Articulation of regional headquarters in the Industrial University of Santander for a unified basic cycle of engineering

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Abstract. The Industrial University of Santander has five headquarters in Santander and one of the main challenges is to achieve articulation between subjects of the basic engineering cycle and the processes they entail. ExperTIC project, developed within the framework of the Academic Excellence System by Academic Vice-rectory of the University, who is supporting this articulation, standardizing the Teaching-Learning processes, creating and administering didactic resources in a centralized manner, facilitating access from all students to resources, through content management platforms such as expertic.uis.edu.co and Moodle virtual classrooms. In addition, information and content assets have been consolidated for Department of Physics, through links to e-books and Wikiversity pages. At regional headquarters of the Industrial University of Santander, evaluation is supported through the design and implementation of the evaluation process coordinated with a defined model, clearly establishing the stakeholders, using management tools; all this in order to able to design evaluations that will be applied simultaneously in all headquarters.

1. Introduction

The modern teaching process should place more emphasis on research on the Teaching-Learning process and less emphasis on knowledge and skills transmission through conferences. NASA, in a project, carried out with 10th and 11th grade students, has put at your disposal information, games, animations and other fun tools about environmental phenomena on its website, arguing the need for a paradigm shift in physics teaching, with the greatest scientific tool, “curiosity” [1,2]. One of the problems in high education is that content offered in many subjects don’t really correspond to those legally approved in the academic agreements of the institutions, generating great confusion and demotivation in teachers and students.

Virtual resources and electronic learning systems have become common tools in many educational establishments around the world. TECH8 is a modularly designed model in Slovenia [3] and is based on collecting metadata and vital variables system for teaching process. This proposed system supports individualization and adapts to the knowledge level and understanding of each individual on the subject, which has generated better results than traditional teaching. In Industrial University of Santander (UIS) since 2015, a methodology for the realization of Physics 1, Physics 2 and Physics 3 laboratories (classical mechanics, electromagnetism and, waves and particles, respectively) based on research projects for the
strengthening of the research competences of the engineering students have been developed. This methodology is based on several Teaching-Learning strategies, such as Just in Time Teaching (JiTT), active learning and mediated learning that together with a virtual platform allows students and teachers to access teaching resources and improve their experience.

In UIS’ regional headquarters (UIS-RHQs) exist some difficulties in communicating with teachers has favored some problems, such as the lack of clarity in professors and students about requirements for programmed contents, contents readjustments at the will of the teachers for not having clear guidelines from each department, students with unequal opportunities in terms of available resources, few options for training teachers, non-standardized procedures for handling and disseminating summative activities and definitive qualifications, among others. In this sense, UIS has been working since 2016 with ExperTIC project, which seeks to establish processes for these subjects’ articulation in RHQs, in order to provide students with digital resources such as: shared workshops, links to virtual books, Session Preparation Questionnaires (SPQ) and some actions to incorporate active learning strategies [4, 5, 6, 7]. This article presents some strategies for basic science cycle subjects articulation in UIS-RHQs, describing the methodology composed of the following processes; (i) model definition phase for the implementation and determination of the main processes, and (ii) implementation phase, where objectives socialization is carried out, training in pedagogical strategies for participants and the processes implementation are established.

2. Articulation model and methodology definition
In Teaching-Learning processes associated with subjects of the cycle basic sciences engineering offered at RHQs some problems were identified and, subsequently, solutions in Table 1 were proposed.

| Problems                                                                 | Proposed solutions                                                                 |
|-------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| • Teachers and students with little clarity about the scope of the contents. | • Declaration of detailed agendas based on academic agreements. |
| • Readjustments of contents at the will of the teachers.                | • Facilitation of agendas for teachers and students.                             |
| • Students with unequal opportunities in terms of available resources.   | • Provision of follow-up matrices for the topics to be dealt with in each module. |
| • Few options for training teachers.                                    | • Creation of mechanisms to share workshops of all the professors with the students of all the headquarters. |
| • Non-standardized procedures for managing and disseminating summative activities and final qualifications | • Establishment of unified qualification matrices, in Moodle platform. |
|                                                                         | • Teachers training in didactic strategies and in Teaching-Learning processes through “School of trainers”. |
|                                                                         | • Establishment of communication strategies for the deployment of guidelines from the Department Management. |
|                                                                         | • Generation of virtual and face-to-face meeting sites so that teachers can share their experiences and challenges. |
|                                                                         | • Regular visits to RHQs to communicate developments and raise findings of the Teaching-Learning processes. |

2.1. Standardization of processes
In order to standardize processes, the ExperTIC project implemented the following strategies: Modular Content Manager (MCM), some teaching strategies for active learning and the definition of a regular conduit for teachers, which will be described below.
2.1.1. Modular content manager (MCM). It is the process that is carried out for the creation of intervened subjects’ agendas; it is based on a model called Modular Content Manager (MCM) [8]. In this model used by the ExperTIC project, initially, a collection of the contents proposed by Departments and a comparison between them is made, starting from contents declared in Agreement 105 (2004) and Agreement 034 (2005) of the Academic Council. MCM is composed of the following elements, which are represented in Figure 1.

