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PAPER

A New Online Tool to Evaluate Transferable Skills in the European Framework

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ABSTRACT

According to the European classification of skills, competencies, qualifications, and occupations (ESCO), transversal knowledge, skills, and competencies are pertinent to a wide array of occupations and sectors. Transversal knowledge, skills, and competencies are the foundational elements for developing the "hard" skills and competencies necessary for success in the labor market. In this paper, we introduce an online platform for assessing the attainment of transversal and soft skills. This tool allows us to define levels of competency acquisition and measure students' development. The use of these competency levels helps improve the understanding of these skills and the evaluation process. The tool also enhances coordination among courses and teachers. The evaluation process can be established on three different levels: self-evaluation, peer evaluation, and teacher assessment. Developers, students, and teachers have assessed the tool has been developed following a lifecycle of evolutionary prototypes with successive refinements.

KEYWORDS

competency assessment, European higher education area (EHEA), soft skills, student's learning process, transversal skills

1 INTRODUCTION

Engineering curricula in higher education institutions have traditionally reflected the necessity of including subjects related to basic engineering knowledge, such as mathematics, physics, computer science, and technology. A solid understanding of these technical issues equips engineering professionals with valuable resources to analyze situations, design systems, and propose strategies in their daily activities.

Nevertheless, numerous sources, such as institutional recommendations, academic reports, and surveys, indicate that these fundamental engineering skills need to be complemented with transferable skills. These skills are often referred to as soft skills, pervasive skills, professional skills, generic skills, or transversal skills [1] [2] [3] [4] [5].

The ability to make decisions, manage stress, be flexible, show initiative, and stay motivated in any university course is known as a transversal skill. Beyond

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technical knowledge, transversal skills are needed in an organizational environment, and workers should possess them. In short, transversal competencies are what distinguish a great worker from an excellent worker when both have the same technical training. According to the European classification of skills, competencies, qualifications, and occupations (ESCO), transversal knowledge, skills, and competencies are relevant to a broad range of occupations and sectors. They are often referred to as core skills, basic skills, or soft skills, and they are the cornerstone of a person's personal development. Transversal knowledge, skills, and competencies are the building blocks for developing the "hard" skills and competencies necessary for success in the labor market [7]. The four dimensions of the European e-competency framework reflect various levels of business and human resource planning requirements, along with guidelines for job and work proficiency. Attitude and soft skills are embedded in dimensions 2, 3, and 4 [8].

The competencies in engineering education represent a dynamic combination of knowledge, understanding, skills, and abilities. Thus, while many researchers recognize the crucial importance of establishing and enhancing subject-specific knowledge and skills as the foundation for university degree curricula, they have also emphasized the need to dedicate time and attention to the cultivation of generic competencies or transferable skills. This last component is becoming increasingly relevant for training students in a way that prepares them effectively for their future roles in society in terms of employability and citizenship.

In addition, the rapid technological advancements in our society necessitate professionals to continuously update their knowledge, often in an autonomous manner. Therefore, graduates must develop the ability to learn how to learn [6] [9] [10]. New educational models, which rely on a suitable blend of knowledge and generic competencies, will facilitate students' integration into the labor market, enabling them to engage in continuous learning. Since many efforts are being made to change traditional educational methodologies, it becomes necessary to measure the effectiveness of the new learning approaches [1].

With this aim in mind, the assessment of generic competencies [2] is becoming increasingly important, not only in academia but also in the labor market. This assessment requires evaluating individuals' behavior as well as their inherent knowledge.

In this paper, we introduce an online platform for assessing the attainment of transversal and soft skills. This tool enables us to parameterize levels of competency acquisition by establishing suitable descriptors or rubrics [11] [12] and measuring the extent of their development [13] [14] by teachers and students. The understanding of the various levels of skill development and the evaluation process is enhanced in this manner. Additionally, minimum levels that need to be achieved can be established either within a course or within an academic year. The tool enables us to enhance the analysis of each student's progress. In addition, teachers can assess the competencies that students have worked on and the level of achievement they have attained in previous courses. It also enhances coordination among courses and teachers, as it can be customized to set varying levels of achievement (per competency) based on the course or degree. Therefore, a student may acquire a different competency level depending on the program. That is to say, freshmen and senior students, but the level of achievement would be different [15] [16]. The evaluation process will be divided into self-evaluation, evaluation, and assessment by the teacher and peers.

