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An Analytical Study of Digital Competency Assessment Tools for Higher Education Teachers

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Abstract. The aim of this paper is to compare digital competence assessment tools for teachers in higher education. The study answers four questions:(1) What are the types of digital competency assessment tools for teachers? (2) On which frameworks are these tools designed and how do the frameworks differ? (3) What methods are used to promise the reliability and validity of the tools? (4) How can the data collected by these tools be analysed and used? In this study, the systematic review method was used to conduct a subject search for "digital competence assesement tool", and a literature search was conducted in three databases: Web of science, SpringerLink and Google Scholar. The time frame of the search was set from 1 January 2019 to 1 March 2023, with an initial search result of 1648 articles, for which different search criteria were used, resulting in three articles exploring four tools. These tools take the form of questionnaires with items that are primarily self-assessment statements and closed-ended questions. These assessment tools are used to understand the teachers digital technology and to assess their digital competence. The main proposal of this paper is a typology of digital competence assessment tools.

Keywords: Higher education teachers;Teacher digital competence;Assessment tools.

1. Introduction

The explosion of the digital age, characterised by technological integration, will redefine the standard of digital talent for the 21st century.In 2006, the European Union formulated the "Core Lifelong Learning Competencies: A European Reference Framework" (European Commission, 2006) for all people, defining this concept as "the ability to use ICT confidently, critically and innovatively in work, employment, learning, leisure and social participation and listing it as one of the eight core competencies". as one of the eight core competencies. This shows that digital competencies have become an important criterion for international evaluation of talents. Countries around the world have also realized that to cultivate digital talents with the ability to survive and competitiveness in the digital era, it is necessary to cultivate educators with digital competence in the first place. 2022 On November 30th, China's Ministry of Education formulated the "Teacher Digital Competence" standard in order to enhance the awareness, ability and responsibility of teachers to use digital technology to optimize, innovate and change education and teaching activities[1]. Teachers' digital competence has become an inevitable requirement for teachers' education and teaching in the context of digital transformation of education.

At the same time, Foreign scholars Koehler believe that it is not enough just to provide a framework, the framework must be tested in the real world, and through the development of assessment tools, it is possible to both benchmark all levels of dimensions in the framework as well as measure and provide data to support. [2] Many European countries have developed online tools to assess teachers' digital competence based on the frameworks they have developed, such as the EU DigCompEdu Check-In, which was recently updated to SELFIE for Teachers; and DigCompEduSAT; The Observatory for In-Service Teachers, developed by the Catalan government, among others.

Clearly, there is a need to comparatively analyse digital competency assessment tools from relevant foreign frameworks to contribute to the improvement of assessment. A systematic review of these assessment tools was conducted to answer the following questions:

(1) What are the types of digital competency assessment tools for teachers?

(2) On which frameworks are these tools designed and how do the frameworks differ?

(3) What methods are used to promise the reliability and validity of the tools?

(4) How can the data collected by these tools be analysed and used?

2. Literatura review

2.1 Teachers' digital competence

Currently, there is no unified definition of the concept of teacher digital competence. Foreign scholars Tourón et al. define teacher digital competence as a set of knowledge and skills that teachers possess in applying information and communication technology (ICT) as a teaching method and a teaching resource in the educational process. [3] Mandinach believes that teacher digital competence is not only a definition of teachers' ability to utilize data, but also includes the guidance of students' way of thinking, and is a combination of teachers' data access, data utilization, data manipulation, data critique, and data ethics. [4] In summary, teacher digital competencies are a set of knowledge, skills and attitudes that teachers should possess and be able to use safely, effectively and ethically in diverse digital environments. The basis for building a framework for teachers' digital competence is to define what it means to be digitally competent as a teacher.

2.2 Teacher Digital Competency Framework Discussion

Developing teachers' digital competence stems from the requirements of the digital age for the training of digital talents. To promote the construction of education informatization, Many countries or organizations around the world have published teacher-focused Digital Competency Frameworks. The European Union released the "Digital Competency Framework for Educators in the European Union" (DigCompEdu) in 2017, which consists of six competency domains, namely, professional development, digital resources, teaching and learning, assessment, empowerment of learners, and promotion of learners' digital competence. development, digital resources, teaching and learning, assessment, empowering learners, and promoting learners' digital competence.[5] It also sets standards for levels of teacher digital competence based on Bloom's Taxonomy, which is divided into six levels: A1 (Beginner), A2 (Explorer), B1 (Integration), B2 (Expert), C1 (Leader), and C2 (Envelope); and Spain's Common Digital Competency Framework for Teachers (CDCFT) addresses teachers' information and data literacy, communication and collaboration, digital content creation security, and problem solving, with three tiers in each area: basic, intermediate, and advanced; and Norway's Professional Digital Competency Framework for Teachers, constructed based on its national legislation, guidelines for teacher education programmes, and national curriculum and qualifications framework, focuses on seven main areas: subject matter and basic skills, schools in society, ethics, pedagogy and subject matter teaching, leadership in learning, interaction and communication, and change and Development in seven areas and specifies teacher digital competencies in terms of knowledge, skills and competencies.

