality employment, with greater productivity and that contributes to cohesion social and territorial, bringing prosperity and well-being to all citizens throughout the territory.

Spain Digital 2026 is the update of the strategy launched in July 2020 as the country's digital transformation roadmap. Since its presentation, the Recovery Plan for Spain has been approved including different plans for its deployment, the main investment programs have been launched, at the national, regional and local level, and decisive progress has been made in structural reforms.

Digital Spain 2026 acts in three key dimensions: i) Infrastructures and Technology: promoting the connectivity, 5G, cybersecurity, intelligence artificial and other disruptive technologies; ii) Economy: promoting the digitization of SMEs and of public administration, digital entrepreneurship,

¹ <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF>

² <https://espanadigital.gob.es/>

the integration of technology in value chains industry and services and the audio-visual sector; iii) People: promoting digital skills to guarantee access to the professions of the future and the digital inclusion of the entire population, and ensuring the protection of the rights of people in the digital environment.

Strengthening human capital is essential for the Investment and Reform Plan to have the desired impact, both in the generation of activity in the short term, and in the structural reinforcement of the economy and new job opportunities in the medium and long term. To this end a specific plan for digital transformation of education has been created. So called Component 19.I2³ includes an investment plan for Digitization and Digital Competences of the Educational System.

This digital transformation of the educational system can only be carried out if all teachers are substantially involved. The improvement of teaching digital competence is a fundamental element, which will be achieved through a self-assessment by the teaching staff, which will allow the identification of training needs and the achievement of personalized training itineraries.

All the rapid change experienced by digital technologies, alongside the acceleration in the extension of their use, have made necessary a thoroughly review of the reference framework for digital teaching competence in Spain as reflected in Resolution 4 de mayo de 2022⁴. This update has been aligned also in accordance to European Framework for the Digital Competence for Educators (2017), also referred to as DigCompEdu.

This updated framework defines up to 23 competences distributed into six different areas: (i) Professional Engagement; (ii) Digital Resources; (iii) Teaching and Learning; (iv) Assessment; (v) Empowering Learners; (vi) Facilitating Learners' Digital Competence. Areas (i), (ii) and (iii) are anchored in the characteristic stages of any teaching process, whether supported by technologies or not.

In addition, the objectives established in Component 19 highlight the implementation of actions for the digital transformation of education through the certification of digital skills of at least 80% of 700,000 teachers. Such level of competence follows the DigCompEdu six levels of references: A1, A2, B1, B2, C1 and C2.

For each level a role descriptor is provided which reflects the particular focus of digital technology use typical for the competence stage. Newcomers (A1) are aware of the potential of digital technologies for enhancing pedagogical and professional practice. Explorers (A2) are aware of the potential of digital technologies and are interested in exploring them to enhance pedagogical and professional practice. Integrators (B1) experiment with digital

³ <https://planderrecuperacion.gob.es/politicas-y-componentes/componente-19-plan-nacional-de-competencias-digitales-digital-skills>

⁴ [https://www.boe.es/eli/es/res/2022/05/04/\(5\)](https://www.boe.es/eli/es/res/2022/05/04/(5))

technologies in a variety of contexts and for a range of purposes, integrating them into many of their practices. Experts (B2) use a range of digital technologies confidently, creatively and critically to enhance their professional activities. Leaders (C1) have a consistent and comprehensive approach to using digital technologies to enhance pedagogic and professional practices. Pioneers (C2) question the adequacy of contemporary digital and pedagogical practices, of which they themselves are *Leaders*.

A final resolution on July 22, 2022⁵ set the execution period for this Program through January 1, 2021 to June 30, 2024. Some actions included the training courses will aim at the individual training of teachers, while the remaining options will serve as a link to articulate the development of teachers' digital competence with the transformation of centres into digitally competent educational organizations. In this way, it is intended that teachers improve their digital competence, that all educational centres develop a training program in the centre on digital competence for the development of the Digital Centre Plan and that all centres incorporate into their training plan those actions necessary training for their faculty, thus contextualizing the teacher training needs.

2.2. Digital competences base of the study

We will focus our study on competences (v) Empowering Learners and (vi) Facilitating Learners' Digital Competence defined as the more transversal areas in DigCompEdu framework (Redecker C & Punie Y, 2017).

Both areas are interrelated and complementary. The development of digital competences in learners requires the support and guidance of educators, who are responsible for facilitating the acquisition of these skills. At the same time, educators must be equipped with the necessary digital competences to effectively support and guide learners in their digital learning journey.