This paper is organized as follows: Section 2 presents the related work. Section 3 introduces a list of generic (or transversal) competencies to be assessed and the methodology used to develop the tool. Section 4 is devoted to summarizing the assessment process. Section 5 presents the obtained results, and Section 6 discusses the conclusions and future work.

2 RELATED WORK

This section presents some interesting proposals and works on innovative teaching methods in order to evaluate transversal skills in the European Higher Education Area (EHEA).

In academia, several universities have published their assessment methods along with information about the tools they are using to gather all the information. For instance, the computer architecture group from the University of Almeria (Spain) has developed a comprehensive report on the acquisition of competencies by computer science students [1]. In this experience, a digital portfolio developed on a WebCT platform supports the teaching-learning-assessment process. According to the results provided by the authors of the report, there is strong evidence of improvement in the transversal competencies of students who participated in the educational experience.

The University of Cadiz (Spain) has its own tool called "EvalCOMIX," which is integrated under the Moodle platform [17]. The objective of the EvalCOMIX is to design and develop procedures and tools for assessing the competencies acquired by students participating in educational programs based on blended learning methodologies.

On the international stage, one can encounter fascinating experiences, particularly in the field of computer science. For instance, Algo+ is an assessment tool based on information and communications technology (ICT) that aims to evaluate problem-solving competencies [18]. Algo+ has the capability to assess a learner's proficiency in solving algorithmic problems. Feedback provided by the tool helps learners enhance their problem-solving skills and enables lecturers to assess the learning process.

The Center of Excellence in Teaching and Learning (CETL) and Active Learning in Computing (AliC) is a consortium of four universities in the North East of the UK. The ALiC has implemented new learning approaches that enable students to progress towards independent learning, guided by appropriate support materials. They propose that the assessment of software engineering team projects should focus on developing a variety of competencies that can be measured in a manner directly related to professional performance appraisals. They have introduced a contribution matrix method in which individual efforts and contributions are documented and appropriate marks are assigned to each student [19]. With this new appraisal-style method, the students received better feedback on their performance. They were also able to recognize and articulate their development of skills as software engineers more clearly, along with having more transparent assessment criteria.

In terms of the scope of the labor market, significant efforts are being made to assess competencies and their acquisition, particularly by human resource departments. In this case, evaluations are much more focused on demonstrating the correlation between individuals and their work positions. In other words, the competencies needed for a job position are analyzed, and then the suitability of the candidate for the position is assessed. Certain information and visualization tools have the capability to generate all the desired graphs with great flexibility. However, they are not accessible to teachers as they are designed for industry use.

Many of these tools offer fundamental visualization features such as bar graphs, histograms, or pie charts. They are focused on visualizing students' grades rather than assessing competency acquisition. The increasing demand for a reliable method to assess students' competency acquisition in higher education institutions has motivated us to create a straightforward yet effective solution to address the inconsistency in the data. We found it necessary to contribute to the understanding of competency assessment with data and results from our field of knowledge: engineering education. Moreover, we consider it absolutely necessary to include the viewpoints of all stakeholders involved in the process in the assessment procedure.

Unlike the aforementioned studies, we propose a system that enables teachers to parameterize the competencies to be acquired in each course and to assess the progression of students across various courses, academic years, and degree programs. The system also facilitates the use of rubrics to enhance understanding and assess the various levels of achievement. Additionally, this tool allows for the inclusion of self-perception and peer evaluation in the process of monitoring and evaluating a student's progress. In this way, the assessment involves all the stakeholders that take part in the learning process: students, classmates, and teachers.

3 EVALUATING OBJECTIVES, INSTRUCTIONAL MATERIALS, AND ASSESSMENT METHODOLOGY

This section presents a classification of transversal skills to be evaluated, along with the assessment methodology used to develop this tool. The software is customizable and can be adapted to assess any competency.

3.1 Transversal skills

Transversal competencies directly influence employability and are one of the main points of focus in job interviews and selection processes. For this reason, it is crucial to know them and be aware of their importance. They are also a powerful differentiating factor when multiple candidates apply for a job or seek to transition to a different company.

Transversal skills play a crucial role in evolving work environments, where diverse projects are executed by teams and stable jobs are becoming less prevalent. In line with the new curricula defined by the EHEA, transversal competencies can be divided into four major groups (see Figure 1).

