Competence Model Proposal for Mobility in Education as a Service

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Abstract. Education is based on the development of competences, providing students with formal and structured learning. Students nowadays search for mobility programmes, and the achievement of competences is key for profitable stays. Learning objectives leads to structured education, and has the potential to address the complexity of higher education in mobility programmes. Education Mobility as a Service (EMaaS) is a wide range of resources to make it easier learning management. Some of these resources include learning management systems, exchange programme databases, assessment and feedback tools... Competence models assist students' learning paths and act as instruments for gauging their success in achieving learning objectives. In light of these goals, a competence model is suggested based on the Skills Framework for the Information Age (SFIA) and the Technological Pedagogical Content Knowledge (TPACK) model, along with the harmonisation of competence standards IEEE 1484.20.1 and CWA 16655-1. The HFramework approach was used for the standard harmonisation, enabling analysis of both standards and the choice of attributes for defining competences. The proposed competence model was validated in a workshop of the eMediator research project, where it was briefly described with examples and evaluated by participants through a survey. Overall, the model received a positive perception and was deemed useful. Additionally, survey results highlighted participants' willingness to use it in a test scenario.

Keywords: Competences model, Harmonisation, Knowledge, Skills, e-Learning.

1 Introduction

Mobility in education allows students to acquire competences that are useful for navigating in a globalized world (Lei, Wong and Knowles, 2023). The importance that mobility in studies has received is unprecedented and is associated with excellence due to its disruptive and innovative approach (Mu *et al.*, 2022).

Student exchange is on the rise over the years. According to a study conducted by UNESCO, in 2019, up to 6 million students were studying abroad, representing a 5.5%

increase compared to the previous year and a 66% increase compared to the year 2000[1]. Among all exchange programmes, the European Union's Erasmus+ programme hosts the highest number of students, with over 10 million students selected in its programmes since its establishment in 1987 (Ferreira-Pereira and Mourato Pinto, 2021). China is the country that sends the highest number of students abroad, followed by India and South Korea (Barnett *et al.*, 2016). The countries that receive the highest number of mobile students are the United States, the United Kingdom, Australia, Canada, and Germany (Qayyum and Zawacki-Richter, 2019).

Mobility has brought significant benefits in terms of cultural exchange and diversity. Thanks to it, students interact with individuals from other cultures, enhancing their intercultural competences and developing a more global mind-set. The academic and professional development of students is aided by all of this. Indeed, it has been found that students who have taken part in mobility programmes do better academically, have developed their interpersonal skills, and have a higher chance of landing an international employment (Nada and Legutko, 2022). Governments have supported these programmes to create equitable opportunity and eliminate economic barriers because of this (Rizvi, 2023).

The phrase "Education Mobility as a Service" (EMaaS) becomes relevant in this context. By giving students flexible and individualised learning options, EMaaS hopes to overcome the geographic limitations of conventional schooling. It focuses on how technology and digital services might be used to encourage student mobility

A competence model for utilising the potential provided by EMaaS is presented in this paper. The Technological Pedagogical Content Knowledge (TPACK) model (available at tpack.org), the Skills Framework for the Information Age (SFIA), and the harmonisation of the standards IEEE 1484.20.1 and CWA 16655-1 were the sources on which this competence model was built (IEEE, 2008; European Committee for Standardization, 2013; Frezza *et al.*, 2018).

The structure of the paper is as follows. The competence sources and the building method used to create the model are described in the Materials and Methods section. The model validation procedure is described in the Results section, along with the methodology employed and the validation's outcomes. A quick examination of the findings from the validation of the competence model is provided in the Discussion section. Finally, several facets of the model are described in the Conclusions section.

2 Materials and Methods

Competences are sets of skills and knowledge that students need to perform a task in a particular area or situation. Competences are measurable, essential for an individual's development, and enable them to show an identifiable level of expertise in a certain context. In order to solve problems and adapt to changing circumstances, they require

[1] https://www.iesalc.unesco.org/en/2022/02/25/future-of-international-mobility-will-combine-physical-and-digital-experiences-to-reach-a-wider-range-of-students/

not only having knowledge of facts and information but also using it in practical contexts. Competences can be obtained through formal education, self-directed learning, involvement in projects or activities, social interaction, etc.

