

**Analysis of the perception that students have of a subject.
Application to Integrated Information Systems of the
Industrial Engineering Degree**

***Análisis de la percepción que los alumnos tienen de una asignatura.
Aplicación a Sistemas Integrados de Información del Grado de
Ingeniería Industrial***

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Abstract

The main purpose of this work is to establish and analyze the perception that students of the Degree in Industrial Engineering (GIOI) have about the subject Integrated Information Systems (IIS) in relation to the Task Value, and how this perception varies by taking a subject of the subject-matter analyzed. To achieve the objective, two surveys have been carried out on the students of the subject “Integrated Information Systems in Industrial Organizations” of GIOI. The first survey was passed to the students at the beginning of the course, prior to taking the classes of the subject. The survey was repeated at the end of the course, once the subject was completed, to see the changes in the assessment of the students. GIOI Students have a relatively low initial assessment of IIS subject, especially when compared to other subjects of the degree. However, after taking a subject in this area, its relative assessment increases, and its perception of Utility and Cost improves significantly. The course gets the students to perceive the IIS as something key for their future work. This did not happen before the course. Consequently, it can be concluded that taking the subject changes positively the perception of the students about IIS. Once this result is obtained and validated that it is positive, the research should deepen in which activities, contents or methodologies of the course help to achieve this result, with the objective of enhancing them with respect to those that are not so effective. This work allows teachers to find out the students' perception of a particular matter-subject, and its variation after taking a subject in that matter-subject. With this information, it will be possible to design and carry out the most appropriate teaching-learning actions to the given situation, to develop, as far as possible, a deep learning of the subject

Keywords: *Student perception, Task Value, Teaching, Integrated Information System.*

Resumen

El objetivo principal de este trabajo es establecer y analizar la percepción que los estudiantes del Grado en Ingeniería Industrial (GIOI) tienen sobre la materia "Sistemas Integrados de Información" (SII) en relación con el "Valor de la tarea", y cómo esta percepción varía al cursar una asignatura de la materia analizada. Para lograr el objetivo, se han realizado dos encuestas sobre los estudiantes de la asignatura "Sistemas integrados de información en organizaciones industriales" de GIOI. La primera encuesta se pasó a los estudiantes al comienzo del curso, antes de asistir a las clases de la asignatura. La encuesta se repitió al final del curso, para ver los cambios en la valoración de los estudiantes tras cursar la asignatura. El análisis de los datos indica que los estudiantes de GIOI tienen una percepción inicial relativamente baja de la materia SII, especialmente en comparación con otras asignaturas de la titulación. Sin embargo, después de cursar una asignatura de esta materia, su valoración relativa aumenta, y concretamente, su percepción de la "Utilidad" y "Coste" mejora significativamente. El curso hace que los estudiantes perciban los SII como algo clave para su trabajo futuro, cosa que no sucedía antes de cursar la asignatura. Por tanto, se puede concluir que cursar la asignatura cambia positivamente la percepción de los estudiantes sobre los SII. Una vez que se obtiene este resultado, y se valida que es positivo, la investigación debe profundizar en qué actividades, contenidos o metodologías del curso ayudan a lograr este resultado, con el objetivo de potenciarlos respecto a aquellos que no son tan efectivo. Con esta información, será posible diseñar y llevar a cabo las acciones de enseñanza-aprendizaje más adecuadas a la situación dada, para desarrollar, en la medida de lo posible, un aprendizaje profundo de la asignatura.

Palabras clave: *percepción del estudiante, valor de la tarea, enseñanza, sistema integrado de información.*

Introduction

The learning process is conditioned by many factors such as motivation or understanding. These subjective factors are in turn conditioned by the students' perception of the subject matter (Alfalla-Luque et al., 2011). Thus, students of a subject have a greater willingness to learn it comprehensively, when the content of the subject is perceived as interesting, important and useful. In the same study, the authors cite Ausubel (1989), indicating that the most common reason for students' lack of motivation is that they do not see the usefulness of the subject in a real environment. Therefore, it can be said that motivation directly affects the way of thinking and, therefore, also the learning process and its final result (Alonso Tapia, 1995). Moreover, the academic performance that students have in a subject, is directly related to their perception of it (Frende et al, 2017). Of course, the teacher exerts a great influence on the process and can favor these factors, these subjective variables (Rinaudo et al., 2003). Using appropriate teaching methods, it is possible to achieve a remarkable improvement in the perception that students have about a subject, thus capturing their interest, and being able to achieve deep learning.

