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Teaching Innovation in Architecture and Building Engineering

Challenges of the 21st century

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ISBN 978-3-031-59643-8 ISBN 978-3-031-59644-5 (eBook)
https://doi.org/10.1007/978-3-031-59644-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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Preface

Educational innovation in the Architecture and Building Engineering degrees is a process of evolution and improvement in teaching-learning practices. This process aims to adapt higher education to the scientific and technological advances that affect the development of these disciplines, as well as the needs of today's society. The Architecture, Engineering and Construction (AEC) sector is in constant evolution and transformation due to factors such as globalization, digitalization, sustainability, accessibility, safety, quality, efficiency, and competitiveness. These factors demand continuous and up-to-date training from architecture and building engineering professionals, enabling them to develop the necessary skills to design, execute and manage innovative construction projects. For this reason, educational innovation in Architecture and Building Engineering degrees becomes a key element to guarantee the quality and excellence of teaching process, as well as to respond to the expectations and demands of the AEC sector. Teaching innovation in these university degrees involves the implementation of new pedagogical approaches such as new methodologies, tools, and resources, which facilitate the learning process of students.

In addition, digital technologies have become particularly important as enablers of distance learning and teaching. The digital transformation of higher education was accelerated as a consequence of the health crisis of the global pandemic, which forced universities to adopt virtual or hybrid teaching modalities. However, numerous difficulties and challenges were faced during this process, both for teachers and students, who have had to adapt to a new learning scenario, with its advantages and limitations. The teaching experiences derived from this adaptation offer an insight into the opportunities offered by the digital transformation to improve the quality and equity of education, and to prepare students for the challenges and opportunities of the future.

In this context, *Teaching Innovation in Architecture and Building Engineering: Challenges of the twenty-first Century* includes real teaching and learning experiences from a multidisciplinary approach in the Architecture and Engineering degrees. This book explores a broad approach that includes building engineering and areas such as materials, structures, installations, etc. Several aspects of

educational innovation are addressed, including an in-depth discussion of innovative and active methodologies in the teaching-learning process.

The book is structured in three sections: the first part focused on studies about active learning methodologies. This part includes real experiences related to gamification, flipped classrooms, project-based learning, collaborative learning, service-learning, and team-based learning. The second part included studies about the implementation of new methodologies such as Geographic Information System, Scrum, Building Information Modeling, and other computer applications. Finally, the third part included studies about traditional vs. advanced techniques.

The book offers inspiration for teachers to implement recent developments in the fields of building engineering and architecture, as well as professionals in the AEC sector who want to learn about the trends and opportunities offered by educational innovation to improve the quality and competitiveness of their projects. This book aims to be a contribution to the debate and exchange of knowledge on educational innovation in these degrees, as well as a source of inspiration and reference for the development of new proposals and innovative actions in this field.

Finally, an international perspective is included in this book, with contributions from real teaching experiences of academic and teachers from Chile, Colombia, Mexico, Japan, Italy, Portugal, and Spain. This fact makes this book a valuable resource for teachers interested in innovating educational processes and improving the teaching of AEC professionals.

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Chapter 12
Effectiveness of Collaborative Learning in Engineering Degrees: Improvement of Professional Skills

María Paz Sáez-Pérez, Carmelo María Torre, and Francesco Tajani

1 Introduction

The introduction of technologies and the influence of the business environment in the educational environment have caused transformations in the training approached and processed, especially learning [1]. Therefore, the supply of solutions adapted to the emerging training demands of the twenty-first century, as well as the preparation of students for the acquisition and development of strategies, skills and competencies, is considered a fundamental responsibility of contemporary educational institutions [2].

Within the framework of the European Higher Education Area (EHEA), the concept of "competences" refers to the capabilities, knowledge, and skills that students must acquire in their learning process, being crucial to address the challenges in their respective professional areas and in society in general.

Since their implementation, competencies have become an essential part of higher education curricula. Through them, the skills and knowledge that students must have upon completing an academic program are clearly identified and defined. These competencies are considered specific, focused on the field of study and transversal, aimed at achieving fundamental skills for employability, for example, collaboration, analytical reasoning, problem-solving, and effective communication.

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D. Bienvenido-Huertas et al. (eds.), *Teaching Innovation in Architecture and Building Engineering*, https://doi.org/10.1007/978-3-031-59644-5_12

Likewise, importance is given to personal skills, such as professional ethics and adaptability.

Therefore, it can be stated that the concept of collaborative work and the EHEA is closely linked, concentrating on raising the quality and effectiveness of higher education in Europe. Collaborative work, understood as collaboration among individuals to achieve common goals, agrees with the principles of the EHEA by promoting interaction among students, diversity of perspectives, and the acquisition of social and professional skills.

In the educational field, the practice of collaborative work implies that students collaborate on projects, tasks, or activities that promote the exchange of ideas, problem-solving, and mutual learning. This methodology has acquired increasing relevance in higher education, reflecting the reality of the work environment, where teamwork skills are crucial. In this way, it is confirmed that collaborative work and the EHEA share the vision of raising the conditions of higher education, enabling students to practice the challenges of the professional world and help to the development of more interconnected and collaborative societies.

In accordance with this purpose, educational institutions have highlighted the relevance of the development of transversal skills focused on employability throughout the educational process of university students. It is crucial to emphasize that the development of cognitive skills related to tasks involving analysis, evaluation, classification, and reasoning occurs through the correlation between the enhancement of abilities and progress in learning content. In addition, great importance is given to the promotion of competencies, since through this approach, students are recognized participants in the educational process, which enables them to generate new knowledge and solve problems. In this context, the didactic strategy proposed by another of the fundamental actors in the process, that is, the professor, is essential, since it impacts the way in which students learn and face the inherent difficulties [3, 4].

In recent years, the impact of collaborative work in the educational system is one of the best ways to achieve meaningful learning, as well as share and improve skills and abilities [5–9]. This approach has become a key objective, seeking to achieve universal education where the entire community collaborates systematically. Therefore, education must be based on a community approach, as the collaborative work has the potential to make a difference both in the educational community and in society at large while promoting inclusive education [10].

In general terms, the collaborative work has been developed as a didactic and training methodology applied in various areas [10], thus contributing to enhance the standard of living. At the institutional level, it is used to support and/or contribute to the advancement of knowledge, thus mobilizing all knowledge and developing competencies in the participants of the educational process [11]. Furthermore, it enables active interaction among individuals through a design of accommodation and interdependence [12]. Consequently, the collaborative work involves jointly addressing the resolution of a problem or the completion of a task, with a shared objective and ensuring the strengthening of actions not only at the individual level, but also at the group level, promoting equitable participation.

In the university context, collaborative learning is presented as an appropriate pedagogical method to acquire skills by focusing learning on students working in groups [13], with the purpose of maximizing both their individual and collective learning [14].

Following the perspective of [15], it is highlighted that the collaborative learning generates a type that is relevant, motivating, useful, lasting, deep, and significant, by integrating theoretical and practical aspects in an interrelated way, which translates into an improvement of academic results. Furthermore, as [16] indicates, collaborative learning is structured through various educational technological techniques and resources, thus enhancing classrooms in a didactic manner and generating significant events. In the context of the education process, this methodology has become essential, allowing the application of an active and interactive methodology in classrooms [17].

From the student's perspective, it is important to note that the collaborative learning is carried out through both synchronous and asynchronous interactions, which favors not only group work but also the autonomy of each member by using various means to exchange information with each other in the team. This enables learning to be achieved in a democratic and shared way [18].

The roles are changed, allowing the student to take on an active and responsible role in achieving their proposed goals [19], while the professor assumes the role of a collaborator and a guide, facilitating the learning process and allowing the professors to fully develop their functions [20].

Currently, classrooms are constituted by a diverse group of students, as noted [21]. This implies the need to address the different needs of all students, which has led to an evolution of teaching methodologies and practices toward a more student-centered approach [22]. Addressing these needs, educators have witnessed an increasing focus on the implementation of actions and work procedures in small groups, as noted by several researchers [21, 23, 24]. This not only addresses the diversity within the classroom but also leads to the enhancement of the development of skills relevant to college and career readiness, thereby improving the preparation of diverse students for their future.