There are three competences associated to Area (v): Accessibility and inclusion, Attention to personal differences in learning, and Active engagement of students with their own learning. Regarding Area (vi), five competences are defined: Media literacy and information and data processing, Communication, collaboration and digital citizenship, Digital content creation, Responsible use and digital well-being, and Problem resolution.

Some studies related to higher education identified such areas as the least developed competences (Boté-Vericad et al., 2023) and competences that teachers should improve (Dias-Trindade & Ferreira, 2020). Furthermore, those areas also pay specific attention to pedagogic strategies that foster learners' transversal skills, deep thinking and creative expression. Those are also the skills that labour markets and students of higher learning

⁵ [https://www.boe.es/eli/es/res/2022/07/01/\(6\)](https://www.boe.es/eli/es/res/2022/07/01/(6))

institutions pursue to acquire in the current environment with a permanent reorientation towards digital Industry 4.0 (Oksana et al., 2020).

In summary, both areas Empowering learners and Facilitating learners' digital competences are interconnected and essential components of the DigCompEdu framework too, as we will try to demonstrate in our study.

We are going to provide further details about these competences in order to create a mapping of CanSat teacher training content base of the study. This will allow us to correlate digital competences with a proper version of the questionnaire at a later stage.

AREA V: Empowering Learners

The digital competences in this area should enable teachers to act, in collaboration with schools, administrations and families, to overcome and compensate for existing inequalities, and to ensure accessibility for all learners according to their personal educational needs. The three competences related to this area are:

5.1 Accessibility and inclusion: this competence focuses on the application of the principles of equity, universal accessibility and design for all in the integration of digital technologies in teaching practice in order to guarantee equal opportunities and the full development of learning for all pupils.

To ensure **equitable access to digital technologies and resources** regardless of their socioeconomic background or access to technology at home, the teacher should set up a schedule that ensures all students have equal access to required hardware and software. This will act as a powerful inclusive tool (Ferri & Favalli, 2018; Manzoor & Vimarlund, 2018).

Teachers can **select and employ digital pedagogical strategies** that respond to learners' digital context. It involves designing and implementing learning experiences that make use of digital tools, resources, and environments to enhance student learning as project-based learning. This method is one of the most preferred among teachers, who mostly perceived themselves as facilitators and considered motivation and transmission of values central to their work (Habók & Nagy, 2016). Furthermore, CanSat training involves different strategies as blended-learning, gamification, and flipped-classroom providing teachers with a range of tools to improve students' skills.

Teachers can **employ digital technologies and strategies** in their teaching in order to enhance students' learning experience and support their achievement as video conferencing, Learning Management Systems (LMS) platforms like Moodle, simulations and games.

When selecting, modifying, or creating digital resources, it's important for teachers to consider **potential accessibility issues** and provide alternative

or compensatory tools or approaches for learners with special educational needs. Teachers can use Universal Design for Learning (UDL) principles to create digital resources that are designed to be accessible to all learners, which should be introduced carefully though (Roski et al., 2021).

Design principles for **increasing accessibility** can help ensure that digital resources and environments used in teaching are accessible to all learners, regardless of their abilities or disabilities. Besides, **monitoring and reflection** are important parts of the process of improving accessibility in digital learning environments too; since both are powerful stimulus for change and growth in teaching practice (Tay et al., 2023). Teachers can also collect feedback from students on the effectiveness of accessibility measures implemented. This feedback can be used to make improvements to the accessibility of digital resources and environments.

5.2 Addressing personal differences in learning: Using digital technologies to accommodate pupil differences and guaranteeing their digital rights so that all can achieve the learning objectives.

In general terms, the term "personalised learning" will be understood as the interpretation suggested by the UNESCO International Bureau of Education (IBE) of this concept in its document Personalised Learning (2017)⁶, according to which "Personalized learning is teaching and learning that is focused on the background, needs, potential and perception of the learner. It is learner-centred education".

The use **digital technologies to address the special needs of individual learners** means to be creative and flexible in the use of digital technologies, with a focus on providing equal access and opportunities for all learners.

To devise individual learning plans by creating customized plans that are tailored to the unique needs of individual learners, it is built around teacher expertise and mutual responsibility between teachers and students (Prain et al., 2012). These plans may involve different learning goals, instructional strategies, and assessment methods, depending on the individual learner's strengths, weaknesses, and learning preferences. For instance, students with Attention-Deficit Hyperactivity Disorder (ADHD) may benefit from gamification that incorporates frequent breaks and rewards for progress, and students with dyslexia may benefit from having access to audiobooks or having more time to complete assignments.

