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RENEWING OURSELVES IN ENGINEERING EDUCATION

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Abstract: The production and use of didactic materials allows having more sources that meet the subject program and with laboratory results and construction practice in Paraguay, in a first stage from 2010 to 2014 (6 books). In a second stage (2015-2019), (4 books) having taken another five chairs to be able to focus materials in a different way but now from materials science engineering, chemical engineering, architecture, forestry engineering and environmental, physics. Thus we were able to build learning and teaching with greater expectations and horizons. From 2020 till now (6 books) the phenomenon of the Covid-19 pandemic (2020-2021) occurs, from there on classes become virtual, and since then our teaching systems have changed, although in 2022 we returned to face-to-face. There are still classes, seminars, etc. that take place virtually.

Keywords: Civil Works materials, chairs, teaching materials

INTRODUCTION

The didactic materials of the Department of Civil Works Materials were foreign texts, sometimes little used in practice and known by few. The challenge was for some teachers to start writing a Manual for the Chair, some basic texts and other complementary ones, using numerous international references and local laboratory and work results.

Before 2010 there were no texts that covered the program of the subject, some manuscripts were gathered, summaries that the teachers had as notes, and with that it began, in addition to the most used books until then to gather the required information and with a category similar to that of an international book.

We started with five teachers, we continued with three, another issue was having the capital to start, the work began as a private initiative, but this is another issue. We had the support of teachers from National Universities of

Argentina and Federal Universities of Brazil who gave us some interesting information to start with the first books. The first issue was when to start, where to start, with what means, how to reach the student. This was answered during the course of the beginning of 2010 and the Civil Works Materials Manual was finished with 10 volumes in the year 2022. It was possible to write on other topics and with other titles on civil construction, education and engineering extension.

METHODOLOGY

The first stage or beginning, covered the period from 2010 to 2014. The undersigned started the work since having an unorthodox calligraphy, it was better to prepare digital printed materials, then mainly power point presentations, classes and didactic materials then turning digital. Of course, videos of material manufacturing, laboratory tests in laboratory were shown and those that could not be carried out there in the form of videos with presentation of results. Also in this period filming of laboratory practices began, since as a teacher in 2013 I was leaving the laboratories to dedicate myself to the theoretical or conceptual part of the course. Practical work carried out by the students was also presented in various ways, including oral presentations and videos. 5 volumes of the Civil Works Materials Manual were prepared (one per year; one general, others on concrete, waterproofing and thermal-acoustic insulators, ceramics and mortars, and on nanomaterials and composite materials) and an Introduction to the Stability and Resistance of Materials, something basic but useful in laboratory management. The comment at this stage was that the subject was no longer a “small” subject but was already a “big” subject, and that therefore the standard of content and qualifications deserved a more exhaustive study. (It should be noted that in 2013 the course on Civil Works

Materials is divided into two parts (1. Civil Works Materials 1 having various materials as content (3rd Semester) and 2. Civil Works Materials 2 having concrete component materials as content (5th semester)). The survey at this stage were the attendance and grades that were treated statistically during this period in order to lay the foundations for the correct completion of the course and the corresponding academic activities.

A second stage from 2015 to 2019 made it possible to consolidate knowledge, regroup it, improve presentations, edit four new volumes of the Civil Works Materials Manual (soils, asphalt, metals and wood) and 3 new editions of already published books. However, the result of the bibliographical increase in this stage was in other materials upon assuming chairs in other careers such as chemical engineering and materials science, as well as concrete technology, in addition to advising thesis on architecture, physics, forestry, Environmental Engineering, Civil Engineering and postgraduate consultancies in these areas, which allowed the increase in the flow of knowledge in order to write more books. However, the classes did not suffer great variation with respect to those of the first stage, they multiplied due to the number of chairs, this did not improve at the moment in terms of the class or didactic moment, but in the third stage, the fruits would be seen, much of it because the contents were different, from the microscopic, chemical aspects and above all emphasizing metallic, ceramic and wood materials, the rest did have similar contents to those of Civil Works Materials in the Faculty of Engineering. Let's call this stage of consolidation, where national and Mercosur teachers, university authorities were also interviewed on aspects related to the area of Materials, where the Chair of Civil Works Materials is taught and where the undersigned has cultivated educational issues consulting

experts in order to "substantiate" the activity as a teacher.

