Digital Competence Assessment System: Supporting Teachers With the CRISS Platform

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Abstract. *This paper presents the Digital Competence (DC) Assessment System for primary and secondary schools developed in the H2020 CRISS[1] project. A qualitative approach consisting of an integrative literature review, experts' and users' validation, and a proof of principle were used to develop the construct. The system implements a DC operational concept of five areas and 12 sub-competences with associated performance criteria and indicators. The system adopts the integrative pedagogy approach for implementation within the school curriculum. It proposes a process assessment based on a set of scenarios that use multiple methods for evidence collection and that implements rules ensuring validity and reliability.*

Keywords. CRISS, digital competence, assessment, integrative pedagogy.

1 Introduction

Digital Competence (DC) is one of the key competences any individual needs for personal fulfilment, active citizenship, social inclusion and employment in the 21st century (European Commission, 2006; Sargent, 2014). The European Commission has developed a digital competence framework (DigCom) for all citizens composed of 21 sub-competences, where the digital competence is defined as a "set of knowledge, skills, attitudes (thus including abilities, strategies, values and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socialising, consuming, and empowerment." (Ferrari, 2012. p.4).

Despite the numerous projects implementing DigCom in different contexts and for different purposes, the initiatives focusing on digital competence evaluation are rare or only tackle the problem partially. Different European programmes, either public or private, have focused on the evaluation and certification of citizens' and, in a few cases, students' digital competences. Most of them are summative-oriented and based on the evaluation of digital skills and knowledge using e-tests with different degrees of difficulty or complexity (e.g. IKANOS[2], PIX Beta[3]).

In recent years, governments have shown increasing interest in digital competence assessment and certification (e.g. ACTIC[4]). Nevertheless, most of these programmes are limited to a set of recommendations and they do not provide enough information on how to apply them in school curricula.

In this paper, we present a Digital Competence Evaluation System developed under the H2020 CRISS project (demonstration of a scalable and cost-effective cloud-based digital learning infrastructure through the certification of digital competences in primary and secondary schools). CRISS is a user-driven, flexible, scalable and cost-effective cloud-based digital learning ecosystem that allows the guided acquisition, evaluation and certification of digital competences in primary and secondary education, and is easily scalable to other educational levels. CRISS aims at developing an innovative adaptive learning solution supported by the most advanced pedagogical methodologies and technologies that will be tested with a pilot involving more than 490 schools including 25,400 students and 2,290 teachers across Europe. CRISS will provide a unique certification system with the aim of

[1] CRISS is a project financed by European Commission, Horizon 2020 (ID:732489, 2017-2019). http://www.crissh2020.eu/

[2] IKANOS is a project on digital competences developed by the Basque Government (Spain). http://www.innova.euskadi.eus/informacion/what-is-ikanos/v62-ikanosi/en/

[3] PIX is a public project for the evaluation and certification of digital competences in France. https://pix.beta.gouv.fr/projet

[4] ACTIC is the accreditation system for digital competences in Catalonia (Spain) http://actic.gencat.cat/ca/

contributing to the standardization of digital competences at the European level.

The CRISS Assessment System was developed in coordination with the deployment of a Digital Competence Operational Concept -DCOC (Guitert, Romeu, Baztán, *2017*) addressed to primary and secondary schools. The DCOC is the result of an analysis and mapping of seven European digital competence frameworks and schemes already in use with the DigCom. The DCOC consists of five areas (digital citizenship, communication and collaboration, searching for and managing information, digital content creation, digital problem solving) that group 12 sub-competences and corresponding performance criteria and indicators. The DCOC provides a comprehensive structure that facilitates DC development through the implementation of learning and assessment activities.

We present below the foundations and methodology leading to the development of a theoretical construct and the basis for a system supporting digital competence assessment and certification.

2 Theoretical Background

Competence assessment goes beyond the traditional evaluation of knowledge, as it also focuses on skills and attitudes. Competence assessment is defined by Pepper (2013) as "*a process of making inferences about individual knowledge, skills, attitudes using information collected through tests, observation, interviews, projects or portfolios usually in regards to predefined criteria*" (p. 1).

