

# Study Material on Construction Quality for the Civil Engineering Career

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**Abstract:** The objective of the work was to design a study material that would favor the learning process of the quality management system in construction in civil engineering, when verifying bibliographic insufficiencies that would facilitate it. The use of theoretical and empirical survey methods laid the foundation for a detailed explanation of these methods and sparked necessary technical knowledge on the topic. The material was submitted to the criteria of specialists, who considered its elaboration very necessary and evaluated its structure and content as very adequate, responding to the determination of needs for which it was made.

**Key words:** quality; learning; study material; civil engineering

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## 1. Introduction

Training competent and qualified professionals for the working world is crucial in the educational process promoted by each institution and region. The current demand is the result of the continuous growth of knowledge in different knowledge sectors, which is the key goal of social development in each country. This requires science, technology, teaching, education and human resources to meet the quality standards in the training process.

In Cuba, this highest priority is the national priority, which is proved by the economic and social policy guidelines of the Party and Revolution. Article 120 of the guidelines indicates that the country is continuing to make progress in improving the quality of the education process; We must pay attention to teachers, working conditions and links with production; The career problems that must be faced in the future of career are included in the curriculum (Communist Party of Cuba, 2017).

Consistent with the above, one of the challenges faced by Cuban Higher Education is to train professionals with high levels of knowledge, skills and ways of action, who are in line with the socialist principles guiding our social process and the changes in the production process of enterprises. In turn, it must play the role of the source and promoter of scientific development, so that it can not only train the technical application professionals needed for production, but also develop new knowledge and applications through effective knowledge management.

In particular, the training of new construction professionals, especially those in the field of civil engineering, is not new to these challenges. It requires the education process to make students become active participants in learning and have the ability to make efficient, economically feasible and environmentally friendly technical decisions, and the task of teachers is to provide teaching materials and means that help develop stronger, more prepared and more efficient professionals.

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As part of the Study Plan D, the elective course "Quality, Safety and Environment" is taught in the fourth year of civil engineering specialty to promote decision-making, improve the opportunities and positive impacts of the project, and predict and manage the adverse impacts, potential risks, damages and benefits derived from them and their positive impacts. Therefore, in order to promote the sustainability of infrastructure projects, it is necessary to equip professionals in these contents.

From the experience of the authors participating in the teaching-learning process of the subject, in the fourth year of the civil engineering course of the School of Construction of the Central University "Marta Abreu" of Las Villas, it has been found that there are deficiencies in the topic: "Quality in Construction" that limit the self-preparation of students in the development of tasks and their preparation for the fulfillment of the proposed objectives.

The elements presented so far justify the present research, in view of the existing bibliographical insufficiencies that limit the preparation process of the fourth year student of the civil engineering specialty in the optional subject mainly on the quality management system in construction companies in Cuba. Therefore, it limits the knowledge and its practical application in the integrating projects, as well as in the training of the professional. This explains the need to propose a study material that favors the teaching-learning process in fourth year students of civil engineering in the optional subject on the quality management system in construction.

The following specific objectives were also established for the development of the research:

- To support the theoretical assumptions that sustain the use of teaching means to facilitate the teaching-learning process on the study of the Quality Management System in construction companies in Cuba.
- To diagnose the needs presented by the fourth year students of civil engineering in the teaching-learning process of the subject.
- To elaborate a study material on the Quality Management System in construction companies in Cuba that would favor their learning.
- To evaluate design, content and quality of the proposed learning materials through criteria of specialists.

## **2. Development Methodology**

In the pedagogical literature, there are numerous works that address concepts, categories and principles of the teaching-learning process.

For Hector (2009), in the teaching and learning process:

There is a dialectical relationship between teachers and students, which are differentiated by their functions. The teachers must encourage, guide and control learning in such a way that students become active and conscious participants in this process, that is, "to teach" and the student's activity is "to learn". (p.5)

This author places greater emphasis on the subjects involved in the process, while others define the terms "teaching" and "learning" in order to arrive at a common language. In this regard, Meneses (2007), in addressing the concept, expresses: "teaching can only be understood in relation to learning; and this reality relates not only to the processes linked to teaching, but also to those linked to learning" (p.32).

The author of this paper draws on Meneses' point of view and believes that the teaching process is the process of transmitting special or general knowledge about a subject, and its dimensions in academic performance are transmitted according to the factors that determine its behavior in a certain institution. However, in order to further study this complex process, we cannot ignore the contribution of this theoretical institution to in-depth analysis of educational practice, which is an important way to further conceptualize the two key and interrelated concepts of teaching and learning.

