CRISS: A CLOUD BASED PLATFORM FOR GUIDED ACQUISITION, EVALUATION AND CERTIFICATION OF DIGITAL COMPETENCE

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ABSTRACT

This paper deals with a problem of digital competence acquisition and certification. In order to overcome the problem of still inadequate number of digitally competent students and the tools that merely focus on skills acquisition, this paper proposes the CRISS platform which is a unique cloud-based digital learning solution, based on the most advanced pedagogical methodologies and technological solutions Its purpose is to allow guided acquisition, evaluation and certification of digital competence in primary and secondary schools in Europe. The platform is based on the CRISS Digital Competence (DC) Framework created as an adaptation of a well-established European digital competence framework, DigComp. The platform's architecture includes seven different modules that support the CRISS DC Framework and employ advanced techniques such as learning analytics, intelligent tutoring and certification. The platform will enable teachers to track the work of their students acquiring the digital competence with a detail insight into their learning paths. CRISS platform is piloted in around 90 schools, with 600 teachers and 3400 students during the school year 2018/2019.

KEYWORDS

Digital Competence, Certification, e-Learning Platform, Learning Analytics, Intelligent Tutoring

1. INTRODUCTION

Digital competence is one of the eight key competences for lifelong learning identified by the European Parliament and Council of the European Union (2006). It is a transversal key competence, which, as such, enables the acquisition of other key competences (e.g. mathematics, communication in mother tongue and foreign languages, cultural awareness, etc.). Also, according to Ferrari (2012) and Calvani et al. (2008) digital competence is a "set of knowledge, skills and attitudes (including abilities, strategies, values & awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; etc." There is a need to support citizens in the acquisition and development of digital competence, as well as schools, teachers, learners, parents and educational actors with a series of tools that could facilitate the implementation of media and digital competence courses and interventions.

European Commission (2013) reports that only 30% of students in the EU can be considered as digitally competent. To address this problem and create a common language between the worlds of education and labour market, the European Commission developed and published in 2013 the European Digital Competence Framework for Citizens (hereafter DigComp) (Ferrari, 2013). However, DigComp is by all means a generic framework that needs adaptation for different levels of education and for different national context (Ferrari, 2013).

With that respect, an EU funded research project CRISS has been established in order to develop a standard methodological framework and the online platform for digital competence acquisition, evaluation and certification for students of primary and secondary school.

This paper describes the model and implementation of a CRISS platform which is a flexible, scalable and cost-effective cloud-based digital learning ecosystem that delivers a user-driven and adaptive technological solution to allow the guided acquisition, evaluation and certification of digital competence in primary and secondary education, and scalable to other educational levels.

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2. CRISS DIGITAL COMPETENCE FRAMEWORK

As indicated in Kluzer (2015), DigComp framework is widely used across Europe as a reference framework for digital competence. It was inspired by three existing frameworks: The Common European Framework of Reference for Languages (CEFR), the European Qualification Framework (EQF) and the e-Competence framework for ICT professionals, from which four of DigComp's five framework areas were taken (Kluzer, 2015).

In order to adapt DigComp to enable digital competence acquisition, evaluation and certification for students of primary and secondary school, an innovative CRISS Digital Competence framework (hereafter CRISS DC Framework) was developed (Guardia et al, 2017). It follows the "integration pedagogy" concept introduced by Roegiers (2010) as a valid approach to developing competence assessment. The pedagogy of integration focuses on learning (mastering) competences, as opposed to the simple juxtaposition of skills (Roegiers, 2000). The CRISS DC Framework is aligned with DigComp and decomposes digital competence into 5 Areas and 12 sub-competences. Each sub-competence is composed of a set of performance criteria (PC) that translate the sub-competences into more specific elements of what a student should be able to demonstrate. Each performance criterion is composed of a set of indicators that provide measurements or conditions required to interpret the evidence in terms of performance criteria and competence attainment.