2 Collaborative Work

Collaborative learning is defined as an approach that links the learning process with the construction of knowledge and with a social exchange among individuals [25, 26]. In the classroom context, this approach conceptualizes the training process and student participation as two closely interrelated phenomena. According to [27], the situated perspective on learning and knowledge creation implies that a student learns actively when he/she is engaged in his/her own learning processes. This perspective is aligned with a strategic conception in which students recognize their skills, abilities, and knowledge, helping them to become active participants in the construction of learning by feeling valued within the work group.

As a teaching tool, collaborative learning is based on the principle of "learning by doing" and offers undeniable advantages and possibilities to achieve this goal. Currently, according to [28], there is a need to establish a professional culture based on collaboration, which includes communication, collaborative work, collective reflection, and the search for shared solutions. However, as [29] points out, the careful design of collaborative learning activities is crucial and requires detailed planning and rigorous monitoring, since achieving an environment of communication and collaboration does not simply depend on being able to find a common space for work. Furthermore, it is essential to consider the creation of a climate of trust in the group, according to [30], in order to address possible internal conflicts, thus becoming a mediating tool of social interaction that encourages the development of interaction among colleagues in an inclusive and without discrimination, minimizing exclusion and lack of security [31].

Based on the preceding remarks, it is affirmed that the interaction and cooperation among students, integral to the collaborative process, emerge as a fundamental aspect in the learning experience. Its most outstanding attributes are the following:

Positive collaboration involves peers connecting and clearly understanding the group's task and objective, to achieve the desired outcome together. Therefore, each member of the group must take into account that individual effort influences collective success [32, 33].

Face-to-face communication is achieved through reciprocal interaction and verbal communication among group members. Therefore, it requires the active and committed participation of students. Groups should be limited to a maximum of four members, as they will sometimes do double duty by adhering to cooperative work, allowing for a shift in their various roles. Thus, the student will achieve optimal performance [34].

Each group member is responsible for playing his/her part in achieving shared goals, involving taking individual responsibility and appreciating others avoiding depending on the work of another. The purpose is to strengthen students academically and emotionally through learning teamwork, allowing the identification and making it easy to see who needs more help or support to finish their task [33, 35].

Regarding interpersonal skills, they are considered fundamental for the student's education. Social skills such as clear and precise communication, mutual support, constructive problem-solving, acceptance, and trust are practiced. These skills are crucial for performing well in group tasks, aiming to achieve advanced learning [36].

Group evaluation or self-assessment involves identifying the behaviors manifested by each student during group work. In addition, it is a component of the process of assessing its accomplishments, suggesting modifications and improvements to achieve the established objectives [37].

From the professor's perspective, the implementation of tasks collaboratively allows evaluating strategies such as: (1) assertive and relational communication skills [38] and (2) social construction of knowledge [39]. In this context, it is essential to highlight the need to design collaborative activities in a didactic manner,

aligning them with the previously established objectives according to the training and content needs and respecting the particularities of the students [40–42].

In this approach, the professor becomes a facilitator and a guide of the process, while students actively take responsibility for their own learning, simultaneously developing social and teamwork skills [43, 44]. Along these lines, authors such as [45] maintain that collaborative learning drives the improvement of communication skills, positive attitudes toward the community construction of knowledge, and group cohesion [43, 46].

On the other hand, collaborative work as a teaching instrument is based on the principle of "learning by doing," and in this sense, the usefulness of Information and Communications Technology (ICT) for its development is undeniable. Along the same lines, it can be stated that learning communities and networks exist, thanks to the possibilities of socialization and personal exchange that these technological supports offer, becoming one of the most common options for intercommunication and the establishment of significant relationships among people who intervene in them [47]. Figure 12.1 shows the interactions that derive from collaborative work in face-to-face teaching.

Among the advantages of the development of collaborative projects, the contribution proposed by authors such as [48] is notable, who suggest that these tasks favor the interdisciplinary integration of content in the EHEA. Likewise, results from other research indicate that students significantly value the knowledge acquired and the challenges faced in this work approach [49, 50].

Additionally, collaborative work emerges as an outstanding tool to cultivate student autonomy [43, 46]. This autonomy is nourished by the debates generated during decision-making, facilitating, at the same time, the social construction of knowledge mentioned above. In this context, it is essential to establish motivating work environments based on trust and respect, with the aim of ensuring that all team members perceive themselves as active agents and can exchange opinions and ideas assertively [51].

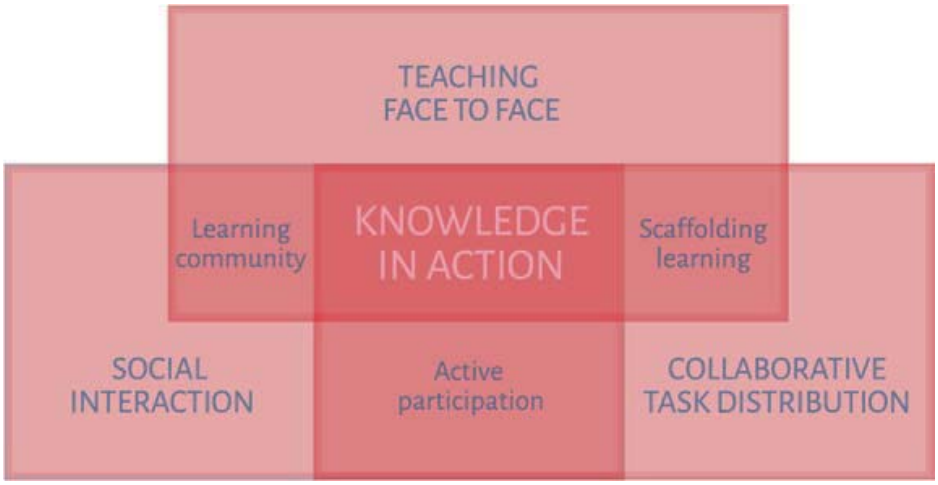


Fig. 12.1 Interactions in collaborative learning

In this study, the need to implement improvements and advances in teaching work led to the proposal of an innovation in the teaching-learning system with the objective of achieving effectiveness. To do this, a basic characterization of the situation identified in the teaching field and in professional performance was carried out. The comparison between the two made it possible to identify the differences and look for points of convergence.

From a professional perspective, the field of real estate valuation as a specialty requires highly specific knowledge and practice. Therefore, professionals should be experts in the field and capable of handling different cases that arise in each situation and purpose. In real practice, as per [52], cases often present "vaguely defined objectives, multiple solutions, multiple solution paths, and undeclared constraints," and deviations from the expected commonly occur. Moreover, the approach to solutions may be case-specific, evolve over time, or be entirely unknown [52, 53]. Additionally, in such situations, the difficulty of professional activity does not follow a linear sequence; that is, it does not increase in complexity as time, training, or knowledge of the technician handling the activity progresses.

Reality confirms that in the educational field, the problems, cases, or situations typically presented usually have well-organized plans, employing specific and strategic approaches to address the attainment of particular objectives. These cases tend to restrict, limit, or solve problems within their specific context, typically recognizing a single solution and enclosing themselves in a gradual and linear learning scheme, considerably simplifying the complexity of the environment. Furthermore, it is common for these scenarios not to consider external situations, remaining closed to possible external influences. On some occasions, the lack of professionals specialized in specific topics can lead to not considering relevant details for resolution.

Following the line of discussion raised by [54], the importance of engaging students in solving real-world complex problems is emphasized during their professional training. It is crucial to develop the ability to recognize, formulate, and solve problems, as well as define and address situations using bases of technical and professional knowledge, with a focus on "solving real technical problems" [55]. Therefore, curriculum plans for developing professional skills should focus on training technical analytical and problem-solving skills.

Traditionally, university teaching mainly relied on lectures where the professor explained concepts to students [24, 56]. In this model, students worked individually, with limited participation in their learning during class. This approach resulted in graduates facing an intense learning period when entering the professional world, not only acquiring new technical knowledge but also developing teamwork skills [57]. Various authors, including [58–61], have explored experiences to enhance and enrich methodological approaches in the context of these studies. The ongoing quest for improvement has driven such exploration.