The objectives of Study Plan D for the civil engineering major are to increase the quality of the graduate in order to meet the needs of society and improve the active and committed participation of construction professionals, particularly civil engineers. It states that there are a number of suggestions for optional/elective subjects in the degree program and a list of possible subjects to be taken are included (Ministry of Higher Education, 2013). The Higher Education Institutions may decide to adopt them or substitute them for others that may be convenient, based on the regional interests that exist at any given time.

The optional subject: "Quality, Safety and Environment" is not in the list of possible subjects to be taken, but the Civil Engineering Department of the Central University "Marta Abreu" of Las Villas, decided to include it in the important construction process of the development of the region, such as the Cayería Norte de Villa Clara, and because it is state policy that each construction company should have a quality management system.

In order to ensure the success of this elective course in the teaching process, self-learning is one of the essential aspects. That is why the pedagogical strategy to be used must be endowed with the use of a teaching medium that stimulates the student in the search for documents and information in digital format.

In the book *Pedagogy*, Babanski et al. (1981) states that the students' behavior tends to reproduce knowledge rather than infer their answers, which has limitations in the generalization and application of knowledge. There are few students carefully design questions, and the exploration of learning and action planning methods is limited. Most of them focus on the final answer without being aware of the error. It is rarely possible to critically and self-critically reflect on what he has learned, which leads to his limited learning development. This problem has a negative impact on the formation of a competent and qualified professional, which is why a constant improvement of higher education is required, and this is impossible without studying in depth the issue related to the teaching means involved in it.

In higher education, there are already elaborated resources and materials, but some of them are not in accordance with their study plans, therefore they must be elaborated and designed by the professors or by the students themselves with direct or indirect participation. These materials can be oriented in the different organizational forms of teaching activities such as conferences, seminars, etc. It is necessary to create effective and efficient design materials for the technical and theoretical content of specific disciplines, and universities need these materials to improve the education and teaching process.

In order to carry out this work, a mixed method has been used, which plays a decisive role in the field of teaching, especially when researchers clearly intend to give participants a voice. In this sense, qualitative data is more relevant when it is not only to obtain digital data, but also to seek the closest perspective of participants.

It is important to emphasize that this article carries out a thorough work regarding the integration of data in search of unity, which facilitates a better understanding of its subject of study. In this process, the resource of triangulation is extremely valuable, therefore, in the particular case of the experience developed, it should emphasize theory, methods and techniques and data collection instruments.

### 2.1 Research scene, population and sample

The research scene is composed of the School of Construction of the Central University "Marta Abreu" of Las Villas. The research object of demand diagnosis is 78 fifth-year students majoring in civil engineering in the School of Construction, Central University, "Marta Abreu", Las Vegas. In order to select samples, intentional non-probabilistic sampling was used. A group of 30 fifth-year students majoring in civil engineering accepted the optional course "Quality, Safety and Environment", as well as five teachers who have taught in the School of Architecture for many years.

## 2.2 Results and discussion

After applying the instrument to the selected sample, the student's results are:

- (1) Among the students surveyed, 60% said that they were always satisfied with the knowledge obtained in the class about different topics of the elective course: "Quality, Safety and Environment", while the remaining 40% commented that they were only sometimes satisfied.
- (2) For 86% of students, construction quality is the longest and most complex discipline in this discipline, while the remaining 14% of students said that it was never the most complex.
- (3) a). 50% of the students analyzed said that the seminar and the final work always enabled them to study the content that had been received in the class in depth, while the other 50% believed that this only happened sometimes; b). A total of 43.3% of the students examined indicated that the seminars and the final work always allowed them to expand on content that had not been covered in class, while the other 56.7% of the sample said that this happened only sometimes.
- (4) 100% of the sample agreed that they never had a basic textbook for the study of the subject.
- (5) Of the students taken into account, 10% stated that they always had sufficient reference materials available to them in the Quality Management System. Most of them stated that this never happened (73.3%) and the remaining 16.7% of the sample stated that this was sometimes the case.
- (6) 60% of the respondents always consult the literature on the subject of Quality Management System in the library, and the remaining 40% only consult occasionally.
- (7) 100% of the samples agreed that it would always be beneficial to provide the latest "learning materials" for the most extensive and complex topics and as supplementary texts to support independent work.

In addition, some of the elements that the students considered necessary to improve their preparation and/or self-preparation on the subject of quality in construction and that need to be included in the structure of the material to be designed are: benefits and importance of the use of a quality management system, quality guidance laws and standards, evolutionary and historical process of quality and images of quality defects in construction works.