CRISS DC Framework proposes the development of Competence Assessment Scenarios (CAS) (see Figure 1) with activities and tasks enabling the assessment of one or more performance criteria. Teachers are responsible to plan the learning, to provide feedback and to evaluate activities and tasks. The activities and tasks are retrieved by the CRISS repository and teachers can apply or adapt them in their curricula. The students should realize the activities by performing one or more tasks and generate products (the evidences) as a result of a task that can be used to prove the acquisition of a specific competence.

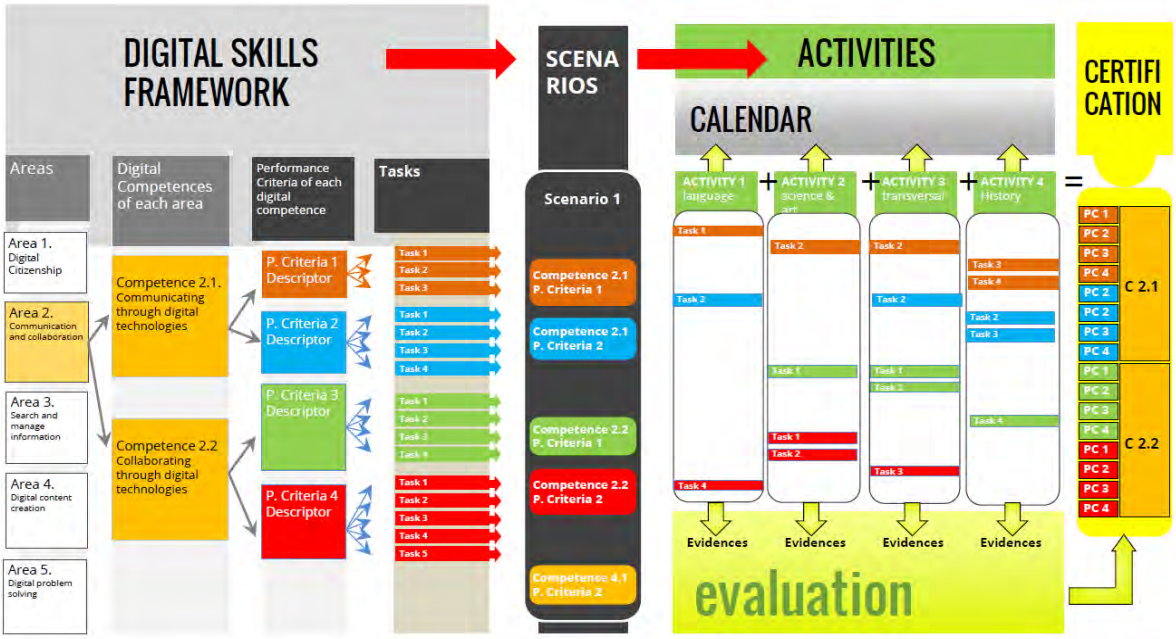

Figure 1. Overview of the CRISS certification process

The assessment of digital competence is performed through two types of interventions: human and technological. Human interventions are carried out by teachers and students using tools like Rubrics, Check Lists, Scales, etc., that will be automatically generated by the CRISS platform and customised by teachers. All these tools are created to be easily used for teacher, self and/or peer evaluation. The technological intervention is executed by the CRISS platform which is set to track the students while working in their assigned activities and collect relevant information i.e. the indicators of the evaluation of the evidences.

3. RESEARCH BACKGROUND

In order to design a cloud-based learning infrastructure for acquisition, evaluation and certification of digital competence based on the current CRISS DC framework we approached the literature review to reveal any existing implementations of similar platforms that deal with competence acquisition, evaluation and/or certification. The most relevant electronic journal databases were selected and searched to provide a comprehensive bibliography of research papers on digital competence assessment. The selected sources include IEEE Xplore Digital Library, ScienceDirect, Web of Science, Springer Link, Taylor & Francis, and Wiley Online Library.