3 Goals

After the bibliographic review carried out and the university context in technical degrees was known, the need to, on the one hand, advance in the student's knowledge of the subject was revealed, an issue partially resolved with the teaching of theoretical content and practical simulations, and on the other hand, giving the absence of professional experiences, it becomes essential to facilitate actions that enable direct engagement with the profession, thereby gaining insights into professional activities. As a result, the proposed objectives were set with a dual focus: one aimed at the training and professional activities of the students, and another directed toward the teaching and research activities, incorporating the collaborative work methodology.

In the training-professional aspect, the main objective was to prepare future professionals in generic skills within the context of the subject, which are referred to in the curriculum as transversal competencies. However, in this context, the main objective was not focused exclusively on the resolution of practices, but rather, the base structure was provided to be able to achieve the required competencies as well as the motivation for students to discover the knowledge acquired in the development of other skills required by their profession. It also encouraged students to explore and apply their knowledge in developing skills essential for their profession. Furthermore, the final assessment verified that the commitment to this methodology and improvements in European systems were indeed enhancing skills and acquiring competencies.

In the academic and research field, there was a recognized need to connect with reality and develop new methodologies, combining various forms of work, some previously developed by authors [24, 62]. Shared experiences in [63–67] indicated that these proposals aim not only for learning objectives or guiding students in fundamental concepts but also to pursue broader and essential goals for building their future professional paths. Therefore, it was suggested to address them collaboratively in a team format.

Based on these premises, the main objective of this research was focused on achieving the improvement of transversal skills, through collaborative work, without neglecting the understanding of fundamental concepts and testing the methodology.

Specifically, the goals were the following:

- Explore the perspectives and level of commitment of the students of the building degree in relation to collaboration at work, covering the examination of the tools and resources they use for their development.
- Determine and analyze both the positive aspects and the challenges linked to the use of collaborative work as a learning method to cultivate professional skills.
- Identify possible training needs associated with the ability to work collaboratively as an integral part of professional competencies.

4 Methodology

This section provides a detailed description of the implemented experience and covers the key aspects for a clear understanding of the obtained results.

The innovation was carried out during three academic years in the subject of "Assessments," belonging to the fourth (and last) year of the building degree of the University of Granada, of six credits (ECTS), in which they collaborated in the design of surveys and analysis of results by professors who teach this same subject at the universities of Bari and La Sapienza of Rome. The practical nature of this subject and the professional attribution that it has recognized by the Law of Professional Attributions [68] as well as the content worked on make it possible to develop different methodologies in the classroom, including collaborative work, which allows progress in professional skills and acquire the ability to work as a team. It is important to highlight that final year students recognize very specific training needs, fundamentally specialization, which in turn includes transversal issues related to the way of working of a fundamentally professional nature.

4.1 Participants

The students of the real estate valuations subject, in which the innovation proposal was implemented participated in this project. It was a total of 157 students (≈50 on annual average), and the experience was developed during 3 academic years, lasting one quarter each.

To achieve the proposed objectives, the development of practical work was proposed in heterogeneous collaborative work groups of three people, including students in an adaptation course who already have their own qualifications and sometimes professional experience. The same methodology is applied to all of them, as set out below.

4.2 Procedure

The students have been divided into teams (each one constituted by three people) to which one case selected for each subgroup was randomly assigned. In the first session, the professor has presented the type of activity (real cases) and the teaching methodology to be implemented, exposing the objectives planned for it. During that session, questions have been asked, and knowledge of the assumption to be made, tasks, team organization, and evaluation system has been learned. In addition, essential concepts of this work methodology have been presented with the purpose of providing a more complete understanding and facilitating its implementation both in the subject's practice system and in future professional work. Finally,

recommendations have been offered aimed at improving both learning and knowledge of digital and documentary techniques and resources relevant to the activity to be carried out. To this end, it has been proposed to take advantage of ICT to carry out work synchronously or asynchronously, use work documents (templates, minutes, forms, formats), and organize meetings outside the classroom.

4.3 Chronology

In relation to the time scale, no intermediate times have been specified in which to carry out activities or partial actions, considering all the necessary development in a single block. Only the initial and final proposal delivery dates have been set, providing a flexible calendar that they adjusted to meet their needs.

The students have dedicated the following weeks to solving the activity, searching information sources and data for resolution, and collaborating with their teammates to prepare for oral presentations. Throughout the implementation, participants have had full autonomy to explore similar real cases. During in-person class sessions dedicated to case work, the professor actively has participated in group discussions, addressing doubts and questions.

The final 2 weeks have been allocated for subgroup presentations, where proposals have been presented and defended. It is important to note that feedback during this phase did not necessarily focus on having a correct solution but rather on recognizing the work system, progress, and improvement in learning through collaborative efforts.

4.4 Data Collection and Analysis Methods

In this research, questionnaires (surveys) have been used as both quantitative and qualitative methods. The choice of quantitative data has been based on obtaining results expressed numerically, thus facilitating the analysis through frequencies, means, and standard deviations. To this end, a structured questionnaire has been designed with two sections: the first focused on the qualitative approach and addressed six groups of open questions related to the concept, benefits, difficulties, team roles, and resources used during the development of the assigned activity. In the second section, a quantitative study has been carried out using 15 closed Likert scale questions, to which numerical values from one to five have been assigned, with corresponding descriptions: 1 = totally disagree; 2 = disagree; 3 = neither agree, agree, nor disagree; 4 = agree; and 5 = completely agree. The initial questionnaire has been validated by the three professors participating in the research. The questionnaires have been completed anonymously at the end of the subject. In order to preserve the confidentiality of the responses and communication of the

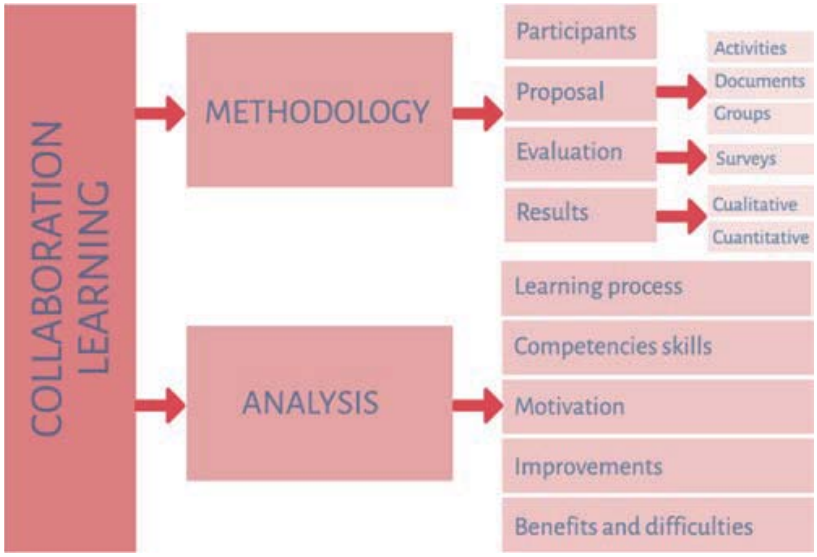


Fig. 12.2 Collaborative learning framework in the innovative experience

participants in the qualitative analysis, a coding system was implemented. Figure 12.2 shows the outline of the methodological proposal developed as a teaching innovation experience.

5 Results and Discussion

Once the experience is concluded, the results derived from the evaluation of the subject and the experience itself are presented. It is relevant to highlight that the analysis is carried out jointly for the three academic years, given that it was not possible to evaluate the same students in different courses, except for those who repeated or enrolled for the second time. Following the structure of the study, the analysis of the results is broken down into two sections. The first focuses on detailing and evaluating the data collected in the group of open questions, constituting the qualitative component of the research. The results are presented in Figs. 12.3, 12.4, 12.5, 12.6 and 12.7, where the frequency of appearance (FA%) and the relative frequency (RF) are grouped with respect to the total number of participants (calculation carried out using the formula FA/n, with $n = 157$) for each item. These items reflect the perception of the participants in relation to collaborative work, benefits, improvements, assigned roles, participation, and resources used during the application of the methodology.

