Research in Education and learning Innovation Archives

Autunm (July – December) No. 35. Pp. 74-92 / eISSN: 2659-9031 / DOI: 10.7203/realia.35.30340

ARTICLES / OPEN ACCESS

Rubric for the Acquisition of Competencies for the Development of Construction Details for Buildings: Design and Evaluation of the Rubric

Rúbrica para la adquisición de competencias para la elaboración de detalles constructivos de edificios: diseño y evaluación de la rúbrica

Rúbrica per a l'adquisició de competències per a l'elaboració de detalls constructius d'edificis: disseny i avaluació de la rúbrica

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Received: 03/02/2025 | **Accepted:** 23/06/2025 | **Published:** 18/07/2025

ABSTRACT: This research focuses on the training of students of Technical Architecture or Building Engineering who, together with other technicians, are involved in the Spanish construction sector. The production of construction details as a communication tool allows any kind of ambiguity or doubt derived from oral language to be eliminated, and facilitates the correct planning of the works, proper measurement and budgeting of the items and, above all, good execution on site. For this reason, the acquisition of skills for the execution of construction details is a key competence for building technicians. The main objective is to design a rubric that allows the evaluation of skills in the execution of construction details of the interior finishes of the building (flooring, false ceilings, partitions, etc.) of the students of the Degree in Technical Architecture of the University of Alicante. The results show that, as the planned exercises were carried out, there was a significant improvement in the students' resolution of the construction details. The rubric designed allows for the assessment of complex thinking, through the use of real projects in problem solving, which is reinforced by the use of the rubric by the students themselves through peer assessment. The rubrics make it possible to assess the acquisition of the competences required by the European Higher Education Area and to foster students' autonomous and self-regulated learning. In addition, peer assessment has provided students with a tool for training and self-assessment.

KEYWORDS: Evaluation rubric; construction details; peer review; construction; building engineering; professional competencies in construction.

RESUMEN: Esta investigación se centra en la formación de los estudiantes de Arquitectura Técnica o Ingeniería de Edificación que, junto con otros técnicos, intervienen en el sector de la construcción español. La realización de detalles constructivos como herramienta de comunicación permite eliminar cualquier tipo de ambigüedad o duda derivada del lenguaje oral, y facilita la realización de una correcta planificación de los trabajos, una adecuada medición y presupuestación de las partidas y, sobre todo, una buena ejecución en obra. Por ello, la adquisición de destrezas para la realización de detalles constructivos es una competencia clave para los técnicos de edificación. El objetivo principal es diseñar una rúbrica que permita la evaluación de competencias en la realización de detalles constructivos de los acabados interiores de la edificación (pavimentos, falsos techos, particiones,

Citation: Maria-Francisca Cespedes-Lopez, Raul-Tomas Mora-Garcia & V. Raul Perez-Sanchez. (2025). Rubric for the Acquisition of Competencies for the Development of Construction Details for Buildings: Design and Evaluation of the Rubric. *Research in Education and Learning Innovation Archives*, 35, 74–92. 10.7203/realia.35.30340

Sponsor / **Funding:** No funding declared in this research.

etc.) del alumnado del Grado en Arquitectura Técnica de la Universidad de Alicante. Los resultados muestran que, a medida que se realizaban los ejercicios previstos, se producía una mejora significativa en la resolución de los detalles constructivos por parte de los estudiantes. La rúbrica diseñada permite evaluar el pensamiento complejo, mediante el uso de proyectos reales en la resolución de problemas, lo que se ve reforzado por el uso de la rúbrica por los propios estudiantes a través de la evaluación entre iguales. Las rúbricas permiten evaluar la adquisición de las competencias exigidas por el Espacio Europeo de Educación Superior y favorecer el aprendizaje autónomo y autorregulado de los estudiantes. Además, la evaluación entre iguales ha proporcionado a los estudiantes una herramienta de formación y autoevaluación.

PALABRAS CLAVE: Rúbrica de evaluación; detalles constructivos; revisión por pares; construcción; ingeniería de edificación; competencias profesionales en construcción.

RESUM: Aquesta investigació se centra en la formació dels estudiants d'Arquitectura Tècnica o Enginyeria d'Edificació que, juntament amb altres tècnics, intervenen en el sector de la construcció espanyol. La realització de detalls constructius com a eina de comunicació permet eliminar qualsevol tipus d'ambigüitat o dubte derivat del llenguatge oral, i facilita la realització d'una correcta planificació dels treballs, un adequat mesurament i pressupost de les partides i, sobretot, una bona execució en obra. Per això, l'adquisició de destreses per a la realització de detalls constructius és una competència clau per als tècnics d'edificació. L'objectiu principal és dissenyar una rúbrica que permeta l'avaluació de competències en la realització de detalls constructius dels acabats interiors de l'edificació (paviments, falsos sostres, particions, etc.) de l'alumnat del Grau en Arquitectura Tècnica de la Universitat d'Alacant. Els resultats mostren que, a mesura que es realitzaven els exercicis previstos, es produïa una millora significativa en la resolució dels detalls constructius per part dels estudiants. La rúbrica dissenyada permet avaluar el pensament complex, mitjançant l'ús de projectes reals en la resolució de problemes, la qual cosa es veu reforçat per l'ús de la rúbrica pels propis estudiants a través de l'avaluació entre iguals. Les rúbriques permeten avaluar l'adquisició de les competències exigides per l'Espai Europeu d'Educació Superior i afavorir l'aprenentatge autònom i autoregulat dels estudiants. A més, l'avaluació entre iguals ha proporcionat als estudiants una eina de formació i autoavaluació.

PARAULES CLAU: Rúbrica d'avaluació; detalls constructius; revisió d'experts; construcció; enginyeria d'edificació; competències professionals en construcció.

Practitioner notes

What is already known about this topic

- Construction details, as a communication tool, eliminate ambiguities in oral language and facilitate the planning, measuring, budgeting and execution of works.
- Architectural projects do not usually include construction details, nor construction details of the execution of singular points.
- There are shortcomings in the technicians when it comes to construction details.

What this paper adds

- A rubric that allows the development of the necessary competences for the execution of construction details.
- Tools that favor autonomous and self-regulated student learning, such as peer assessment.

Implications for practice and/or policy

- The use of the rubric has made the assessment system more objective and comprehensible for the students.
- The use of this tool has made it possible to analyze whether students have acquired the competence to tackle the resolution of technical problems on the construction site.