To search the sources, we used phrases "digital competence", "competence certification", "competence assessment", "competence acquisition" and "competency measurement". In sources that offer advanced search, we used these phrases with operator OR. Additional filters were used to limit results to area related to computer science, education or both. Finally, through the application of inclusion and exclusion criteria, 136 related papers, published between 2001 and 2018, were selected.

Review of these papers showed that while many of them focus on theoretic models of digital competence assessment, very few of them deal with practical ICT implementations of digital competence assessment, let alone certification of digital competence. We describe some of them very briefly.

The first example is Ikanos project by the Basque Government who uses the DigComp framework to deploy their Digital Agenda (Kluzer, 2015). This includes a free online testing tool for self-assessment based on DigComp's five areas of digital competence grouped in 3 thematic blocks. The test addresses these blocks by asking about 30 questions of different type (yes/no, single or multiple choice, scoring etc.). Depending on the respondent's answers, additional information about local resources and initiatives related to specific questions may be given. The test produces a personalized "Digital profile report" in 4 sections: (1) Overall assessment score (basic, intermediate, advanced with a related visualization) and a short explanation about its meaning; (2) Visualization of the results according to DigComp's 3-level scale; (3) Aggregate result for each of the DigComp's 5 areas of competence, with a visualization and a description of each competence area content; and (4) Results for each one of DigComp's 21 digital competences.

The second example (Kluzer, 2015) is Skillage which is an online tool for ICT skills assessment. It contains about 100 questions grouped into five competence areas. Questions were originally identified according to Skillage's employability orientation and aligned to DigComp. Since 2012, about 10,000 tests have been gathered each year, mostly during the Get Online Week organized by Telecentre Europe and now part of the eSkills for Jobs campaign of the European Commission.

ACTIC - *Acreditación de Competencias en TIC* (ICT competences accreditation) is the digital competence certification system for citizens 16 years old and above, developed by regional government of Catalunya. Currently, it contains eight competences and provides three certification levels (basic, intermediate, advanced). ACTIC certification is delivered by Catalan telecentres network of Punt TICs, member of Telecentre Europe. ACTIC was one of the cases studied in DigComp's preparation process (Kluzer, 2015).

Some other examples involve the e-Schools project by Croatian Academic and Research Network to support the professional development of teachers, the ECDL certification which is focused on tools and applications which cover competences defined in DigComp framework and the French platform PIX that provides all citizens with opportunity to evaluate and certify their digital competence.

Another example is from Florian-Gaviria et al (2013) who propose an adaptive evaluation engine architecture implemented in their AEEA software. This approach is aligned with the European Qualification Framework (EQF). For each competence, this framework provides a set of capabilities that need to be proven for each level. This framework enables learning providers to adapt their offers toward achieving these capabilities in learners and certify learning outcomes accordingly. The arrangement of learning activities represents a scenario for moderating and guiding students learning process. This scenario can be visualized as a matrix of learning activities and competences. Each entry in this matrix represents an expected competence level for an activity. A row of this matrix defines the steps from the initial qualification level (prerequisite) to the final expected qualification level (learning outcome) through one or more assessment activities. (Florian-Gaviria et al, 2010).

The above described examples were thoroughly analysed and will present a backbone for the design of a novel CRISS platform for digital competence acquisition, evaluation and certification.

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4. CRISS PLATFORM

When designing the CRISS platform the main aim was to implement requirements from the CRISS DC Framework and to employ innovative pedagogical elements, guidance for users and gamification.

CRISS platform follows a modular design with two main parts: the CRISS Core and the CRISS Certification and Learning Analytics (Figure 2). The different modules, sub-modules, components and elements can be plugged in and unplugged from the CRISS Core. Such approach also allows a more flexible approach to the market, as the different components can be used separately, depending on the specific needs of a potential client.