The specialized literature identifies three main types of assessment: diagnostic, formative and summative. Competence assessment for **diagnostic** purposes focuses on the evaluation of the background and the student's current level of competence acquisition. It allows learning needs to be identified. **Formative** assessment, according to Taras (2005), focuses on "*feedback which indicates the existence of a 'gap' between the actual level of the work being assessed and the required standard. It also requires an indication on how the work can be improved in order to reach the required standard*" (p. 468). Sargent (2014) points out that feedback is indissociable to competence assessment. The purpose of the feedback is to inform and guide the student in what they must do to improve the competence. Feedback must be timely and include specific suggestions on how to improve future performance. According to the definition provided by the report *Task Group on Assessment and Testing* (1988), formative assessment involves a student's positive achievements that may be recognized and discussed and the appropriate next steps that may be planned. Finally, **summative** assessment is based on recording the student's overall achievement at the end of a learning cycle leading to a score or mark. In some cases, summative assessment is the result of an aggregation of formative assessments. Summative assessment may also lead to certification.

Competence assessment should respect three basic principles: validity, reliability and equity (Pepper, 2013). **Validity** deals with the extent to which an assessment tool measures what it was designed to measure (Pepper, 2013; Wiliam & Black, 1996). **Reliability** is related with the extent to which an assessment tool consistently and accurately measures learning (Harlen, 2005). In this sense, case studies, professional tests and integration situations in general are mostly recommended. **Equity** relates to the social nature of assessment and highlights the need to consider differences which are not the focus of the assessment but which could influence the assessment (Pepper, 2007 & 2013).

Competence assessment is growing in different European educational systems as the new paradigm in contrast with the knowledge assessment approach. Digital competence has attracted special interest for its relevance to all aspects of personal and professional life. Digital competence, in terms of its generic nature, can be understood within the 21st century skills framework (Pepper, 2013; http://www.p21.org). A thorough and systematic review of 21st century skills research provided a set of recommendations for competence assessment (Lai & Viering, 2012):

- Assessment systems should provide multiple measures that support the triangulation of inferences.
- Assessment tasks should be of sufficient complexity and/or offer sufficient challenge.
- Assessments should include open-ended tasks.
- Assessments should use tasks that establish meaningful and/or authentic, real-world problem contexts.
- Assessment tasks should strive to make student reasoning and thinking visible.
- Assessments should explore innovative approaches to address scalability concerns.

According to these recommendations, competence assessment requires advanced assessment solutions based on robust pedagogies and complex situations that provide authentic problem contexts giving sense and meaning to students. Roegiers (2010) introduced "**integration pedagogy**" 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 goal of integration is to enable students to master situations that they will have to deal with in their lives and the most relevant learning methods associated with this approach are: project-based learning, problem-based learning, work-based learning, inquiry-based learning, case-based learning, game-based learning, etc.

Rather than only testing students' digital knowledge and skills, a model based on integration pedagogy allows teachers to assess students' digital competences as embedded in disciplinary or interdisciplinary problem situations. This approach confronts the student with meaningful situations and demands the mobilization of a set of competences in order to solve the problem or achieve the expected learning outcomes. In this sense, "integration pedagogy" involves developing integration activities that require a higher level of sophistication or complexity than typical standard tests on digital skills or knowledge. At the same time, integration activities are those that allow different competences and subjects to be assessed in the same learning scenario.

With integration pedagogy, CRISS adopts a **learner-centred** approach that puts the learner at the heart of the learning process. Integration pedagogy makes the learning more meaningful, relevant and engaging by contextualizing it within practical situations and daily life (Peyser, François-Marie & Roegiers, 2006). Learner-centred pedagogies are gaining importance whenever the goal of education shifts from memorizing facts to building competences, taking on responsibility, working effectively in teams or promoting creativity (Motschnig, et al., 2016).

3 Methodology

The first phase in the development of the CRISS Assessment System is based on a qualitative approach to define an initial theoretical construct, which is the focus of this paper. The empirical validation of the assessment system (second phase) will be conducted during the pilot tests due to take place in schools in eight European countries.