1. INTRODUCTION AND REVIEW OF THE LITERATURE

The construction sector is a field that brings many benefits to society, as it is responsible for providing buildings for various activities: residential, labor, teaching, hospital, and leisure, as well as the necessary infrastructures that accompany all these activities.

This research focuses on the training of one of the agents involved in the Spanish construction sector, especially in the building subsector; graduates in technical architecture (GTA) or building engineering (GBI). These professionals have many professional opportunities, such as the technical management of new constructions or rehabilitation projects, the management of the construction work production, project and work implementation audits, and the drafting of technical reports, expert opinions, appraisals, and valuations, among others. This vast field of work requires that the technicians must not only acquire the necessary knowledge during their training, but also acquire competencies that enable them to communicate their knowledge orally, in writing, and graphically. The implication of this situation is that universities must adapt to the demands of the market (Mora, 2003) and include tools in their curricula that allow students' knowledge and skills acquisition to be assessed.

The design of the building engineer curriculum includes different classes, in addition to drawing, in which the use of graphic representation systems for communication is very important. Some of these classes include construction, in which the development of construction details plays a very important role in the evaluation of the classes. The development of construction details allows for the clarification and definition of specific areas of the building that require special attention because they are unique aspects of the construction. Some examples include façade starts, the joints between the enclosure and the carpentry, slab fronts, parapets, overhangs, and roof drains, which are all part of the set of unique points established by the Spanish Technical Building Code —TBC— (MV, 2006) and whose object of study is part of the objectives of these classes.

The graphic representation used for the construction details removes any type of ambiguity or doubt resulting from oral language and allows for the correct planning of works, the adequate measurement and budgeting of the items, and, above all, a successful development of the work on site. A number of authors (Arjona Borrego, 2003; Carranza Núñez et al., 2010; Piñeiro Martínez de Lecea et al., 2008) have indicated that architectural projects do not usually include construction details or the procedures for the construction of the unique points. Therefore, the technicians in charge of site management and site managers need to have the necessary knowledge and skills to be able to solve these problems and resolve any doubts that may arise during the construction phase (Arjona Borrego, 2003).

Authors such as Rich & Dean (1999) and Martínez Sánchez (2009) observed that the new generations of technicians were lacking when it came to making sketches or resolving construction details. This finding, together with the absence of construction details in architectural projects, has led the teaching staff of the Construction of Non-Structural Elements (CNSE I and II) class in the Building Engineering degree at the University of Alicante to ask themselves the following questions: how do we evaluate the acquisition of competencies in the development and interpretation of construction details? How do we verify that students acquire the appropriate technical knowledge?

To try to answer these questions, teachers have decided to use rubrics as they allow students to develop competencies, improve performance, and understand the objectives and weight of the class studied. Therefore, we searched for research where rubrics were used for the acquisition of competencies in the development of construction details. To the authors' knowledge, there is only one document by Celadyn (2020) where a rubric has been used to evaluate the development of construction details in architecture. Rubrics have also been used by other researchers in fields such as engineering and design. Authors such as Souza et al. (2022) proposed a process where they developed rubrics for the assessment of competencies in Project Management; Cantera et al. (2021) applied a rubric designed to assess the writing skills of a group of engineering students; Boyd & Hassett (2000) developed a rubric for assessing specification or report writing in engineering and technology; Besterfield-Sacre et al. (2004) investigated the use of a rubric to assess knowledge integration using concept maps in industrial engineering; Kelley & Sung (2017) created a rubric to assess how students learned and used design sketches to support their learning of science and design practices; and Sáiz Manzanares et al. (2015) employed rubrics to assess foundation construction systems, considering aspects regarding the graphical representation of the construction elements.

Other studies in the field of higher education used rubrics, especially in integrative or workshop subjects, where students applied their prior knowledge to address complex problems. Martínez Vitor (2021) designed three rubrics for the evaluation of architectural design projects, focused on assessing student performance in dimensions such as project concept, architectural research, and architectural program development. One of the rubrics included criteria oriented to the evaluation of the graphic representation of the architectural project and the volumetric composition in 2D and 3D. In turn, in the Architecture degree program at the Universidad Nacional del Nordeste, rubrics were applied for self-evaluation and peer evaluation as well as for teacher evaluation in a subject dedicated to industrialized construction systems (Rosanna & Claudia, 2025). In another study, Siddiquee et al. (2024) developed a set of rubrics for the subject "Vernacular Architecture" in architectural studies, including criteria for evaluating the quality, neatness, and proportion of the sketches produced by the students.

Despite the limited literature found in the field of construction details, Allen & Tanner (2006) and Velasco-Martínez & Tójar-Hurtado (2018) show that there is a growing use of rubrics in the university environment. One of the reasons for this is that rubrics can be used to evaluate the acquisition of competencies required by the European Higher Education Area (EHEA) (Cebrián de la Serna & Bergman, 2014; Fernández March, 2005; García-López et al., 2017; Reddy & Andrade, 2010; Romero-López, 2017) and favor autonomous and self-regulated student learning (Padilla-Carmona et al., 2010).

The main objective of the present work is to design and evaluate a rubric that allows for the evaluation of the competencies that students studying the Building Engineering degree at the University of Alicante have acquired for the development of construction details. The secondary objectives are to ensure that the weight of the criteria is adequate and that a high percentage of students have acquired the competency. Therefore, this work represents a new contribution to the scarce bibliography.

The first hypothesis (H1) put forward in the research is that the rubric makes it possible to evaluate the students' competencies for the development of construction details. The second hypothesis (H2) is that the weighting or scoring of the criteria is adequate. The third hypothesis (H3) is that the use of the rubric by the students has allowed for the measurement of whether the students have acquired the competency to carry out the construction details.

This document is organized as follows: The second section describes the materials and method. The third section details the results. The fourth section discusses the results, and the fifth section summarizes the conclusions and limitations.

2. MATERIALS AND METHODS

2.1. Research design

The research developed in this work is instrumental and consisted of the preparation of a rubric, the analysis of its properties, and its application (Montero & León, 2002). The information collected was organized using Microsoft Excel 365 (Microsoft Office) software and analyzed using version 26 of the SPSS statistical package for Windows (IBM Corp., 2019).

