GRAF: A System for the Assessment, Accreditation and Representation of Competency Learning in Online Higher Education

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Abstract. The evaluation and accreditation of competencies is one of the challenges that higher education must address in the 21st century. GRAF is a system of evaluation and accreditation of curricular competencies based on the integration of pedagogical engineering methodologies with data architecture design and technological applications, especially tailored to online higher education. From the teaching point of view, it provides a model, a methodology, and a tool for designing competency-based programmes and assessing the evidence of competency learning generated by the students in the teaching and learning process throughout the semester. From the student's perspective, it enhances conventional evaluation by accompanying marks with educational feedback on the level of competency achieved, and provides a graphic representation of progress. Specific tools and applications have been developed for each phase of work: for the design stage, the Competency Design Tool; for the evaluation and monitoring stage, the Competency Assessment Tool; and for the graphic representation stage, the Competency Graph Report. The Universitat Oberta de Catalunya (UOC) has spent two years developing GRAF. It has been applied to five programmes in different areas: an MBA, two master's degrees, a postgraduate course, and a university extension course. A total of 56 compulsory subjects and 293 students have been involved in these programmes. Due to the success of the initiative, the UOC has decided on a widespread application of GRAF to other programmes. We are interested in sharing the experience and lessons learned in order to improve GRAF.

Keywords: Competency assessment report · Competency-based design · Competency accreditation

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1 Introduction

For some years now, design of higher education programmes has been oriented to developing personal and professional competencies. Despite efforts to date, graduates still have problems clearly identifying their stage of competency development on finishing a university programme. At the Universitat Oberta de Catalunya (UOC), as at many other universities, the training design of degree programmes is reflected in a competency map

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or matrix and specified in the proposed learning activities and methodologies. However, during the student teaching and learning process, formative and continual competency assessment becomes elusive, eclipsed by qualifications, marks, and academic transcripts, which hardly reflect competency learning and acquisition. This acquisition is not always evident to students or assessors.

The project presented here is an approach to competency design and assessment and a graphic, tailored representation of each student's competency development. A new competency assessment experience at the UOC needed to provide added value and an advance in habitual assessment practices up to now. The GRAF[1] project aims to specify the assessment process for interdisciplinary and specific competencies in degree programmes. It provides a visible place where professors can assess evidence of learning from a perspective that complements traditional assessment: assessing how well ways of doing things, acting, and behaving in professional and work contexts related to the degree, expressed in competencies, have been acquired. The project was also motivated by the desire to cover certain demands from the labour market and some of the needs expressed by universities. An academic transcript shows academic results. A graphic representation of competency development showing leadership capacity, teamwork in multidisciplinary environments, and effective communication, to give just a few examples, allows students to show and demonstrate their skills in a useful, valuable, and visual format.

Apart from providing a tool for, and graphic representation of, competency assessment, GRAF also offers a comprehensive competency design system for a full university programme. The competency work is interlaced evenly over all courses in a degree programme and specified in each of the related learning activities.

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2 The State of the Art in Higher Education Competency Learning Assessment and Accreditation

Universities and higher education institutions are working to improve processes of competency assessment and their graphic visualization. GRAF is an example of this, together with other experiences, such as the University of Canberra (New Zealand) and Deakin University (Australia), or the result of the joint development among university members of the Europortfolio (European Network of ePortfolio Experts & Practitioners) European project [5, 6, 13]. In the next section, we will consider what this involves and what difficulties it entails for teachers and institutions.

Competency assessment and design of the learning process are two sides of the same coin. We can only assess the elements we decide to include in the course curriculum. This might seem obvious, but it is the cornerstone of competency assessment and also the main stumbling block for many initiatives.

Assessing competency learning means moving from a concept of content-based learning, i.e., syllabuses, toward a competency-based concept, or the skills needed to carry out an activity in the professional or academic context [18]. This fact, which in many cases might require a change in the institution's teaching culture, greatly increases complexity throughout the chain of processes involved in learning design and assessment.

[1] GRAF (from "Gráfico", in Spanish) stands for "Graph": Competency Graph Report.

Positioning ourselves in this competency design framework requires adopting an interdisciplinary approach. Skills and knowledge are no longer organized along the lines of old knowledge area taxonomies, bringing about a complex interactive relationship, designed to develop functions, actions, and behaviours in real contexts. Thus, design for competencies involves the effort of deconstructing reality to transfer its fragments to a training context, without losing sight of what connects the fragments to each other and their original context.

This approach has a number of methodological implications, which affect, to varying degrees, the value chain in the training process, from programme design to the accreditation system, without forgetting the design of training activities or assessment methods and instruments. Consequently, certain elements recur when discussing competency assessment: providing a competency map with levels of specificity; rethinking learning activities; using objective and scalable assessment instruments, such as rubrics; and designing types of accreditation suitable for the nature of competencies, such as visual systems or micro-credentials. These issues are discussed below.