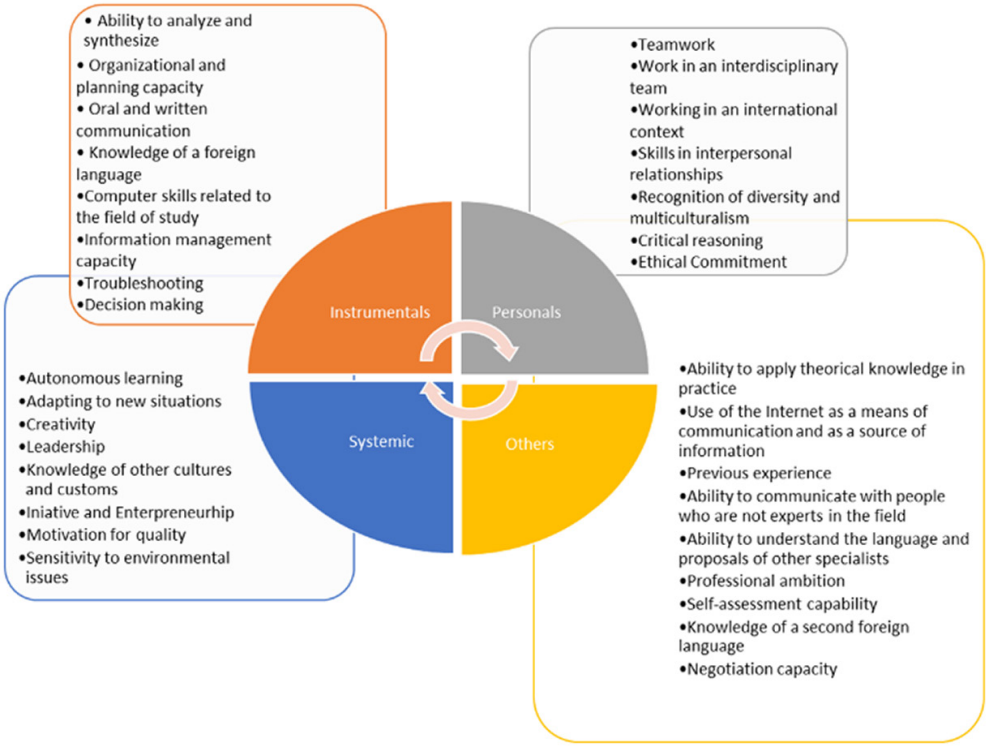

Fig. 1. Transversal competencies according to the EHEA

According to the Tuning Project, competencies can be either transversal or specific. Transversal competencies are generic and shared by all fields of knowledge. The specific ones are related to particular disciplines. A specific course must consider both aspects. In fact, transversal competencies are classified as instrumental, interpersonal, and systemic. Interpersonal skills measure social integration skills within various groups and the ability to collaborate effectively in specific and multidisciplinary teams. Systemic competencies measure individual qualities and motivation at work.

According to [20], there are two types of conceptual domains used to define the competencies of professionals: cognitive intelligence (related to information and intelligence), also known as technical skills, and emotional intelligence competencies (intra- and interpersonal abilities), known as soft skills. Soft-skill competency categories have also been established, namely problem-solving and critical thinking skills, self-management, ethical and moral values, leadership, time management skills, and communication skills.

According to [21] and [22], "soft skills represent a dynamic combination of cognitive and metacognitive skills, interpersonal, intellectual, and practical skills, and ethical values." Soft skills help individuals adapt and behave positively, enabling them to effectively handle the challenges they face in their professional and everyday lives. In the present proposal, the teacher overseeing the pilot experience determines which competencies will be assessed and sets the minimum level of competency that students must achieve.

3.2 Methodology

The methodology used for developing the tool is a lifecycle of evolutionary prototypes with successive refinements as a starting point. In the methodological stage of design, the classic instruments of representation that support the cognitivist-constructivist approach, as outlined in [23], are included. The methodological proposal considers the construction of the educational program from an integral perspective, taking into account pedagogical aspects throughout the lifecycle. There is a particular interest in the configuration of the profiles of various users. In the incremental prototype lifecycle, the following stages are defined:

1. Feasibility
2. Definition of system requirements
3. Specification of prototype requirements
4. Prototype design
5. Detailed design of the prototype
6. Development of the prototype (coding)
7. Implementation and testing of the prototype
8. Iterative refining of prototype specifications (increasing target and/or range).

Successive refinements were made. Finally, the design and implementation of the final system were achieved.

Educational software is defined as computer programs designed to facilitate the teaching process and, consequently, learning assessment. In the process, some specific characteristics have been established: ease of use, interactivity, and the ability to measure the progress of various students in the learning process.

