

DIGITAL COMPETENCES FOR EDUCATORS IN THE ITALIAN SECONDARY SCHOOL: A COMPARISON BETWEEN DIGCOMPEDU REFERENCE FRAMEWORK AND THE PP&S PROJECT EXPERIENCE

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ABSTRACT

Schools are facing a new challenge in their approach to education, due to the spreading of digital technologies. New tools and new ideas take shape at an increasing rate. Educators and teachers at all levels need to be trained and keep up to date with technological opportunities. Some help comes from official EU documents providing directions, guidelines, and reference framework. This is the case of the DigCompEdu, a resource about digital competences for educators, which lists 22 digital competences divided into six main areas equally important for the development of good practices in digital education. In this paper, we want to observe the list of competences in the "Problem Posing and Solving" project, an Italian experience with teachers in STEM disciplines, supported by the Italian ministry of Education; this project makes use of digital technologies of different kinds and innovative methodologies that enhance teaching and learning in secondary schools. We will analyze the competency framework from the point of view of teachers and students participating to the project.

KEYWORDS

Digital Competences, Digital Education, Digital School, Problem Solving, Secondary Education, Teacher Training

1. INTRODUCTION

Nowadays trend in education massively involves the use of digital technologies and environments. The structures and the environments need to be prepared and suited for this digital transformation. The first structure that younger students encounter during their compulsory educational path is the school, which must adapt their approach to education according to the potentialities that digital technologies can offer. Ministries, professors, and other stakeholders started running many projects related to school and education, with different purposes:

- Integration: connect digital technologies to other topics in learning and to other specific disciplines.
- Comprehension: understand the state of the use of digital technologies at schools.
- Training: contribute to the knowledge and skills of staff and teachers.
- Inclusion: address accessibility issues or gender studies.

There are some tools that can facilitate the transition to the digital education: the so called LMS, Learning Management System. Since the beginning of the digital era, many developers have worked to create environments that encourage didactical purposes. Among these environments, one of the most renowned is Moodle, which is an open source software.

The "Problem Posing and Solving" project, PP&S, (Brancaccio et al., 2015a), headed by the Italian Ministry of Education, promotes the training of teachers of secondary schools on innovative teaching methods through the use of digital technologies, and on the creation of a culture of problem posing and problem solving, through the use of Information and Communication Technology (ICT). Teachers involved in the project have learned - and still do - how to use different kinds of digital tools, in order to enhance their daily didactics. The essential

tool for professional development of teachers and for the renewal of teaching and learning is the VLE, a Moodle-learning platform, available at www.progettopps.it, integrated with an Advanced Computing Environment (ACE), an Automatic Assessment System (AAS) and a web conference system. The tools used within the PP&S project support innovative and adaptive teaching:

- the VLE allows synchronous and asynchronous discussions, collaborative learning, interactivity and interaction, integration with tools for computing and assessment, activity tracking;
- the ACE allows interactive exploration of possible solutions to a problem, different ways of representation and feedback from automatic calculations and interactive explorations;
- the AAS allows students to carry out the necessary exercises independently, to have step-by-step guided solutions to learn a method and to make repeated attempts of the same exercise with different parameters and values. The AAS promotes students' autonomy and awareness of their skills and facilitates class management for teachers.

All the actions, developed in compliance with the PP&S directions, enable collaborative learning among teachers and promote problem posing and problem solving as learning methodologies (Barana et al., 2017). Technologies are not useful without the right methodologies, and this is the reason why teachers were trained in the following areas: problem posing and solving with an ACE that supports problem resolution and generalization, automatic formative assessment with adaptive questions aimed at teaching students how to solve problems, collaborative learning among teachers in a community of practice for the exchange of ideas, and collaborative learning among students in a learning community. The PP&S Project offers various training activities that allow teachers to reconsider their day to day teaching using technologies: face-to-face training, online training modules, weekly online tutoring, online asynchronous collaboration, and collaborative learning within a learning community.

The project started following the Italian National Strategies about STEM disciplines but, as it keeps growing and developing, it can respond to even more needs. Education is changing very fast and the European Union is trying to keep up with its development. In fact, the European Commission science and knowledge service proposed a document called DigCompEdu (Punie et al., 2017) which describes what skills an educator is required to be digitally competent. This document contains a reference frame to support the development of digital competences specifically for educators at all levels of education.