At the current stage, starting in 2020, where the Covid-19 pandemic developed. We can subdivide it into two sub-stages: the pandemic and the post-pandemic, although infections are still continuing in various parts of the world. Classes mutated from face-to-face to virtual by Presidential decree, which forced the teacher to improvise and improve as the classes progressed. We had been given some indications, guidelines and courses to improve ourselves in the art of virtual classes such as classroom platforms, meet, moodle, teaching techniques such as problem-based learning (PBL) and project-based and others, the same was done with the students later. Having previously recorded the laboratory practices was like an "advance" that was used during the quarantine decreed by the President of the Republic. The majority of the students were able to continue with the courses, in our case, we also innovated with the PBL, this allowed the students to deepen by their own means, specifically in terms of the materials and technologies used in temporary constructions to face the contingencies of said pandemic. At this stage we completed the Civil Works Materials Manual in its last volume (temporary and industrialized constructions), adding ten volumes in total. Writing was about activities of University Extension and Education in Engineering, Environmental Management of Construction, Evaluation of Intervention of Structures, Concrete Pavements. (six books), what previous writings allowed, these new materials used in postgraduate and other subjects within the Faculty of Engineering will be consolidated. Without a doubt, education during the pandemic was a challenge not only for the chair, but at country level, in other countries there were already virtual chairs and courses, here according to the Accreditation Agencies of the careers, virtual classes were

allowed during that time, but from the second cycle of 2022, this would no longer be allowed. Since it is considered that virtual classes cannot replace face-to-face classes, because more activities and questions are generated from face-to-face, such as technical visits, laboratories, workshops.

In 2022, in its second cycle, face-to-face classes were taught again, which was well received by the students, since they were uncomfortable with virtual classes, perhaps because they had to be addressed in a different way in many departments. Practical works were left to deliver virtually in our chair, in addition to the presentations of the classes by the teacher. The books are part of the texts to use and others to consult for practical work, there are also in the Libraries of the Faculty of Engineering.

In 2020-21 and in 2022, two student surveys were conducted, including questions about virtual classes and activities. They were treated statistically.

However, the continuity of teaching in the Civil Works Materials chair was not interrupted, and the most appropriate technical and didactic effort was made from this context in order that classes were as dynamic as possible. This project deals with several events that occur and presently allow us to continue working efficiently in the chairs.

RESULTS

What was mentioned in the methodology was possible thanks to the constant research of the author in various fields of knowledge from didactics, online classes, the study of numerous bibliographic sources, YouTube channels, the creation of a YouTube channel in the third stage, with the videos prepared in the first and second stages and during the third. This allowed students to see and review the classes in order to consolidate their knowledge, it was an incredible help, since

from the chair they were encouraged to watch the videos several times in order to learn.

During the first stage, a statistical recount of the qualifications of the students in the Department of Civil Works Materials (MOC 1 and MOC 2) was carried out.

This stage of the project or work began with the teaching practice of making class attendance evaluations, partial and final evaluations, and through them obtaining representative statistics in order to provide feedback. Actually, the project described here, the result of these reflections, was implemented for the first time in the classroom by the researcher in 2010 and the following years, remaining as a teaching method, marking milestones in the national didactics of the subjects of Civil Works Materials of the Faculty of Engineering of the National University of Asunción (FIUNA).

The chair in question was the result of a merger of at least three chairs: Workshops I, Knowledge and Testing of Materials, and Technological and Analytical Chemistry. The texts to consult were varied. They used brochures or class summaries, copies of old books, and other study elements such as brochures presented by manufacturers of construction products. The Head of the Chair of said subject, Prof. Eng. Oscar Bieber Alonso, commissioned me to write a book for the chair together with the other professors in 2008, but the first volume and volume were only published in 2010.

Statistics show us that students benefit of classes was 20% more than when this material did not exist, measured in class attendance and partial evaluations, but above all final evaluations. The subject in the period of 2006-2009, had a percentage of students who passed the subject of 65%, then during the years 2010 to 2012, this percentage increased to 85%, also increasing the percentage of students with grades of 3, 4 or 5, something unusual

previously in the area of basic courses of the Faculty. The Civil Works Materials chair, which started students in the professional area of Civil Engineering, but which continues to be part of the Basic Courses, went from having 60 to 80 students in the years 2008-2011, to having in the year 2013, 120 students. Due to this interest after years, this subject is divided into two sections A and B for this subject, interest growing in the Civil Engineering career. [31]

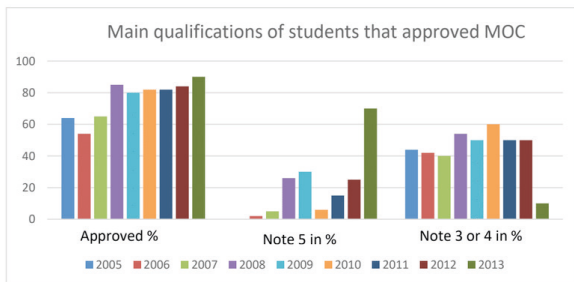


Figure 1: Main qualifications of students that approved MOC

When interpreting these results and contrasting them with other results in other contexts, the results were similar.