In the second section, the results of the quantitative component of the research are displayed (see Fig. 12.8), in which the closed responses are quantified to evaluate the collaborative work through the mean value and the standard deviation (SD) and the percentage of participants considering those who assigned the highest values.

In addition to the data obtained in the different items, the analysis that the students carry out on the applied methodology must be focused, including their

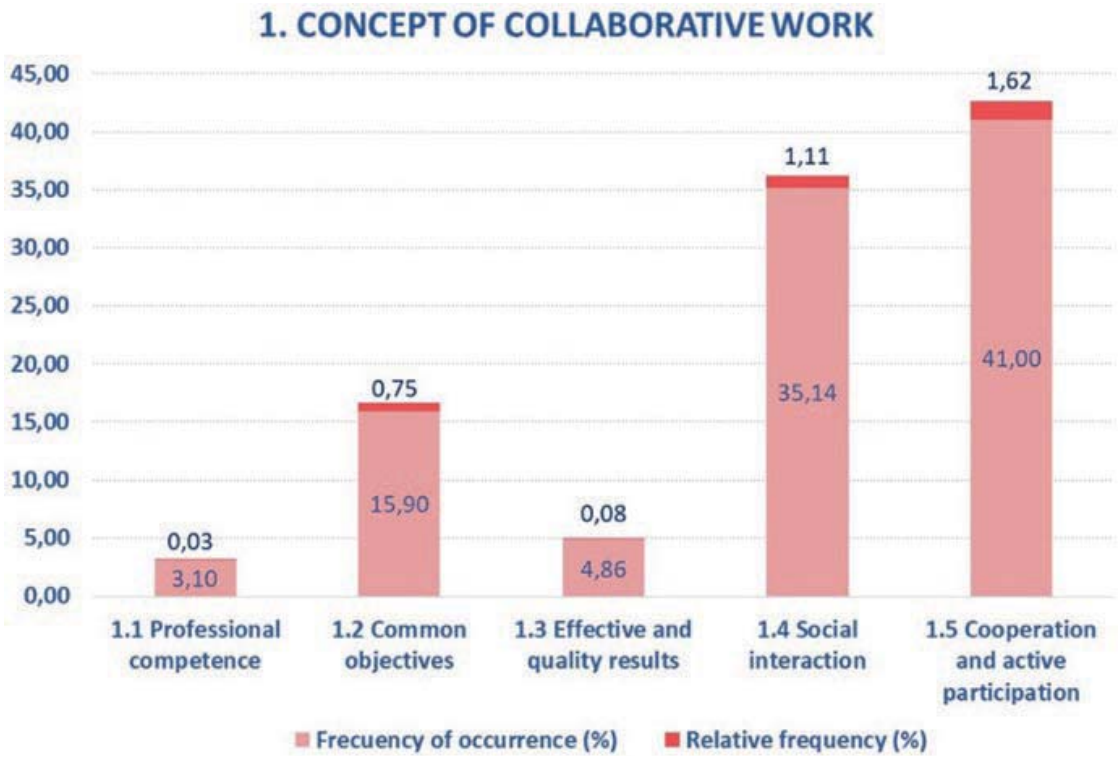


Fig. 12.3 Results of the open survey about "concept of collaborative work"

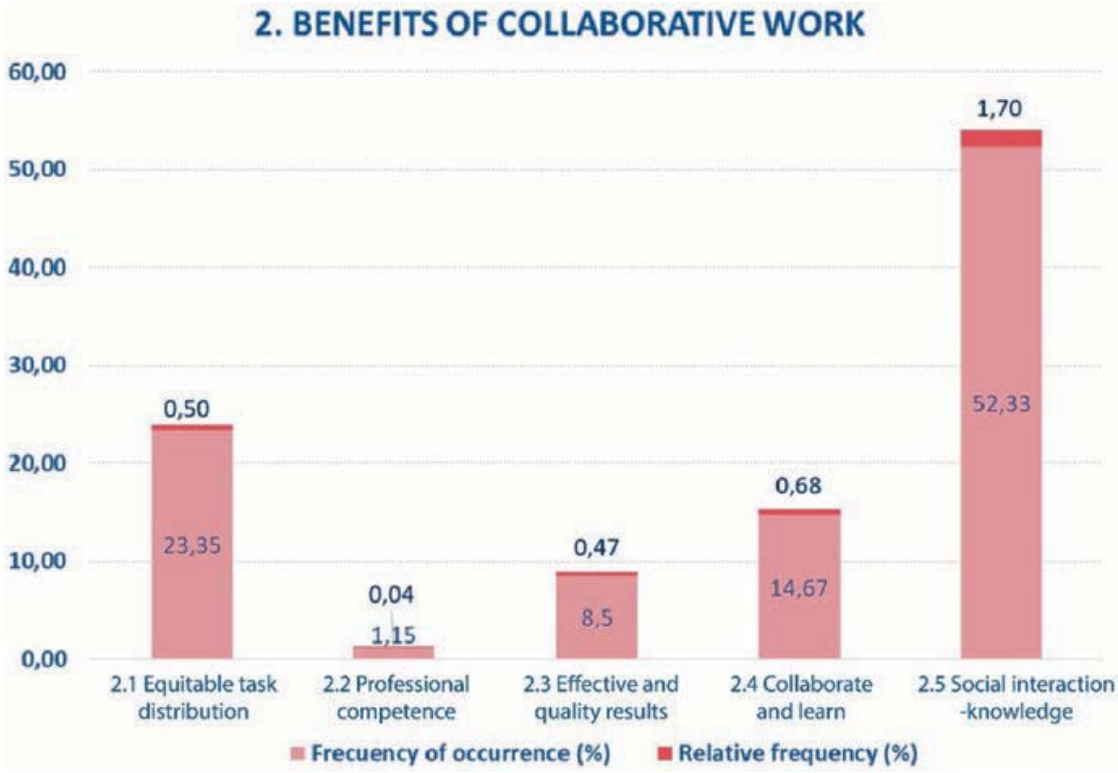


Fig. 12.4 Results of the open survey about "benefits of collaborative work"

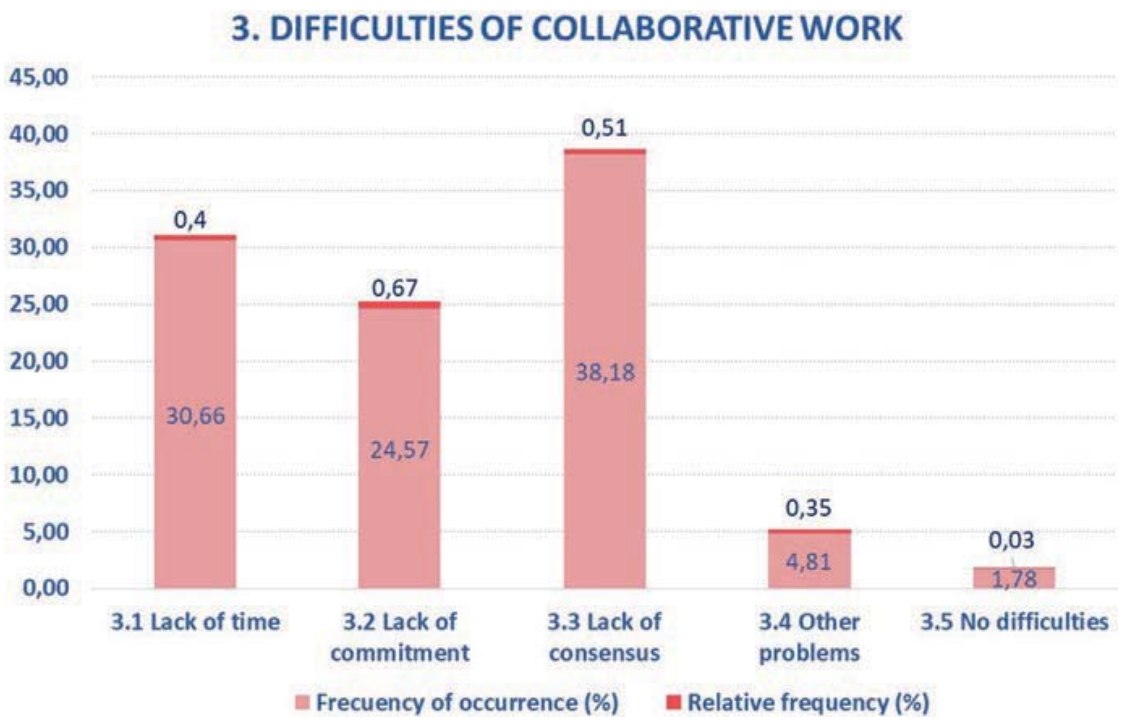


Fig. 12.5 Results of the open survey about "difficulties of collaborative work"