The research was carried out through the following phases:

1. Definition and procedure for the development of construction details.
2. Design of the rubric.
3. Application of the rubric to the students of the CNSE-I class in the Building Engineering degree at the University of Alicante.
4. Reliability and construct validity analysis of the rubric.

2.2. Construction detail

In the Construction of Non-Structural Elements I (CNSE-I) class, the UA Moodle (Dougiamas, 2001; Dougiamas & Taylor, 2003) platform allows teachers to have a digital and computerized support where students can download materials, submit and grade exercises, and take evaluation tests or workshops, among other tools (Al-Ajlan & Zedan, 2008). At the beginning of each academic year, the students enrolled in the course have access to the platform, where they are provided with all the teaching material to be used, the technical building and graphic representation regulations, as well as the distribution plans for a real construction project.

During the course, different practices were carried out, for which the students had to carry out different freehand construction details based on the construction project provided. On the Moodle platform, the instructions for the exercises were published, indicating the sections to be done and the materials that made up the construction elements that had to be drawn (Figure 1).

The work had to be done on a template in an A3 landscape format provided by the teacher, on which the area where the requested construction section and the legend were to be carried out were defined (Figure 2). In the first classes, the students were

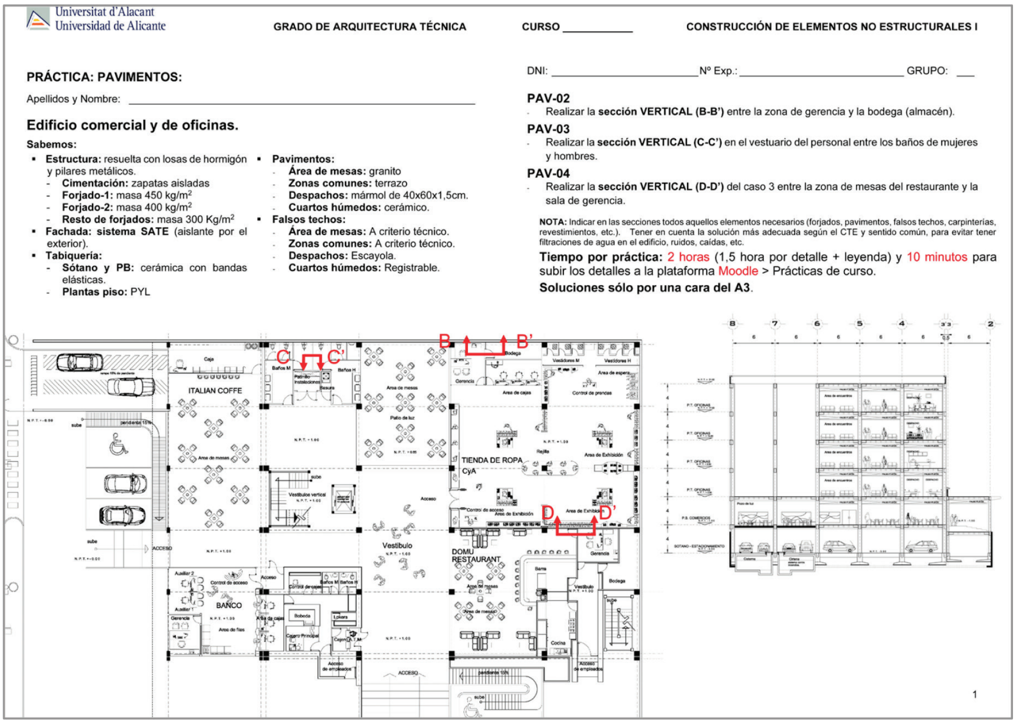


Figure 1. *Summary of one of the course exercises. Source: authors*

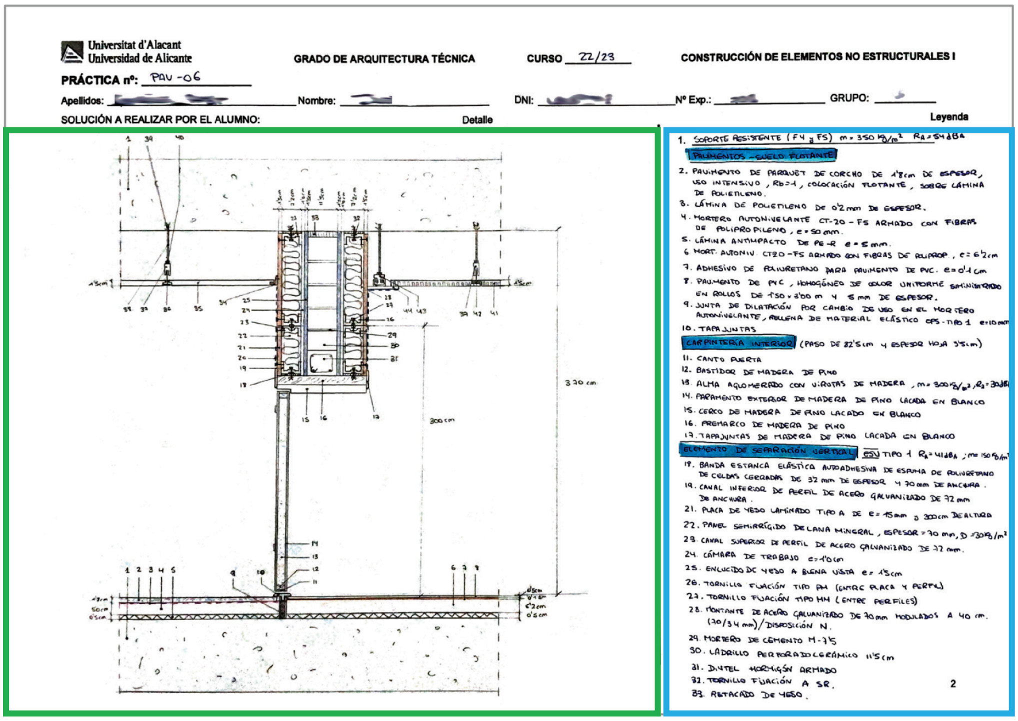


Figure 2. *Template for the course exercises, with the resolution made by a student. The box on the left is the area for solving the construction detail and on the right is the area for the legend. Source: student of the subject (2022)*

instructed on the procedure to follow to produce construction details and were shown other construction details from previous courses as examples. The following is a summary of the instructions provided to the students for producing construction details:

1. Compliance with regulatory requirements. Students should list and check the regulatory requirements that must be considered when creating the detail, such as the different basic documents of the Spanish Technical Building Code (TBC) (MV, 2006), the seismic-resistant construction standard (MF, 2002), and the habitability and design regulations by the Valencian Community —HD-09— (CMAAUV, 2009). For example, the thickness and type of anti-shock layers to be used for floors must be calculated in order to comply with the requirements of the Spanish basic document on noise protection —BD-NP— (MF, 2019), the need for aerators in the interior carpentry in accordance with the requirements of the basic document on health and safety —BD-HS— (MITMA, 2022b), thermal insulation as defined in the basic document on energy savings —BD-ES— (MITMA, 2022a) or the separation between fire sectors in accordance with the basic document on fire safety —BD-FS— (MITMA, 2022c).
2. Definition of the production process. Students must include a definition and explanation of the order of the different operations to be carried out, given that these have an influence on the graphic representation of the different construction elements (structure, floating floors, partitions, suspended ceilings, etc.).
3. Production of the construction detail. Students must define a scale to make the drawing, evaluate which elements are being sectioned according to the section plane indicated in the outline and which are being left in projection. They must also indicate the names of each space and dimension, according to the regulations on construction drawing in force (ECS, 1997, 1999a, 1999b, 1999c, 2019, 2022).

4. Definition of the materials used. Students must make a numbered legend where the materials used are defined.

2.3. Instrument. Design of the evaluation rubric

The rubric was created to assess competencies in the development of construction details for the interior sections of buildings. It was named "Rubric for Partitions, Cladding, Suspended Ceilings, Carpentry, and Flooring" (Rub_PCSCF). For these interior sections, the components to be represented are the interior partitions and their linings, suspended ceilings, carpentry, and interior flooring.

The rubric was developed based on the recommendations of previous research carried out by other authors, who suggest that a rubric should contain the optimal number of criteria, a description of the criteria, and a score that allows the performance of the exercise to be rated (Allen & Tanner, 2006; Moskal, 2000; Roblyer & Wiencke, 2003).

Based on these recommendations, a list of criteria, levels, and scores was created and agreed upon for each of the construction elements analyzed. The chosen criteria directly impact the acquisition of competencies by the students. For each criterion and level, a score was assigned in such a way that the students evaluated could obtain a total score between 0 and 100 points. The criteria were categorized according to the construction element sectioned (partitions, carpentry, flooring, and suspended ceilings) and the quality of the graphics in the construction detail (See "Additional material" at the end of the document).

Eight experts from the Building Science Department of the same university participated in the design of the rubric, all of them have a doctoral degree and teach in a university degree in building engineering. The eight experts teach or have taught classes on building construction processes and systems at different levels of the degree (1st, 2nd and 3rd year).

2.4. Participants and procedure. Application of the rubric

The rubric was introduced on the Moodle platform as a "workshop" exercise for the CNSE-I class during the 2022-23 academic year, with a total of 32 students being enrolled, of which 62.5% were male and 37.5% were female.

The Moodle workshop exercise enables the evaluation and grading of assignments by the students themselves, which is also known as student-to-student peer assessment. This type of exercise provides an environment for collaborative learning (Casal, 2016; Ibarra Sáiz et al., 2012). The Rub_PCSCF rubric was used to establish the correction criteria for the workshops and the grades obtained by the students were part of the final evaluation of the class.

The workshops are developed in five phases which were planned by the teachers and were visible within the exercise itself. In the first phase, called *configuration*, the teachers established the dates of completion and the instructions for the exercise. Moreover, the possibility of sending comments was made available as an option, and adjustments to the grade were made to give a weight of 8 points to the submission of the detail and 2 points to the correction made by the student, thus allowing a maximum grade of 10 points per delivery to be obtained with the sum of both sections. This first stage was a preparatory phase for the work to be done, in which the students did not have to perform any exercise. The second stage was the *sending* phase, in which the students uploaded the construction detail which they had previously scanned with their cell phones in the classroom to the platform. In this phase, the teachers could visualize the number of submissions made. When the submission phase ended (on the due date and time of the submission), each student was randomly assigned a submission for further correction. The random submission was configured so that a student would not be assigned their own submitted work. The third phase was the *evaluation* phase, where the students used the Rubric Rub_PCSCF to correct the exercise of a fellow classmate, which corresponded to the construction detail assigned to them in the previous phase. In addition, students could voluntarily provide specific comments on the evaluated detail. The fourth phase was the *grading* phase, in which Moodle, based on the scores assigned in the rubric, calculated the provisional grade for each exercise. In this phase, the teaching staff reviewed the submissions and the evaluations made by the students and provided additional specific comments when appropriate for both. The last phase corresponded to the *completion*, which implied that the grades were final and were transferred to the grade book. From this point onwards, the students had access to the submissions made, the corrections with the rubric, and any comments, as well as the score obtained.

In the planning of the course, 7 two-hour sessions were scheduled, in which the students were required to produce a series of construction details in the classroom. Another 7 two-hour sessions were also planned, in which the teachers would freehand the solution of the construction detail, with its corresponding legend on the blackboard or through the use of a digital tablet. In the first sessions, following the construction detail, the teacher selected a student at random and corrected their work with the rubric, while the students also had to correct the randomly assigned student. As suggested by (Price & Rust, 1999), any doubts that might arise during the grading would be resolved on the spot, allowing the teacher to know if the students had a good understanding of the rubric descriptors and allowing the students to identify common rules for grading that would facilitate the task by helping them to focus their comments on the corrections.

The evaluation of the details allowed for the analysis of whether the student had acquired the skills to solve technical building problems, showing the level of knowledge acquired on the theoretical contents of the course, materials, construction systems, and technical drawing.

2.5. Rubric Analysis

The reliability of the internal consistency of the items that make up the rubric was measured by Cronbach's alpha (Cronbach, 1951). Construct validity was evaluated through the exploratory Factor Analysis technique using the Principal Components method and Varimax rotation (Kaiser, 1958).