The developed software includes functions for motivating teachers as well as evaluative and research functions [25]. Thus, the role of the teacher is to integrate individual and group work with an additional research function [26]. The use of this software tool enables us to gather data about the learning process and

identify students' difficulties, particularly those related to individual students, group integration, and competency development.

The educational tool objectives include improving follow-up, evaluation, and the competency development process. This is achieved through the use of: (1) a more precise measurement tool; (2) a more comprehensive evaluation conducted by the various agents involved in the process; and (3) a continuous feedback process. The evaluation process concludes with measuring the final results of the training program.

There are various cognitive activities or "thought processes," that students develop when interacting with the tool. Since students must be able to self-evaluate and evaluate their group peers, they need to activate the cognitive process of understanding the situation, reflecting on their and their peers' learning processes, and reasoning, making decisions, and reflecting on problems or feelings. Among other aspects, they may need to evaluate competencies related to the adequacy of established planning, the presentation of relevant arguments against alterations to such planning, the defense of a point of view and the foundation of criteria, problem-solving, organization and expression of ideas, classification and selection of information, etc.

Some of the main objectives of the tool are:

- To direct the students' attention to the learning process
- To stimulate the mental processes and emphasize the significance of learning
- To motivate the transfer of learned knowledge to their peers
- To provide constant feedback and inform about the learning processes

The implementation of the interface aims to have the following characteristics: ease of use, homogeneity, adaptability, interactivity, etc. [24]

The software evaluation was initially conducted internally by the development team members and later externally with the involvement of teachers and students who benefited from the program. The instruments used were evaluation questionnaires. The questions were evaluated on a scale from 0 to 5 to determine the user's level of conformity with the proposed statements or to assess the difficulty and/or utility of the tool. The evaluation methodology followed is an adaptation of the one presented in [23]. In most of the questionnaires surveyed, some key or outstanding aspects were considered: achievement of objectives, technical aspects, content development, activities, and documentation. These aspects were categorized into items based on each proposal.

The general evaluation considered pedagogical aspects (software goals and educational objectives) and functional aspects (advantages that the tool provides to the teacher as a facilitator of the learning assessment process). The evaluation was conducted using checklists with closed-ended questions. The results obtained were then used by the developer to make the necessary and convenient changes. Finally, the external test version and the final evaluation with students have been completed. The results of this latest evaluation are presented in this paper.

For the development and testing of the tool, a didactic plan was established. The tool was integrated into the curriculum for junior students in the computer science degree program. The tool was parameterized with the competencies to be evaluated. Moreover, the activities were presented to the students along with an explanation of the thought process required to carry them out (analyze, investigate, evaluate, and build). Groups were created, providing them with the necessary resources and tools for interaction. Finally, the training process assessment and the software evaluation were presented and conducted. User manuals were also provided with frequently asked questions for each different type of role (teacher or student) involved in the process.

4 EVALUATION OF COMPETENCIES

The aim of the tool is to create educational software that enables the acquisition and subsequent treatment of multiple assessments of transversal competencies acquired by students during their academic career. It will improve the evaluation of the teaching-learning process. Moreover, we aim to standardize the treatment of competencies by transforming abstract concepts such as behaviors and skills into tangible, calibrated actions. In this way, the student's progress is evaluated over time, bringing numerous benefits such as individual and group monitoring, analysis of strengths and weaknesses in the process, identification of areas needing improvement in the teaching and learning process, detection of integration problems, and training needs.

This tool also establishes a descriptive scale that allows the competency to be evaluated based on behavior; each value establishes a specific behavior that indicates a level of development of that competency (refer to Table 1). This scale establishes standards for evaluating a group of people, reducing evaluator errors, and promoting greater consistency in evaluation criteria.

Table 1. Schema of the creation of the generic competencies

Item 1	Item 5
Competency	Concern for Quality and Improvement
Description	This is the aptitude to start or support a way of doing things, fundamentally, to satisfy the client and to improve processes and results, day to day. At the same time, to establish management based on continuous improvement.
Level of achievement 1	The student is concerned about doing things with quality by applying the instructions and procedures determined by managers or directors.
Level of achievement 2	The student is familiar with quality policies at the University and application in a proactive way.
Level of achievement 3	The student analyzes the information received on the basis of the acquired knowledge that he/she has in order to detect possible improvements in the learning process.
Level of achievement 4	The student designs and implements improvements within the process that he/she knows by carrying out follow-ups as well as corrections.
...	
Level of achievement 10	The student becomes a top-level precursor of improvements or changes that will benefit the community and will improve services.