- **Skills Framework for the Information Age (SFIA)**

Literature offers a variety of sources on competences. Information and communication technology (ICT) capabilities are described in the Skills Framework for the Information Age (SFIA). Its application in the sector for talent management and competence development is extensive. It is organised into a hierarchical framework with a total of seven levels, according to the level of specialty. Each level is further broken down into several competence categories with more specific competence components. Project management, software development, infrastructure and communication, analysis and design, and information security are just a few of the ICT topics covered by the SFIA model. Notably, this strategy emphasises competences rather than technology. This makes it possible to use competences in a variety of contexts, including the educational sector. The model is also frequently changed to reflect changes in the market and technological advancements.

- **Technological Pedagogical Content Knowledge (TPACK)**

A theoretical framework for comprehending the knowledge that instructors need to successfully incorporate technology into education is provided by the Technological Pedagogical Content Knowledge (TPACK) model. It is currently one of the most significant models in the fields of technology and education. Technical knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) are its three interconnected dimensions.

Understanding and utilising technologies and instruments for education are both included in technological knowledge (TK). It comprises expertise in hardware and software as well as the abilities to use them. Learning principles and techniques are studied as part of pedagogical knowledge (PK). It has to do with the capacity to modify instruction to meet the needs and characteristics of students. The last component, Content Knowledge (CK), focuses on the particular subject matter to be taught. It necessitates a command of the concepts that must be explained.

- **IEEE 1484.20.1**

There are two key standards that stand out when it comes to the defining of competences: IEEE 1484.20.1 and CWA 16655-1.

The main goal of the IEEE 1484.20.1 standard is to establish a uniform framework for the documentation and preservation of competences related to learning and professional development. The standard suggests a data structure that groups fundamental characteristics like title, prerequisites, description, competence level, etc. For this, it makes use of a hierarchical structure. The basic competences, which are typically more general, are found at the highest level. The competences are separated into more specialised categories below that. This structure enables the model to be flexible and scalable, enabling adaption to different environments based on their complexity.

In IEEE 1484.20.1, a data model is introduced that makes it possible to describe competences in an organised and descriptive way, making it simpler to reference and share competences. Every competence must adhere to the standard's Reusable Compe-

tence Definition (RCD), which is a fundamental framework. These two data components must be present in this structure at a minimum: (1) Identifier, to locate a defined competence clearly. (2) Titles that should briefly describe the competence, using a limited number of words. The IEEE 1484.20.1 standard also suggests the following extra fields in addition to these required ones: (1) Description, which is longer than the title and offers specifics about the competence. (2) Definition, which should use a structured approach to describing the competence and offer more flexibility and structure than just utilising the identifier, title, and description. The keywords, states, circumstances, competence classification criteria, and other rules from external standards can all be indicated in this area as additional external models for competence definition. (3) Metadata that round out the competence definition.

- **CWA 16655-1**

A framework and methodology for evaluating competences in digital contexts are provided by the CWA 16655-1 standard. Its primary goal is to offer methods for assessing competences in a digital environment. It outlines a structured method for evaluating competences and lists the competences necessary for assessment and subsequent certification. This method is evidence-based, which means that the evaluation of competences emphasizes palpable and obvious signs of performance in tasks, projects, practice, certificates, and other ways that show mastery of the subject.

This standard proposes a model with similar characteristics to the IEEE 1484.20.1 standard. The standard defines two main elements: (1) The model includes a basic and individual unit for specifying a competence, referred to as a LOC (Learning Outcome and/or Competences). (2) A structure with multiple LOCs, called LOCStructure. This artifact contains several LOCs with associations between them. The associations between competences within the same structure can be hierarchical. The attributes that constitute a LOC object are as follows: (1) Identifier, which allows access and reuse of competences. Each LOC must have a unique and global identifier. (2) Title or Name, which should be meaningful and representative of the competence. (3) Level and Credit, providing information about the progress of competence acquisition and allowing for comparison with the level of learning required to achieve the competence. (4) Topics, this attribute allows for categorising a competence by thematic areas, defining its context and domain. (5) Metadata, competences can have metadata associated with them to provide more precise definition.

- **HFramework**

It is a framework for the harmonisation of multiple models and standards. It provides a precise methodology that allows dealing with the complexity of harmonising diverse sources. It establishes three layers: conceptual, methodological, and technological. In the conceptual framework, information is adapted to the context by proposing a set of two ontologies that enable the representation of contextualized knowledge for the entire harmonisation process. Additionally, the framework defines systematic guidelines that give rise to the harmonisation strategy. Lastly, HFramework offers a software solution to assist in the harmonisation process by monitoring, controlling, and verifying the process at all times (Calvache *et al.*, 2009; Pardo *et al.*, 2012).