In the second stage, a mixed investigation (qualitative and quantitative) was included, where referents from the national Materials area and Mercosur teachers were interviewed, it was carried out in 2015, in order to profile the teachers of the Materials area. [32]

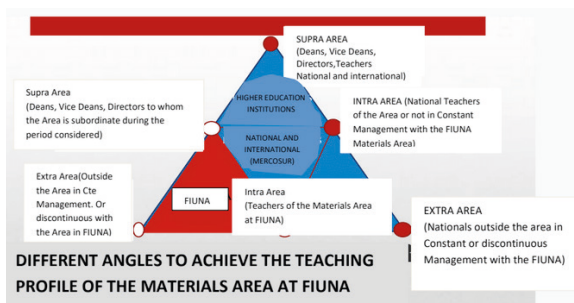


Figure 2. Different angles to achieve the teaching profile of the Materials area at FIUNA

Roles with which the interviewees identify themselves in UNA from a sample of 20 experts

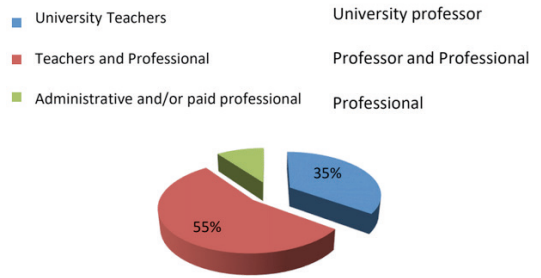


Figure 3: Roles with which the interviewees identify themselves in FIUNA

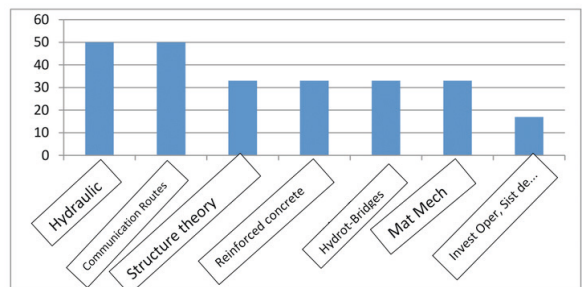


Figure 4. Most important subjects Professional Area-Supra Area, sample of 6 (%)

Ranking of teaching and non-teaching experts from the total sample of 43 experts

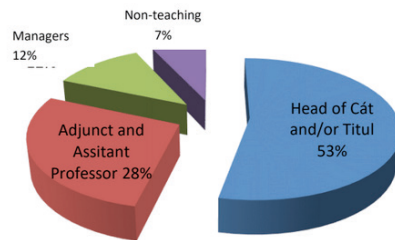


Figure 5: Escalation of teachers surveyed

Teachers without hourly dedication of a sample of 20 - FIUNA

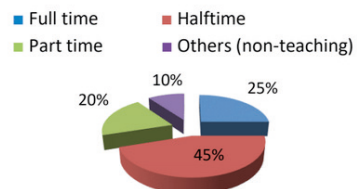


Figure 6: Teachers according to time dedication

CIVIL WORKS MATERIALS	2005	2006	2007	2008	2009	2010	2011	2012	2013
Amount of students taking final exams	59	60	60	60	60	68	68	100	80
Approved %	64	54	65	85	80	82	82	84	90
Qualification 5 in %	0	2	5	26	30	6	15	25	70
Qualification 3 or 4 in %	44	42	40	54	50	60	50	50	10

Table 1: Students according to performance in final exams of CIVIL WORKS MATERIALS

Teachers according to hours dedicated to the FIUNA Materials area

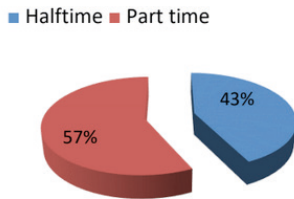


Figure 7: Hourly dedication of the Teacher of the Materials area at FIUNA

Distribución con tiempo disponible para tutorías de tesis de grado y postgrado (11) de una muestra de 20 por Área - FIUNA