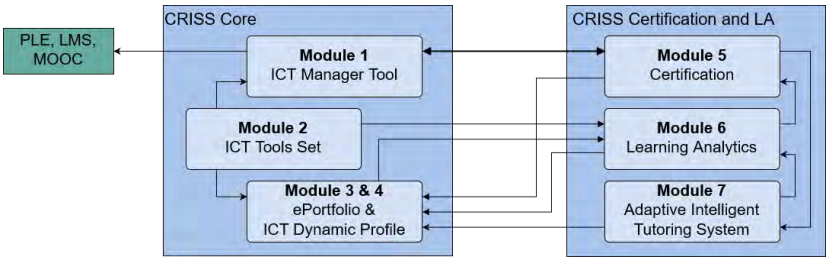

Figure 2. High-level overview of the CRISS platform

CRISS core comprises of four modules which allow teachers and students to work and perform their tasks: (1) ICT Manager Tool (module 1) allows the user management, activities planning and assessment (together with the ePortfolio and the Certification Module, submodule A); (2) EPortfolio (module 3) showcases the students' progress and assessments; (3) ICT dynamic profile of each student (module 4); and (4)ICT tools set (module 2) allows the users to create unique content.

Within Certification and Learning Analytics we distinguish among: (1) Certification of Digital Competence (module 5); (2) Learning Analytics (module 6) which provides insights useful for the certification and personalization of the learning process and (3) Adaptive Intelligent Tutoring System (module 7) which infers adequate actions meant to fill learning gaps during students' ICT lifecycle.

In the next sections we describe the CRISS platform modules in detail.

4.1 Module 1: ICT Manager Tool

On the one hand, this module allows to perform general functions such as registration and user management, permission management, etc., and on the other, it offers specific modules for managing activities related to acquisition, curriculum planning, evaluation and certification of digital competence and sub-competences.

It includes the following submodules:

1. Administration - designed for user creation, management of roles and permissions, credentials etc. It is composed by several submodules: User Manager Module; Data Connector Module; Authentication System and SSO; User API.
2. ICT Planning - designed for teachers to create, individually or in teams, their lesson plans (calendar, dates of assessments, in order to provide the students with the necessary Scenarios, activities and tasks to acquire the Digital Competence).
3. Scenarios Creation - allows CRISS partners and teachers to create the scenarios, activities and tasks for the acquisition of digital competence. It is connected to the Certification Module in order to allow teachers to align their scenarios with the criteria established in the CRISS DC Framework. There is a set of predefined scenarios available, each including a set of activities and the relevant evaluation tools. Each scenario covers a certain level of DC acquisition which is depicted to a "Certification Weight", according to the number and type of included activities and tasks. The user is able to search for specific scenarios based on specific criteria i.e. by subject, area, level of difficulty etc.
4. Evaluation and Assessment - provides all the necessary features and tools for the assessment and evaluation of Scenarios, tasks and activities, and, through this, for the assessment and certification of Digital Competence.

4.2 Module 2: ICT Tools Set

This module offers a set of ICT Tools that enable users to enhance their experience and achieve their pedagogical objectives by using different ICT tools. It allows teachers to include different tools in their courses and lessons as is or to use them to create educational experiences. Students will use them for their individual or collaborative productions related to the tasks assigned by their teachers.

These ICT tools include: (1) Social Network, where students and teachers participate in groups, post comments, express preferences or create circles of relationships; (2) Magellan, a visual programming environment enabling an author to quickly create any type of interactive applications including 3D, VR, AR, from serious gaming to Location Based Experiences; (3) Portabily, a tool for the creation of custom-made multimedia content in multiple formats; and (4) a selection of External ICT tools such as mind maps, timelines, etc.

4.3 Module 3: EPortfolio

This module allows students to recollect and show the evidences of their learning through their entire educational life (Lorenzo & Ittelson, 2005), and to become reflective learners (Stefani et al., 2007). It is the place where all student activities converge: work, evaluation communication with peers and teachers, behaviour, collaborations, interests, etc. In addition, it collects and shows the certificates and badges. The students' portfolios follow them throughout their academic lives and beyond.

On the other hand, for a teacher, this is a place where they can access and follow their students' work and follow progress, organize and share their contents and educational materials.