Factor analysis is a multivariate technique of interdependence, in which the interrelationships of all variables are analyzed simultaneously, and whose main purpose is to define the underlying structure of a data matrix (Hair et al., 2014). With factor analysis it is possible to analyze the structure of the interrelationships between a large number of variables to determine whether the information can be condensed or summarized into a smaller number of factors. The general steps for a factor analysis can be summarized in the following steps (Brown, 2015; Cattell, 1965; Hair et al., 2014; Pla, 1986):

1) Previous aspects. The variables must be conceptually relevant to what is to be measured or evaluated.
2) Analysis of the correlation matrix. There must be high correlations between the variables, allowing the identification of redundant information in order to simplify the factors that explain most of the total variability.
3) Adequacy of the data for factor analysis. To determine whether it is appropriate to use this technique, several tests are used to measure the degree of association between variables, as a complement to the descriptive analysis of the correlation matrix.

- The determinant of the correlation matrix is an indicator of the degree of intercorrelations between the variables and should be a value close to zero.
- Bartlett's test of sphericity checks whether the correlation matrix is an identity matrix. The Chi-square statistic must be statistically significant.
- The partial correlation coefficient is used as an indicator that represents the intensity of the relationships between two variables eliminating the influence of the other variables involved in the analysis. Low values (close to zero) should predominate in the partial correlations.
- The Kaiser-Meyer-Olkin (KMO) test is a measure of the adequacy of the data for factor analysis, measuring the sampling adequacy for each variable in the model and for the entire model. The statistic is a measure of the proportion of variance between variables that could be common variance. The KMO test checks whether the partial correlations between variables are sufficiently small. The higher the KMO value, the greater the linear dependence that exists between the set of variables.
- The anti-image correlation matrix should contain few high values (in absolute values) and there should not be a large number of coefficients with zero values.
- The Measure of Sampling Adequacy (MSA) for each variable, the diagonal of the anti-image correlation matrix, should be greater than 0.5.

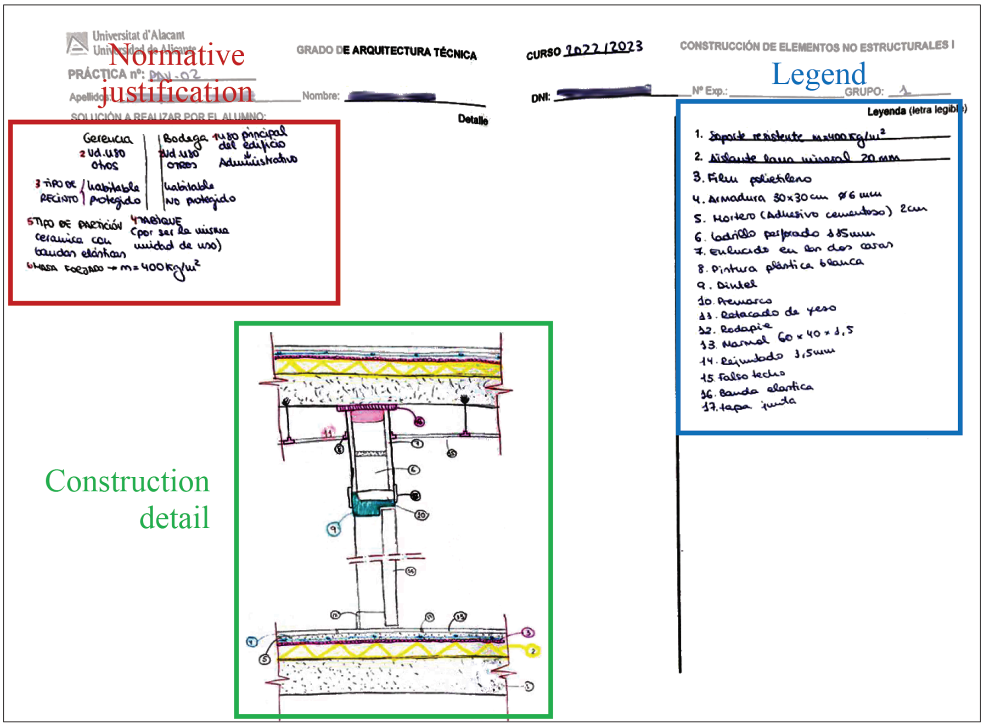
4) Extraction of the factors. The factors are ordered according to the greatest amount of variance explained. The number of factors to be retained is determined using the criterion of eigenvalue > 1.
5) Analysis of the factorial matrix. It is used to interpret the role that each variable plays in defining each factor. The values of the factorial matrix represent the correlation coefficients of the standardized original variables with each of the factors or components. A rotation of the factorial axes is performed to facilitate the interpretation of the factors.

3. ANALYSIS AND RESULTS

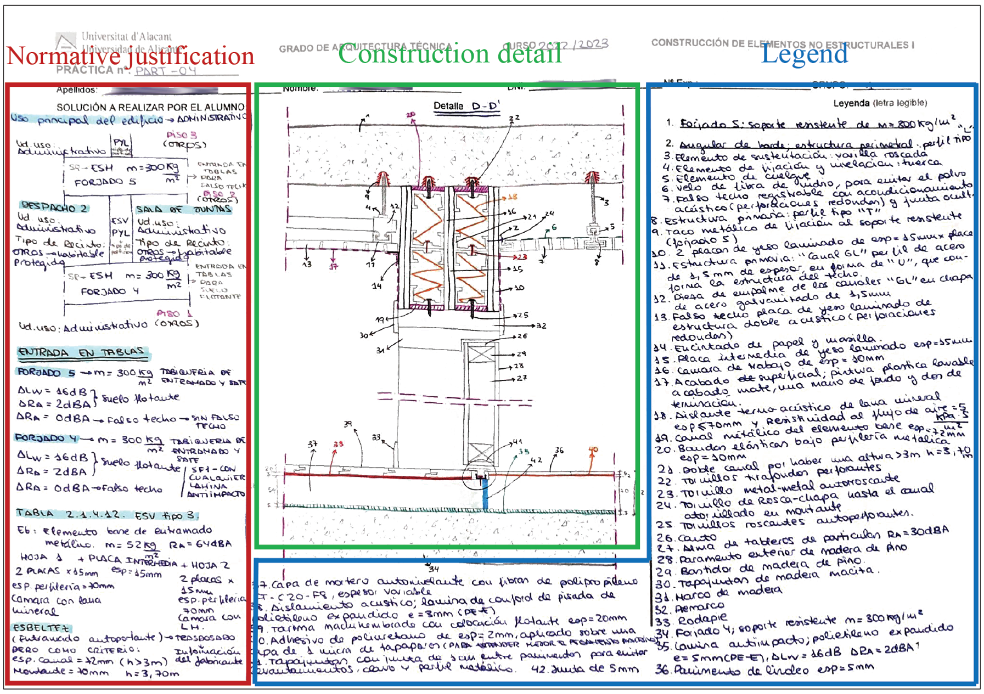
Throughout the exercise resolution sessions, the teachers used the rubric to correct the construction details, helping the students to understand the evaluation criteria in order for them to be able to carry out the peer assessment, as well as addressing the wording of those sections where the students could have comprehension issues. In this way, the existing doubts and suggestions were specifically identified and the modifications to be included in the rubric were decided with the students in the classroom. This feedback process made it possible to incorporate the students' suggestions to improve the rubric during the last four sessions.