Since the PP&S project acts on digital education, the aim of this work is to understand whether the strategies and the methodologies initially adopted by the project, fulfill the indications later provided by DigCompEdu. We will prove the adherence to the framework with examples and data. After Section 2, which denotes the State of the art, the following sections articulate the research questions and the analysis and discussion on the connections between the reference frame of DigCompEdu and the PP&S project actions. The results section contains some data on the training of teachers carried out within the project, referring to the academic year 2019-2020, and some data on the use of the platform by students by teachers. During the current Academic Year, there has been the global pandemic caused by Covid-19. For this reason, starting from March 2020, many training activities focusing on Online Didactics have been provided.

2. STATE OF THE ART

The state of digital education in European schools is described in the document Digital education at school (Eurydice report, 2019). In line with the European indications, many countries define digital competence as a key competence. Most countries include the development of digital competence at all levels of education. Unlike other school subjects, digital competence is not only addressed as a topic on its own, but also as a transversal subject. The curriculum is changing in half of the European education systems in relation to digital competence. All national digital competences frameworks emphasize that teachers must be aware of how to integrate digital technologies into their teaching and professional development and they must be able to put them into practice. Even if digital competences are part of the curricula, they are little assessed at school through national testing.

In addition to European directions, there are some national and international implementations of these guidelines. As an example, the Digital Schools of Europe project aims at enhancing digital integration in learning, teaching, and training (Digital Schools of Europe Final Evaluation, 2018). Moreover, the project wants to address low achievement in basic skills and to develop basic and transversal skills, both objectives by

using innovative and effective methods. Another example of implementation is SELFIE (SELFIE | Education and Training), a free, easy-to-use, customizable tool to assess where a school stands in the approach to learning in the digital age.

Behind the competences framework, the professional development of teachers plays an essential role. In this sense, a European experience was provided by the Erasmus+ SMART (Science and Mathematics Advanced Research for good Teaching) project (Brancaccio et al., 2019), whose main output were two open online courses called “Mathematical Modelling” and “Observing, Measuring and Modelling in Science”. These two open online courses were created to help teachers in their continuous professional development, in an open self-paced path. In order to deploy the most expressive potentialities of digital technologies, both courses use interactive materials ready to be downloaded, modified to be used in the classroom and redistributed to the community.

An important document to state the needs of competences is DigCompEdu (Punie & Redecker, 2017), a reference framework directed towards educators at all levels of education. Teachers and students are the main target, but it is important to also mention the people who train the teachers so that they improve their didactics.

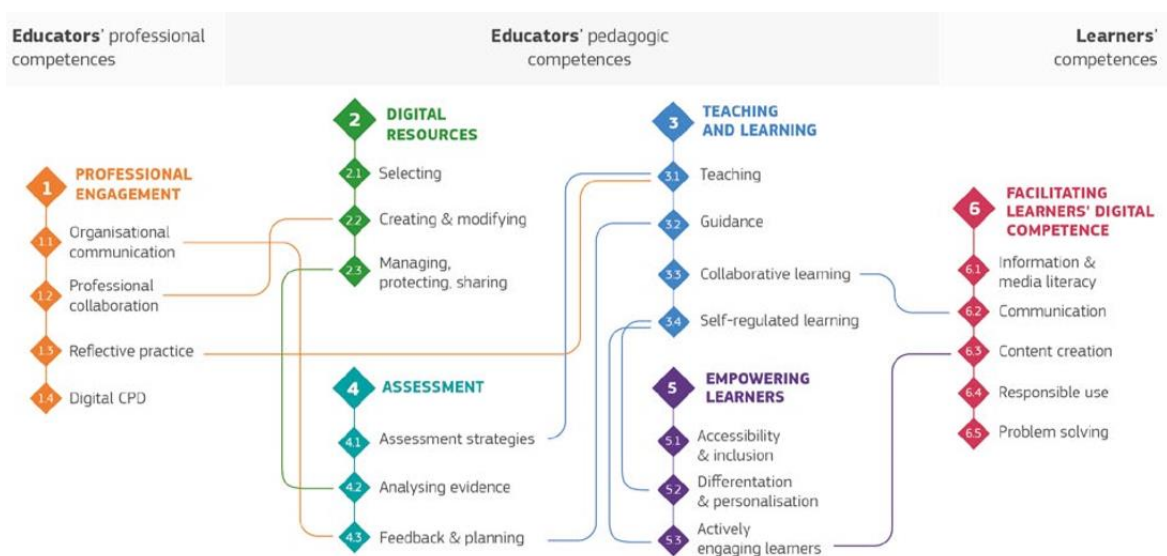


Figure 1. The DigCompEdu framework, divided into areas and sub-areas

The six DigCompEdu areas that focus on different aspects of educators' professional activities are:

- Area 1: Professional Engagement Using digital technologies for communication, collaboration and professional development.
- Area 2: Digital Resources Sourcing, creating and sharing digital resources.
- Area 3: Teaching and Learning Managing and orchestrating the use of digital technologies in teaching and learning.
- Area 4: Assessment Using digital technologies and strategies to enhance assessment.
- Area 5: Empowering Learners Using digital technologies to enhance inclusion, personalization and learners' active engagement.
- Area 6: Facilitating Learners' Digital Competence Enabling learners to creatively and responsibly use digital technologies for information, communication, content creation, wellbeing and problem-solving.

These areas are further divided into specific sub-competences that covers all the main aspects that a student, a teacher or any other actor involved in education may face.

3. PP&S TEACHER TRAINING MODEL IN COMPARISON WITH DIGCOMPEDU

Even if the PP&S project was born in 2012, that is around 5 years before the DigCompEdu (published in 2017), it seems to anticipate and address many of the areas and competences detailed in DigCompEdu. The PP&S project is not just a set of actions addressing STEM teaching, but it developed a model that combines didactical methodologies and strategies with technologies, connecting different actors and peers. The assessment of the adherence of the PP&S model to the EU guidelines can contribute to the educational community, since it is possible to export and reuse the same approach in different contexts and countries. Thus, the questions of this research paper are the following:

1. Do the actions of the PP&S project fall within the European indications of the DigCompEdu?
2. Which areas of the DigCompEdu are covered and which of them are not?

We are going to enter systematically in all the specific areas and competences to see which ones are activated and addressed by the project PP&S. Figure 1 represents a scheme of all the competences described in DigCompEdu.

3.1 Professional Engagement

Area 1 of DigCompEdu describes professional engagement. Communication is essential for the project, since in the online platform teachers interact with students and with their peers in a collaborative approach (Competence 1.1). In fact, teachers are enrolled in a virtual Community of Teachers (Competence 1.2). The main tool for collaboration is the discussion forum, in which teachers discuss different topics: curricula, usage of ACE and AAS, methodologies (like problem solving and automatic formative assessment). The interactions with teachers also take place synchronously, via web conference tools, connecting with experts in digital education at the University of Torino, providing teachers with an up-to-date training session at the frontiers of research. Within the Community, teachers can also share their products and their resources, and they can find contents for self-training, promoting the continuous professional development (Competence 1.4). Beyond the Community, every teacher manages one or more courses to share and work with students. Access to teacher's personal course is available to colleagues, so they can see how peers use technologies and apply methodologies, thus fostering reflective practices (Competence 1.3).

3.2 Resources

Area 2 of DigCompEdu describes sourcing, creating and sharing digital resources. The community of PP&S Teachers owns a shared database of contents and educational resources, one for interactive materials for teaching STEMs with an ACE and one for tests with automatic assessment. Teachers are guided in selecting the right resources: databases are organized by types of contents and degree of education (Competence 2.1), and every entry provides descriptors such as topic, objectives, prerequisites, etc. The search in the web and the use of a variety of tools, according to the purpose of didactics, is strongly encouraged, even if the project proposes a precise methodology and specific tools. Teachers are supported until they become autonomous in the modification of existing resources and in the creation of their own ones, which are strongly recommended to be interactive (Competence 2.2). The shared contents are copyrighted with the logo of the project in order to acknowledge that they were prepared by a teacher in the PP&S project (Competence 2.3). The project provided training in all aspects of digital education and the most interested teachers are aware of copyright issues, of the advantages of the use of open licenses like Creative Commons and data protection, even if, to date, these topics are not included in the "starting package" for teachers.