5.3 Actively engaging learners in their own learning: Integrating digital technologies in pedagogical strategies that promote the active engagement of pupils with a subject, making them the protagonist of their own learning and encouraging the development of complex cognitive operations and transversal competences, such as critical thinking or creativity. **Using digital technologies to visualize and explain** new concepts in a

⁶ <https://unesdoc.unesco.org/ark:/48223/pf0000250057>

motivating and engaging way means that teachers are leveraging technology to present information in a way that is visually stimulating and easy to understand.

AREA VI: Facilitating Learners' Digital Competence

As a summary of the five digital competences belonging to this area are: The digital competences of Media literacy and information and data processing, Communication, collaboration and digital citizenship, Digital content creation, Responsible use and digital well-being, and Problem resolution are also crucial for modern teachers.

On the one hand, **Media literacy** and information and data processing are important competences as they enable teachers to critically evaluate and effectively use digital media and information resources in their teaching. This includes assessing the reliability and relevance of sources, selecting appropriate media and information to support learning objectives, and teaching students how to navigate and evaluate digital content.

On the other hand, **Communication**, collaboration, and digital citizenship competences are essential for teachers to effectively communicate with students, parents, and colleagues through digital channels, foster collaboration and teamwork among students, and promote responsible and ethical digital behaviour and citizenship.

Moreover, **Digital content creation** is a key competence for teachers as it enables them to design and develop engaging and interactive digital learning materials that align with learning objectives and cater to the diverse needs of learners.

Responsible use and **digital well-being** competence are also essential for teachers to ensure safe and ethical use of digital technologies by themselves and their students. This includes protecting personal information, preventing cyberbullying and other online risks, and promoting healthy and responsible use of digital technologies.

Finally, **problem resolution** competence is important for teachers to be able to identify and solve technical and pedagogical issues related to the use of digital technologies in their teaching. This includes troubleshooting technical problems, adapting teaching strategies to address technology-related challenges, and supporting students in using digital technologies effectively.

3. Literature review

Teachers' digital competences training

While training programs can help secondary education teachers develop their digital competencies, there is a lack of research on the effectiveness of such programs and their implementation in practice. Most studies are focused on university level or future teachers studying at university. This is one of the key factors to focus our study over in service teachers at secondary education level in Spain.

It is crucial for in-service teachers to receive adequate training and support to effectively integrate digital competencies into their teaching methods and equip students with the skills they need to thrive in the digital age. Reisoğlu (2022) points out a gap in the literature regarding the effectiveness of trainings for improving teachers' digital competencies and the extent to which the knowledge provided in these trainings is put into practice. This gap highlights the need for further research and evaluation of digital competence training programs for teachers to ensure that they are effective and provides tangible benefits and strategies of technology integration (Hew & Brush, 2007).

Space as a context, and CanSat as a specific Project Based Learning (PBL) space project, will help students to construct their own knowledge (Hudson & Whisler, 2008) and their teacher can be accomplished it by guiding them through scenarios where they are required to actively explore the content in order to reach a goal, solve a problem, complete a project, or answer a question.

In our case and taking into account a national point of view where the training course could be considered as a large-scale course to be implemented in different Autonomous Communities, it requires a scalable and flexible strategy (Pantazatos et al., 2020) . Including online sessions, peer support from forum-based communities and best practices. And it is also important to offer professional development opportunities that support teachers' digital proficiency (Lucas et al., 2021).

Such professional development could encompass informal activities within schools (e.g., microteaching, peer coaching), collaborative learning with colleagues, or participation in professional online networks (e.g., social networking, communities of practice), all of which have been included in CanSat Teacher Trainings. Similarly, the findings of previous research (Contente & Galvão 2022) indicate that students engage in advanced cognitive processes as they navigate the intricacies of the interdisciplinary project. Specifically, the students employ cognitive behaviour strategies to comprehend computer language and physical-mathematical calculations while also utilizing problem-solving skills that involve lateral, divergent, and convergent thinking.

Teachers' digital competences evaluation

In order to improve the digital competencies of educators, it is important not only to provide them with training but also to evaluate the effectiveness of these programs and ensure that they are tailored to the specific needs of

individual teachers. As appointed in previous studies, (Ingvarson et al., 2005) it was found that the content focus, active learning, and follow-up in professional development programs had a significant impact on teachers' knowledge, practice, and professional community.

One crucial matter concerning teachers' digital competences is the need for an appropriate tool to evaluate them. Despite the existence of numerous theoretical analyses, it is remarkable that there is a scarcity of specific instruments that can provide independent assessments of digital competences. These assessments are essential in order to provide proper guidelines for their potential improvement (Calvani et al., 2009).