4.4 Module 4: ICT Dynamic Profile

The enrichment of the student's ePortfolio with the ICT dynamic profile provides a 360 degrees picture of the students daily learning activity, considering among this activity not only the results of tasks, exams or group work but also the students' behavior, interests and social attitudes. This dynamic and continuously evolving picture allows teacher and students for themselves to know their strengths and weaknesses based on the objective measurements, to detect opportunities, to improve and progress, to understand and recommend training actions, to enhance such evolution and to understand different topics.

The ICT Dynamic profile offers the teachers and students the visualization of the data related to the results of evaluation and assessments, the level of acquisition of digital competence, and the certification of digital competence, including sub-competences.

4.5 Module 5: Certification

The Certification module is a core module for CRISS as it implements the criteria and indicators determined in the CRISS DC Framework for evaluation and certification of digital competence. It enables the teachers to evaluate the student's performance throughout the learning procedure based on the aforementioned criteria and indicators and provides the ICT Manager Tool with the criteria and feedback to create scenarios, activities, tasks and evaluations according to the CRISS DC Framework.

The certification module is based on CRISS DC Framework and follows example from Vuorikari et al. (2016). Also, the works by Hickey (2012) and Sullivan (2013) were used as basis for implementing Open Badges into the system as part of the certification of sub-competences and areas of CRISS DC Framework.

4.6 Module 6: Learning Analytics (LA)

The Learning Analytics module (LA) constantly gauges students' assessment data and provides teachers with a comprehensive tool to monitor student progress, lesson plan delivery and assessment records and various other data in real time allowing them to navigate seamlessly through comprehensive key metrics to help them get insights, draw conclusions and take appropriate actions. Teachers will be able to design and improve the learning activities for a specific student by taking into consideration personalized insights delivered by the LA.

The works of Williams (2014) and Redecker & Johannessen (2013) were used, which cover the use of learning analytics and data mining for assessment and accreditation in educational context, as a basis for implementing this module.

4.7 Module 7: Adaptive Intelligent Tutoring System (AITS)

The Adaptive Intelligent Tutoring System module provides feedback to students and teachers (alerts, notifications, suggestions) on how to adjust the learning path of each individual student to improve their learning experiences and outcomes. It provides individualized gap analysis between student's achievement to date and the progressive/final certification threshold. It also enables teachers to proactively identify students at risk and spot their areas of improvements. For students, it will enable automatic matching of their required academic assistance and personal coaching need with the tutors' profiles.

This module follows examples from Adaptive Hypermedia Systems such as InterBook (Brusilovsky et al, 1998) and INSPIRE (Papanikolaou et al, 2003); Adaptive Information Filtering systems like MLTutor (Smith and Blandford, 2003); and Intelligent Tutoring Systems like German Tutor (Heift, 2000).

5. TESTING THE CRISS PLATFORM

The CRISS platform is piloted in around 90 primary and secondary schools during the school year 2018/2019, with 600 teachers and 3400 students in Italy, Spain, Croatia, Greece, Sweden, and Romania. The main objective of the pilot is to test the effectiveness and acceptance of the CRISS platform.

The piloting activities require teachers to apply or to adapt Competence Assessment Scenarios (CAS) within their curricula (i.e. Mathematics, Geography, etc.). A CAS is a set of activities and tasks that correspond to performance criteria established in the DC Framework (see Fig. 1) stored in the CRISS platform. Teachers are responsible to assign tasks to their students based on CAS within their subjects and to plan their learning, to provide feedback and to evaluate activities and tasks. In such way, digital competence acquisition is horizontally integrated into curriculum across number of different subjects. The students are allowed to use any ICT tool they find appropriate to realize the task and generate and upload content (the evidences) into the CRISS platform as a result of a task that can be used to prove the acquisition of a specific competence.

The completion of a set of tasks within a CAS is automatically mapped by the CRISS platform to a completion of an accompanied performance criteria (PC) that leads towards the acquisition of a sub-competence. On the other hand, teachers are notified by the Intelligent Tutoring System in case a student is about to fail his/her tasks. The platform can suggest teacher to replace tasks if possible.