In relation to the interview with the professors, 100% stated that it is necessary to teach the optional subject: "Quality, Safety and Environment" in the civil engineering major, for the training of future construction professionals, due to the important construction processes developed in the region, as in the case of the North Key of Villa Clara and because it is state policy that each construction company should have a quality management system. They also said that the topics taught in them were crucial in the ongoing implementation projects, and all professionals must comply with these standards.

100% of the teachers interviewed believed that students did not have the necessary tools to solve the subject of the quality management system and its use in construction companies in Cuba. 80% of those surveyed consider that the bibliography available to students on the subject of quality in construction works is not sufficiently updated, and said that although there were documents in recent years, these data and reports were more likely to be provided in graduate courses. On the other hand, the remaining 20% believe that the bibliography is updated but is dispersed. 100% of the surveyed professors agree that the elaboration of a study material on the Quality Management System and its use in construction companies would lead to a better assimilation of the contents by the students, which is why they affirm that such elaboration is very necessary. Their main arguments include:

- The learning materials will help students learn and prepare independently;
- It would facilitate the work of teachers, both specialists and non-specialists in the field, and would be able to exemplify how quality contributes to the entire life cycle of a construction process.

### 2.3 Preparation of learning material

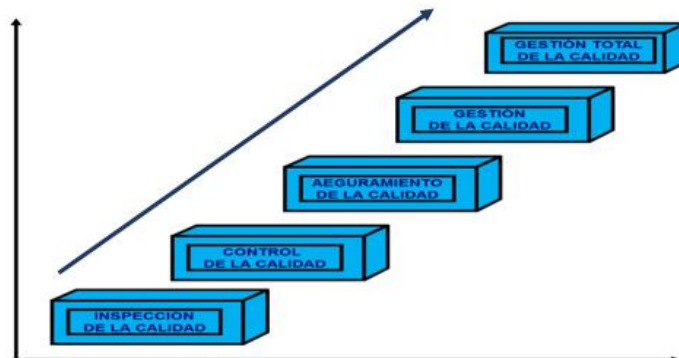
Learning materials are a very effective means to promote teachers' work and students' self-preparation, because they summarize the latest content by promoting the development of teaching process.

The main purpose of preparing learning materials is to collect the latest information about the scattered contents of the Quality Management System within the life cycle of the construction project, and take into account the particularity of the construction company. The design is based on the psychological and pedagogical foundations related to teaching methods and technical results applied to teachers and students, subject themes and PI 4 integration project objectives. It provides satisfactory answers to the questions of autonomous learning and independent learning, so its content must achieve the following functions:

- Provide elements to enable students to have greater motivation for the content of the topic to be discussed.
- Improve learning level and achieve greater content fixation.
- Promote students' independent work according to the content provided by the learning materials.
- Promote the connection between theory and practice.

The chapters of learning materials are based on building quality, because it is the most complex and extensive elective course in the fourth year of civil engineering: "Quality, Safety and Environment". Its teaching structure is composed of introduction sheet or cover, preface, index, introduction, chapters, glossary and bibliography. The main topics will be listed below, no matter where they are.

In topic 1, called "Historical Background of Quality", it can be seen how quality has gone through several stages until reaching total quality management, which is a philosophy that promotes continuous improvement in each organization and the involvement of all its members, focusing on the satisfaction of both the internal and external customers (Figure 1).



**Figure 1.** Historical evolution of quality.

"The key to effective work is to design a way to understand and serve customers so that employees can enjoy a successful work life" (Crosby, 1994, p. 275). This is why topic 2 is called "Quality As a Management Process" and has cooperated with the main classical quality authors to prove that quality management is both a strategy and a process. When its management philosophy penetrates into management and fully understands its laws and regulations, how will it be fully legalized.

Based on the above, topic 3 entitled "Normative Models of Quality Management: ISO9000 Standards" is created, which establishes that standardization is the use of important normative models for a correct practice of quality assurance.

The International Organization for Standardization (ISO) is the world federation of national standardization bodies (all ISO member bodies). International standards are formulated through ISO technical committees. The undeniable importance of this standard largely stems from the fact that it represents a pioneering initiative in international standardization, and the terminology in this field is unified in Spanish.

The ISO9000 Standards cited in Table 1 have been developed to assist organizations of all types and sizes in the implementation and operation of effective quality management systems.

**Table 1.** ISO9000 Family Standards

Standards	Characteristics
ISO9000 Standard: "Quality Management Systems. Fundamentals and Vocabulary".	Describe the fundamentals of the quality management system and specify the terminology of the quality management system
ISO9001: "Quality Management Systems. Requirements"	Specify the quality management system requirements applicable to any organization that needs to prove that the product meets the customer's requirements
ISO9004: "Quality Management Systems - Guidelines for Performance Improvement"	It provides guidelines for considering the effectiveness and efficiency of the quality management system. The objective of this standard is to improve organizational performance and customer satisfaction

Topic 4 of the study material, "Business Improvement of the Quality Management System" provides tools to work on the main processes of planning, control and improvement of quality in companies.