Obviously, to find out if there has been an improvement in the degree of perception that students have of a subject, the first thing is to know what the initial situation is. Subsequently, once the initial perception is

known, it is possible to establish the most convenient strategies, in order to design a teaching-learning process appropriate to the identified context.

This research arises because, after several years of experience teaching subjects in the degree of GIOI within the UPV, it has been observed that the students of the degree do not give too much importance to the matter of IIS. They have the perception that it is something alien to them, closer to computer science professionals and outside of their work environment without a direct application in the possible performance of their future work as graduates in Industrial Engineering. Therefore, they establish a superficial learning approach to the concepts of IIS. However, nothing is further from reality. IIS is a fundamental matter in the future work of a GIOI, and this is reflected in the "Study Guide" of this degree at the UPV, which describes the skills to be acquired by a graduate in this degree.

The study presented in this article is specifically focused on the subject of IIS that is taught in the GIOI Degree of the Polytechnic University of Valencia (UPV). Therefore, to carry out the work, the specific objectives of the research are presented below, and then the context of the research is described, explaining the context of the subject in which the research is carried out. In the fourth section of the paper the methodology followed in the investigation is presented, based on the protocol presented in Oltra-Badenes (2018), and in the fifth section the results are presented. Finally, the conclusions drawn from the analysis of the results obtained are presented.

Objectives

The main objective of the research presented in this article is to know what the GIOI students' perception of the SII matter-subject is. The research questions that are intended to be answered through the research carried out are related to that final objective, as well as to the value that the students give to the matter-subject. The questions would be the following:

- To what extent do GIOI students recognize the importance of training in IIS for the performance of their future work? In relation to other matter-subjects?
- Do GIOI students believe that IIS is a useful matter-subject? To what extent they believe it?
- Do they find the matter-subject of IIS interesting? It means, do they like this matter-subject? To what extent?
- Do GIOI students perceive IIS as a difficult, costly matter-subject to study?
- Does taking an IIS course change students' perception? If so, how?

It is evident that a "why" should be added to all these questions, in order to identify and analyze the main causes, taking the research to the qualitative field. However, in this first stage of the research work, this aspect will not be investigated. This will be a future line of research, which will be undertaken once the quantitative data has been obtained and analyzed.

Context description

The work of a graduate in GIOI will be related to corporate responsibility jobs. This work can be carried out in any department, both in the industrial sector and in the services sector. This work performance can

be developed as responsible for different areas such as production, maintenance, quality control, logistics, R&D, etc. or through project management and management or (ETSII UPV, 2018).

With the objective that students, in their professional future, could develop their work, the Degree in Industrial Organization Engineering trains “*graduates who can advise, operate or improve organizations, production systems, processes, services or information systems to favor the competitive advantage of companies, taking into account the human aspects and the economic viability of the proposals designed*” (ETSII UPV, 2018).

To carry out all this professional activities, having and managing an adequate Information System is essential, and consequently, in the curriculum design of the degree there is a specific IIS matter-subject. The GIOI curriculum is structured in 5 modules, which in turn are structured by matter-subjects, and the matter-subjects can be constituted by one or several subjects.

One of the modules in the curriculum is "Industrial Organization Technologies". This module includes the matter-subjects defined as basic and essential to be able to carry out the profession of Industrial Engineer, and it is mandatory. The SII matter-subject, which this article focuses on, is one of the six matter-subjects of which this module is composed (Table 1) and is taught in the 2nd quarter of the 3rd year of the degree:

Table 1. Matter-subjects of the module "Industrial Organization Technologies" (ETSII UPV, 2018)

Matter-subject	Credits
Quantitative Methods for Industrial Organization Industrial	9
Production Management	19.5
Industrial Economy	9
Industrial Business Administration	13.5
Integrated Information Systems	6
Quality Control	4.5
TOTAL	61.5

As can be seen in Table 1, the matter of IIS consists of six ECTS credits, out of the total of 61.5 credits that make up the total of the Industrial Organization Technologies module.