3. Research design

3.1 Research Methodology and Process

This study was implemented based on a systematic review and meta-analysis Transparent Reporting (PRISMA), which attempted to sort out all the series of studies that met the previous inclusion criteria were designed to answer specific research questions.

Based on this methodology, the screening and analysis of assessment tools related to digital competence of university teachers from 2019 to 2023 was carried out in the following process: (1) specifying the literature search terms according to the research objectives; (2) conducting literature search in databases based on the search terms; (3) developing the inclusion criteria based on the research questions and completing the initial screening by effectively evaluating all of the literature searched; (4) conducting a primary screening of the literature, select accessible/descriptive assessment tools, and synthesize the final results.

3.2 Data sources

In this study, the topic search was conducted with "digital competence assessment tool", and the literature search was carried out in three databases, namely, Web of science, SpringerLink, and Google Scholar, and the search time range was set as 1 January 2019 to 1 March 2023, and the preliminary search results were 1,648 articles. The search time range was set as 1 January 2019 to 1 March 2023, and the initial search result was 1648 articles, and the following criteria were used to screen the literature screening process in this study.

1) Only English-language articles published in journals available in full text were included;

2) Excluding reported and duplicated articles;

3) Include only articles where the research topic was digital competence and assessment tools for teachers;

The initial screening articles that met the inclusion criteria were read in full, and the final sample literature obtained was 3 articles. These 3 literatures dealt with 4 assessment tools that were accessible or describable, and these 4 assessment tools became the main research object of this paper, as shown in Table 1. Based on the research questions, this study compares the assessment types, framework comparison, assessment methods, and data collection methods of the four assessment tools, COMDID-A, COMDID-C, DIGIGLO, and Digcompedu-checkin.

Table 1. Research literature and tools

Author	Study	Assessment tools
José Luis Lázaro Cantabrana1	Assessing Teacher Digital Competence: the Construction of an Instrument for Measuring the Knowledge of Pre-Service Teachers[6]	COMDID-A COMDID-C
Rafael Alarcón	Development and validation of the DIGIGLO, a tool for assessing the digital competence of educators[7]	DIGIGLO
Suadad Muammar1	Evaluation of digital competence level among educators in UAE Higher Education Institutions using Digital Competence of Educators (DigComEdu) framework[8]	DigCompEdu-checkin

4. Analysis and discussion

4.1 Types of Assessments for the Teacher Digital Competency Tool

Teachers' digital competence assessment tools can be differentiated into self-assessment, knowledge-test-based assessment and performance-based assessment [9]. Self-assessment is the way in which the assessor himself/herself conducts internal self-testing as an assessment agent [10], which, by being self-directed, enables the assessor to actively participate, autonomously evaluate, reflect on himself/herself, and determine whether the desired goals have been achieved [11]. Self-assessment in this study refers to teachers' assessment of their own knowledge, skills and attitudes related to Information and Communication Technology (ICT) in the digital environment. The tools such as COMDID-A, DIGIGLO, and DigCompEdu-checkin are all types of self-assessment; the assessment based on the knowledge test mainly measures procedural knowledge, which is selected based on the real needs of the teachers and the training requirements.

Teachers are tested on their knowledge and skills about digital competence after a period of training, and the test can clearly reflect which aspects of teachers' strengths and weaknesses, as well as the extent to which the objectives of the training programme match the dimensions of the digital competence framework. The knowledge-based test can not only directly reflect the training effect, but also give teachers the opportunity to intuitively understand their own digital competency level, and through analysing the content of the test, they can grasp the important and difficult points of the training course and strengthen the consolidation and enhancement of this aspect. It can thus be seen that assessment based on knowledge tests is, to some extent, an effective form of assessment, and the COMDID-C assessment tool in the study by José Luis Lázaro Cantabrana1 belongs to this type of assessment, which was constructed as a criterion-referenced test (CRT) for the purpose of accurately measuring the standard of knowledge of the assessed person, and required teachers to participate in a variety of activities oriented towards the enhancement of teachers' digital competencies, which were assessed upon completion; performance-based assessment refers to the process of identifying, observing, measuring, and developing the performance of people in an organisation. Performance-based assessment in this study refers to the process of observing teachers solving digital teaching and learning problems when they are faced with a real professional scenario, such as using software such as browser, word, excel, ppt, smart classroom, and Teaching Cloud Platform in the educational process. None of the four assessment tools is a type of performance-based assessment.