Based on this methodology, a total of four steps were defined to harmonise the competence standards IEEE 1484.20.1 and CWA 16655-1. These steps are as follows: (1)

formalisation, which involves defining ontologies to represent the contextualised knowledge throughout the harmonisation process; (2) homogenisation, where structural differences between the competence standards are resolved; (3) comparison, which considers three possible scenarios: (3.1) the standards have common elements, such as the competence identifier, title, and description; (3.2) the standards have a set of similar elements that, although not defined identically, serve the same purpose; (3.3) the standards have a set of non-common elements, such as the definition and modelling of metadata associated with the specific competence; and the final step, (4) integration, which resolves any discrepancies that may arise in the previous comparison phase.

3 Results

The creation of the competence model based on the SFIA and TPACK models and the harmonisation of the IEEE 1484.20.1 and CWA 16655-1 standards is described below.

- **Formalisation**

The HFramework methodology defines the PrMO ontology to harmonise the standards based on a core concept, which is the concept of process. First, it was verified whether this ontology could be used to prepare the subsequent harmonisation step. The IEEE 1484.20.1 and CWA 16655-1 standards are not defined by dividing standards or specifications into different processes. In these standards, there is a format for specifying competences, and XML Schema technology is used for this purpose. Each section of the standard defines each section in the mentioned format. Since both standards use this technology, it was observed that it was not necessary to adapt the PrMO ontology, and code snippets from both standards were directly used. Thus, the formalisation phase was simplified.

- **Homogenisation**

In this phase, the structural differences of the standards were analyzed. In general, each standard follows its own structure for specification. In some cases, the standards can be structurally very different or, on the contrary, very similar, simplifying the harmonisation work. In the case of the IEEE 1484.20.1 and CWA 16655-1 standards, both have a similar structure, with the exception of some particularities for specifying natural language models. In the chosen standards, although they specify competence models differently in natural language, both use XML Schema. Since both standards are based on the same technology for defining attributes (i.e., for the definition of a competence), it can be concluded that this phase is not necessary.

- **Comparison**

The next phase of harmonisation was based on comparing the XML Schemas to resolve potential conflicts. In this stage, the following possible cases were taken into account: (1) there are common elements in both standards. Examples include the identifier, title, and description. (2) There is a set of similar elements that are not defined exactly the same but serve the same purpose. For example, the attribute "Definition" was found. Both standards mention it to formally define the competence but do not specify what information should be included in this attribute. (3) There is a set of non-common elements. The definition and modeling of competence metadata defined in

each standard may differ. Generally speaking, the CWA 16655-1 standard is more restrictive in terms of format compared to IEEE 1484.20.1.

- **Integration**

The following phase of harmonisation was based on comparing the XML Schemas to resolve potential conflicts. The decisions made to harmonise the standards are described below:

1) The definition of the identifier, title, and description is the same in both standards. Therefore, no modifications were necessary.
2) IEEE 1484.20.1 and CWA 16655-1 are similar in that a competence can store a collection of elements that contribute to the Definition attribute. However, each standard models this attribute differently. The harmonisation in this case was based on the following aspects:
    a. The CWA 16655-1 standard was chosen to establish the Definition attribute as it is more comprehensive than IEEE 1484.20.1.
    b. Some specific elements from the IEEE 1484.20.1 standard that are not defined in the CWA 16655-1 standard were also included.
        i) In addition to the natural language description of the competence, the use of key-value pairs is allowed. This expands the model defined in IEEE 1484.20.1, as the use of key-value pairs is also possible.
3) Regarding metadata in a competence, IEEE 1484.20.1 allows for the inclusion of any metadata as long as the reference model defining the metadata is indicated. However, the CWA 16655-1 standard implicitly defines the metadata. The following decisions were made:
    a) The CWA 15566-1 standard was followed to define and limit a specific number of metadata. This simplifies the task for a user writing a competence and reduces the likelihood of errors.
    b) The possibility of considering additional metadata was provided through a new element called OtherMetadata. The reference model and version of the new metadata must be indicated.
    c) IEEE 1484.20.1 states that when the external reference model is not defined and new metadata is present, the default value for the version will be 1.0.
4) Lastly, only the CWA 16655-1 standard considers associations between competences, which allows for the definition of additional metadata. The harmonised model considered the associations from the CWA 16655-1 standard.