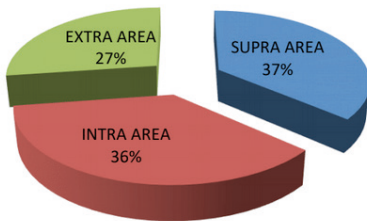


Figure 8: Distribution of time for Tutorials

Number of teachers who advise on learning methodology (Series 1 Advises) and Series 2 (Does not advise) out of a total of 20- FIUNA

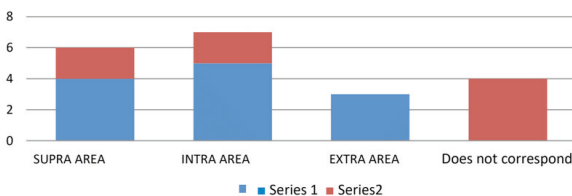


Figure 9. Teachers who advise on methodology and learning at FIUNA.

It is an area that advises on learning methods.

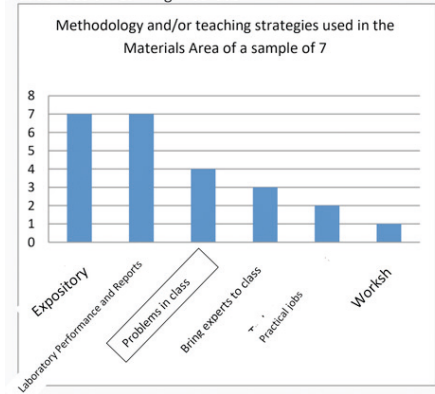


Figure 10: Methodologies and/or teaching strategies used in the Area of Materials

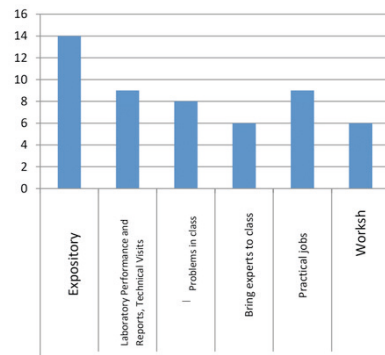


Figure 11. Didactic styles used by teachers from other National, Private and International faculties on a sample of 15

Roles with which the National and International teachers of the total sample of 43 experts identify

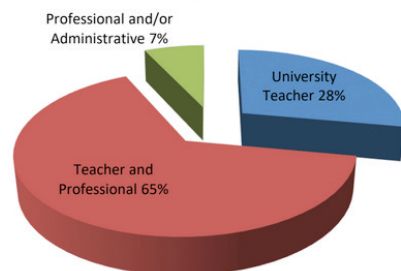


Figure 12: Roles with which the National and International teachers of the total sample of 43 experts identify themselves

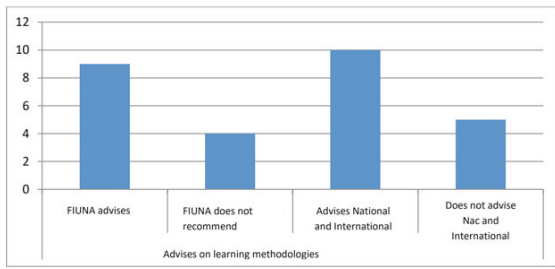


Figure 13. Regarding advice on learning methodologies on a sample of 28 teaching experts

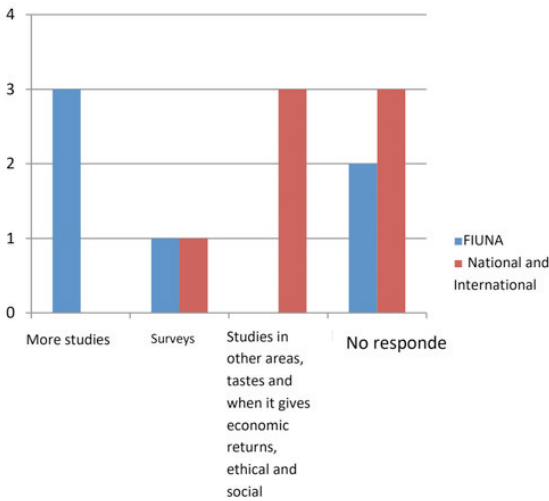


Figure 14. Aspects that need to be improved Supra Area of a sample of 13 experts

Attendance at talks, national and international professional and educational conferences - General