In a recent study conducted by Alférez-Pastor et al. (2023), which aimed to examine the educational impact of training digital competences on future Primary teachers, it was found that there was a notable enhancement in learning engagement. Additionally, the study revealed that such training provides support for active and collaborative learning, while simultaneously fostering creativity, communication, and critical thinking. Furthermore, when fostering young students' evolving digital competence, teachers need to consider digital technology use holistically and in long-term (Pöntinen & Rätty-Záborszky, 2020).

An initial instrument tool based on DigCompEdu was carried out from a process of expert consultations, tests prior to the pilot phase and review of elements (Ghomi & Redecker, 2019), providing important conclusions for teachers to learn more about the DigCompEdu framework: delivering teachers a first understanding of their own individual strength, and to get ideas on how to enhance their competences. Likewise, teacher trainers could identify the needs and strengths of their CPD participants and select design suitable training courses.

Another questionnaire, called Check-In was studied in Portugal with positive results after analysing the impact of different continuous professional development (CPD) sessions to measure the improvement of teachers' digital competences (Lucas et al., 2021).

However, as the Check-In was also based on teachers' self-perception, which may over- or underestimates their digital competence, it was also appointed that it does not allow an assessment of the effective application of competences in a professional context. Therefore, considering the complexity of the development process of teachers' digital competence and factors that are interrelated, we consider that the use of space related content as CanSat should be explored and combined to deepen understanding of the results.

Recently, Cabero-Almenara et al. (2020) conducted a translation and validation of the "DigCompEdu Check-In" questionnaire. However, notable modifications have been made to both the questionnaire items and the six competence areas during recent years. The revised model is now known as "SELFIEforTEACHERS" (Economou, 2023) and fulfil all Spanish normative previously defined as scope of this study.

A more recent study in Italy, based on previous version of "SELFIEforTEACHERS", investigates the perceptions of school leaders, teachers and students of the digital capacity of their schools Teaching and Learning Practices; this is one of the areas where all the three actors expressed the most positive perceptions. Specifically, school leaders and students positively perceived the use of digital technologies in their schools respectively to try out new ways of teaching (Bocconi et al., 2020).

"SELFIEforTEACHERS" Questionnaire

The digital transition and digital transformation of education towards quality teaching and learning is a prominent objective on the European agenda. Teachers are expected to develop digital competences for themselves as professionals, for their teaching, and for their students' learning. In pursuit of this objective, specific policies are being formulated as said before. In line with this policy mission, SELFIEforTEACHERS, has been created as an online self-reflection tool, in order to assist in developing teachers' digital competence.

SELFIEforTEACHERS utilizes DigCompEdu by converting its key concepts into practical and relevant statements for teachers' everyday practice. This tool offers a self-reflection roadmap for teachers to assess their digital competence. It is a valid and reliable tool for primary and secondary teachers across Europe, consisting of 32 self-reflection items within 6 competence areas. Each item is introduced by a description of the competence and provides six competence statements within a six-level proficiency model. Additionally, a seventh statement is available for those unaware of the competence.

Teachers receive feedback on their results based on a score ranging from 1 to 6 points for each item. Suggestions for levelling up are provided based on their competence level for each item.

SELFIEforTEACHERS Toolkit (Commission et al., 2023) presents each competence area with its description; the items associated with each area with their introductory statements, and the six proficiency level statements. Feedback for each proficiency level is also included.

SELFIEforTEACHERS questionnaire has been chosen as the fundamental component of our investigation, given its inclusion in all Spanish regulations aimed at assessing the digital skills of educators in a strategic manner for upcoming years throughout all the Autonomous Communities in our country.

4. Case study: CanSat teacher training

European Space Education Resource Office in Spain (ESERO Spain⁷) in delegation of European Space Agency (ESA) is the national coordinator for

⁷ <https://esero.es/>

CanSat Spain competition. ESA is promoting teacher’s trainings and students’ activities in order to follow its educational goals described in its Agenda 2025⁸. ESA is not only interested in preparing the future workforce but also in building future generations equipped to face the challenges of the future, whatever profession they choose.

CanSat school project challenges secondary school students to develop an operational sort of satellite-like project, integrated within the volume and shape of a soft drink can that must carry out a scientific experiment, among other activities similar to a space mission. Participation is open to teams of 4-6 young people aged 14 to 19 years old that must sign up with a teacher/mentor. The understanding of space is a global concern, and through project-based learning experiences like this we can help build a robust space workforce for the future (Ximenes et al., 2019).

In the context of digital competences for teachers, Continuous Professional Development (CPD) is vital for integrating technology into teaching practice, as noted by García-Ruiz et al. (2023). ESERO Spain is providing homologated training courses for secondary teachers in most of the Spanish Autonomous Communities to address this need.