- **Validation**

To guarantee the model's efficacy and correctness, validation was performed. A simple usage scenario served as the basis for the validation, and examples were employed to describe it. Ten higher education specialists contributed their knowledge to the validation process by reviewing and assessing the competence model. Their knowledge and perceptions made it possible to evaluate the model's thoroughness, applicability, and compatibility with academic and professional competences. The model was improved through in-depth talks and iterative feedback loops between the authors to guarantee its robustness and applicability.

Through a poll meant to gauge participants' opinions of the competence model, the model was validated. The Method Evaluation Model (MEM), a theoretical framework for evaluating the efficacy of information system design approaches, served as the foundation for this survey (Moody, 2001). Four key categories were used to group the survey questions: perceived utility, perceived ease of use, attitude towards use, and intention to use. The survey and results are accessible at the following link (results- table.xlsx file) https://umubox.um.es/index.php/s/nvrCT1mwAXa4upJ.

Table 1. Competence model.

Competence	Competence identifier		Description
Metadata	Title or name		Autonomy
	Description		Business skills
	Definitions		Influence
	Extra identifier		Complexity
	Abbreviations		Knowledge
	Date of creation		Skill level name
	Date of modification		Skill level number
	Validation start date		Cognitive soft skill
	Date of issue		Affective soft skill
	Author		Psychomotor soft skill
	Topics		Roled-based hard skill
	Credits		Skill-based skill
	Level	Knowledge	Technology Knowledge
	Version	Attributes	Pedagogy Knowledge
	Explicit metadata		Content Knowledge
Skill	Skill name		Combination
Attributes	Code		

4 Discussion

In general, the competence model was well received among higher education specialists. In a total of 6 questions at least 7 or more participants agreed (results-table.xlsx file).

There was consensus on the balance of the number of attributes to represent the competences. This feature is crucial for the usefulness of the model. Representing competences adequately is necessary for students to have a deep understanding of course content. Studies have shown that multifaceted competences in courses support students in becoming confident professionals (Tuomikoski *et al.*, 2020). Furthermore, it is observed that constructing competences from different perspectives can generate greater confidence during the learning process (Heller and Kern, 2021), which is also related

to multifaceted competences. Therefore, it is necessary for the competences to be accurately reflected in the model involving the participation of multiple actors in the proposal of competences.

One of the main reasons why software tools cease to be used is due to their lack of usefulness and adaptability (Okumuş *et al.*, 2016). It is essential for the model to be user-friendly in order to prevent abandonment. This characteristic also received consensus in the validation survey, with more than 7 respondents confirming their comfort with the implementation of the model. This feature aligns with the need for the introduction of competences to be easily done to describe the courses with an appropriate set of competences.

Within the framework of the eMediator project, the competence model is implemented in a demo portal. Survey responses indicate a willingness on the part of participants to use the demo portal to work with the competence model. Once the model is fully implemented, it will be studied whether widespread use has indeed been achieved.

One of the questions that received the highest score in the survey was recommending the use of the model among colleagues. This result can serve as leverage to gain initial adoption. It has been demonstrated that word-of-mouth is one of the most powerful forms of advertising, both in the short and long term (Olmedilla, Martínez-Torres and Toral, 2019).

In general, there is a predisposition to use the model whenever it is available. Therefore, it is a priority to fully implement it in the demo portal to test it in more detail from a practical perspective. This could lead to its initial use on a small scale and subsequently on a larger scale.

5 Conclusion

The competence-based education approach offers plentiful benefits. Firstly, it allows a focus on the knowledge and skills that are directly applicable. Students can acquire competences that they can immediately apply in the professional world or personal situations. Secondly, education can be goal-oriented (Spada *et al.*, 2022). Competences establish precise and measurable objectives, providing students with a clear understanding of expectations and directing their efforts towards achieving learning goals (Antonietti, Cattaneo and Amenduni, 2022). The breakdown of education into competences provides flexibility in studies, allowing customisation for each student based on their progress. This enables students to have a clear understanding of their learning stage and effectively manage their time, leading to a more personalised educational experience (Akimov *et al.*, 2023). When education is competence-based, these competences can be transferred and applied in a variety of contexts, empowering students to apply them in different fields of their lives. Competences have a positive impact on meaningful and active learning, as students are engaged in problem-solving and practical situations that require their active involvement. By adopting a competence-based approach, assessment can be more authentic, going beyond traditional exams (Wang *et al.*, 2023). Students can be evaluated based on how they apply their competences in real-world sce-

narios, resulting in more accurate and comprehensive assessments. Lastly, the acquisition of competences prepares students for the workforce as these competences are highly valued by employers, leading to successful professional development (Bergsmann *et al.*, 2015).

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