2.1 Competency Map

A number of experiences have used competency maps from which learning and assessment processes are designed [2, 16]. Such maps help specify competencies to a degree at which they become workable. This means identifying dimensions or levels of acquisition [15] or learning results [1, 17] on which training and assessment activities and dynamics are based.

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2.2 Learning Activities and Assessment Instruments for Competencies

Conventional training activities are not always suitable for assessing competencies. Activities are required whose design is based on complex learning situations, where knowledge and skills have to be mobilized and integrated [14], and are assessable using instruments such as rubrics, which provide rigour, objectivity, and clarity to the process and facilitate the work of the assessing professor [7].

2.3 Accreditation Systems that Recognize the Student's Competency Acquisition Progress

A competency is a personal capacity in permanent development. Helping the students to be aware of their acquisition process, whether encouraging self-reflection, providing self-diagnosis tools or showing the roadmap of the process itself, is a goal that is present in a number of experiences [8] (González-Martínez et al. [10]). Some of them focus on using visual metaphors as a strategy to convey this information to the student in an explicit and interpretable way, both at the end and throughout the training process [3, 11].

Finally, as it is possible to deduce, the application of a system of competency assessment requires the performance of an exhaustive pedagogical and methodological design that affects the entire training process in all the essential elements. We are not talking about an educational innovation that modifies certain steps of the value chain, but about a cross-disciplinary and interdisciplinary training engineering challenge.

3 Description of the System

At the UOC, we have designed a system, model, methodology, and tools for the design of competency-based training programmes and for assessing evidence of competency learning. The purpose of the system is for students to improve their competitiveness and employability in the labour market with a report accrediting their acquisition level of curricular competencies [4]. Students can then make their reports public and shareable in professional environments or to employers who might place a value on them.

In recent years, higher education institutions have begun to build their own data architecture to monitor their processes and give them visibility [19]. Our experience consists of a system based on integrating pedagogical engineering methodologies with data architecture design and technological applications, especially tailored to online higher education.

The **objectives** GRAF hopes to achieve are:

- The generation of a "Personal Competency Report", which provides visibility to student assessments by showing acquisition levels for each competency dimension and related activities and courses. The report includes a customizable graphic representation of the student's competency acquisition progress within the framework of a training programme.
- The creation of an agile, rubric-based grading system for learning activities, allowing professors to assess competencies and provide formative feedback on training, while minimizing their workload in the assessment process. The system is compatible with the traditional credit rating system and the UOC educational model.
- An accurate competency-based design for study programmes in which learning activities are linked to competency dimensions and facilitate grading and feedback [9].

The system is based on the following pedagogic principles:

- Assessing competencies involves more than correcting activities; the results students obtain for an activity need to be observed beyond the habitual grading system. This means assessing the degree of learning acquisition and orienting it to the progressive development of competencies.
- Constructive alignment of competencies, dimensions, learning results, and activities is the necessary condition for system consistency.
- Learning assessment is evidence-based. Evidence is produced by students over the course of the programme through the learning activities.

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- Students receive tailored, continuous feedback on their learning and competency acquisition [12], based on the descriptions in the rubrics. The rubric is the instrument used to design and assess students' output. It describes the competency quality standards or degrees of development as defined in the training design phase to make them assessable. The rubrics are shared with students from the start, thereby informing them of what they are expected to learn.

Based on these foundations, with a painstaking pedagogic design, work then proceeds in three phases: (1) The training design phase for the competency-based programmes; (2) the student learning assessment phase; and (3) the graphic competency report generation phase. For each phase, GRAF has developed three different tools whose operation is interconnected in the virtual classroom:

- The Competency Design Tool (CDT): this enables professors to draw up competencies, dimensions and assessment rubrics, design the competency map and match up courses, competencies, dimensions and activities.
- The Competency Assessment Tool (CAT): this facilitates assessment and shows the assessment results for activities and competencies while generating tailored feedback for the student.
- The Graphic Competency Report (GCR): this reports the degree of competency acquisition and presents it graphically.

The GRAF technological design is thus consistent with its underlying pedagogic concept.

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4 Application in the Context of the UOC

4.1 Application Phases

GRAF has been applied at the UOC since 2018, involving a number of different implementation phases. During the first four pilot phases (see Table 1), work processes, adaptation of competency designs, and pedagogical engineering to the characteristics of each programme and the tool development and implementation were carried out in test mode. Thus, in the first pilot tests, we focused solely on design and assessment of programme interdisciplinary competencies, while in subsequent phases, the competency map and tools also incorporated the specific and general competencies in the participating degree programmes.

Currently, GRAF includes five degree programmes. It is applied to 56 courses (242 ECTS credits), 139 professors, and 435 students[2]. The following table lists the participating programmes and the agents involved in each case.