The main objectives of the training are: (i) To provide tools for teachers to include and develop a CanSat project inside the school curriculum. (ii) To introduce general technical concepts to create an acknowledgement base that helps teachers work and develop their own ideas together with their CanSat team. (iii) To develop technical skills necessary to implement a CanSat: project design and planning, electronics concepts and programming, mechanical design, and construction: 3D printing.

The teacher-training plan combines face-to-face and online sessions. ESERO offers engineering support and a rocket launch campaign. This plan uses scaffold-type methodology and emphasizes life-long learning. Teachers can develop the CanSat project with their students step by step.

The first edition was implemented for the Canary Islands during the academic year 2019/2020 and gradually expanded to encompass 11 regions by the academic year 2022/2023 as represented in Table 1.

Table 1. CanSat Teacher Training plans for the school year 2022/2023 (Source: Own elaboration)

Region	Teacher Training Plan
Andalucía	<i>Junta de Andalucía</i>
Aragón	<i>Educaragón</i>
Asturias	<i>CPR Gijón Oriente</i>
Illes Balears	<i>CEP IBSTEAM</i>
Canarias	<i>Gobierno de Canarias</i>

⁸ https://www.esa.int/About_Us/ESA_Publications/Agenda_2025

Cantabria	<i>Educantabria</i>
Castilla y León	<i>Internal process</i>
Castilla-La Mancha	<i>CRFP</i>
Extremadura	<i>Junta de Extremadura</i>
Galicia	<i>Internal process</i>
Madrid	<i>Educamadrid</i>

Considering the results of the previous editions, a new teacher-training plan was developed for the current school year. The result is a teacher training hybrid plan, which uses a scaffold-type methodology. All these characteristics help to teachers without experience engage and facilitate teachers' learning, making it flexible (Rodrigues & Garcia, 2022), and also easier to homologate in each region.

This format allows online sessions, face-to-face sessions, recorded videos, talks, and offline work. From November 2022 to February 2023. During November and December five online sessions were delivered: Session zero: General introduction; Session 1: Primary mission; Session 2: Introduction to programming temperature and atmospheric pressure sensor; Session 3: radio communication and ground station; Session 4: Parachute calculations. In January face-to-face sessions were scheduled, Session 5: focusing on problem solving and reinforcing the contents. Finally, two online sessions about 3D design (Session 6) and reporting (Session 7) took place in February. Therefore, the training length is 22 hours to 30 hours in total, depending on the region's necessities to certificate the training.

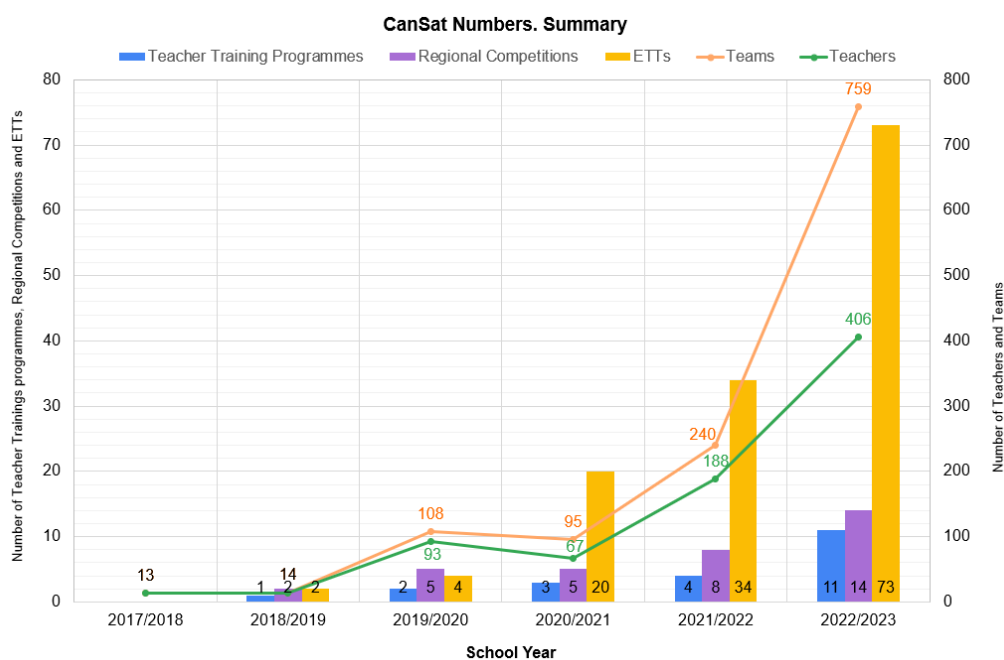
In general terms, the training course is designed by the combination of five elements concluded (Joyce et al., 2002): theory, demonstration, practice, feedback, and coaching. Furthermore, the teacher network is based on some essential components for educational improvement: (i) Engagement with specific CanSat innovation, fitting all electronic components in a small volume and researching takes students to find a proper secondary mission. (ii) Share a goal, launch the rocket, and complete the project. (iii) Provide specific information and support, resources and technical support delivered during the teacher training. (iv) Effective enabler, space as learning and teaching context. (v) Voluntary and open to diversity, the CanSat project is open to all teams that want to build their own small satellite without restrictions (e.g., handicapped team with special educational needs participated during the 2021 edition).