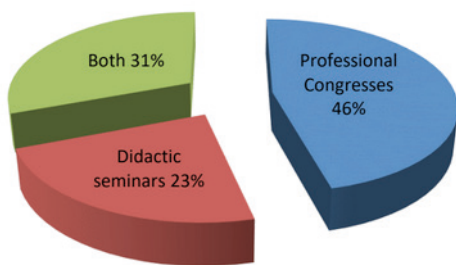


Figure 15: Preferences regarding conferences of the interviewees

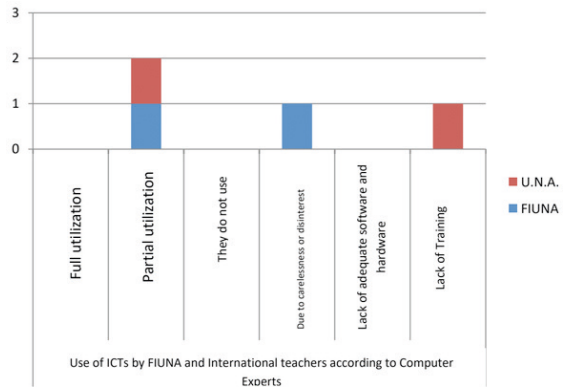


Figure 16. Use of ICTs for teaching by teachers according to experts from the Computer Science-General area

	Docentes	Alumnos	Externos y/o funcionarios
FIUNA	35	51.599	10
U.N.A.	5.100	750.000	58.000

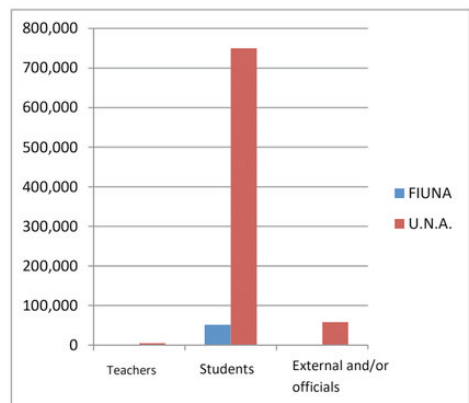


Table 2 y Figure 17. Consultations to Libraries by teachers or students per year (a/FIUNA y Central Library UNA) [32]

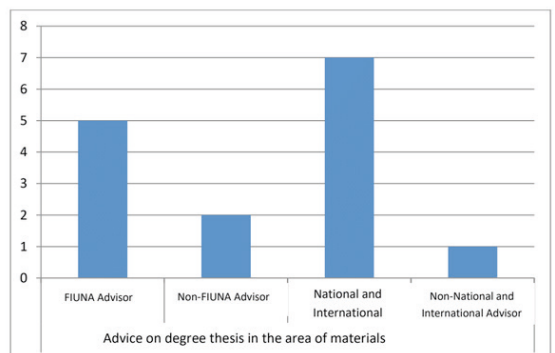


Figure 18. Graduate or Postgraduate Thesis Advisor according to 15 experts from the Area in FIUNA and at the National and International level

Final quantity yielded	161	161	141	153	116
CIVIL WORKS MATERIALS 1	2015	2016*	2017	2018	2019
Approved %	100	92	87	84	92
Note 5 in %	75	30	40	17	40
Note 3 or 4 in %	24	48	35	40	40
**2 plans (2009 and 2013)					

Table 3: Number of Students and grades in percentage - 2nd stage

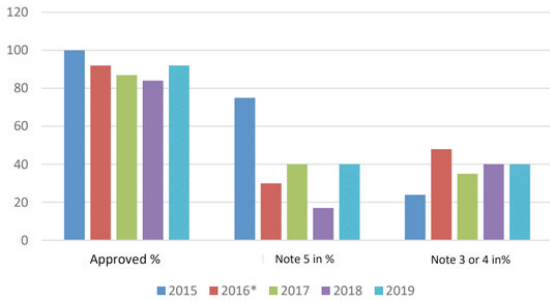


Figure 19: Qualifications 2nd stage Civil Works Materials

In the third stage, in its online sub-stage, during the pandemic students were surveyed about complementary and supplementary activities to virtual class activities. Total respondents 318 of the active virtually in a first stage, taking into account those who took virtual classes on how to learn in the classroom, approximately 850 people represent 37% of them. After each activity, there was an opportunity to complete the survey. Part of the results are the following:

Would you be willing to delve deeper into the topic?

317 responses

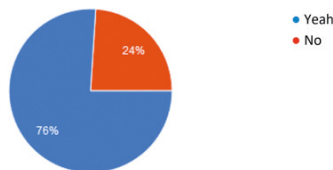


Figure 20: Availability to deepen the topic:

Which of these options do you prefer for a training or refresher course?