[2] At the time of publication, the number of students was 435. Note that the previous abstract mentioned 293 students. Since then, a new master's degree has joined GRAF, hence the number has increased.

Table 1. Phases and programmes in which GRAF is applied.

Phase*	Study program	Courses	Credits	Professors**	Students**
Pilot	MBA Global Executive Education	27	80	60	105
Pilot	University Master's Degree in Strategy and Creativity in Advertising	8	60	28	75
Pilot	Assessing for learning (Postgraduate Course)	6	30	17	20
Pilot	Project Leadership and Management (Professional specialization course)	3	12	10	49
Develo-pment	University Master's Degree in Design, Visual Identity and Branding	12	60	24	186
	Total	56	242	139	435

* The Global Executive Education (MBA) programme was a pilot test in 2018–19, which has not yet reached the full development phase. The professional specialization course was a pilot test which incorporated assessment of both specific and interdisciplinary competencies.
** Professor and student numbers include all participants in each phase, regardless of whether they were also involved in other phases.

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4.2 GRAF Tools

Competency Design Tool (CDT). This is a web tool that provides a design methodology for constructing a degree programme competency map. First of all, programme directors define the competencies, dimensions, and assessment rubrics. Next, directors and professors distribute the weighting for the competencies and dimensions over the degree programme, its courses, and learning activities in accordance with the work and assessment load involved. Thus, professors share in the methodological decision-making with regard to the assessment weighting, which is rated and checked from an interdisciplinary perspective covering the whole degree. The assessment weighting is expressed in percentages. The decision-making process is meticulous and based on consensus.

Professors are accompanied by an expert from the eLearn Center (eLC) in the work and are provided with guidelines and support resources produced specifically for the purpose (Fig. 1).

Competency Assessment Tool (CAT). This is an agile and efficient tool that allows professors to assess the degree of competency development, visualizing a student's complete output (deliverables) in a single space. For each student and activity, the tool shows the output or work, the dimensions assigned for observation, and the assessment rubrics. Professors make their assessment by deciding on the degree of competency development that best applies to the output or deliverable (Excellently Acquired, Acquired, Partially Acquired, Not Acquired), while automating feedback. This feedback can also be enriched by providing the student with tailored comments, broadening or clarifying descriptions from the rubric, which are then sent automatically to the student (Fig. 2).

The eLC trains professors in the use of this web tool and in assessing competencies based on evidence of learning in the UOC online environment.

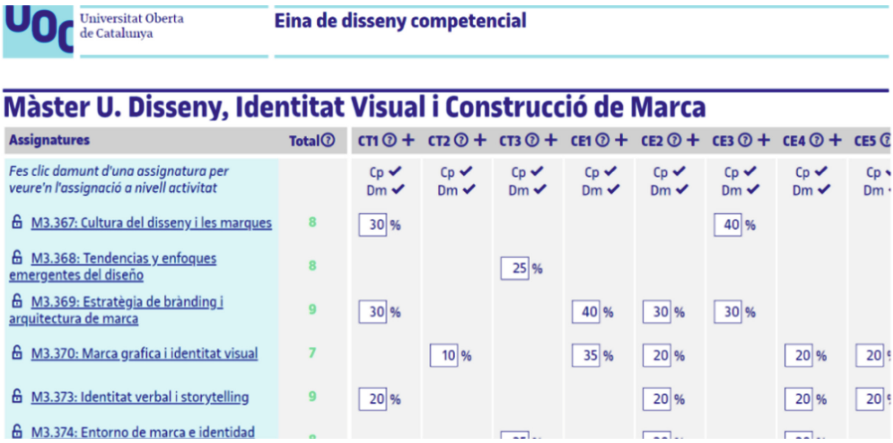

Fig. 1. Competency map for the University Master's Degree in Design, Visual Identity, and Brand Building.

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Fig. 2. Competency assessments in the assessment tool.

Graphic Competency Report (GCR). This is the result of the competency learning assessment. As students complete activities and progress in their studies, a graphic report is generated which shows their degree of acquisition for each competency. Each student has their own tailored graphic report, which they can personalize, export, and share on the web and in professional and work situations. The report accredits their competency

acquisition. Currently, the report is not valid as an academic certificate issued by the UOC; however, it represents a major step towards formal accreditation, which could accompany the qualification or provide micro-credentials or badges (Fig. 3).