Students who use this tool will be able to track their progress temporarily. If the group creators permit it (in this case, teachers), students can self-assess and evaluate their peers, providing additional evaluation information. Teachers or employees who use this application can create student control groups, either within a course they teach or a subgroup of it, or, in general, for any group they wish to mentor. They can conduct evaluations of the entire control group or of each individual. They are able to observe the evolution of the student throughout their training and even customize the learning. This tool also enables the coordination of teachers within a degree program in terms of the level of competency achievement. The data aggregation and results visualization sections provide coordinators and administrators with the flexibility to view and process the results. The analysis of the collected data enables the study of personal or group evolutions, participation, behavior patterns, and more. Furthermore, the tool facilitates data collection, sorting, and analysis.

In this specific case, the tool has been parameterized to demonstrate its usefulness by focusing on the development of transversal skills. However, this tool can be used to track any type of skill.

The tool consists of three different profiles or roles (see Figure 2), as well as a generic or anonymous profile. The anonymous profile should have access to both the login form and the registration form. The student profile represents students who have access to the application. This role is assigned by the administrator during the student registration process. The teaching or work profiles represent the evaluating staff (teachers) or company staff (labor scope) with access to the application. This role is assigned by the administrator during the user's login process. The administrator or coordinator profile (admin) represents the person in charge of maintaining and/or analyzing information (generating reports with access to the application). It also has the possibility of creating multiple users. The interface is consistent throughout the application, both visually and in its functional parts.

- The data is displayed to the user for interaction.
- Validation of the entered data is performed, if necessary, so that the information of the page is validated before entering the business logic.
- Data collection and data processing. Once the validation has been completed, the data is collected and sent to the server for processing. When it comes to lists, the item to be processed is gathered, the data is queried in the database, and the details of the item to be modified are saved. In the case of forms, data from the forms is collected, corresponding operations are carried out in the database, and if necessary, information is updated (lists, global variables, data in memory, etc.). In the case of actions, the operation stored in the database is executed, and the data in the corresponding list is updated.

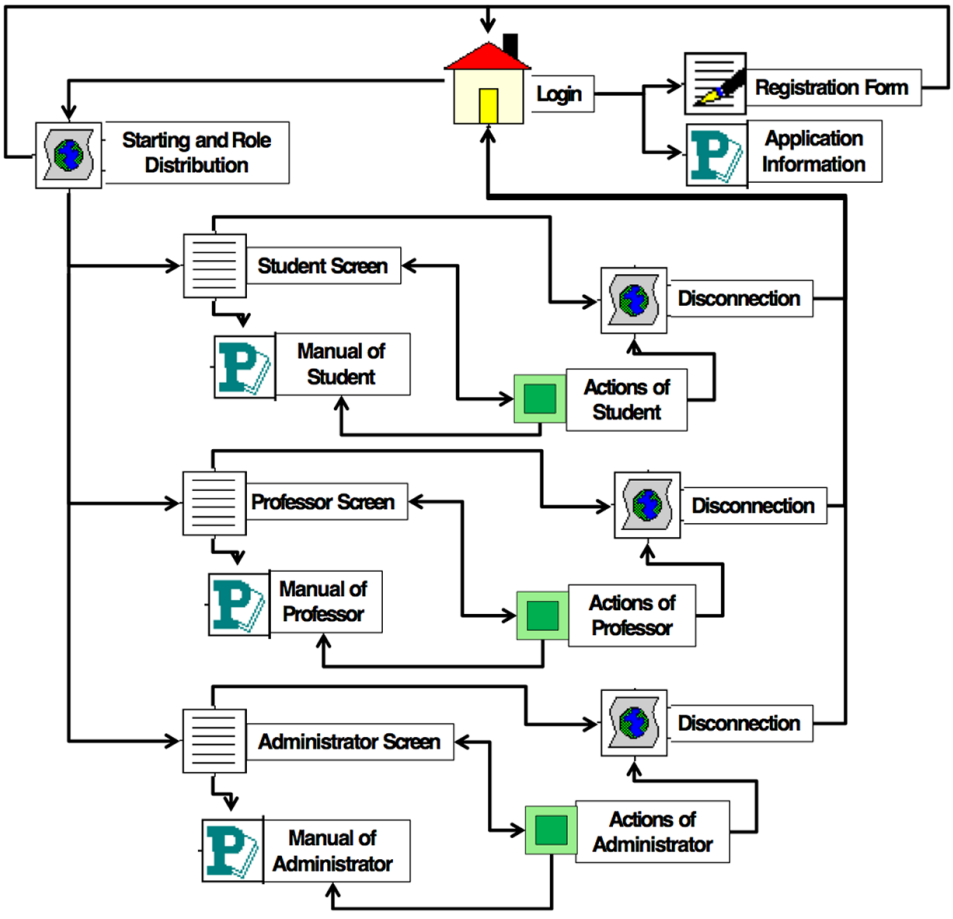

Fig. 2. Tool roles

5 RESULTS

Data have been collected from senior students (n = 12) enrolled in a computer science degree program. The subject teacher chose competencies for analysis.