317 responses

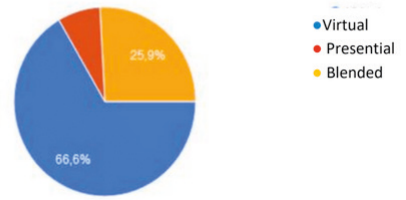


Figure 21: Preferred modality for the courses by the students

Were you able to participate with questions and opinions?

317 responses

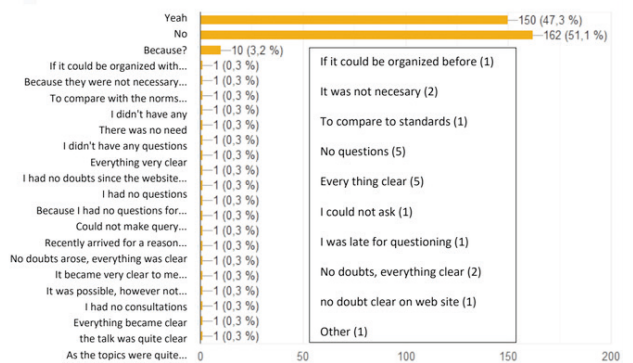


Figure 22: Participation with questions or opinions.

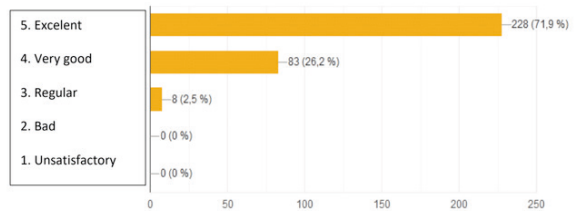


Figure 21: Usefulness of the information

Were the themes presented clearly?

317 responses

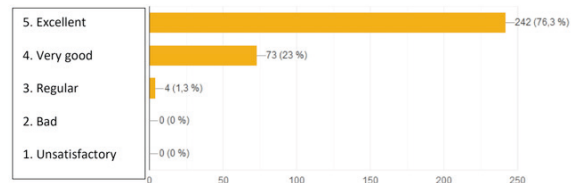


Figure 22: Presentation of the topics covered.

They were asked about what time they have for virtual activities such as seminars and others, part of what was stated by the respondents is transcribed:

None (6), Limited hours or time availability (10), Limited time (10)

That it coincides with an exam (2)

The time with the subjects and schedules of the faculty (6)

It takes me time to study college subjects

Final exams, and the loss of internet connection. Accessible hour

The time if there are exams and the cost if it is very high

Labor Responsibilities. The time in which it is carried out, preferably after 6 p.m. Time according to class schedule. That hours do not coincide with business hours. None, as long as I have time.

The exams (2). Mobility in the case that it was face-to-face (2)

Without delving. Monetary drawbacks. Availability of time and transportation (2)

The other answers hovered around the answers already exposed, only arguing in different ways.

The last sub-stage in this work mainly includes a survey carried out after emerging from the pandemic. The objective of the survey was to know about the reality of the students, from where we get the answers that are shown here.

During the year 2022, the questions about the virtual classes gave the following results from 287 respondents out of a population of 1088 civil engineering students enrolled in 2022 with email availability:

Are you satisfied with the study method adopted by FIUNA for virtual classes?

287 responses

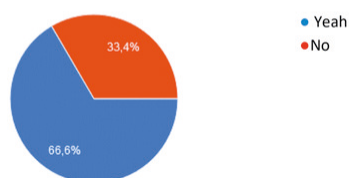


Figure 23: Satisfaction with the study methodology of virtual classes at FIUNA.

Below is part of the arguments of the students on the previous question:

It allowed quite a bit of versatility and the quality of the classes remained at the same level as the face-to-face classes.

Because there was no compulsory attendance.

It was an advance for the faculty in that sense.

At the time only because it made it easy for me to work.

Better organization of schedules.

Most of the teachers put effort into it.

I particularly liked it because I could manage my time very flexibly, having content from several professors, which allowed me to consult another professor if I didn't understand something with a particular professor. Not having to go to the university saved me hours of trips weekly to the university.

Because having materials on hand and easily accessible at any time of the day is convenient for students.

The virtual method adopted was good, especially the release of attendance since it allowed the student to have the recordings of classes and the materials despite not having been able to attend during class hours.

Because less time is wasted on trips and less expense on bus tickets.