The results show that, over the four-month period, and as the planned exercises were carried out, there was a significant improvement in the resolution of the construction details by the students. The improvement observed corresponds with the criteria established in the Rubric Rub_PCSCF and refers to the justification of the regulations, the graphic definition of the construction elements sectioned, and the description of the materials used (legend). By way of example, and with the aim of showing the mentioned improvement, the first and the last exercise of one of the students (Figure 3) has been selected.

Figure 3a shows the image of the first course exercise done by the student and shows that the justification of the normative criteria (red box) is very insufficient. The



a)



b)

Figure 3. *The submissions made by the same student are compared, figure a) corresponds to the first exercise done in class and figure b) corresponds to the last exercise done in the class. Source: student of the subject (2022)*

graphic representation is not very defining and the elements are represented in a very basic way (green box). The content and extent of the legend are very limited since the materials are not described in a detailed way in order to be able to build the section represented (blue box).

In Figure 3b, the image of the final course exercise done by the same student is shown. Compared to Figure 3a, the improvement is considerable, with a rigorous normative justification (red box), a considerable improvement in the graphic layout of the detail and definition of its elements (green box), and a significant improvement in the description of the materials used (blue box).

To assess construct validity, a factor analysis is performed. Construct validity is defined as the ability of the instrument to actually measure what it is intended to measure. Factor analysis allows us to identify the number of factors that explain the covariance between the rubric's criteria. That is, it identifies the extent to which each criterion is correlated with the factor.

The correlation matrix showed that the rubric criteria are related, and Bartlett's test of sphericity (X^2=7124.7, p<0.000) confirms that it is not an identity matrix. Furthermore, the low value obtained for the determinant (3.214×10^{-15}), confirms the adequacy of the analysis performed.

A value of 0.956 was obtained in the KMO test, which supports the application of factor analysis. If the result obtained is between 0.8 and 1, the use of factor analysis is considered appropriate (Dziuban & Shirkey, 1974; Kaiser & Rice, 1974).

The anti-image correlation matrix was also analyzed and two issues were observed. On the one hand, the non-existence of a large number of high absolute values and zero coefficients. On the other hand, the Measure of Sampling Adequacy (MSA, diagonal of the anti-image correlation matrix) of each variable is close to unity. These two questions, together with those indicated above, demonstrate the goodness of fit of the data to be able to apply factor analysis.

Once the feasibility of the factor analysis was verified, the factors were extracted by grouping the 26 criteria that make up the rubric (Rub_PCSCF). For this purpose, the principal components method was used, which extracts components whose eigenvalue is greater than unity (Figure 4). From the sedimentation plot it can be identified that there are two underlying factors, the first being the most relevant.

Analyzing the factor loadings of Table 1, it can be observed that factor 1 mainly includes the criteria related to the design of the solution. These criteria include questions of understanding the statement, application of the regulations and execution of the construction elements analyzed (flooring, partitions, etc.). Factor 2 groups the criteria related to the graphic representation and the definition of the materials used in the solution, that is, the descriptive legend.

To verify the suitability of the scores assigned to the 26 rubric criteria, an analysis of the internal consistency of the scale was performed for each of the exercises

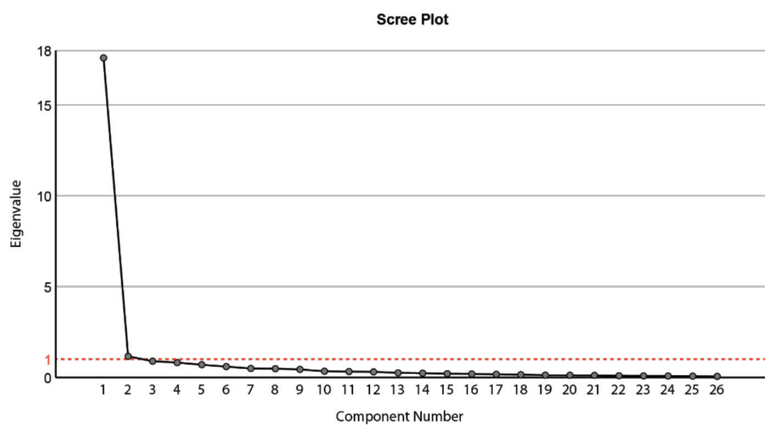


Figure 4. *Sedimentation plot of the principal component analysis of the rubric (Rub_PCSCF). Source: authors*