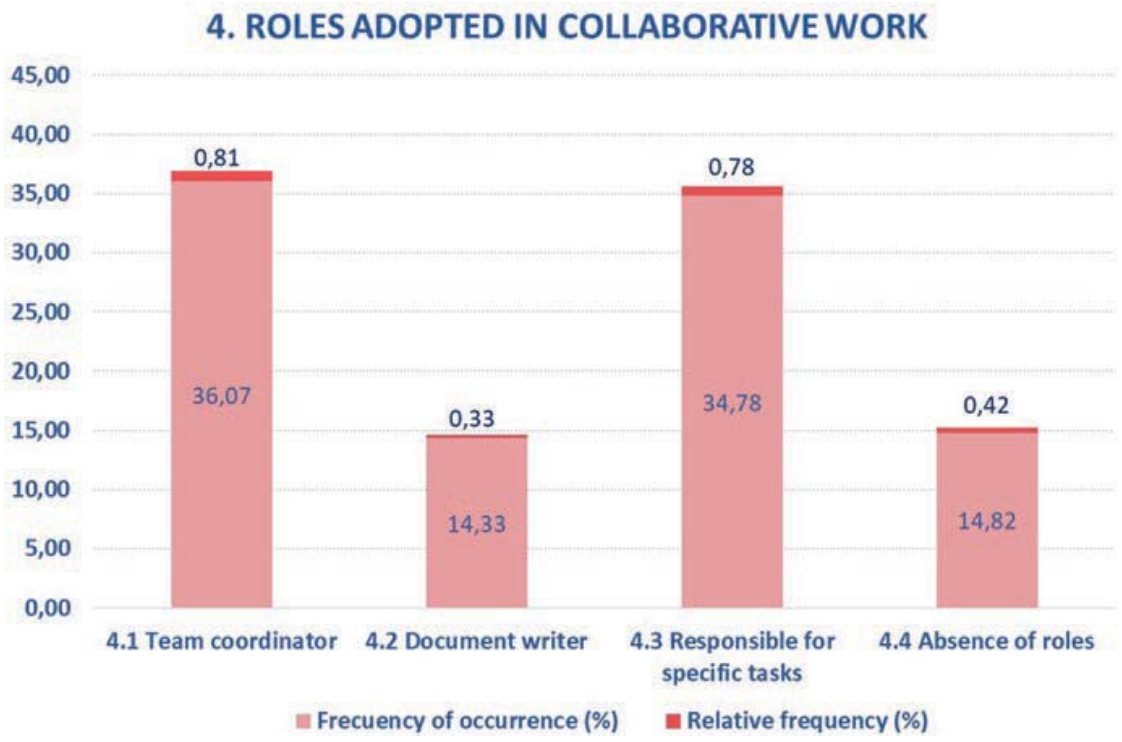


Fig. 12.6 Results of the open survey about "roles adopted in collaborative work"

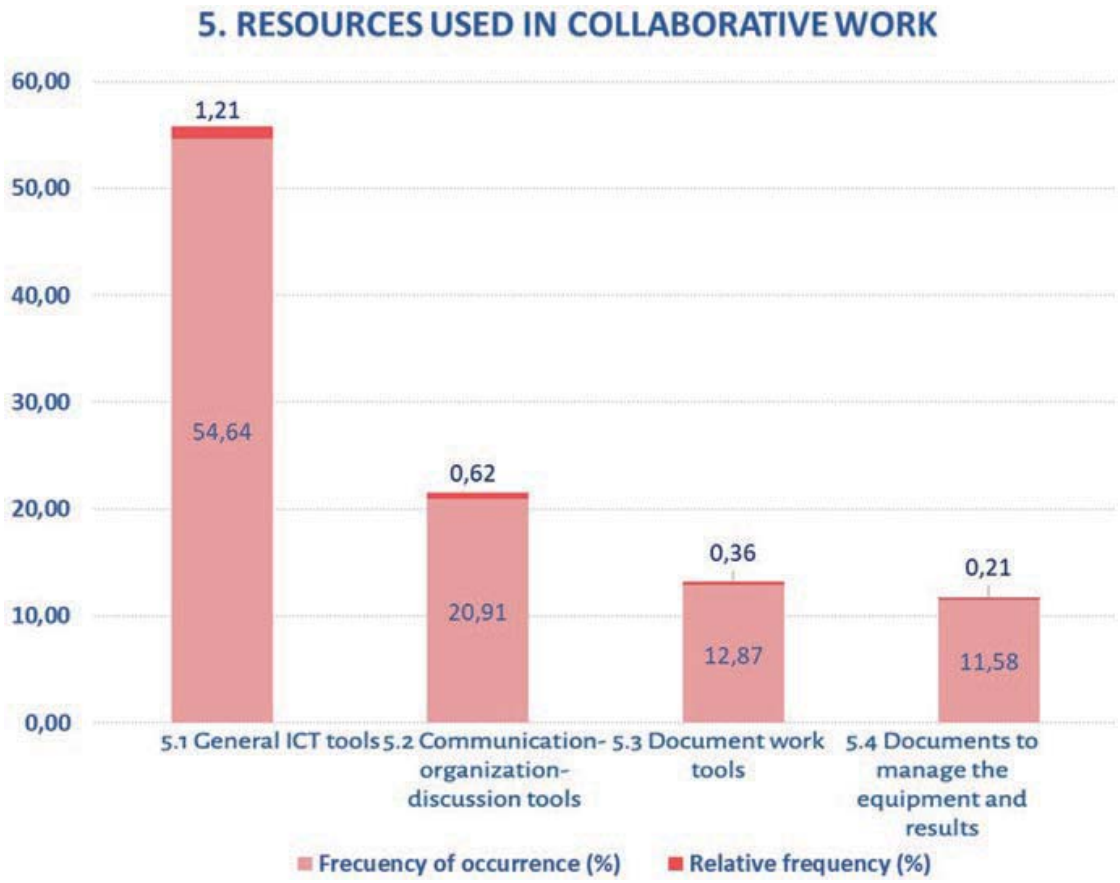


Fig. 12.7 Results of the open survey about "resources used in collaborative work"

knowledge and opinion about collaborative work, the benefits perceived, the improvements identified, the difficulties experienced, and the way of implementing teaching innovation with the available means and in the established time. This information provides a deeper understanding of student impressions and the effectiveness of the methodology in improving teaching, as well as their perception when implemented in the professional setting. This feedback is valuable for the participating professors, contributing to the continuous improvement of the methodological application. The aforementioned results are presented below, accompanied by some examples of answers provided by the students who were part of the experience in each group of items for the set of open questions.

5.1 Section 1: Qualitative Analysis

The data from the set of questions linked to the "Concept of collaborative work" [GROUP 1] are presented in Fig. 12.3, confirming that the majority of participants have an understanding of its meaning and indicate that it implies teamwork, with social commitments, and improvements in results.