This allows creating the network of teachers that take part in each training course, so called ESERO Teacher Trainers (ETTs) figure that is also recognized by the educational authorities. It means active teachers that will assist other teachers during the training courses are selected and trained. This has been identified as a key factor to succeed in the CanSat network expansion.

CanSat Teacher Training evolution

As shown in Figure 1, we have compiled data from the CanSat Spain challenge since 2017 to show the results obtained. The data are classified by school year, from 2017/2018 to the current school year, 2022/2023. The lines represent teams and teachers registered. Notice that some teachers usually supervised more than one team. Then, we can see the number of teacher training programmes, regional competitions and ESERO Teacher Trainers (ETTs) in columns.

Figure 1. CanSat Numbers. Summary (Source: Own elaboration)



Once the teacher training in 2019 was implemented, the participation of both teachers and students increased. In 2020, five regional competitions were held, with two of them delivering the training program, resulting in an increase of teams up to 108. In 2022, nine regional competitions were organized, involving 240 teams and three training programs.

Over the past 5 years, all numbers have increased positively. Teams have increased from 13 to 759, with a nationwide impact. Teacher numbers have also increased, with 11 teacher-training programs now available. Around 10.41% of teachers supervised more than one team in the 2021/2022 school year. This percentage is now approximately 46.5%. Teachers feel more confident to register and supervise more than one team if they have a training plan.

As a final observation, it can be noted that the mean rating for all instructional sessions subsequent to the receipt of feedback is 4.67 out of 5, which is indicative of a considerable degree of recognition regarding the quality of training afforded to educators.

5. Methodology

Objective:

The initial assumption of this study is that CanSat Teacher Training will improve teachers' digital competences (v) Empowering Learners and (vi) Facilitating Learners' Digital Competence defined in DigCompEdu framework.

Tools and materials:

ESERO Spain will provide teacher training programs, including speakers, materials, and outdoor activities, as part of innovation or teacher training programs developed in each region. They will also be responsible for delivering and certifying these courses.

Instrument:

The level of digital competences according DigComEdu framework will be evaluated using SELFIEforTEACHERS self-assessment teachers' test.

Investigation phases:

The research has been structured in four stages.

The initial phase (January 2023-June 2023) consisted of a conceptual and documentary evaluation, as well as the selection of a verified instrument that encompasses the diverse areas of proficiency specified in the DigCompOrg pattern (SELFIEforTEACHERS survey). Additionally, we will establish pedagogical approaches that create explicit connections between the DigCompEdu competencies and the study's foundation, syllabus, and learning objectives (DigCompEdu course mapping). Lastly, we will collect data on the number of teachers who have been certified through the DigComEdu regulations (if any), as all Autonomous Communities are currently in the process of standardizing them, and no structured or officially published information is available at this time.

In the second phase (November 2023 - December 2023), we will initiate the development of the pre-test component. This coincides with the commencement of enrolment for the CanSat competition, which is subsequently followed by communication with all participating teachers. The research participants will be selected from among those teachers who voluntarily express interest in joining the "CanSat Spain 2024 Teacher Training Programme". Additionally, a second group of teachers will be selected as a control group, comprised of individuals who have not previously participated in the competition nor any of the training courses. To address this type of study properly, we will follow statistical and econometric standards. Following this, we will proceed to the initial evaluation (pre-test), scheduled to take place by the end of 2023, in order to get initial insight of the digital competency levels of each group of study's teachers.

Additionally, we will collect overall data from ministerial or regional sources regarding the level of Teachers' Digital Competences and certifications issued in accordance with the national digital normative base. This will enhance the general information and provide a current national perspective on the state of Teachers' digital competences in phase 1.