5.1 Example of competency assessment development for two different students

Here are two examples of individual evaluations that demonstrate the variability in assessments. The values represent the average of all assessments completed and received by a student throughout the semester. Therefore, AUTO refers to student self-assessment of competencies, P2P indicates inter-peer evaluations within the same group, DEV represents the typical deviation of measurements from the mean value, and PROF signifies teacher evaluation. The teacher did not evaluate all competencies, as some were only assessed by students and their peers. As observed in Figure 3, this student prioritizes his personal growth over feedback from his classmates and the teacher. The final student's mark in the group project is 7.5 out of 10.

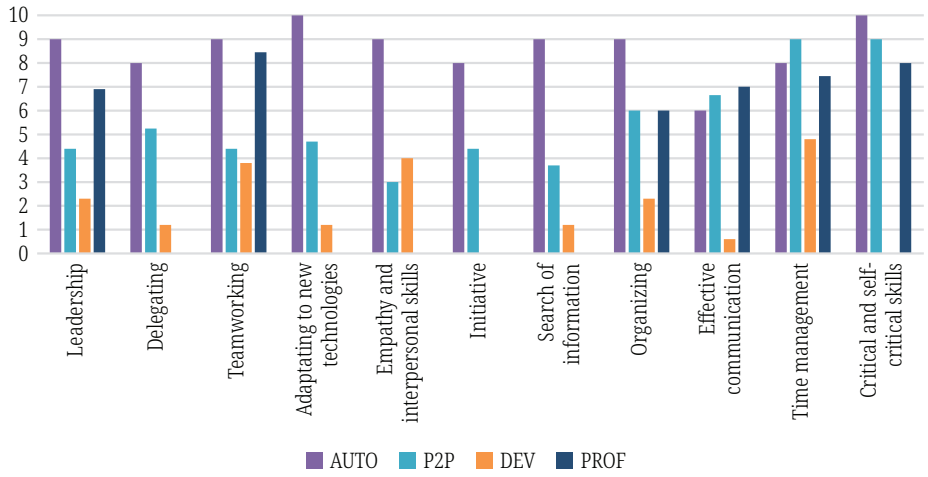

Fig. 3. Example of competency assessment (Student 1)

As observed in Figure 4, this student tends to value their development at a similar level to the assessment of their peers and slightly above the teacher's assessment. The final student's mark on the project is 8.5 out of 10. When we work with average values (see Figure 5), we lose the individual perspective of each student. However, thanks to working with a small group of junior students, we have been able to not only track the group's progress but also analyze it individually and draw the following conclusions. In general, groups that function effectively typically receive positive intergroup evaluations, scoring above 6 points. In order to assess intergroup evaluations, it is necessary to work with relative evaluations. In other words, a student who works well with their group will typically rate their peers with values between 6 and 9. These values can be used by the teacher to determine which students within this group need more support in their learning process for the development of cross-cutting competencies. If there is a problem within the group where a student is underperforming, it will generally be easily detectable. Whenever there is an integration problem, it will be detectable. This is because the tool evaluates not only

a semester or year but also the development of individuals in all groups throughout the formative stage. The levels of established competencies have been almost reached for all competencies.