3.3 Teaching and Learning

Area 3 of DigCompEdu describes competences about teaching and learning, which is the core of DigCompEdu. One of the proposed teaching methods is the problem solving with an ACE, with contextualized situations in which students must apply and develop knowledge to solve problems (Branaccio et al., 2015b). Since the project proposes the use of specific tools dedicated to problem solving methodology, teachers have the

opportunity to install the ACE for free on their personal computer and in school labs, empowering their devices (Competence 3.1). In this way, students can work independently with the ACE to develop problem solving and computational thinking skills (Barana et al., 2019). Teacher can freely manage their online classes and experiment, develop new formats and teaching methods for education. Teachers learn about the use of adaptive resources, mainly questions (which will be described in the next subsection) to provide personalized feedback and action into the learner's processes (Competence 3.2).

3.4 Assessment

Area 4 of DigCompEdu describes competences about assessment. This is one of the main topics of the PP&S, since one of the selected tools to enhance learning is an Automatic Assessment System (AAS). The integration of the platform with an automatic assessment system, based on a computing environment, allows the creation of questions with variable parameters and with open answers, evaluating the process and not the result. In particular, the focus is on Automatic Formative Assessment using the model developed at the University of Torino (Barana et al., 2018; Barana, Marchisio & Rabellino, 2019) with interactive and immediate feedback, promoting adaptive teaching and self-regulated learning (Competence 4.1). The teacher can constantly monitor students' behavior on the platform and interpret all the learning data of each student. Basic analytics can be provided by the LMS and the AAS in order to evaluate the effectiveness of the resources and activities (Competence 4.2), but this is just for the more expert teachers, since it is also a quite new research topic (Marchisio et al., 2019; Barana, Marchisio & Sacchet, 2019). Some teachers use the AAS for summative assessment, too, providing important feedback and planning intervention and recovering according to the results (Competence 4.3).

3.5 Empowering Learners

Area 5 of DigCompEdu describes competences related to empowering learners. This is something strongly dependent on the teachers' approach, but technologies can provide fruitful advantages. Accessibility is addressed, which is crucial at school level, even if not very detailed in online environment. Luckily for teachers, Moodle supports accessibility as a main project goal (<https://docs.moodle.org/31/en/Accessibility>). To enforce the accessibility of Moodle, the platform uses EasyReading, a font suitable for dyslexia. Even personalized paths are left to the teachers' responsibility and since they provide blended learning, it is something that can happen both online and in the class. Competences of area 5 are more difficult to assess compared to those of the other areas.

3.6 Facilitate Learners

Area 6 of DigCompEdu describes how to facilitate learners' digital competence. This is the mirror of Area 1, from the learners' point of view. It is very difficult to understand whether the PP&S project reaches a standard in these competences or not. Every teacher uses the platform differently: in person with students, shown in the classroom or in the lab, or in a blended way, for online lessons, homework or flipped classroom. Moreover, some teachers facilitate students' group activities. Since students browse an online environment, they are used to search and find many information autonomously and, sometimes, they are motivated by the teacher in a personal search all over the web to look for Open Educational Resources (Competence 6.1). In this setting, collaboration is automatic (Competence 6.2) since students meet in the classroom every day. Some students, the most skilled ones, were able to create their own contents using the ACE to present a mathematical topic in a contextualized situation during their secondary school final exam (Competence 6.3).

4. RESULTS

The PP&S project operates since 2015 promoting new STEM teaching methods to teachers all over Italy, reaching many different schools and teachers.

In the absence of similar experiences, for dimension and openness, the project developed a model to sustain an introduction of the technology into the Italian secondary school. The PP&S model has evolved during these years and has been continuously improved and refined and proved effective by working with a substantial number of teachers and students who have worked on the e learning platform over the past 5 years. The following table (Table 1) presents an overview of the project scale.

Table 1. General overview of the PP&S project, last update April 2nd, 2020

	Amount		Amount
Users	25623	New users AY 2019/2020	3967
of which teachers	1827	of which teachers	356
of which students	23796	of which students	3611

In the Academic Year 2019/2020 there are 2015 courses in which teachers work with students (every teacher has got at least one course). In order to promote teacher training, material for self-training is always available on the platform. Moreover, at the beginning of the Academic Year 2019/2020 a synchronous online training module entitled "Innovative teaching methods for teaching and learning STEMs in the PP&S Project" actively involved 37 teachers who were new to the project, with four 1-hour online meetings. To obtain complete certification, each teacher had to participate in at least 3 meetings, structure and customize the course for their class and set the contents of at least one section (inserting an interactive material and a test with automatic evaluation). This module comes with weekly meetings for all teachers: ten 1-hour slot on STEM didactics with an ACE and ten 1-hour slot on automatic evaluation for STEM disciplines.