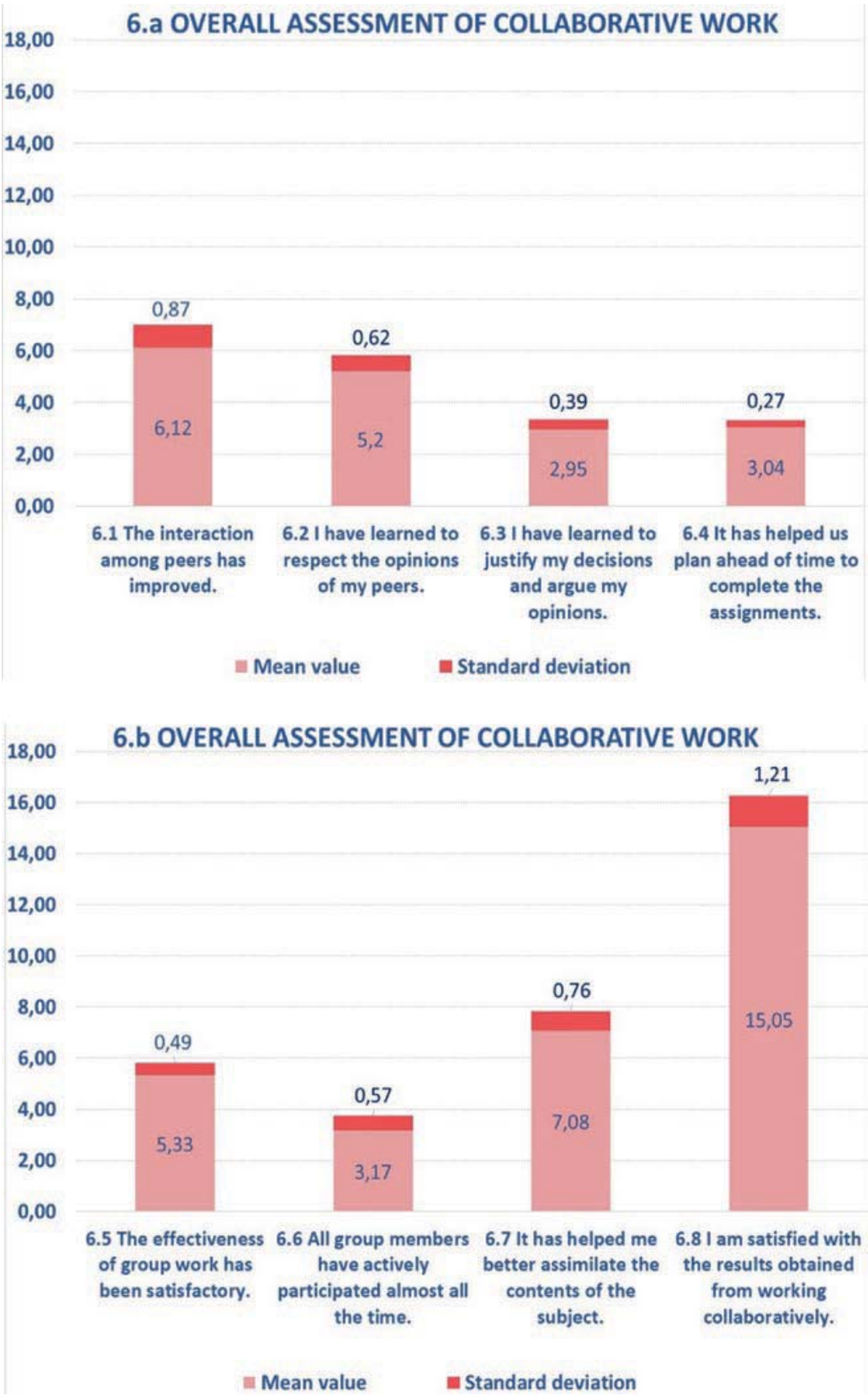
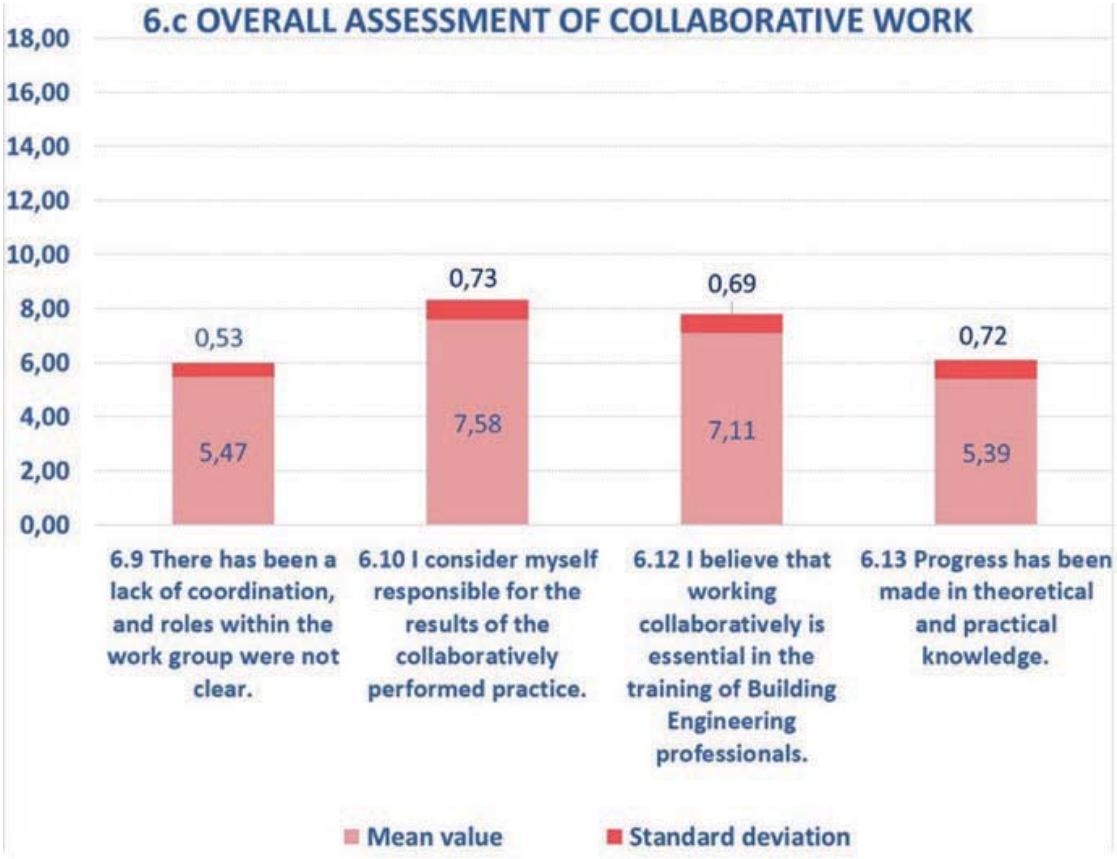


Fig. 12.8 Results of the open survey about "resources used in collaborative work"



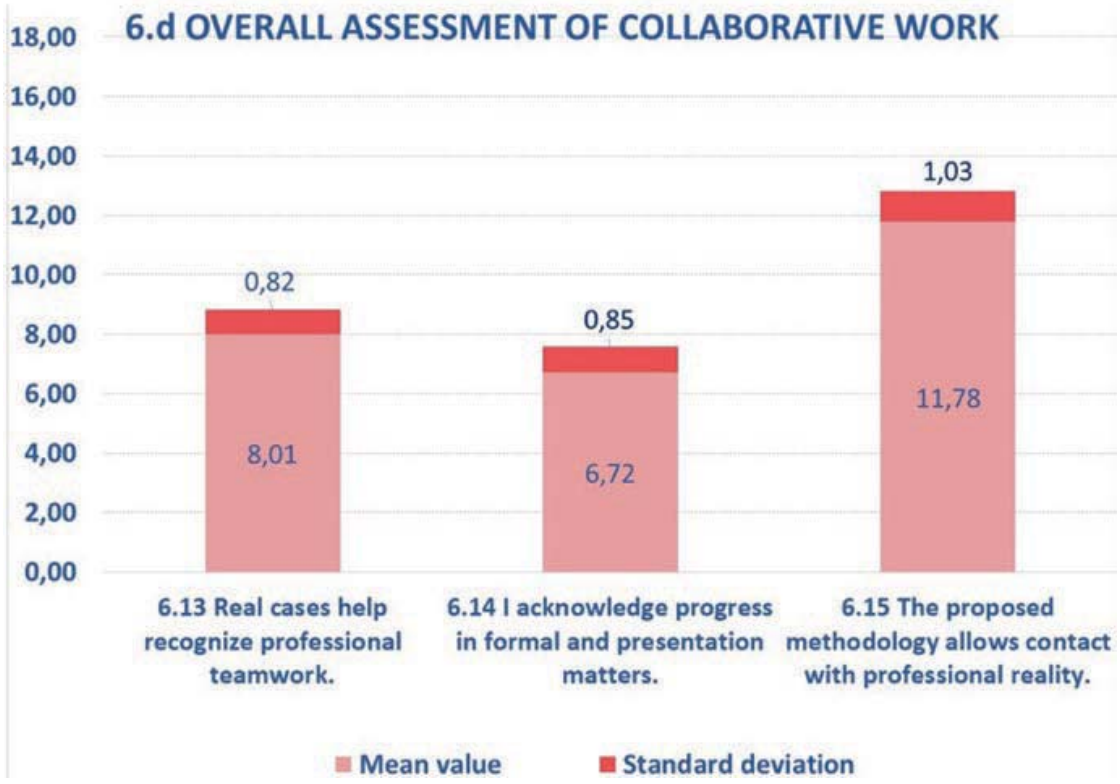


Fig. 12.8 (continued)

