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Problems Without Data: An Emerging Methodology to Change The Way of Teaching Engineering Problems*

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Changing the way in which students work in the university environment is necessary. Thus, conventional classes based on problem solving were eliminated. Instead, active dynamics were used. With them, students participated in a closer way to the way how later they will have to do it into the working world. This new methodology to face the engineering problems was called "problems without data". Its implementation was done using an App. Students had to choose, for a certain problem, what data have to buy to be able to solve it successfully. In the same way, this paper explains how to introduce this new methodology in the classroom. A series of stages were shown so that the reader can transform their conventional engineering problems in new ones adapted to the new methodology proposed. Statistical studies proved that the university students that use PWD methodology improved their academic results.

Keywords: engineering problems; higher education; ICTs; problems without data

1. Introduction

For a long time, it has been noted that the way in which engineering students face to problems in the university classrooms is quite far from the manner they have to do it in the workplace. Today, this is a major problem, even more so if we consider that, internationally, the recruitment, management and retention of students has become a high priority for universities [1]. Despite this, there are studies that show that graduates are apparently not as ill-prepared for the workplace as anecdotal comments from employers would suggest [2].

When a problem is posed to students, they collect the data available and begin to investigate which is the most accurate formula they remember to complete the data in order to achieve a numerical result. Numerical result that may be or not the answer to the question asked. However, in the industrial sector, when, as workers, the students have to solve any situation, they are not magic formulas or only the exclusively necessary data. They have to consider what is the best way to solve the situation deciding what measures or analytics should be done. Hence, thereby, it will be more effective that person who, spending less time and money, is able to solve the problem.

It is a fact that it is necessary to generate a change in our teaching engineering model. The students do not have time to assimilate the information received. What students have to study now in a few months has taken hundreds of years for humanity [3]. The research team considers that this form of action, which is essential in the professional development of students, is far from being found in the university classrooms. In these, the most common situation is to have a statement that is accompanied by data that the student need to solve it, with an additional inconvenience, all the data that appear next to the problem statement must be used by the students. That is, only the data that is necessary appears.

In this article, firstly, it has been described a research methodology [4] for studying learning of engineering concepts and instructional design for the implementation of this new methodology. Secondly, authors used a case study research to check the behavior of the new proposed technology. These two tools, together with a collaborative relationship between academic institutions and industrial expectations can be a significant process towards analytical thinking (linking the theory and practice) [5].

The authors of this article want to verify if it is possible to change this form of action (widely related to science, technology and engineering classes) and so far from the professional world of these branches of knowledge. To this end, a new teaching model for engineering classes based on reflective learning has been developed. It was called PWD (problems without data). A series of inherent concepts has been used in the educational process and in the application of any new learning model: models, methods, techniques, environments, resources and evaluation. All these concepts have been studied and shown in this paper. Teachers can not stand aside when they face with a society that demands new educational models [6] directed towards the search and handling of the information

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in a reflective manner [7]. According to the indications of [8] related to the coherence of the educational models, special attention must be paid to four essential components that must be perfectly delimited when implementing a new learning model. In this way, the ultimate goal of the model (philosophy) is to improve the reflective learning process of engineering students removing their current tendency to solve problems by imitation [9]. Its internal ordering (theory) is based on the incorporation of elements that prevent students from achieving academic goals without the use of reflective processes during their learning period. Its practical (political) orientation focuses on its use for engineering problems classes and, finally, its implementation (method for educational practice) is achieved through the gamification employing the called PWD (problems without data) methodology [10]. To achieve a change as radical as the proposed one, tools that make this task easy are necessary. Although literature shows several cases of new teaching ways [11], it is also true that students are unwilling to the change [12].

Gamification is known as the process of game-thinking and game mechanics to engage users and solve problems [13]. In this way, any game related to gamification concept must not only influence the psychological and social behaviour of the player, but it also has to serve to help the player to achieve some answers to certain problems, in such a way that the players, the more they play, the more time they want to dedicate to the game by increasing their comfort and the number of responses found [14]. Is has been already described how the gaming implementation can achieve engineering students to obtain better results in the learning process in the way that they have more fun in the classes [15].

It is necessary to distinguish between gamification and conventional videogames [16] and between gamification educational classroom games [14]. The first ones simulate an environment of enjoyment by using incentives such as score, ranking, etc. In addition, they accelerate the acquisition of knowledge improving the judgment and decision-making capacity of the player [17]. For its part, scientific material is taught as a game during the gamification educational classrooms.