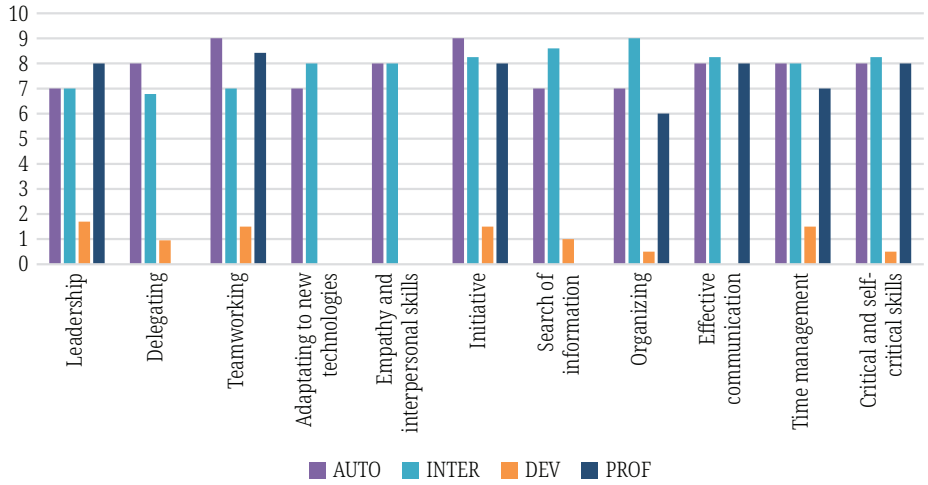

Fig. 4. Example of competency assessment (Student 2)

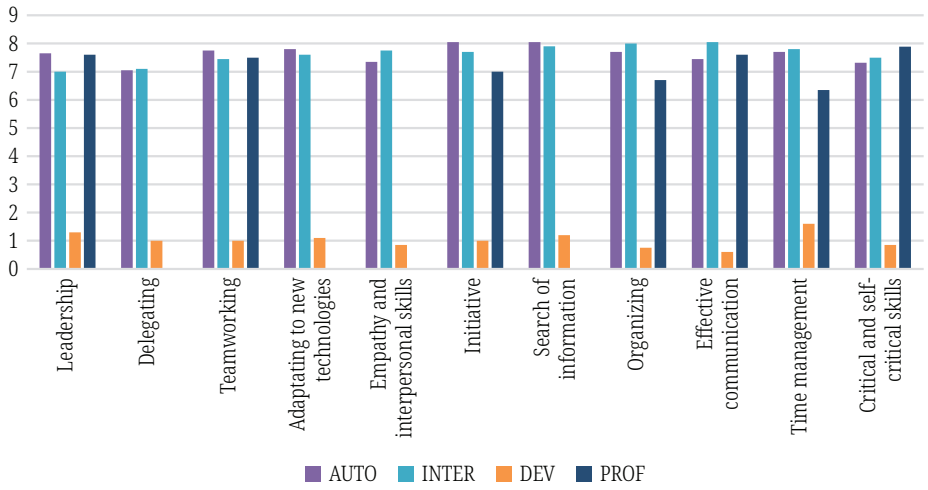

Fig. 5. Student competency assessment (average)

To evaluate the effectiveness of rubrics, student satisfaction surveys were conducted and rated on a scale from 1 to 10 (1: not difficult, 10: very difficult). Students rated the following sentences: "I find it difficult to self-assess myself," and "I find it difficult to value my colleagues." The self-assessment rubric had an average score of 6.1 (±1.95), while the peer assessment rubric had an average score of 3.6 (±2.05).

Students find it more difficult to assess themselves than to assess their peers. The evaluation of the tool was also conducted (see Figure 6). The values were rated from 1 to 10: (1: it does not help me; 10: it helps me a lot). The students rated the following sentences in reference to the tool's functionality: "The tool allowed me to conduct a suitable self-assessment." "The tool is beneficial for conducting a suitable peer assessment." "The feedback from the teacher received through the tool is helpful in the learning process." "I would appreciate feedback from my group peers." "I consider it would help in my learning process." "The tool is appropriate for understanding competency levels and carrying out the evaluation."