In contrast to these utility implications, only some responses were identified that established a connection between the concept of collaborative work and "professional competence" [item 1.1], which future graduates must develop as part of their training. Some of these specific responses were the following:

> *"This methodology helps to work in the profession in a simpler and more balanced way."*

> *"Collaborative work is necessary for the development of the activity of the Building Engineer."*

> *"Working collaboratively is the usual way of doing it in construction companies".*

Regarding the "common team objectives" [item 1.2], it is confirmed that they are considered intrinsic characteristics of this type of work and, therefore, serve as a starting point for its development. In addition, students also agree that to understand the common objectives of a project or activity, it is first necessary to understand what must be done, the purpose to be achieved, and that the tasks are coordinated. Consequently, they emphasize that if these issues are not taken into account, complications could arise.

> *"This type of work involves carrying out tasks together, trying to achieve shared objectives."*

> *"It is considered that cooperation between team members seeks to achieve the same objectives."*

> *"The synergy of collaborative work enhances the achievement of common objectives, and favors the connection between the team".*

In relation to the item "effective and quality results" [item 3.1], the majority of the responses are positive, even ensuring that they manage to obtain better results and in less time.

"This type of work undoubtedly improves the results and improves them by contributing the entire team."

"This work is what is done with teammates, which helps to improve even in less time."

"The results obtained are better than in individual work when done in a group."

Regarding relationship and "social interaction" [item 1.4], the responses highlight the importance of this type of activity and explain that it is crucial to improve interpersonal relationships. By working in a group, they develop respect for others, learn to listen, and strengthen participation, sharing of ideas and dialogue.

"The work done helps you learn to listen and give your opinion."

"Everyone's opinion and work counts for the results."

"By working with other people, dialogue is practiced and everyone's participation is encouraged."

"The work involves the collaboration of everyone and favors mutual respect for the opinions of others to reach agreements."

"Executing activities together improves interaction and work."

In the last item of this section, "cooperation and active participation" [item 1.5], the relevance of the approach presented to students is confirmed so that they reflect and define the concept of collaborative work. For the most part, the results confirm the importance of the participation of all team members, pointing out that it is a good option to improve their learning. Some comments that support this idea are:

"The work done helps us participate actively in the team and promotes cooperation."

"It is a group work in which you learn from everyone's contribution."

"A job in which all members of the group participate actively and jointly."

In reference to the set of questions related to the "Benefits of collaborative work" [GROUP 2], Fig. 12.4 shows the results obtained.

In this context, it is clear that students recognize the "fair distribution of tasks." as one of the main benefits [item 2.1]. Likewise, they point out that, to the extent possible, each member can take charge of the actions that they best master.

"It is important that it can be assigned according to the capacity of each component."

"Teamwork reduces the load although coordination between everyone is needed."

"It offers the possibility of working according to the capabilities and skills of each member of the group."

"Collaborative work makes it possible to distribute responsibilities according to each member of the group."

"In my opinion, the most important thing is that each member can take the task most appropriate to their level of knowledge."

In relation to the item "collaborate and learn" [item 2.4], the importance that students give to collaboration is reiterated, considering that learning is a crucial part of their academic stage. This is especially notable given that most of them, being senior students, do not focus their thoughts solely on the assessment. Some of the comments expressed were:

> *"From my point of view, the main advantage lies in the possibility that, in case the work is intense, each member of the team can be in charge of a specific task, thus distributing the workload."*

> *"Tasks can be assigned to the individual characteristics of each person".*

Regarding the item "social interaction-knowledge" [item 2.5], the participants maintain that collaborative work is based on optimal social interaction. This perspective is reflected in numerous opinions, which emphasize the importance of relationships with other participants and how shared knowledge among members provides additional opportunities to the group.

> *"Every participant contributes to the individual growth of each group member."*

> *"The group's knowledge is disseminated among all participants."*

> *"There are different group techniques and ways to resolve situations."*

> *"From my perspective, I would highlight a main advantage, achieving results through the knowledge and interaction of everyone."*

Finally, among the benefits, coinciding with the items in group 1, the relevance of professional competence and the improvement of results by being perceived as more effective and of higher quality stand out.

In order to identify difficulties that may arise during the experience (see Fig. 12.5), students were asked to address the possible problems detected when implementing this learning methodology.

One of the most prominent difficulties is "lack of time" [item 3.1], a concern supported by researchers by recognizing that the philosophy of the Bologna plan has generated an increase in the practical workload for university students in several subjects. This entails difficulties in planning their times and schedules for the development of the projects of the subjects taken, as expressed:

> *"It is conditioned on the availability of colleagues, which sometimes makes coordination difficult to establish work schedules."*

> *"The only recognized problem is that, in some cases, it is difficult to coordinate due to the tasks and subjects of the rest of the team, sometimes it is also a problem where they can meet."*

Regarding the "lack of commitment" [item 3.2], it is corroborated that students admit the lack of responsibility and commitment in the development of the experience, thus affecting the preparation of the tasks. This aspect adds to the lack of coordination and organization, as indicated and described:

> *"The lack of coordination and organization of the team has caused delays and difficulties in work."*

> *"After experience it has been confirmed that the adaptation of collaborative work must be group-oriented instead of focusing on each person."*

> *"In some cases, a lack of collaboration has been observed in some tasks, having to be resolved by some members of the group."*

Another of the main difficulties is identified with the "lack of consensus" [item 3.3], which manifests itself from the beginning when the group must design the actions for the development of a task or later, when disagreements arise in the organization and planning, or simply, lack of coordination during the course of work. Some comments were:

"Sometimes there is no agreement in the way of doing the work, which delays the results."

"The adaptation problems of a component of the group paralyzed part of the work."

"Sometimes we don't agree on how to do the proposed activities."

Finally, in the item "other problems" [item 3.4], they indicate that they recognize other issues, but that they occur occasionally. Some examples mentioned are:

"Although it has only been on occasion, you don't always want to do the job the same way."

"In the group, some problems have been identified that arise from the work dynamics due to the delivery date."

"It is necessary to adjust to all colleagues and their work methods to achieve good results."

Students even confirm that in some cases they do not recognize the existence of difficulties [item 3.5], indicating that:

"We have had no problems and we have resolved the issues by talking to all members of the group."

"The team worked from the beginning, we had worked as a team before."

Another important aspect in the study of this teaching methodology has to do with the "roles adopted in collaborative work" (GROUP 4), being fundamental both the coordination tasks and all those that derive from the work to be done and the role it plays each component. The results are shown in Fig. 12.6.

In this case, only a small group of students consider that they have not assumed a specific role, and a third confirm that the development of the functions was carried out through consensus and equitable distribution of work.