Hence, with this proposal, it has been tried to transform the classic dynamics based on solving problems into active and ludic dynamics. This character based of gamification is achieved through the design and implementation of an application for tablets and mobile devices, the use of which will be encouraged in the classroom but which may be used by students outside the university's physical teaching space. Although there are many experiences of the use of ICT in the university classroom [18], the use of the same by the student is conditioned to the educational approach given by the teacher, differentiating, according to [19], between ICTs that support transmission, ICTs that support active learning and ICTs that facilitate interaction. However, the literature does not consider the existence of an ICT that involves a profound change in the way of solving problems by engineering students, reducing their operational procedure to make way for a much more rational model and close to their future work [20].

2. Objectives

2.1 General objective

The main goal of this research was to destroy the pure operating method used for students of science, engineering and technology when solving engineering problems. It is intended to relate the university environment with the work world through the implementation of a new methodology called PWD (Problems Without Data). The students will work with it in their classrooms in a stress-free way.

2.2 Specific objectives

2.2.1 Offer a systematic procedure for the utilization of the new methodology in order to teach engineering concepts. It will make students modify their current way of solving engineering problems through the new PWD methodology based on the actual work situation of the science, technology and engineering sector. This specific methodology will be implemented through an app employed for students of several university degrees related to chemical engineering subjects.

2.2.2 Check, through quantitative research, using a case study, that the use of the new PWD methodology improves students' academic results in several engineering institutions of education. In this way, the proposed new methodology was tested with chemical engineering students of similar academic level belonging to the University of León (Spain), the Catholic University of Valparaíso of Chile and the Xiangtan University (China).

3. Addressing the problem: the PWD methodology

3.1 Staff involved

The experience has been developed by the teaching innovation group of the University of León (Spain) called DINBIO (Didactics in Biosystems Engineering) in coordination with several engineering education institutions from Chile and China. The following university degrees were addressed: agronomy, chemistry, biotechnology, environmental sciences and general and applied didactics. As may be seen, it was a multidisciplinary work team from the world of science, technology and engineering, always supported, in its tasks of teaching innovation, by General and Applied Didactics staff.

3.2 Developed the PWD methodology

In this section, it is explained how to introduce, in an engineering learning place, the new methodology called PWD (Problems without data) to address the problems described above (Fig. 1). The following requirements for addressing these problems were identified:

1. Successful learning is related to the time spent collecting data.
2. The methodology should be useful for the student, leading to their learning and minimizing additional distractions.

These requirements led to the selection of the procedure for the implementation of the new teaching methodology [21-22].

The following is a rigorous and systematic procedure that allows any teacher of engineering subjects to adapt the conventional statements (those that only includes the necessary data for the student to solve them) to PWD problems.

There are four steps needed to achieve the implementation of this methodology:

1. Determine the different ways, depending on the subject, to solve the problem.
2. For each way, the necessary data to solve the problem are identified. Each one has a cost between 15 and 20 points. If it is advisable to solve the problem in a concrete manner, the data cost for this particular form will be lower than the rest.
3. At least 7 additional (unnecessary) data must be incorporated into the statement. Each of these unnecessary data is assigned a cost of between 5 and 20 points. The lowest score will be for those data without utility.
4. Students are offered the statement without data as well as the list of data they can acquire by spending points. The initial score of each student will be equal to the product of 20 for twice the amount of data necessary to solve the statement. For example, if 3 data are needed to solve the exercise, the initial score will be 120 points ($20 \times 3 \times 2$).
5. Students must solve problems by spending as little points as possible.

4. Teaching experiment

4.1 The study of cases relevance

The study of cases has become a fundamental tool when quantitatively assessing the results of the