Another of the modules in the structure of the GIOI curriculum is the "Specific Optative" module, with 36 ECTS credits. This module is located in the fourth year of the degree and has three "intensifications", one of which is the intensification in Industrial Organization. In this intensification, in the first semester students study a common “Industrial Organization” matter-subject, with 18 ECTS credits, distributed in four subjects. In the second semester, they study the matter-subject of "Intensification", where they can choose between two alternatives, the "Production and Logistics" option or the "SII and Knowledge Management" option. Both intensification options have 18 ECTS credits, structured in three subjects of six ECTS in each case.

It should be said that these are the two intensifications currently active in GIOI of the UPV, although up to eight different alternatives are contemplated in the curriculum. However, the other six alternatives are not active. This is clear evidence that IIS are important for a GIOI in the labor market and recognized as such, since this activation of intensifications responds, as it cannot be otherwise, to the needs of the labor

market, where IIS and knowledge management, in its continuous evolution (Gil et al, 2010) are essential for a GIOI.

In addition, of the eight "specific competencies" to be developed in the GIOI degree that are detailed in the curriculum, there are two whose acquisition is unequivocally (and almost only) related to this matter-subject (Oltra-Badenes, 2018). In addition, the works of Marin-Garcia et al (2008) and Marin-Garcia et al (2009) propose specific competencies for a GIOI, which can only be achieved through the matter of IIS, such as: *“Manage the storage and recovery of information”* or *“Develop and deploy information systems to support business decisions. Model and develop computer applications or queries to applications related to information management in the company (CIM, MRP, ERP, SCM, etc.)”*

Further, IIS allows to improve process management, increasing its efficiency (Oltra-Badenes et al, 2019a) and being able to promote more sustainable production management (Oltra-Badenes et al, 2019b)

Therefore, given that the IIS matter-subject is a key factor for the professional development of a GIOI, it can be thought that students should perceive the IIS matter-subjects as one of the most important in the degree, with an assessment equivalent to the subject of the other active intensification at present, production and logistics. However, this has not been studied. Moreover, in fact, it seems that this is not the case, and other matter-subjects are perceived as more important for their future work.

Methodology

The research presented in this article follows the protocol established by Oltra-Badenes (2018). Thus, it is carried out at the UPV, a University less than 50 years old, with a budget of about € 400M. This University employs about 6000 workers and annually has around 40,000 students of formal regulated training. This University has been during the last years among the “50 best young universities in the world”, so it can be considered one of the references in the Universities of the technological area (Marin-García et al, 2018).

Research data are obtained using a survey. This survey is presented to the students of the subject “Integrated Information Systems in Industrial Companies”, a subject of the GIOI IIS matter-subject. The Google Forms application is used, and a specific questionnaire is developed for the students to answer the questions. Therefore, the students have the survey form available through a link provided by the professor.

The questionnaire will be passed to students twice. The first occasion (initial survey) will be in the first session of the course, to know the initial perception of the students, prior to any interaction with the teacher and the subject. The second occasion (final survey) will be in the last week of the course, just before the final exam. In this way, it will be possible to know the students' perception at the end of the subject, and it will be possible to compare them with the initial situation, analyzing if there is any effect on the students' perception of it. The subject is taught in the second semester of the 3rd course of GIOI, and is a compulsory subject, so all GIOI students must take it. In the subject, different training activities are developed, with different characteristics. Some of these activities are more traditional, such as the master lessons or the resolution of type problems, while others are more participatory, such as the execution of projects or case studies, all in work teams.

The questionnaire used for the research is the one proposed by Oltra-Badenes (2018), in which the variables related to the task value are collected. They are, therefore: Utility, Interest, Importance and Cost. In addition, a quantitative question is added in which the student is asked to assess the importance he perceives of each matter-subject from 1 to 10. From a qualitative approach, open answer questions were included to the questionnaire. The question “*What do you think about Integrated Information Systems from the point of view of a GIOI?*” was included in the initial survey. In addition, for the final survey, the questionnaire was completed with the question “*How has your perception of information systems changed since the beginning of the course? Why?*”.