The use of synchronous and asynchronous classes seemed correct to me, so each one could adapt according to his schedule. In addition to the fact of being able to consult any material at any time. The assistance released was also correct for the aforementioned.

The use of technologies and recorded classes helps to gather more information.

There are subjects that choose to reuse recorded classes from previous semesters to avoid developing again, which is not always ideal, and on other occasions many teachers take the opportunity to modify the already established schedule, altering the schedule of

each student.

The level of the classes was mostly lower than in person.

Certain subjects should be essentially virtual.

-They were also asked a question about choosing a career in civil engineering

The result of why they chose the career, the predominant responses were firstly the Job Opportunities, secondly the graduation profile and thirdly the good remuneration, to a lesser extent family influence, others and the suggestion of third parties.

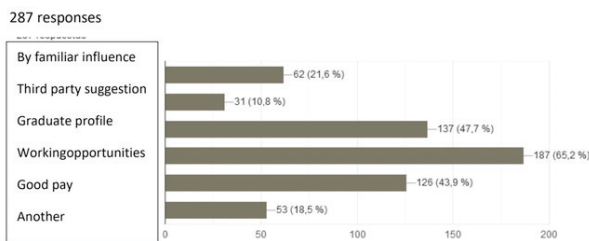


Figure 24: The choice of career was due to?...

Explaining the reasons why they decided to pursue civil engineering, are the following:

Like the career, personal preferences, study plan or curriculum, desires to become a high quality professional, influence and prestige, social status, likes construction, because of focusing on real estate, thanks to the technical high school in civil constructions that he liked, likes mathematics, by vocation, lack of engineers in the country, to contribute to the urban development of the country, economic situation, because of the use of human inventiveness, interest in ecological constructions, possibility of working independently, interest in technological advances, structural calculation, curiosity and desire to learn, since he was a child he was already interested in the career because of his father who practices the profession, among others.

Finally we have the statistics of this 3rd stage:

Final quantity yielded	87	70	181	70	78
CIVIL WORKS MATERIALS 1	2020	2021-ciclo 1	2021-ciclo 1	2022-ciclo 1	2022-ciclo 2
Approved %	95	96	99	86	97
Note 5 in %	71	66	92	60	59
Note 3 or 4 in %	18	28	6	30	35

Table 4: Number of students and grades MOC 1 -3rd stage

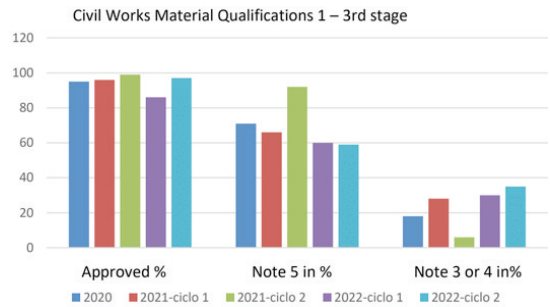


Figure 27: Qualifications of Civil Works Materials 1 – 3rd stage

Final quantity yielded	24	127	108	34
CIVIL WORKS MATERIALS 2	2021-cycle 1	2021-cycle 2	2022-cycle 1	2022-cycle 2
Approved%	96	98	78	97
Note 5 in %	50	48	22	47
Note 3 or 4 in %	38	43	39	41

Table 5: Number of students and qualifications MOC 2 3rd stage

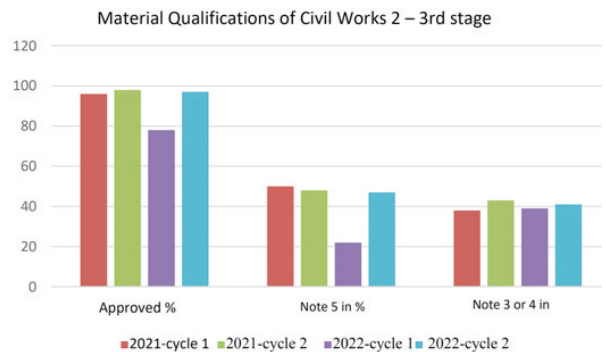


Figure 28: Qualifications of Civil Works Materials 2 – 3rd stage

The following books remained in order to study and in order to encourage research in the area of materials and civil construction:

1. Volume I volume I –Third Edition[1]
2. Volume I volume II- Concrete, reinforcement and formwork, 2nd Edition revised and expanded[2]
3. Volume I volume III-Geomechanics and Foundations- 2nd Edition[3]