At this first stage, the development of the assessment system consists of three consecutive methods: an integrative literature review, an expert and teachers' validation, and a proof of principle.

We started with an **integrative literature review** approach as "*a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated*" (Torraco, 2005: p.356). The aim was to provide an overview and our understanding of digital competence assessment, identify assessment requirements, benchmark existing solutions and elaborate a first construct. This construct should align with the CRISS DC Operational Concept, provide a general assessment approach anchored in school curriculum, and inform the development of the CRISS platform. Firstly, we defined keywords that helped to select relevant literature from the research perspective but also from grey literature and other authoritative sources (e.g. existing related past projects, proposed solutions, tools, etc.). The Mendeley reference management system was used to store and share files and annotations. Salient topics were identified and grouped into categories organized in tables of key concepts and summaries. All the information was mapped in order to support the conceptualization and development of the competence assessment system for the CRISS project.

After creating a first stable assessment theoretical construct, underpinned by theories and other theoretical frameworks and previous empirical research models, we proceeded to an experts' validation by the other academic partners involved in the project annotation and structured feedback. We also conducted a first **teachers' validation** through a discussion with the schools participating in the project. Their comments and suggestions were integrated into an improved construct.

The validation process was completed using a **proof of principle** approach designed to test the construct applicability to actual situations. We used real learning and assessment activities facilitated by schools involved in the project. We employed two project-based learning examples and adapted them to Competence Assessment Scenarios (CAS). This exercise of transposition showed the compatibility of the construct in terms of concept correspondences and structure coherence with the chosen examples. In addition, this proof of principle showed the power of the construct in supporting the refinement of the assessment strategy of the learning examples used.

4 Results: Digital Competence Assessment Framework

The **CRISS Operational Concept** proposes **five areas** that group **12 sub-competences**. Each sub-competence is composed of a set of **performance criteria** (PC) (between two and four) which translate the competences into more concrete elements of what students should be able to demonstrate. Each performance criterion is assessed according to set of **indicators**. These indicators are observable characteristics of the PC and consist of predefined measures or other types of qualitative information which learner evidence will be measured against or evaluated with.

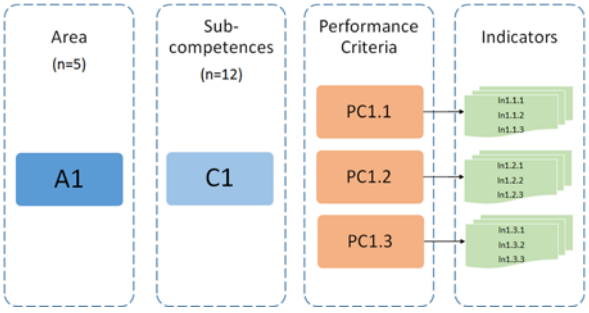

Figure 1. Hierarchical structure of CRISS Digital Competence Assessment System

In order to ensure the validity, reliability and equity of the assessment process, CRISS proposes:

a) Presenting the student with different competence assessment opportunities.

Roegiers (2005) points out the need to ensure fairness and validity in competence assessment. The author proposes using De Ketele's (1996) empirically tested rule that requires providing the learner with multiple opportunities to perform and verify the competences. In CRISS we have established that a DC sub-competence is considered attained when all performance criteria have been successfully fulfilled. The rule of "2/3" applies and gives the student three occasions to verify each performance criteria. Roegiers (2007) also highlights that not all the items assessed may have the same importance for the competence assessment. In order to avoid this possible drawback, the CRISS competence assessment approach gives different weights to PC and indicators according to their relevance.

b) The development of **Competence Assessment Scenarios** (CAS) where digital competences are assessed in context.

CRISS assessment is based on assessing competences through different CAS. These CAS can be implemented at different moments and their duration may vary.

CAS integrate one or more subjects or disciplines in the school curriculum. They are designed on the basis of advanced instructional approaches where the learner or learners are required to solve problems, develop projects or search for solutions in realistic contexts and meaningful situations. Instructional approaches are macro-strategies that "*set a general direction or trajectory for the instruction and are comprised of more precise or detailed components*" (Reigeluth & Keller, 2009, p.31). This pedagogical macro level (e.g. problem-, project-, case-, inquiry-based learning) articulates a set of activities and tasks where competences are performed and assessed.