It is important to note that, in order for the students to be as honest as possible, the answers will be completely anonymous. This implies that the results cannot be compared in an "individual to individual" way. However, it is possible to make a comparison of the overall result, of the students as a whole. Therefore, the analysis of the data obtained will be descriptive and through an ANOVA, comparing the initial situation against the final one.

Results

The survey was answered by a total of 32 students in the first pass, and 28 in the second. The total number of students enrolled in 2018-2019 was 70. However, the students who attended class regularly were about 30, so the sample and the number of responses can be considered representative of the students who followed the classes.

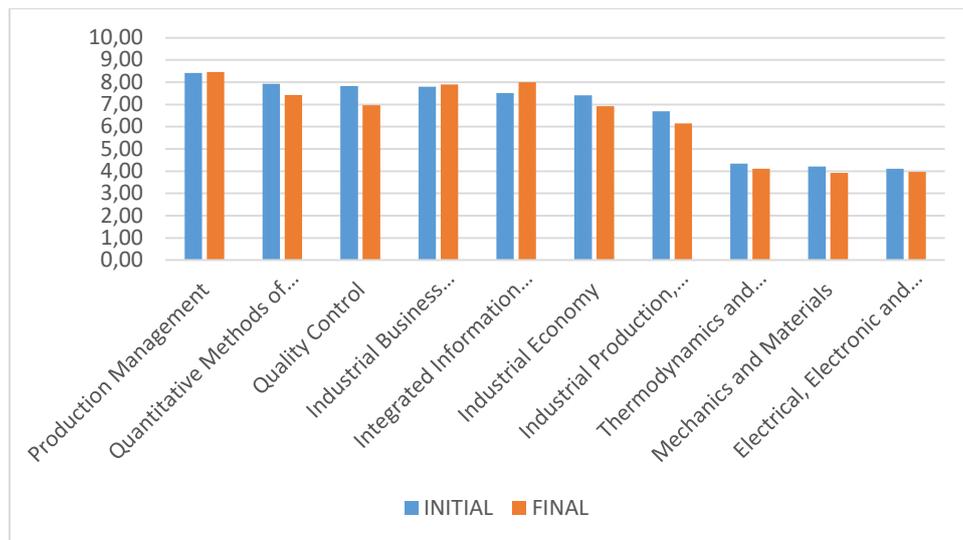
Next, in table 2, the summary of the quantitative results obtained is presented. The values presented are the means of the students' responses. In the assessment of the matter-subjects (question 1) the values are on a scale of 1 to 10, while, in the next 4 questions, related to the Task Value, the values are between 1 and 5.

Table 2. Summary of responses to the Initial and Final surveys

	INITIAL	FINAL	DIFFERENCE
Assessment of matter-subjects from 1 to 10			
Electrical, Electronic and Automatic	4,1	3,96	-0,14
Mechanics and Materials	4,21	3,93	-0,28
Thermodynamics and Fluid Mechanics	4,34	4,11	-0,23
Industrial Production, Projects and Environment	6,69	6,14	-0,55
Quantitative Methods of Org. Industrial	7,93	7,43	-0,5
Production Management	8,41	8,46	0,05
Industrial Economy	7,41	6,93	-0,48
Industrial Business Administration	7,79	7,89	0,1
Integrated Information Systems	7,52	8	0,48
Quality Control	7,83	6,96	-0,87
I think this subject will be useful in my professional future	4,07	4,54	0,47
The content of the subject seems interesting to me	3,79	3,96	0,17
I think what I will learn in the IBS class is important	3,97	4,04	0,07
I think that understanding this matter will cost me more than the rest	2,69	2,14	-0,55