During the Academic Year, there was the global pandemic caused by Covid-19. This caused a period of emergency, during which the weekly meetings were suspended in favor of a general training on online teaching. In fact, the PP&S project decided to open enrollments to teachers of lower and upper secondary schools of all disciplines, not only STEM. The main training topics concerned the use of the Virtual Learning Environment to manage and offer students activities and resources, and automatic formative assessment to monitor and facilitate learning, creation of adaptive tests. 186 teachers participated in the extraordinary training. Table 2 shows data related to users in the PP&S project between the period Pre Covid-19 (01/09/2019 - 29/02/2020) and during Covid-19 (01/03/2020 to the present date, written in the table caption).

Table 2. Comparison between Pre and During Covid-19, last update April 2nd, 2020

Period	Pre Covid-19 01/09/2019 - 29/02/2020	During Covid-19 01/03/2020 up to date	Increase
New users	1466	2847	+194%
Average of new users per day	11	80	+627%
Average login per day	4875	7727	+59%
Average distinct user login per day	117	1120	+918%

These numbers do not only show an increased number of accesses to the platform, but they are also prove of an active engagement and collaboration in the Community of Teacher forum. In the Pre Covid-19 period (6 months), 133 forum threads and 303 posts were created, with 3351 visualizations, while during Covid-19 (1 month) 56 forum threads and 124 posts were created, with 1148 visualizations. The numbers are significant when considering the time span, since the Pre Covid-19 period of time is 6 times longer than the Covid-19 period of time.

During this period, the collaboration among teachers on the platform to overcome this emergency situation was particularly important and significant. The teachers discussed a lot about how to best propose an online teaching, to carry out synchronous online lessons and how to prepare relevant materials and resources. The teachers collaborated mainly through the forum of the Teacher Community (Table 3), where each teacher can open a discussion, write an intervention in a discussion already present or simply consult the forum. The ever-present support of the trainers was also fundamental.

Table 3. Data from the Teacher Community forum Pre and During Covid-19, last update April 2nd, 2020

	Pre Covid-19	During Covid-19
Period	01/09/2019 - 29/02/2020	01/03/2020 up to date
Threads created	77	56
Threads read	2203	1148
Posts created	179	124

All the teachers have completely transformed their teaching into online teaching, structuring the course on the platform and inserting different types of activities and resources for the students. Figure 2 shows an example of an online course on the platform with examples of activities within one of the various sections.

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STUDIO DI FUNZIONE

STATISTICA

DERIVATA DI UNA FUNZ...

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- Definizione di derivata e suo significato geometrico
- Significato geometrico della derivata: problemi guidati
- Equazione della retta tangente
- 4AEL compiti 31marzo2020
- 4AEL compiti 1aprile2020

Figure 2. The DigCompEdu framework, divided into areas and sub-areas

5. CONCLUSION

Activation of competences is certainly addressed by the project PP&S, even without being the main aim of the project. Students and teachers are involved together in an online environment, pulling out some basic competences, and trained to use specific digital competences every time they interact with the LMS. Thus, the educational action provided by the project PP&S mostly adhere to the guidelines of DigCompEdu. The interested teachers cover all areas of competences, while most of them are involved in Areas from 1 to 4, which are the essential ones for good practice in teaching. As we emphasized in the paper, when the competences are addressed, they are close to research level, since teachers interact directly with experts, researchers and professors at the University of Torino. The training of teachers within the project was particularly emphasized and appreciated during the emergency period for the COVID-19 pandemic. As the results show (partial data only for the month of March 2020), the participation of teachers in the training activities and the collaboration among teachers on the platform was relevant. This period of emergency and online teaching will certainly also be relevant for students and for their development of digital skills, such as the use of information and digital media for activities and the use of technologies for communication and collaboration for educational activities.

The guidelines of the DigCompEdu framework should be followed in every country in Europe. The PP&S model could be an implementation of these guidelines that could be adopted in different educational contexts and grades. Besides the adherence to the guidelines, the availability of an online environment, where people with the same needs can share ideas and resources, and bring competences to a wider group of peers, even internationally, plays an important role to rebuild the human relations interrupted by Covid-19 .

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