4. Volume I volume IV-Asphalt Materials[4]

5. Volume I volume V-Science of Materials and Metals[5]

6. Volume II volume I-Waterproofing, primers, adhesives, thermal and acoustic insulation. [6]

7. Volume II volume II-Ceramics and mortars. [7]

8. Volume II volume III-Nanomaterials, Composite materials and new materials. [8]

9. Volume II volume IV- Timber and its sustainability. [9]

10. Volume II volume V-Temporary and Industrial Constructions and alternative materials. [10]

11. Manual of Evaluation and Intervention of Structures. [eleven]

12. Introduction to the stability and resistance of materials. [12]

13. Let's devise an education for all or almost all-Science + art of teaching. [13]

14. Environmental Management of Construction. [14]

15. Technological extension in higher education. A paradigm in the 21st century. [fifteen]

16. Concrete pavements-More than an Alternative. [16]

The qualifications did not vary in the chair, since a control of the evaluations, the revision of the same allows a better analysis and promotion of the student to the following levels.

DISCUSSION OF RESULTS

It is important for the teacher to go gradually, to “burn stages”, not to remain stuck, to shake and shake students with knowledge, to search the best way to communicate with the class and with the community, in regards to laboratories, technical visits, conferences, congresses, which add up in terms of real, simulated or theoretical experiences that make up the construction of the chair.

In the first stage, the path of deepening in the chair began (2 chairs since 2013). In the second stage, the content and essence of being a teacher of both chairs was perfected. In the third stage of this composite research, what had already been done was increased with a greater amount of materials in less time, experiences were shared with teachers.

The teachers of other chairs were consulted, and the books remained as reference books for these chairs, since the depth of the contents dealt with in some of the books do not correspond to the basic and conceptual levels of the 3rd and 5th semester covered by the Materials Civil Works chair.

The participation of the student body in the surveys is increasing, we could say that it is even a habit, this nourishes the objectives of the Faculty of Engineering, the training, orientations, the topics covered are highlighted by the quality of the presentations and the tools available for virtual teaching, there are also some students without adequate access to virtual videoconferences, debates and training, in addition to problems with class schedules, exams, study, among others. It has been possible to make students participate and make them participate as future engineering professionals.

During the time of the pandemic, an attempt was made to respond mainly to the problems of equipment, connectivity, effective programs for distance and semi-face-to-face education, as well as responding to the needs

of the market, knowing trends, realities and the return of each of the events developed, including projects, reports, activities, etc.

In the post-pandemic sub-stage, it was possible to carry out the face-to-face classes again, the videos can be uploaded or the respective links shown, the presentations of the classes and auxiliary materials can be uploaded by the teacher to the platform available to the faculty. Practical work can now be submitted online on platforms available for that, FIUNA has two Classrooms and Moodle, above all, it was also able to grade the process as part of the partial exam scores and this influences when it comes to qualifications (grades) in final exams.

The increase in the first substage of the pandemic stage was mainly due to virtual exams, a matter that significantly benefited the student. The situation was normalized again when the exams began to be face-to-face, both partial and final.

CONCLUSIONS

The greatest invention of humanity is education, and how would there be education without the appropriate texts, and especially the fundamental technical education for the progress of humanity. We must fight for better knowledge, more approaches to reality in the world of higher education, it is there where engineering stands out, not only for the works completed, but to sustain technological progress, there must be those who take a moment apart to write in order to know what to do and what not. The bibliography must go according to each period leaving the following one a legacy that can be understood, continued, that can advance and progress towards quality, maintain it and continuously improve it.

The most productive learning occurs in a team, which implies for teacher leaders to design work from a collaborative perspective,

adopt a more participative and open style, it facilitates multiple relationships between teachers, staff and students of the institution. In the area of materials, teamwork and feedback, as well as designing incentives of a collective nature that strengthen said characteristic and doing things together, since from the success of this learning of teamwork arises their possibility of entering the labor and professional world.

The recapitulation and contrasting of the statistically treated data, the use of better methodologies, techniques and didactic tools in different stages, result in a teacher who with a spirit of improvement and with bibliographic and applied research in laboratories, embodied in books that make up the abc of the chair and the present sowing for the harvest in the near future of our students in their professional functions.

In addition, the teacher must manage and connect to the administrative area, in order to be able to give continuity to the requirements of the chairs, he must lead and at the same time manage knowledge and its actors, understanding the organizational dynamics of the institution, and when he must contribute something in equipment, research, teaching materials, do so, in order for the educational community to connect and organize. During the process, the importance of monitoring evaluations was seen in order to improve them and that they do not deviate from their objectives.

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