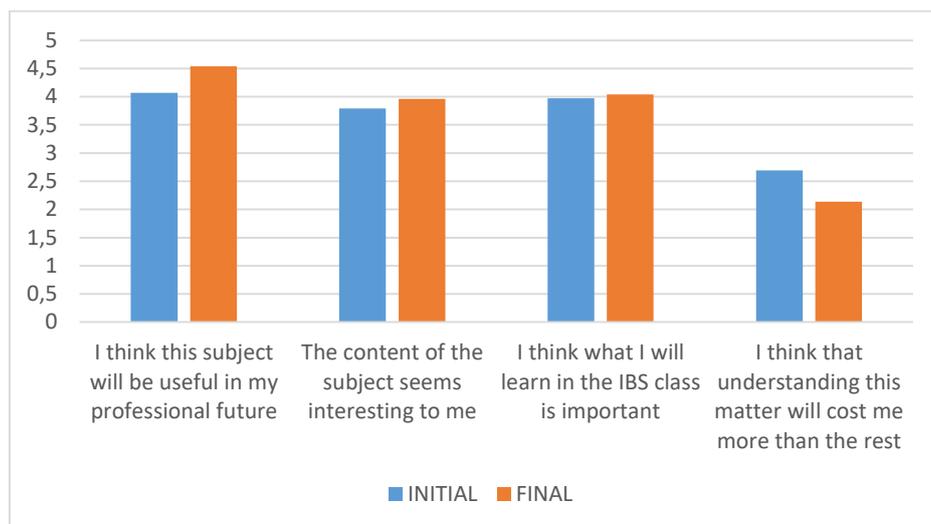
As can be seen, the matter of IIS has increased in terms of its relative assessment with respect to other matter-subjects, going from being the 5th most valued matter-subject in the first survey, to being the 2nd in the post-study. In this second survey, it is only surpassed by “Organization of production”. The following figure (Figure 1) shows the valuations granted to the subjects. The matter-subjects are sorted from highest to lowest according to the response of the first survey, and the assessment is shown next to the final survey, so that the variation can be seen graphically. Data shows that the one with the greatest increase is the matter-subject of IIS while “Quality Control” is the one that decreases the most in its valuation.

Figure 1. GIOI matter-subject assessment



Regarding the questions related to the Task Value, and therefore with the students' perception of the matter-subject being studied (IIS), the values of the initial and final survey are shown below, in Figure 2.

Figure 2. Valuation of the Task Value Items (Utility, Interest, Importance and Cost)



As can be seen, the first 3 Items (Profit, Interest, and Importance) have increased in terms of their valuation, while the fourth, the cost, has decreased. However, the variations in the first and fourth cases are significant (+0.47, and -0.55), while in items 2 and 3 they are quite minor (+0.17 and +0.07)

For that reason, an ANOVA is performed, to analyze if the variation is significant. The analysis is performed directly with Excel, using the function " ANOVA: Single Factor".

When performing the ANOVA, the results shown in table 3 are obtained, which shows the test for each of the 4 items (Utility, Interest, Importance and Cost).

Table 3. ANOVA test results for each of the Task Value items

SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
Utility T1	32	131	4,09375	0,410282258		
Utility T2	28	127	4,535714286	0,257936508		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-Value</i>	<i>F Crit</i>
Between groups	2,916964286	1	2,916964286	8,595418462	0,004816236	4,006872886
Within groups	19,68303571	58	0,339362685			
Total	22,6	59				
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
Interest T1	32	122	3,8125	0,415322581		
Interest T2	28	111	3,964285714	0,924603175		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-Value</i>	<i>F Crit</i>
Between groups	0,344047619	1	0,344047619	0,527355671	0,470641213	4,006872886
Within groups	37,83928571	58	0,652401478			
Total	38,18333333	59				
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
Importance T1	32	127	3,96875	0,353830645		
Importance T2	28	113	4,035714286	0,850529101		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-Value</i>	<i>F Crit</i>
Between groups	0,066964286	1	0,066964286	0,114458624	0,736345693	4,006872886
Within groups	33,93303571	58	0,58505234			
Total	34	59				
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
Cost T1	32	87	2,71875	0,789314516		
Cost T2	28	60	2,142857143	1,08994709		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-Value</i>	<i>F Crit</i>
Between groups	4,952678571	1	4,952678571	5,329677793	0,024549336	4,006872886
Within groups	53,89732143	58	0,929264163			
Total	58,85	59				

The analysis shows that the value of P is less than 0.05 in the cases of Utility and Cost. However, this value is higher in the case of Interest and Importance. In addition, Fisher's F is greater than its critical value in the case of Utility and Cost, while it is lower in the case of Interest and Importance.