4.2 Framework basis for a digital competency assessment tool for teachers

In this study, two instruments are based on COMDID and the other two are based on DigCompEdu. In most of the tools，the statements/questions are directly related to the description of the framework and competencies. the descriptions of the questions of the COMDID-A, COMDID-C self-assessment instruments and the test instruments developed by José Luis Lázaro Cantabrana1 et al. Corresponding to the dimensions of the COMDID framework and their descriptions, the final level of the respondents' competence assessment corresponds to the three competence levels included in the framework. Whereas the question design of the DIGIGLO and DigCompEdu-checkin tools is based on the 22 competencies organised in the six domains of the EU Digital Competence Framework for Educators, in addition, the DIGIGLO tool adds two external factors related to the digital competencies of teachers in addition to the digital competencies. In-depth analyses of each level of these frameworks reveals that there is also a close relationship between the dimensions of competence at each level. This is shown in the table below.

Table 2. Framework Comparison

COMDID	DigCompEdu
D1. Didactic, curricular and methodological aspects	A3. Digital pedagogy A4. Evaluation and feedback A5. Students’ empowerment A6. Facilitate students’ digital competence
D2. Planning, organization and management of digital technological resources and spaces	A2. Digital resources
D3. Relational aspects, ethics and security	A1. Professional commitment A5. Students’ Empowerment A6. Facilitate students’ digital competence
D4. Personal and professional aspects	A1. Professional commitment

Of the 22 competence descriptors in COMDID, five are not recognized in DigCompEdu, which are about pedagogical methodologies, teaching and learning environments, management of the digital technology space in schools, participation in items involving digital technology, and

individual learning environments. In addition, COMDID does not contain a description of reflective practice, as found in DigCompEdu.

4.3 Validity and reliability of assessment tools

José Luis Lázaro Cantabrana1 identified the cut-off points and conducted a preliminary pilot study to lay the groundwork to ensure the external validation of the COMDID-C tool. The tool is designed to be tested in two parallel formats, with the "Test A" format having a true or false answer (0 or 1 point), and the "Test B" format having an answer divided into five options from 0 to 1 (0, 0.25, 0.5, 0.75 and 1 point). Both forms of the test were designed based on the self-assessment questionnaire COMDID-A (REFS), which has been validated. And it has been validated with kappa values showing that these two tests are parallel, in other words, we can implement one of them without discrimination.

Rafael Alarcón calculated linear Pearson correlations between each item corresponding to each of the eight domains. We conducted a validated factor analysis (CFA) using structural equation modelling to verify the internal structure of DIGIGLO. The psychometrics of DIGIGLO were also tested by item analysis and calculation of Cronbach's alpha coefficient, with values greater than .70 considered acceptable. For item analyses, corrected item factor correlation coefficients were calculated and values above .30 were considered satisfactory. Structural validity analyses were conducted using EQS 6.3. Relevance, reliability and item analyses were also carried out using IBM SPSS 24.

The DigCompEdu-checkin mentioned by Suadad Muammar1 was designed and validated with the participation of experts invited by the European Union, so the assessment tool is valid and reliable.

4.4 Data analysis of assessment tools

These four assessment tools use different methods of analysis and have produced different findings. COMDID-C was tested at the end of the training and a threshold value was established to measure the proficiency of teachers, in other words, exceeding this threshold is certified as a pass, and the identification of this threshold is addressed using the Angoff method. Assessors base their judgements on a group of teachers with lower numerical teacher competence. For each question on the test, the assessor produces a final value or minimum score based on the teacher's responses.COMDID-C aims to provide reliable data for measuring the development of digital literacy and digital competence gained by teachers, as well as to enable teachers to receive immediate feedback and advice on how to improve their skills through the use of technology.DIGIGLO is a questionnaire designed to assess the digital competence of teachers. DIGIGLO is a questionnaire designed to assess teachers' digital competence. It consists of 29 items, each rated on a 6-point Likert-type scale across eight domains of digital competence. The first six domains correspond to those described in the DigCompEdu framework, with higher overall scores (ranging from 29 to 174) indicating higher levels of digital competence among educators. The overall score reflects progress in the six stages of the DigCompEdu framework (from A1 to C2).The DigCompEdu-checkin was designed and validated with the participation of experts invited by the European Union and also corresponds to the six phase of the DigCompEdu framework.

5. Summary

The focus of this article is to present the types of digital competency assessment tools, The following types of questions are included: self-assessment, knowledge test, and performance assessment. The shortcoming of this paper is that only four of the tools were included, therefore, a suggestion for future research would be to reapply the analytical methods used in this paper to the other tools for comparative analyses. Additionally, four of the tools were only applicable to a small sample of respondents, which may have affected the analysis of the data from these tools. Future

study could analyze the impact of sample capacity on data analysis and results, thus providing better information to study these issues.

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