- Minimum content unit (MCU) or Content theme, it is each specific topic that integrates a subject and that is defined by Departments in their educational curriculums. In some cases, contents are very well detailed; while in others, it is necessary to decompose the topics.
- Minimum unit of learning (MUL) or Lesson, is a short cycle, with a defined duration that seeks to deal with content issues and that allows defining clear goals, objectives, and goals.
- Modules are units that cover one or more lessons and that generally use a summative evaluation for their closure. In a traditional course, Module is also known as a chapter or cut for an evaluation.

![Figure 1. The life cycle of modules and life cycle of lessons that make up modules.](image)

2.1.2. Adopted teaching strategies. The ExperTIC project uses two educational components (i) didactic strategies based on active learning [9], mediated learning [10] and Just in Time Teaching (JiTT) [11] and (ii) virtual learning management resources such as Moodle and the platform “expertic.uis.edu.co”. These components were adapted to the basic cycle subjects (Calculus, Physics, and Chemistry, among others), impacting Learning habits of students in the previous preparation of their classes, generating a positive effect after it [12,13]. The previous study carried out by students in each subject, is supported with digital resources that are provided on the platform, among which are the Session Preparation Questionnaires (SPQ), links to digital books of the university’s library and wikis to reinforce concepts, taking into account the modular organization that governs the course’s content.

2.2. Provision of didactic tools for students

2.2.1. Creation of virtual digital tools. The virtual digital library Ebooks-7/24 provides all books, with links to each topic established in the MCM model of each subject. In addition, the SPQs associated with each lesson were created, focused on testing the basic concepts of each topic, which will be covered during the week, supported by the wiki of each of the lessons.
2.3. Coordinated evaluations and visits to the RHQs
For subjects’ module evaluations in RHQs, a four levels maturity implementation model was established as shown in Table 2.

Table 2. Maturity model of evaluations by department.

| Level | Characteristics |
|-------|-----------------|
| 1     | Independent evaluations. Teachers define dates of their evaluations before starting the course. |
| 2     | Coordinated assessments by department in each headquarter. Each headquarter independently coordinate a single evaluation per subject. |
| 3     | Coordinated assessments by department for different headquarters. Headquarters together coordinate a single evaluation per subject. |
| 4     | Coordinated assessments by department for all headquarters. All headquarters coordinate a single evaluation per subject (including main headquarter). |

When levels two or more are implemented, coordination with the teachers is required to agree on the day and time of the evaluation, and content themes to be included in the evaluation, for which clear procedures are defined to help the logistics for these levels, as described in Figure 2.

![Figure 2. The life cycle of the evaluation process.](image)

2.3.1. Implementation of the evaluation. Activities involved in the evaluation model have been readjusted since the implementation began. The process begins with the questions request to professors of each RHQs, taking into account the topics to be included in the evaluation that has been verified by teachers through a matrix for the follow-up of topics seen in class. Then, the evaluation team schedules two work sessions. The first session consists of a meeting by videoconference with each RHQs in which professors review and defend each question or problem previously proposed for the evaluation. The result of this meeting is the preselection of refined questions and with adjustments proposed by the
professors. Later, in a face-to-face meeting (second session) the questions or definitive problems that will be included in the evaluations with their weighting are selected.

2.3.2. Visits to RHQs. Yearly, two visits to each RHQs were scheduled, with the purpose of documenting the experiences of the teachers and students in the use of the platform and methodology proposed in the project.

3. Results and discussion

3.1. Indicators of the ExperTIC project

Since 2017, the ExperTIC project has been implemented in the UIS-RHQs. The indicators in the last two years are summarized in Table 3.

| Indicator                                                                 | Goal achieved |
|---------------------------------------------------------------------------|---------------|
| Number of trained teachers in the training program on ICT strategies and methodologies | 30            |
| Number of student enrollments that use e-learning with the Moodle platform | 4000          |
| Number of subjects designed and implemented with virtual learning activities | 12            |
| Number of courses, with support in virtual classrooms of the Moodle platform | 200           |
| Number of accesses per year to library resources through links provided by ExperTIC | 1000          |

In each academic semester, teachers of theoretical physics and laboratory have been incorporated in the training program organized by CEDEDUIS, through the training and continuous improvement of teaching, counseling pedagogical, methodological innovation and the use of information and communication technologies. The process started in 2015 with only Physics laboratories in the main headquarter. At present, there are 12 subjects (3 Physics, 3 Calculus, Differential Equations, 2 Linear Algebra, Analytical Mechanics and Chemistry).