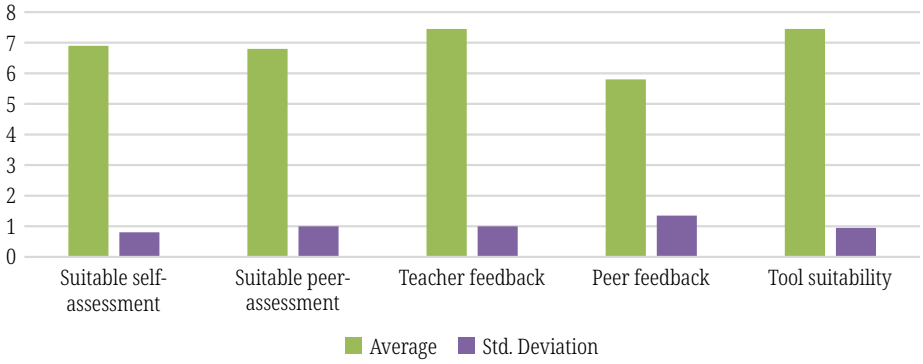

Fig. 6. Tool assessment results

The students positively evaluated the use of the tool to assess the level of competency development, including self-assessment and peer assessment. They found the feedback on the tool to be positive, and they are interested in receiving evaluations from their peers. However, based on several interviews with students, we must conclude that students prefer not to display their peer assessments directly through the tool due to the potential for generating confrontations. The students believe that teachers should act as filters to channel information. In other words, it would be better if the teacher provided feedback from peers to maintain source confidentiality and offer a constructive criticism perspective. This feedback should include suggestions on methods, tools, and materials to enhance the required competencies. Figure 7 illustrates the average assessment of competency development compared to the desired level of development for this level.

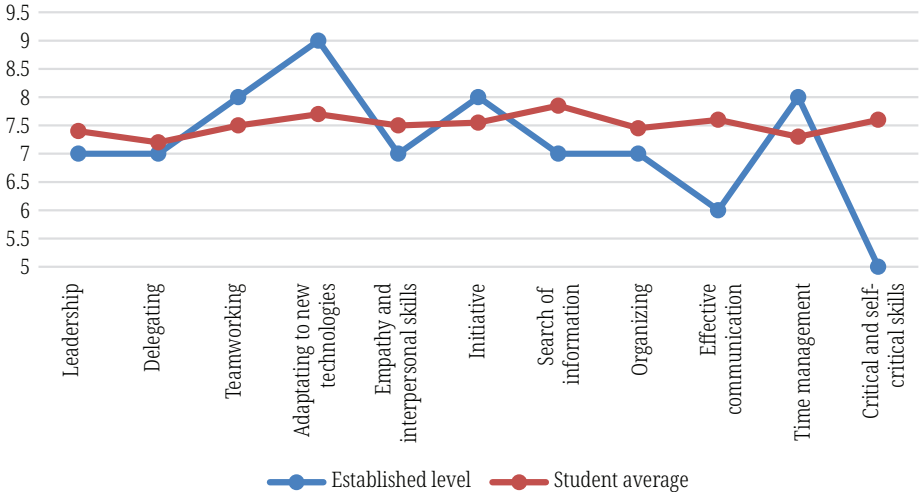

Fig. 7. Student expected level versus real level of student achievement (comparative graph)

As can be observed, teamwork, adaptation to new technologies, initiative, and time management skills are below the recommended level. This can be assessed in two ways: first, it may be due to the fact that a level that is too high is required. However, after talking with the teachers involved, they justify this level due to the fact that students are in the final year of the degree program and have received prior training. Another reason to consider is that sometimes the training in previous courses involved very specific activities, whereas the project used in this experience follows a more project-based learning approach. For this experience, students need

to plan by themselves, develop initiative, and manage their time, among other competencies, to be developed in a deeper way than in other subjects. More structured activities limit students' engagement in tasks such as research, analysis, synthesis of information, time management, and group work. The high score achieved in the competency of "adaptation to new technologies" can be attributed to the technical training received by these students. In conclusion, to enhance the development of cross-curricular competencies and student training, it is essential to analyze and implement methodologies that foster the development of transversal competencies, such as problem-based learning, collaborative work, etc., throughout the entire degree program.

Nevertheless, the experience has been very positive. The final project marks obtained by the students averaged above 6.5 out of 10. The assessment of the students has also been very positive.

6 CONCLUSIONS AND FUTURE WORK

Transversal competencies directly influence employability and are one of the main points of focus in job interviews and selection processes. For that reason, it is crucial to know them and be aware of their importance. In this paper, we have presented a novel tool that enables us to classify transversal skills, configure, and parameterize the various competency levels that students need to acquire. In this way, the tool helps trainers carry out continuous competency assessments throughout the courses and years. The combination of the online tool and the use of rubrics enables us to enhance the monitoring of students' learning processes and facilitate peer and self-assessment of their progress. This tool has been designed to enhance coordination among educators and program administrators in terms of competency acquisition. Thus, the different competency levels can be established beforehand, either per course or academic year. Furthermore, any professor can assess the competencies acquired in previous courses and track the progress of students.

The software is customizable and can be adapted to assess any competency. We have tested the tool with junior students enrolled in a computer science degree program. We were able to measure the students' progress in acquiring competency levels. The students also appreciated the positive impact of the tool.

As future work, we plan to configure the tool to function within a complete degree program and test it over several years to assess student progress and competency development.

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