One of the responses confirmed the absence of roles, indicating that:

> *"In the group, we have all carried out various tasks by consensus; We distribute functions equitably, each one participating in tasks such as coordination, information search, writing and formatting. We were all committed to getting quality work."*

On the contrary, some did carry out the activity after dividing the tasks among everyone, to avoid repetition of functions and work, indicating that each one has played a specific role (coordinator, secretary, editor, etc.). As an example, the following responses are shown:

> *"In the group, the different roles have been distributed; in my case, I assumed leadership by coordinating the others."*

> *"My specific role was that of group editor."*

> *"I was in charge of searching for information, although I never assumed the role of coordinator, since it is not easy for me to do so."*

The use of ICT is recognized as a tool of daily use for university students, necessary for the design and preparation of study and evaluation material on a continuous basis. They were asked about the use and its intensity (GROUP 5), and all confirmed that it turned out to be a key tool for the advancement of the project. The results are shown in Fig. 12.7.

In their feedback, the participants affirmed the utilization of ICT tools and other resources for organizing their work and communication itself when the work was asynchronous or non-face-to-face [item 5.1 and 5.2]. Some notable responses were:

> *"The use of digital tools has been very helpful in the development of the work."*

> *"We have used various social networks, and primarily email for communication."*

> *"We have utilized resources from Google such as Google Drive and Google Meet for collaborative work."*

In relation to the tools for the development of the work [item 5.3] and the team management documents (minutes, summaries, etc.) [item 5.3], everyone has considered the tools used useful, which have mostly been the usual ones (Word, Excel, other image processors). Furthermore, they mention that the documents to manage the team [item 5.4] and improve possible failures or errors of the team have ultimately been helpful and have contributed to the organization.

Regarding the "Documentary work tools," they indicate:

> *"We have used the Word processor and the Excel program."*

> *"The management of software has reduced document work time."*

Regarding the item "documents to manage the team and results" they state that:

> *"The use of documents has been an effective way to address problems that have arisen during the period of joint work."*

> *"Team management documents allow you to understand how the group works and track its progress."*

> *"In my opinion, the minutes have made it easier for us to organize the work and have been useful to know what had been agreed."*

After analyzing the qualitative results, it can be stated that the students consider that collaborative work focuses on the completion of a common project. In this project, all participants actively collaborate, contributing ideas through effective social interaction and sharing the same objectives to achieve satisfactory results. Furthermore, they perceive that this methodology contributes to improving their learning, including the development of professional skills.

5.2 Section 2: Quantitative Analysis

In this second section, the results of the quantitative part of the research are presented, which allows evaluating collaborative work through the mean value and the standard deviation (SD). In this analysis, priority has been given to using statistical data to describe the sample. The resulting mean of the values provided by the participants, the standard deviation of said values to obtain a group perspective, and the percentage of participants who rated four (DA = agree) and five (TA = totally agree) are highlighted for each of the items (see Fig. 12.8a–d).

In this analysis, special attention is paid to the statistical data that characterize the sample. The mean values and their standard deviation obtained from the values assigned by the students to each item are highlighted. On the other hand, the percentage of responses that assign the response "totally agree (TA)" and "agree (DA)" has been represented, thereby knowing the value that applies to each item.

Fifty-three percent of the items have a value >4, which recognizes the importance and value considered of the issues addressed, the most notable being the one that confirms the satisfaction of the results obtained after collaborative work (4.80). In general, these items refer to the recognition of learning through the methodology, progress, interaction between team members, and the importance of opinions in its thematic progress and in formal and presentation aspects. The use of real cases and the usefulness of professional work in their development stands out with a value >4.50 pts. With values around 3 (33% of the items), the items that confirm the effectiveness of group work, the assimilation of the contents discussed, and the value they give to responsibility within the team stand out, highlighting the importance of improving the ability to justify decisions and to learn to organize the areas. Finally, the lowest values are assigned to issues related to participation and discussion of opinions (14%), the type of active participation, which is not always recognized in the group and the lack of coordination and assignment of roles, being an issue not usually addressed in the work they develop in most subjects during their training.

Fifty-three of the items offer a value greater than 4, thus reflecting the recognition of the importance and value attributed to the issues addressed. Particularly noteworthy is that which confirms satisfaction with the results obtained after collaborative work, with a score of 4.80, out of 5. In general terms, these items focus on the recognition of learning through methodology, progress, interaction between the team members, and the relevance of the opinions in the thematic progress and in the formal and presentation aspects. The use of real cases and the usefulness of

professional work in the development of the project stands out with a value greater than 4.50 points.

With values close to 3 (33% of the items), those that confirm the effectiveness of group work, the assimilation of the contents discussed, and the importance given to responsibility within the team stand out. The relevance of improving the ability to justify decisions and organize thematic areas is emphasized. Finally, the lowest values are assigned to issues related to participation and discussion of opinions (14%), the type of active participation, which is not always recognized in the group, and the lack of coordination and assignment of roles. The latter is an issue that is rarely addressed in the work carried out in most of the subjects during the group's training, which is evident.

6 Conclusions

This research highlights how experience serves as inspiration for the adoption of new practices, facilitating the use of rationality through the experiences and practices that a professional carries out on a regular basis. In the workplace, applied to teaching research, the essential connection between accumulated experience and the implementation of new practices is recognized. This connection plays a fundamental role in improving the rational behavior of students.

The experiences gained illustrate the practices, and these, in turn, shape the actions taken. In this context and for the present study focused on the importance of professional experience and its application through collaborative work, the premise of the "technical rationality" model developed by [69] is followed. This model maintains that the professional knowledge view represents the most powerful form of thinking. Exploring professional activities reveals an evident connection between institutional relationships dedicated to research and education, and professional practices. This link contributes significantly to the development of new forms of thought and action in the educational field.

The results and innovation experience confirm the need for and importance of implementing structured approaches in learning to address solutions related to professional issues, with a particular orientation toward the benefits derived from the interaction among members of the same group. Collaborative work facilitates interaction among team members, generating autonomy and interrelation with others. Its advantages are reflected not only in terms of evaluation but also in the acquisition of professional competencies and skills, being formatively integrated into the learning process of students of technical degrees.

For most students, working collaboratively involves coordination and cooperation between team members, promoting social interaction based on dialogue and listening to opinions. The importance of assimilating the contents both individually and as a team is highlighted, an aspect that has not always been addressed. The methodology is proposed as a system for learning skills beyond the classroom, and at the end of the study, this idea was largely accepted.

The recognized difficulties underline the usefulness and need for students to acquire responsibility as part of the team, especially in activities that go beyond the delivery of internships. The need to recognize roles in teams, coordinate, and plan work together to achieve common objectives is a relevant added factor. From the perspective of tools, advances in information and communication technology are crucial, relating to the features available in online environments and to changes in prior knowledge and technological experience applied by students in collaborative learning. The use of ICT and other tools favors team participation, whether synchronous or asynchronous, allowing members to interact until they find solutions according to the proposed activity. Virtual environments offer significant opportunities in the university training context beyond the relationship among students.

In the total experience, in addition to the results presented, other benefits of interaction and skill development are recognized, such as student-professor interaction, which facilitates dealing with professional problems in addition to the activities themselves. Also highlighted is increased student responsibility, mutual learning, and preparation for future professional work situations.

Motivation and confidence to participate play a crucial role in the importance of these benefits. Exchanges involving answers, questions, and justifications require participants to assume various functional and participatory roles, and the improvement of evaluation results is recognized. The results show that student activity is an effective indicator to evaluate the quality of group interaction, without forgetting the development of social interaction skills, especially useful for those students with difficulties in the development of social skills. It is evident that the progress achieved is not exclusively a consequence of this innovation, but is part of a set of strategies. In this case, it stands out as the main one for the recognition of skills during teamwork and the ability to solve problems and situations in the workplace.

The final conclusions of this study allow to affirm that collaborative work is based on common objectives that are assumed as part of collective responsibility and participation, which in turn allows us to configure organizational conditions, thus generating a culture of professionalization to improve the training of the students. On the other hand, it contributes to improving the quality of teaching, since this methodology represents an excellent training opportunity by implementing skills and content in learning.

Acknowledgments This work is framed in the Teaching Innovation Project "Laboratory of previous studies and reports on built historical heritage," belonging to the Unit and Quality, Innovation and Prospective of the University of Granada. Teaching Innovation Projects and Good Practices of the FIDO UGR 2018-2020 Plan was carried out under the auspices of Research Groups RNM 0179 and HUM 629 of the Junta de Andalucía.

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