As a third stage (May – June 2024) the SELFIEforTEACHERS instrument (post-test) will be applied again over the two groups of teachers and the results will be contrasted. In addition, a qualitative collection of information will be carried out with focus groups and interviews.

Upon the conclusion of the training and CanSat challenge, a series of focus group interviews shall be managed to CanSat trained educators with the objective of obtaining insights and self-reflections. This action will allow us to identify key themes and associated cases to provide a more comprehensive understanding of the entire experience. The interview questions will be evaluated in collaboration with a digital competence expert (Coe, 2017). And ESERO Teacher Trainers (EETs) shall be specifically chosen from among CanSat trained teachers to act as ambassadors for the program and to promote increased networking and collaboration.

The fourth stage (July 2024) entails a comprehensive qualitative and quantitative analysis aimed at producing conclusive outcomes and ascertaining the degree of success in achieving our objectives. The quantitative analysis of the SELFIEforTeachers questionnaire results will facilitate the identification of individual teacher weaknesses in each competence area, as well as could highlight areas that could require further studies and training for advancement to any upper proficiency level.

6. Results

As an initial outcome of this investigation, a correspondence has been established between the competences of DigCompEdu shown in Table 2, with specific emphasis on areas 5 and 6, as determined by the study, and the content of the CanSat teacher training. Such an arrangement enables the identification of the correlation that we have matched between the content and the digital competences, which can be enhanced post-training. Furthermore, it has been adopted in some regions in previous CanSat Trainings during the Investigation Phase 1 period.

Table 2. Correspondences between CanSat Teacher Training and DigCompEdu competence for the school year 2022/2023. (Source: Own elaboration)

DigCompEdu Competences					CanSat Training
Area	Competence	Level	Descriptor	Description	Teacher Training content applied to teachers and students
5. Students empowerment	3. Students active commitment	B2	1	Analyses, evaluates and adapts their pedagogical strategies and the use of	Challenge inscription and first report indicating

	with their own learning			technological resources to the students' characteristics, the context and the learning objectives, to stimulate motivation and commitment of the students in the process, developing complex cognitive operations and transversal skills.	Secondary draft mission (Training Session Zero)
			2	Analyses the characteristics of the different types of digital resources (software, hardware and peripherals), selecting those that are most versatile for carrying out the tasks, adapting them to the level of students, and encourages them to use these learning in a critical and autonomous way.	Primary mission requirements and basic team task distribution (Training Session 1)
6. Development of students' digital competence	1. Media, information and data treatment learning	B1	1	Integrates in the classroom practice learning situations in which students must develop different strategies for searching, evaluating, selecting and organizing information and data.	Complexity of engineering approach and originality (Training Session 1 & 6)
		B2	2	Use different and flexibly digital tools to configure technologies provided by the school, so that their students can develop their competence in information and data processing.	The team has devised an outstanding mission regarding the technical aspects, and showed excellent understanding of several complex engineering problems tackled during their CanSat development and included some innovative developments (Training Sessions 2, 3 & 4)
	2. Digital communication and collaboration	B2	1	Designing or adapting new pedagogical proposals so that students develop their competence when using digital technologies to communicate, collaborate with others or participate as citizens in the digital society, as well as to manage your fingerprint and digital identity.	The quality of oral presentations from a communications point of view; providing a visually appealing presentation and convincingly conveying one or more core messages (Regional & National competition event)
	3. Creation of digital content	B2	1	Evaluates their own practice to design or adapt new learning proposals that they involve students in creative design processes to create quality digital content.	How the project was communicated to the school and the local community, considering web pages, blogs, presentations, promotional material, media coverage etc. (Training Session 7)
	5. Problem solving	B1	2	Integration into the teaching and learning processes situations aimed at students developing individual and collective projects that require their own initiative, using digital	Secondary Scientific Mission definition (Training Sessions 5 & 6)

				technologies creatively and critically.	
		B2	1	Design or adapt new pedagogical proposals, based on evaluation of their own practice, so that students develop their competence when using digital technologies to meet needs everyday life and unravelling in the digital society.	The team has devised an outstanding mission regarding the technical aspects, and showed excellent understanding of several complex engineering problems tackled during their CanSat development and included some innovative developments (Training Sessions 5 & 6)
	2		Design learning situations adapted to new socio-technological contexts so that students develop individual and collective projects that require your own initiative and the use in a creative and critique of digital technologies.	The team has a very deep level of understanding of different variables associated to the scientific question and can address the importance of the results of their investigation. They can answer all jury questions in a comprehensive way and elaborate on their answers (Training Session 1,5 & 6)	
	3		Configures the digital technologies provided by the school, adapting to new problematic learning situations so that students, depending on their age and degree, develop their competence to solve technical problems.	Technical reports. Ability to summarise with clarity and provide a readable and complete report. (Training Session 7)	

The accomplishment of the second Phase 1 outcome has proven to be an arduous task as all regions are involved in the homologation and certification process, and no statistical compilation has been carried out at either ministerial or regional levels. Nevertheless, we have succeeded to gather certain official data from four regions (Andalucía, Castilla y León, Castilla-La Mancha, and Galicia) regarding the proficiency of their educators' digital competencies as indicated in table 3.