3.2. Perception surveys of teachers and students

A 71.4% of the teachers belonging to the Bucaramanga, Barbosa and Socorro cities (14 in total) mentioned that the links to the books in each of the proposed topics in the MCM model are useful, a 21.5% consider them moderately useful and only 7.1% don’t find much use. Regarding, the laboratory-theory relationship, the majority of teachers insist that topics covered in theory are not in accordance with the developed laboratories, because in many cases practices don’t follow the order of the topics seen in class or there is a slight gap. On the other hand, they indicated that it is possible to plan a practice where the theoretical concepts of laboratory topics are not required and can be built with practice, and then correct and revise when it is treated in the theoretical classes. Finally, teachers agree that more communication channels should be established so that theory and laboratory teachers can interact a little more and not be seen as two independent courses.

On the other hand, some students from Physics 1 of Socorro city indicated that coordinated and organized by own teacher assessments have a similar degree of difficulty. However, it seems more appropriate that is done by the teacher, because sometimes some teachers don’t reach to touch all topics proposed in the evaluation. Finally, Figure 3 shows the result of the general perception of students surveyed in Physics on a scale of 1 to 5 in the first semester of 2018.

Thirteen (13) students from Malaga and five (5) students from Socorro participated in the survey for Physics 2. Students consider that some improvements should be made to Moodle virtual classroom, among which are: a greater explanation and better quality of laboratories’ videos and include presentations as a summary in each Lesson. These two previous aspects have been taken into account for the implementation of 2018 within the platform some old practices have been replaced by new ones with improved videos, and, review presentations have been added as wikis in a Wikiversity account, they summarize each of the topics by lesson, with the advantage that information can be modified, added and refined by Physics teachers. With respect to evaluations, as in Physics 1, students have different
opinions, some affirm that it is appropriate to unify evaluations as proposed, others, however, consider that it is necessary to ensure that proposed topics in the exam, others insist that more time be given to respond and to improve the impressions’ quality so that images of proposed problems are clearer.

Physics 3 students had a greater participation in the UIS-RHQs. Unlike the findings in Physics 1 and Physics 2, coordinated exams were considered more appropriate, because they perceive a similar level of complexity and some advantages such as equality when evaluating the knowledge acquired in the subject and the greatest responsibility in the course.

![Figure 3](image)

**Figure 3.** The answer to the question: Rate from 1 to 5 the general experience in Physics.

3.3. *Findings found in the visits made to the Regional headquarters*

During this first visit to Barbosa and Socorro cities, a couple of meetings were scheduled (one with students and later one with teachers). In this activity, Barbosa students contributed with suggestions and doubts regarding the implementation. Among the most important comments are: (i) evaluations have been mostly taken care by administrative staff and not by professors, which has generated problems when resolving doubts on specific topics, for which it is recommended look for other schedules in which teachers are present and (ii) extend the duration of the exam to 1.5 h to 2 h. At Socorro, teachers showed great interest in the project and proposed to make different points in the exam or mix the groups of different physics to avoid fraud and review contents of the accreditation program.

In Malaga, teachers and students expressed some concerns about the implementation, which were clarified. On the other hand, students affirmed that adaptation to evaluations coordinated has been complex, in a general way they have not had good results, they suggest that they should ask questions with a lower degree of difficulty. In the case of the platform and digital resources, as in the previous two cities, laboratories’ videos improvement and the inclusion of review slides for Physics content are included.

Finally, teachers of basic engineering cycle are not very familiar with the proposed methodology in Barrancabermeja. However, some teachers showed some experiences where they have applied some didactic strategies in their courses, which can be articulated with Moodle platform tools and support the Teaching-Learning process. Furthermore, some teachers generally suggest forming "excellence committees" to consolidate communities, where strategies are proposed, continue to build content assets with experts support and link more tools for virtual content creation and educational resources open.

Students welcomed the project explanation, didactic strategies that support it and the virtual tools created to support Teaching-Learning processes.
4. Conclusions
From the visits made to UIS-RHQs, it can be concluded that students and professors have very well received the implementation of the ExperTIC project, although some concerns persist associated with the fact of changing study habits and becoming familiar with the coordinated exams. On the other hand, new teachers of subjects such as Calculus and Chemistry are motivated by the experience lived in Physics, but they need more accompaniment to have clear instructions.

Among the aspects that should be strengthened in the project, the need to create a collaborative space in the virtual classrooms of Physics subjects was highlighted, where a summary of each Module is presented, with the possibility of that teachers can edit the information and improve continuously. To solve this request, the educational platform "Wikiversity" was used, which has been well received by teachers and students. On the other hand, one space was created within the Moodle platform to report errors and thus identify faults in the incorporated materials and quickly solve them.

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