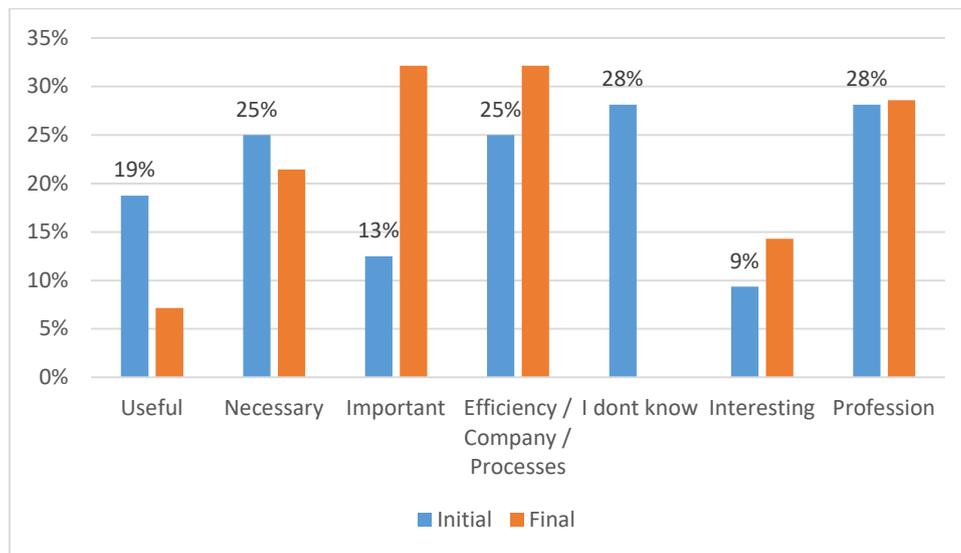
The answers to the last questions, open type, allow a qualitative analysis, which gives rise to interesting insights. To analyze the results, the answers written by the students were collected, read and analyzed. After the analysis, we searched for terms that could group the answers, looking for words or concepts that were repeated in some way in the free text written. It was found that the answers could be grouped under the labels of "Useful", "Necessary", "Important", "Efficiency / Company / Process", "Interesting", "Profession / Career / Future of work", since they were words that they were repeated in several of the answers obtained. Obviously, some of the answers had several of these labels and, consequently, more than one of them are grouped together. For example, a response such as "They are useful for our performance in the workplace", would be grouped under the labels of "Useful" and also under the "Profession / Career / Future of work".

From the initial survey, analyzing the answers to the question "What do you think about Integrated Information Systems from the point of view of a GIOI?", It can be obtained that 28% of the students directly indicated that they did not know what IIS was about. 25% considered IIS as necessary, 19% described them as useful, 13% as important and 9% of the students said they found them interesting. Regarding the application, 25% related them to the improvement of efficiency and productivity processes, while 28% related them directly and positively to their professional future.

Similarly, analyzing the answers to the same question from the final survey, and grouping the answers in the same labels, the following results were obtained. First of all, there were no longer students who did not know what IIS consisted of. Regarding the rest of the labels, after having completed the IIS subject, 21% considered the necessary IIS, 7% rated them as useful, 32% as important, and 14% of the students said they found IIS as something interesting. Regarding the application, 32% related them to the improvement of efficiency and productivity processes, while 29% related them directly and positively to their professional future.

Therefore, the responses have evolved as shown in the following graph.

Figure 3. Evolution of the answers to open type questions



Regarding the last question, "How has your perception of information systems changed since the beginning of the course? Why?", Added to the questionnaire in the final survey, 7 responses were received. Since they are few, but quite interesting, they are transcribed in full below.

- Initially I did not know exactly what to expect from the subject, but the result has been very satisfactory.
- After studying this subject I have realized that it is necessary and has a very interesting agenda, in addition to many useful things for our future work
- When I started taking the SIIO course, I realized the importance and information systems.
- At the beginning of the course I did not consider the subject to be relevant, but in view of the contents we have been seeing, I think it is an important subject.
- Now after passing through the subject, I understand the importance of the design of the tools used in companies, and I have managed to understand the importance of the designer's role in the project and organizational transformation.
- With what has been studied so far, I have a more defined perception of the information systems, their usefulness and especially of the importance for the proper functioning when managing the information of a company.
- It has not changed, had high expectations and has met them.