Table 3. Level of Teachers' Digital Competence (DigCompEdu) per region. Source: Own elaboration

Region/Level	A1	A2	B1	B2	C1	C2	Total Teachers	Year	Data resources
Andalucía	7935	32198	30653	14202	3250	511	88749	2020	Resource link ⁹
Castilla y León	0	1378	0	705	0	0	2083	2022	Resource link ¹⁰

⁹ <https://blogsaverroes.juntadeandalucia.es/tde/informe-global-del-test-de-competencia-digital-docente-contextualizacion-analisis-y-desafios/>

¹⁰ <https://www.tucerticyl.es/estadisticas>

Castilla-La Mancha	3	5	12	6	2	0	28	2021	Resource link ¹¹ (González Sanmamed et al., 2022)
Galicia	8	160	176	98	22	7	471	2021	
TOTAL	7946	33741	30841	15011	3274	518	91331		

As table 3 shows, there are a low number of regions showing results (4 out of 17) and teachers' participation is not even proportional. However, we can appoint an initial indicator, in relative terms, highlighting level A2 (37%) and level B1 (34%) as most achieved.

Expected results:

The examination of the quantitative outcomes will enable us to determine, both by educator and by competence, the domains of higher or lower weaknesses, as well as the areas necessitating further training, with the goal of: i) determine the importance of teacher formation designed specifically on the area of assessment with the digital on the development of digital competences in our base of study areas; ii) comprehending whether teachers' discernment of digital competencies via SELFIEforTeachers is advantageous for the design and implementation of training programs; and iii) determining whether intensive training that is aligned with teachers' present digital competencies fosters their progress to more higher levels, iv) Space-based contents and context fosters teachers' digital competences.

The utilization of qualitative analysis has the potential to enhance the efficacy of training course mapping. This can be achieved through the incorporation of specific case studies and other forms of instruction, thus leading to more effective design of teacher training programmes. Furthermore, a viable intervention strategy for reorienting previously trained teachers or those who have participated in the CanSat challenge for several years, would be to include them in the ESERO Teacher (ETTs) leadership programme. By doing so, these teachers can function as peer mentors, offering guidance and support to help other lower-achieving teachers (Kopcha, 2012).

In addition, a comparative examination of the outcomes has the potential to enable public institutions to plan and allocate resources towards efficacious space-oriented teacher education leading new specific educative innovation programmes (Fernández Miravete & Prendes Espinosa, 2021). These strategic measures may guarantee the enhancement of digital competencies among teachers and foster a positive impact on students.

¹¹ <https://educamosclm.castillalamancha.es/portal/noticias/informe-de-centro-de-la-competencia-digital-docente>

7. Conclusions

The utilization of the SELFIEforTEACHERS tool for self-evaluation is currently being implemented across all autonomous communities in Spain. This presents a unique opportunity to conduct a specific study highlighting the significance of evaluating digital competence among teachers, particularly given the rapid changes in normative. Moreover, the lack of recent studies examining the impact of this framework on secondary education teachers emphasizes the importance of such a study. In this regard, it is essential to consider space-based resources as a learning context that fosters the development of digital competences, which can serve as a decisive tool for public administrations aiming to subsidize formation and strategies to enhance teaching work.

Based on the results of Phase 1, the CanSat training programme has been mapped for a B1-B2 level of expertise. It is also noteworthy that a majority of teachers possess a lower level of digital competencies, ranging from Levels A2 to B1. Nevertheless, this program offers a tangible option for both students and teachers to participate in practical space-based content while improving their digital competences. Furthermore, CanSat programme provides a recurring opportunity for collaboration each academic year (Dingwall et al., 2020).

Future steps:

The process has just started and we must keep gather official statistics as indicated by law that Autonomous Community shall publish indicating the number of teachers and level of DigCompEdu competence certificated in order to achieve Agenda Digital 2026 objectives.

Incorporating additional areas of digital competences, wherein the CanSat training program can exert its influence, can broaden the elaboration of the mapping. Furthermore, we could incorporate an analysis of the effects of students engaging in the diverse array of in-class and extracurricular activities.

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