"Quality in the Construction Industry" is called the fifth topic of the teaching materials and argues how the points discussed in the previous topics such as quality management and total quality in the field of construction are established. In this section, it is defined what is the cost of non-quality, that is, the so-called "price of non-compliance". It establishes the types of errors that affect quality, such as technical factors, management and organizational factors and human factors.

As another main title of the discussion, and the most important of all titles, is item 6 entitled "Quality in Construction Projects". In this project, regardless of the implementation of the quality management system of the construction company, it shows the implementation, update and compliance of quality in each work or project. If necessary, specific documents have been prepared for certain works or projects.

At present, many architectural errors have occurred in the tourism industry, affecting the building quality and customers, rather than improving the quality (Figure 2 and 3). On the other hand, if large projects do not use the drawing technical specifications or other calculation procedures in AutoCAD format (Figure 4), they may fail. In addition, when the quality of the materials provided by the supplier is not ideal and leads to defects and shortened road service life, we can also see errors in the road project (Figure 5). This is why it is important to realize that incorrect control or monitoring of quality in constructive projects will lead to adverse conditions, sometimes causing permanent damage to the environment or individuals themselves.



**Figure 2.** Technical error on the bridge.



**Figure 3.** Technical error on the balcony.



**Figure 4.** Dam design failure.



**Figure 5.** Isolation of defective materials.

In all cases, in order to successfully construct or execute the project with appropriate quality, special attention needs to be paid to "integrating" all necessary actions to make the final result (constructive project) conform to its design purpose, in a timely manner and at an appropriate expected cost.

Each chapter has self-control questions, including the main questions discussed, so that students can correctly answer after analyzing the learning materials in detail. In addition, a glossary is provided to make students familiar with terms they don't know, such as benchmark, turnkey, continuous improvement, etc.

#### 2.4 Evaluation of learning materials according to expert standards

In order to evaluate the research materials, a total of five experts were investigated. The following criteria were considered in the selection: having sufficient knowledge of the objectives to be evaluated, having accumulated five or more years of personal experience on the issues discussed, their professional reputation for the work they did, and their extensive connection with teaching, and being supported by scientific work achievements and responsibilities. Two of them are professors from the School of Architecture at the UCLV. They have carried out several quality theme works in the construction project, and the other two are experts from Clara Villa construction company, such as the Empresa de Investigaciones de Proyectos Hidráulicos (EIPH) and EMPROY. As the fifth expert, a CUJAE senior professor with more than 30 years of experience in this field was selected.

The evaluation results of the experts are satisfactory, and all agree that the learning materials meet the main educational requirements formulated at the beginning of the study, because according to them, these materials strictly conform to the curriculum content of the optional subjects in the quality management system. The experts' assessment of the relevance, feasibility and quality of learning materials supporting the teaching process of vocational learning is consistent, and they also believe that the proposal is novel and applicable.

### 2.5 Application in teaching process

Once the assessment of the specialists had been carried out, the study material began to be introduced into the teaching and learning process of the optional subject, and it became clear that the study material had a positive impact on the learning process:

- Develops skills in the independent pursuit of knowledge.
- It favors the updating of contents in a faster way.
- Facilitates individual research and stimulates the research spirit of students.

In addition, in order to use materials effectively, three basic periods can be determined: before class, during class and after class. This provides a starting point for further research and determination of the needs of other professional subjects, so as to cultivate a competent and qualified professional.

## 3. Conclusion

The theoretical and methodological basis of the study shows the importance of teaching methods in promoting the fourth grade civil engineering students to learn the optional course of quality management system research of Cuban construction companies, considering that the teaching and psychological basis of encouraging self-learning and searching for information are the characteristics of this professional teaching process.

By applying different tools and methods to diagnose the needs of the education field, it can be seen that students who have obtained the optional subject "Quality, Safety and Environment" have put forward restrictions on the development of quality management system proposals in the No. 4 Comprehensive Project (PI-4) without proper bibliographic means to study these management fields.

The learning materials prepared on the quality management system of the Cuban construction company have a logical sequence and an appropriate teaching structure, including models, photos, self-control problems and the latest information, which help improve the learning level and better fix the content discussed.

The evaluation of the design, content and quality of the learning materials according to the expert standards confirms that it conforms to the course content of the optional subject "Quality, Safety and Environment" in the training of civil engineers, and helps to identify the errors in the quality of the project during the life cycle of the construction project according to the requirements of the professional model.

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.



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