Table 1. *Factor loadings for 2 factors. Source: authors*

ID	CRITERIA	Factor 1	Factor 2
14	Criterion 14 (0-1-2 points) FLOORING. Vapor barrier (VB)	**0.839**	0.251
13	Criterion 13 (0-1-2 points) FLOORING. Thermal insulation (TI)	**0.830**	0.310
10	Criterion 10 (0-1-2 points) FLOORING. Noise regulations	**0.771**	0.407
12	Criterion 12 (0-1-2 points) FLOORING. Floating floor (FF) requirements	**0.764**	0.392
16	Criterion 16 (0-1-2 points) FLOORING. Flooring: material	**0.732**	0.468
08	Criterion 08 (0-3-5 points) CARPENTRY. Interior carpentry	**0.718**	0.474
01	Criterion 01 (0-1-2 points) PARTITIONS. Noise regulations	**0.717**	0.475
11	Criterion 11 (0-2-5 points) FLOORING. Noise regulations (floors)	**0.714**	0.477
07	Criterion 07 (0-2-4 points) CARPENTRY. Creation of the opening (doors)	**0.709**	0.480
02	Criterion 02 (0-2-4-6 points) PARTITIONS. Noise regulations	**0.696**	0.523
03	Criterion 03 (0-1-2 points) PARTITIONS. Partitions	**0.683**	0.564
21	Criterion 21 (0-3-5 points) SUSPENDED CEILINGS. Noise regulations	**0.681**	0.565
20	Criterion 20 (0-1-2 points) SUSPENDED CEILINGS. Noise regulations	**0.659**	0.496
04	Criterion 04 (0-1-2-5 points) PARTITIONS. Claddings.	**0.637**	0.545
15	Criterion 15 (0-1-2 points) FLOORING. Expansion joints for the flooring	**0.623**	0.441
09	Criterion 09 (0-1-2-3 points) CARPENTRY. Legend	**0.622**	0.573
25	Criterion 25 (0-1-4-8) SUSPENDED CEILINGS. Legend	0.327	**0.848**
06	Criterion 06 (0-1-4-7 points) PARTITIONS. Legend	0.422	**0.808**
23	Criterion 23 (0-1-2 points) SUSPENDED CEILINGS. Suspended ceiling components	0.387	**0.790**
18	Criterion 18 (0-1-3-6 points) FLOORING. Legend	0.389	**0.786**
26	Criterion 26 (0-3-6-12 points) GRAPHICS. Graphic representation	0.382	**0.778**
22	Criterion 22 (0-3-6 points) SUSPENDED CEILINGS. Type of suspended ceiling	0.387	**0.707**
19	Criterion 19 (0-1-2 points) FLOORING. Adjustment of the height of the flooring	0.449	**0.643**
05	Criterion 05 (0-1-2 points) PARTITIONS. Surface finish	0.517	**0.614**

(*continued*)

Table 1. *Factor loadings for 2 factors. Source: authors (continued)*

ID	CRITERIA	Factor 1	Factor 2
17	Criterion 17 (0-1-2 points)	0.512	**0.601**
	FLOORING. Flooring: laying		
24	Criterion 24 (0-1-2 points)	0.491	**0.518**
	SUSPENDED CEILINGS. Surface finish of the suspended ceiling		
	Explained Variance (total=72.1%)	38.6%	**33.5%**

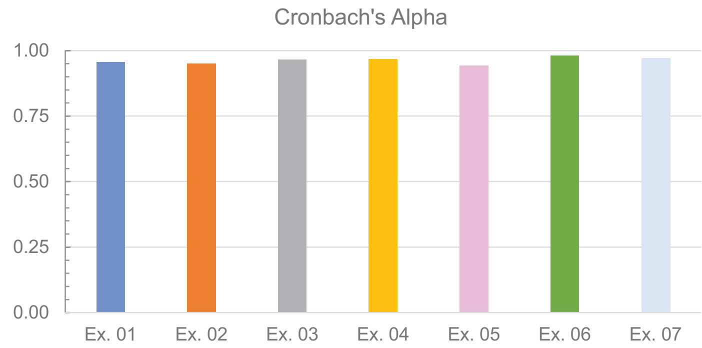


Figure 5. *Bar chart showing the different values of Cronbach's Alpha obtained for each of the exercises performed. Source: authors*

carried out, obtaining high values for Cronbach's Alpha (Figure 5). Authors such as Hair et al. (2014) consider that values higher than 0.80 are adequate. As can be seen in Figure 5, the reliability of the scale scores for each of the activities performed is above 0.9.

To establish whether the students enrolled (S1, S2, ..., S32) have acquired the competency, the grades obtained in the exercises evaluated by their peers with the proposed rubric are observed and the average is calculated. If the average is ≥5, the student is considered to have acquired competencies in the development of construction details for interior building sections (Figure 6). The results show that 63% of the enrolled students have acquired the competency.

4. DISCUSSION AND CONCLUSIONS

In this study, a rubric was designed and evaluated to assess competencies in the development of construction details for the interior of buildings. The research was carried out within the scope of the Construction of Non-Structural Elements I (CNSE-I) class for the degree in Building Engineering at the University of Alicante. In order to achieve the expected objectives, three hypotheses are proposed.

(H1) The rubric makes it possible to evaluate the students' competencies for the production of construction details. This hypothesis is confirmed by the following observations:

- The rubric proposed in this study, Rub_PCSCF, addresses essential criteria in order to be able to produce a construction detail. This is based on the justification of the regulations in force, the graphic definition of the construction elements sectioned, and the description of the materials used (legend). According to Tobón (2017), this rubric is included within the so-called socio-formative rubrics for