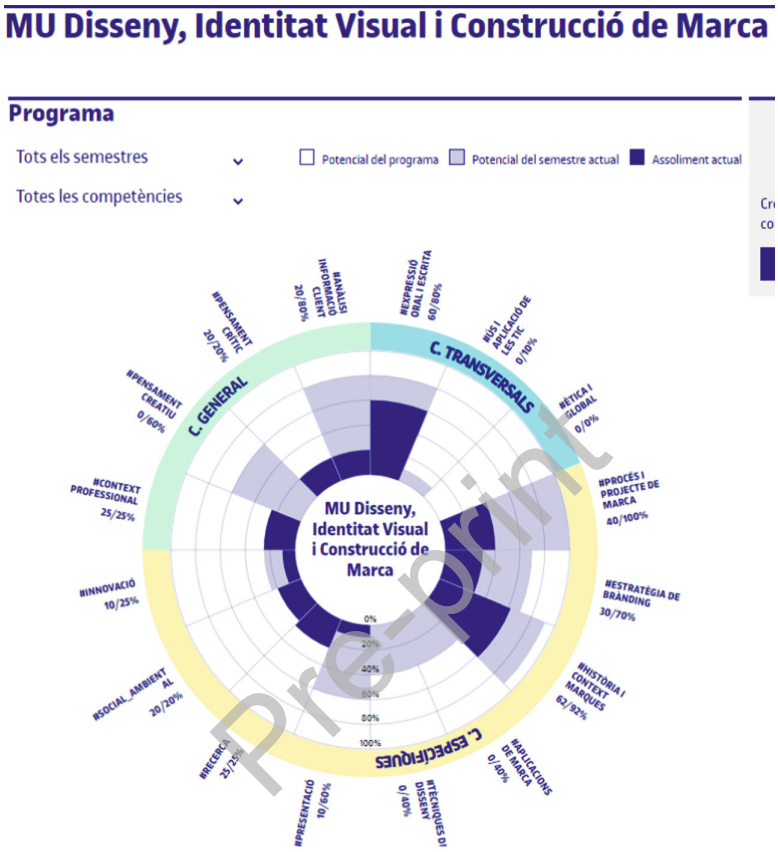

Fig. 3. A student's graphic competency report

Since GRAF started, both the methodological design and technological implementation of all its components have been regularly tested and assessed. These assessments are geared toward decisions on improving processes, tools, functionalities, and effectiveness, incorporating the results into each successive phase and programme.

Students consider this graphic report as value added to their academic transcript and state they would like to have more and better options for personalizing and exporting it. Professors feel that thanks to GRAF they now have a consensus competency map. They also feel competency assessment adds to their workload and that they need training in competencies and their assessment.

5 Conclusions

The GRAF project is an improvement in competency design, as it provides a model, methodology and tool set for competency assessment. The model, based on competencies, dimensions, and degrees of competency development, and the methodology, based on rubrics, are useful, coherent, and flexible for application to a wide range of university degree programmes. Thus, the defined model and methodology can be applied to both short programmes (specializations) and longer programmes (bachelor's, master's, and post-graduate degrees). The methodological architecture means the model cannot be applied by just one professor or part of the teaching staff from the programme. As it is based on global degree programme design, applied to all courses, it requires commitment, involvement, and participation from all course faculty. Ensuring such collective alignment requires specific commitment in terms of institutional strategy to boost its application. Thus GRAF clearly shows the need for institutions to revise their competency design and how it affects the production of degree reports, course design, and, finally, implementation in the classroom and in assessment. For the professors, it means more time spent on the design phase and providing a more detailed classroom assessment. Minimizing this extra workload requires, firstly, specific tools to automate processes and, secondly, expert advice on teaching methodology for competency design and assessment. The CDT solves the problems detected in the initial project phases and provides a robust working environment to record and trace the data on which the model is based. The CAT permits integration of pre-existing assessment tools from before the GRAF project and unifies all the required assessment actions in a single environment. Development of these two tools has produced sufficient automation to make the project sustainable in terms of professors' workload. With regard to the GCR, based on the opinions of the agents involved, it is considered value added to the academic transcript and programme. In conclusion, the GRAF tools represent an advance in competency design and assessment for professors and facilitates qualitative feedback and visualization of the competency development process for students.

The GRAF approach represents an advance towards the application of big data in training processes in higher education. It is also a starting point to promote and consolidate a culture of higher quality evaluation and personalization with great power of transformation.

Future lines of work in the project involve approaching how the model can incorporate evidence from outside the academic world, from students' personal and professional lives. Currently, the assessment and graphic competency representation provided by the project cannot be included in the official academic transcript due to legal limitations. Further work is required to ensure public legislators make the regulatory changes so this type of assessment can be included in official transcripts. At the same time, beyond this goal, the definition of a micro-credential system linked to competency development needs to be explored to provide students with a range of accreditation instruments for each of their competencies. Along these lines, from the technological perspective, blockchain could prove highly relevant in constructing a robust and reliable competency accreditation system, recognized by a range of social agents and employers. Finally, with regard to project scalability and its transfer to more degree programmes, training and advisory strategies, and actions need to be designed so that professors do not require

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teams of experts in methodology providing the intense, tailored accompaniment that the project has so far needed in its initial implementation phases.

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