The CRISS platform is also designed to automatically generate a Certificate of completion if a student has acquired a complete DC, or a Certificate of progress in case student has acquired at least one sub-competence.

At the end of the pilot, in June 2019, once the participants will be using the CRISS platform for a reasonable number of months, the platform will be tested for usability and sustainability by employing and adapting the Expectation Confirmation Model originally developed by Bhattacherjee (2001). Besides taking into account the number of certificates issued, a series of qualitative and quantitative tests will be performed to measure the success of its implementation and to explain the impact of such approach on both, students and teachers, by adapting the well-known DeLone&McLean Model for assessing a successful implementation of an information system (DeLone and McLean, 2016).

6. DISCUSSION

From the research literature, we found that skills or competence assessment platforms are very rare and are mostly based on self-assessments. Furthermore, none of the platforms introduced digital competence to primary or secondary schools, nor they imply advanced learning technologies such as intelligent systems, digital badges or learning analytics.

However, a similarity between CRISS platform and other platforms for digital competence certification is evident. CRISS also follows the idea of a variety of self-assessments and teacher assessments as introduced in Kluzer (2015). Certification elements are similar to those on other platforms. The adaptation and scenarios' similarities can be found with AEEA software introduced by Florian-Gaviria et al (2013).

Despite similarities, there are also some differences that reflect the novelty of CRISS approach:

1. CRISS platform implements CRISS DC Framework developed for primary and secondary schools.
2. It follows the integration pedagogy concept as introduced by Roegiers (2010).
3. Process of digital competence assessment, evaluation and certification is fully integrated in the school's curriculum. It involves teachers, students and CRISS platform.
4. EPortfolio allows students to collect evidence and showcase their work and to become active learners.
5. Learning analytics is employed for comprehensive monitoring of students by their teachers, and also to give students a full insight into their current progress across 5 areas and 12 sub-competences.
6. Gamification elements are introduced with Open badges, so students are awarded with a badge for each sub-competence they achieve.
7. The CRISS platform introduces guidance concept by utilizing an Intelligent Tutoring System for both students and teachers. Both students and teachers receive alerts, notifications and suggestions from the system in respect to current students' progress and their learning path. That way students can be self-guided but also monitored and guided by their teachers.

7. CONCLUSION

This paper describes the original approach related to the modelling and implementation of a platform for guided acquisition, evaluation and certification of digital competence in primary and secondary schools. CRISS platform offers a new and innovative approach that covers the need of a complete model and ecosystem for the development, evaluation and accreditation of the digital competence (understood as a wider approach than just to evaluate digital skills as most of other existing models are providing).

It facilitates user-driven innovation by allowing teachers and students to become the core focus of the knowledge generation process. Moreover, teachers are able to create new assets to be used in the tools or to embrace novel approaches to utilize existing educational content and learning tools. At the same time, harnessing student's experience analytics enriches the entire process of deploying, analysing, learning, and adapting based on the actual student performance indicators, thus allowing them to co-create the next generations of educational approaches and learning frameworks.

In technological sense, the platform is modular which in return enables it to be flexible and scalable by adding modules as necessary to the CRISS Core. Its first part, CRISS core solution is composed of a set of services and new learning experiences in the context of digital competence and digital curriculum portfolio, that enable acquisition and evaluation of digital competence. CRISS Certification and Learning analytics is a support component to offer real-time assessment, analysis and tutoring based on a cutting-edge technology such as Big data and data analytics.

Given the pioneering nature of the proposed CRISS platform, it is necessary to perform additional research to confirm the efficiency of the proposed CRISS platform along with the underlying CRISS DC Framework and to identify needs and possibilities for its further improvements.

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- Modules 1, 3 and 4 - MyDocumenta (Spain)
- Module 2 - EXUS (United Kingdom, Greece)
- Module 5 - Education4Sight (Germany, Tunisia) and MyDocumenta (Spain)
- Modules 6 and 7 - Education4Sight (Germany, Tunisia).

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