CAS provide opportunities to develop and assess targeted competences including some or all the corresponding performance criteria. Each performance criterion is assessed using a set of indicators which are assigned different weights according to their relevance. It is crucial to identify/specify the indicators that will provide measurements or the conditions required to interpret the evidence in terms of performance criteria and competence attainment. CAS also adopt/adapt an assessment strategy composed of assessment methods and instruments to ensure the appropriate evidence is gathered in order to assess the competence.

The following figure presents a diagram of a CAS structure and its main components. The CAS proposes a set of activities and tasks that allow one or more performance criteria to be assessed. Each PC is also identified with a numbered event highlighting the specific occasion when it is worked on and assessed.

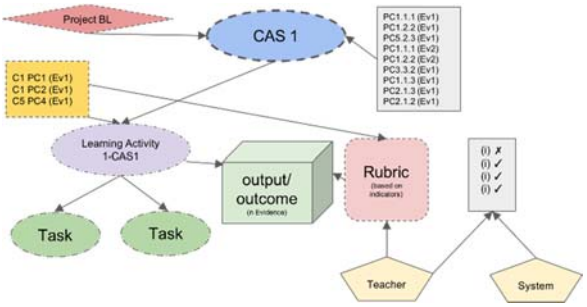

Figure 2. Example of CAS and Learning Activity with tasks and basic assessment with rubric

While the DC Operational Concept and the Assessment System provide a standardized way of understanding the digital competence and defining a generic assessment methodology, the development of CAS remains a highly customizable endeavour. Teachers may design different CAS, precise assessment indicators, and select specific assessment methods and instruments according to their curriculum or other contextual and cultural aspects.

4.1 Assessment methods

A precise assessment of students' competence achievement calls for different assessment methods to be used (Looney, 2011). A wide variety of available assessment methods and instruments (e-portfolios, multiple-choice questions, blogs, free text responses and essays, rubrics, scales, observation grids, etc.) assist in the collection of evidence for assessment. Both the CAS assessment methods and instruments must provide evidence consistent with the predefined indicators.

Redecker and Johannessen (2013) mention that students should be continuously tracked and guided within digital environments, merging formative and summative assessment within the learning process. The CRISS platform is designed to track students while they work on their assigned activities and collect relevant information. At the same time, teachers can/should inform the system by adding relevant information on their students' competence development by using rubrics or other data gathering instruments integrated into the CRISS platform. The CRISS platform will provide an adaptive and intelligent system that helps to link learning evidence to automatic monitoring, advising and assessment. An e-portfolio-like solution forms the basis of this implementation.

4.2 Certification

Each sub-competence has an associated badge reflecting its achievement. The badge is linked to

specific descriptive reports extracted from the e-portfolio. Applying the 2/3 rule, the final assessment for certification takes into account the two best results out of three. Thus, sub-competence assessment is equal to the mean of the best two attempts. The attainment of a sub-competence is established when the mean is equal to or greater than 70%. The **collection of badges** is a requirement for the final certification.

5 Conclusions

The Digital Competence Operational Concept consisting of five areas, 12 sub-competences and associated related performance criteria, together with a set of initial indicators provide a robust standard from which to evaluate the digital competence. The development of the CRISS Digital Competence Assessment System construct builds on the operational concept and stands on best practices and research-informed recommendations for generic competence assessment. The proposed solution is flexible enough to integrate digital competence development and assessment into different disciplines or subject matters, thus adapting to different curricula and organizational structures. It uses Competence Assessment Scenarios that help to contextualize and anchor the assessment in realistic and meaningful situations. The construct provides multiple opportunities to perform and verify the competences, and relies on multiple methods and instruments for gathering evidence to support the assessment and certification process.

Although the assessment system proposed by the CRISS project aims to evaluate and certify digital competence, the approach may be also applied to other type of competences. Its scalability and flexibility is one of the strengths of the system and makes the solution unique and innovative.

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