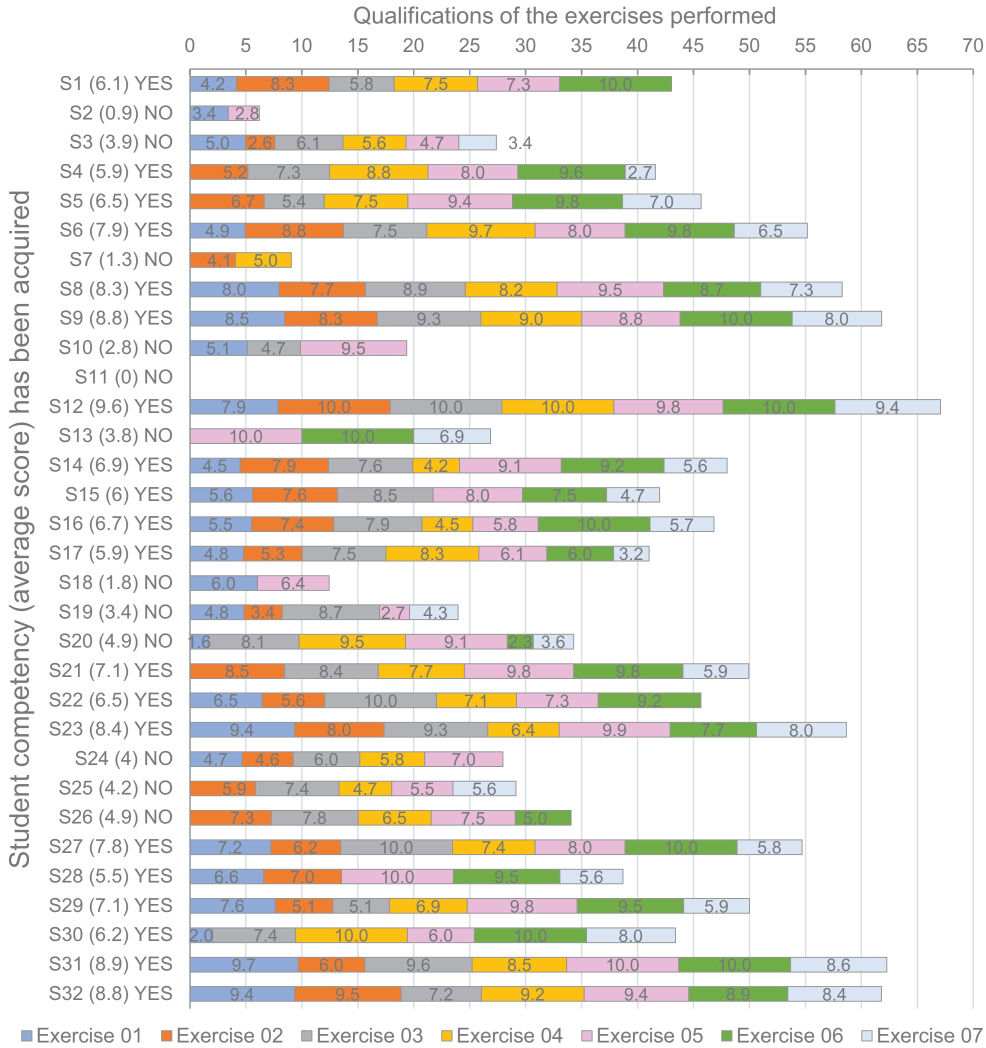


Figure 6. *Bar chart showing the student identifier, the average of the grades obtained by the students in each of the exercises or workshops carried out with the rubric (Rub_PCSCF), and whether the students have acquired the competencies to carry out construction details. Source: authors*

different reasons. The first is that it focuses on the resolution of problems based on real projects of work implementation, in such a way that it gathers the knowledge of different disciplines (architectural drawing, materials, construction, etc.) that help to address the problem. The second reason is that since it is the students who use the rubric to correct the work of their classmates, this requires them to evaluate the work of others, which requires values such as honesty, responsibility, and respect for the work of others.

- The clarity and understanding of the criteria were ensured by involving the students themselves during the first corrections of the exercises. This approach is in line with that used by other authors such as Rust et al. (2003), Sadler (2010) and Van Hattum-Janssen & Lourenço (2006), who emphasize the importance of showing the students the criteria and their interpretation. This helped to identify the criteria where there were greater difficulties in terms of interpretation and made it possible to modify the wording. The results of applying the instrument showed that, once the practice was corrected by the teacher, the students completed the rubric in a reasonable time (between 20-30 minutes).

- All criteria presented good results in terms of reliability and validity. In addition, the criteria presented consistent results in relation to the underlying factors of the rubric. The factor analysis revealed that the criteria have high factor loadings in the two proposed dimensions: 1) design of the construction solution and 2) definition of the materials used.

(H2) The weight or score of the criteria is adequate. The results obtained with the internal consistency measurement using Cronbach's Alpha confirm this hypothesis and allow us to affirm that the weight assigned to the criteria is adequate.

(H3) The use of the rubric allows measurement of whether students have acquired competencies in making construction details. Authors such Chowdhury (2019), Moskal (2000) and Sadler (2010) suggest that students have acquired the competency when certain conditions are met. In this study, the competency is considered to have been acquired when the average score of the activities is greater than or equal to five (on a scale of one to ten), and it is estimated that 63% of the students enrolled had acquired the competency.

The rubric that was designed in this research, Rub_PCSCF, has enabled students to understand more clearly what the objective is and how the rubric is to be implemented as a tool for correcting construction details. In this way, a more objective and understandable evaluation system has been achieved for the students.

Secondly, the rubric allows to analyze whether the student had acquired the competencies to solve technical building problems, showing the level of knowledge acquired on the theoretical contents of the course, materials, construction systems used, and technical drawing. These issues are of great importance for the professional work of future graduates. The designed rubric allows for the evaluation of complex thinking, by using real projects in problem-solving, which is strengthened by the use of the rubric by the students themselves through peer assessment. In addition, the inclusion of the students' comments and/or suggestions in the rubric on a voluntary basis, has made the students more involved in the modeling of the correction system of their exercises, thus considerably improving the participation and the result of the evaluation.

As seen in the literature review, there is a considerable shortage of documents that analyze the use of rubrics in the evaluation of construction details. Only the work done by Celadyn (2020) was found, in which the rubric developed does not mention the reliability of the score, and uses criteria and levels different from the rubric proposed by the work developed in this research. Therefore, it is believed that the rubric proposed here is a tool that serves as a basis to be applied in other universities with the same or similar degrees, as well as in other studies within the area of knowledge.

The results of this research are consistent with the findings of Sáiz Manzanares et al. (2015) and Siddiquee et al. (2024), who point out that the use of rubrics promotes more effective and independent learning by students, facilitating their self-regulation and self-assessment. They also coincide with the results of Rosanna and Claudia (2025), whose research concludes that the integration of self-assessment and peer assessment allows students to reflect on their own work, receive feedback from their peers, and, consequently, improve their performance. Furthermore, in line with Siddiquee et al. (2024), it should be noted that the use of rubrics contributes to a more standardized, transparent, and straightforward assessment, reducing subjectivity and bias in the evaluation process.

In terms of implications for practice and/or policy, the evaluation of competencies allows teachers to focus on those aspects where students need help. The rubric has allowed the students to understand the most important elements when performing a construction detail. In addition, student-to-student peer assessment has provided students with a tool for training and self-assessment.

As limitations of this work, it is important to emphasize that the instrument designed was developed to carry out construction details with students of the Technical Architecture or Building Engineering degree at a specific time and in a specific geographical location. As a result, the regulations used are those in force at the time and in the country where the research is being carried out. Therefore, in the event that this instrument is used as a basis, it must be adapted to the regulations of the country in question, as well as to the existing building technology.

ADDITIONAL MATERIAL

The "Rubric for Partitions, Cladding, Suspended Ceilings, Carpentry, and Flooring" (Rub_PCSCF) is available for download and review at the following links:
https://doi.org/10.6084/m9.figshare.29367182
http://hdl.handle.net/10045/155014

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