Discussion and conclusions

Once the analysis has been carried out, the results show that GIOI students of the UPV, prior to taking the subject "Integrated Information Systems in Industrial Organizations", recognize the importance of the IIS matter-subject, but it is not one of the most valued matter-subjects. IIS is located at a medium level, behind others matter-subjects such as "Quantitative Methods", "Quality Management" or "Business

Administration”, and only ahead of more generic Engineering matter-subjects, such as “Electrical, Electronic and Automatic Engineering”, “Mechanics and Materials”, “Thermodynamics and Fluid Mechanics” or “Industrial Production, Projects and Environment”.

This may seem strange, since IIS is the main subject of one of the only two intensifications of the degree. Therefore, it would be logical to think that it should be valued with greater importance than instrumental subjects, which will not have such an important impact on their professional future. But this does not happen, and IIS is not valued as it seems it should be.

However, once the subject has been completed, the students do recognize its importance for their future work in relation to the rest of the subjects, increasing their assessment and placing it in second place, very close to the first, which remains “Organization of the Production”.

This circumstance, together with the results obtained in the open type responses, seem to indicate that the students initially do not know very well what the IIS consist of, and to what extent they may be important in their future work. In fact, before taking the course, 28% openly state that they do not know what the IIS consist of. This fact changes radically once the subject is completed, finding that there are no longer any students who manifest that situation. In addition, the answers to the question of “how perception has changed and why” are very revealing, since practically all the responses indicate that their perception has changed positively and that they now think that IIS is a key subject for their future work, but they were not aware of it at the beginning of the course.

This suggests that the classes taught, with the contents taught and the methodology used, have made these changes in perception possible, highlighting the importance of this subject in the future employment of students.

Regarding each one of the components of the Task Value, Utility, Interest, Importance and Cost, and related with each of the research questions, it can be affirmed that all have a relatively high level, and that the perceived Utility is greater once the subject has been taken. The Cost of understanding the concepts is also estimated to be lower, so the valuation also improves in this regard. On the other hand, interest and importance vary after taking the course, but not significantly.

Therefore, it can be affirmed that the assessment of the subject does change the students' perception of the subject after taking a subject, to obtain a considerably better assessment.

Therefore, as a conclusion of this work, it can be said that the main objective has been achieved, which was to know what the GIOI students' perception of the SII matter-subject is. To this end, each of the related research questions presented in the objective section has been answered.

As limitations to this work, it can be said that it is a study of a particular subject of a specific degree, also in a specific University and with students of one particular year (2018-2019), to which the subjects were taught by a group of particular professors.

In addition, it must be considered that the response rate is good between the group of students who attend the classes. But there is an important group of students who did not attend class, and of which there is no information. In this sense, new research questions arise that need to be answered, such as: Why didn't students go to class? Did they perceive the subject as unimportant? Did they have classes from other subjects that did not allow them to attend? Did they think it was easy to pass without attending in person?

These and other questions. These and other questions should be able to be answered, in order to propose improvements in the teaching-learning process of the students based on their answers.

Therefore, different lines of future research emerge. The first one should be to ask students who did not attend classes about their reasons for not doing so. With the result of this study, it would be possible to find out what the causes and their effects are, and propose corrective actions to improve the situation. Another line of future research proposed is to extend the study to other years. In this way, a similar analysis could be done, but with a bigger group of students, and considering different teaching courses, which give a more consistent view of the perception of the subject matter, and its evolution after taking courses in the subject. In addition, the study can be extended trying to find out what is the cause of the change in perception, to know which of the activities carried out during the course have led to improve the perception of the subject, and if there are any, which ones have been make it worse. In this way, activities that improve perception could be enhanced and eliminate those that worsen perception, thereby improving the teaching-learning process. Another line of future work is to extend the methodology to the study of other subjects, or other degrees.

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