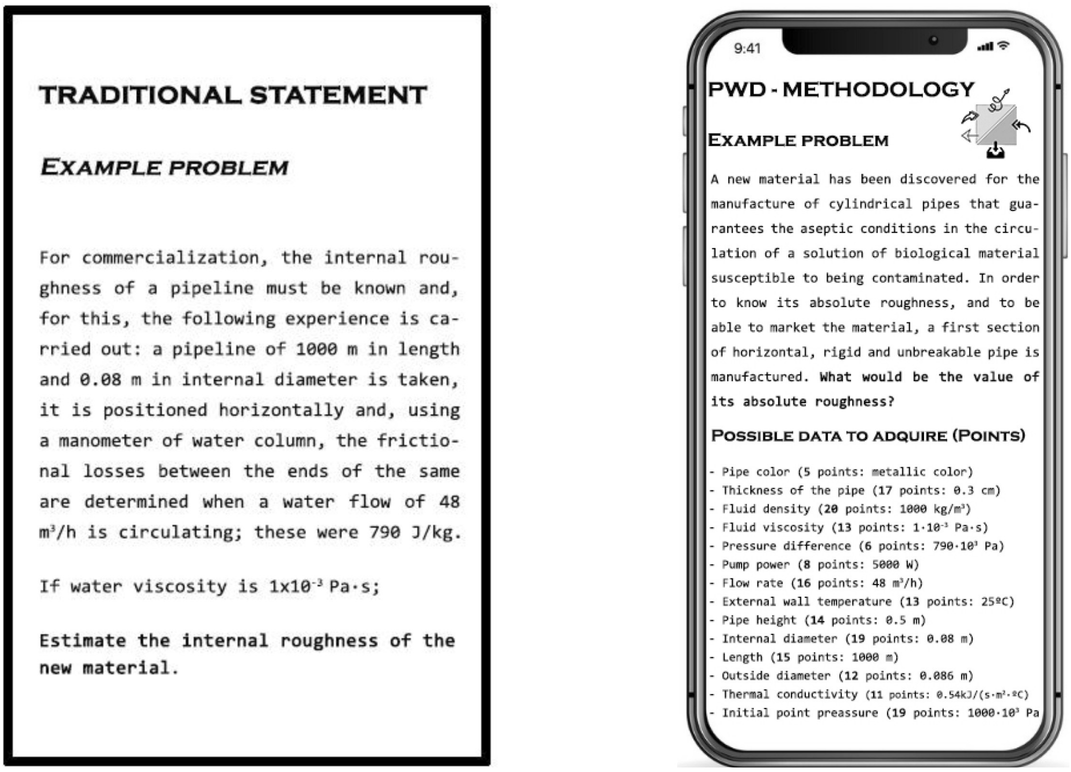

Fig. 1. Example of transformation of a conventional statement (left) into a statement with the PWD methodology (right).

teaching-learning process of new teaching models proposed by the teaching community [23-24]. Knowing its peculiarities and considering the elements that make it up, the great advantages of any case study are:

- It can be reproduced or redefined from any described and bounded reality.
- It is possible to define it in the limit of some borders, which is very useful for its projection.
- The case is framed within a theoretical context that validates it as a projection system for similar experiences.

It is important to bear in mind that there are no representative cases, that is, the possibility of mimetic transfer to any reality is not possible or desirable, but as bibliography indicates [25], it is an opportunity that can not be missed to expand knowledge about the operation of teaching models

The experience presented is a pseudo-experimental investigation. The participants have not been chosen at random. The authors worked with groups of engineering students already established in a non-random way. All the students involved in the methodology denoted to have a similar theoretical knowledge of its use. This was known through an initial knowledge test. Thus, the two groups formed in a random way are similar and comparable to the results of this experience. The students belonged to different universities: 27 students from the University of León (Spain), 21 from the Catholic University of Valparaíso of Chile and 19 from the University of Xiangtan (China). All of them were students of the same academic level of chemical engineering subjects in their universities. In addition, at no time, the language was an impediment to the execution of the proposed action, since the non-Hispanic speaking students had linguistic advice during the entire duration of the experience. Regardless of their origin, they started from a common base: their way of solving problems was based on the operating method. Method they have internalized by having worked with it for several years (from high school to university). Indicating, in addition, that data here presented corresponds to the implementation of the experience (use of the App based on the PWD methodology through gamification) developed during 2018. Previous pilot experiments were carried out to test both the PWD methodology and the designed app.

4.2 Methodology

Students must be aware of their participation in classroom dynamics. No information should be hidden. The idea is to set out a problem definition without data. It must be taken into account that, at the beginning, students may react surprised to this proposal. Likewise, ambiguity must be avoided in order to students can focus on the correct resolution of the problem. Ambiguity, or, in other words, open situations, is an essential characteristic of genuinely problematic situations, being one of the fundamental tasks of scientific work to limit the open problems and impose simplifying conditions. In addition, it is the best way to simulate the labour conditions out of the university environment. Another setback that can be pointed to this type of dynamics refers to the possibility of eliminating the data and precisions of the usual problem definitions and constructing more open problems able to eliminate a resolution according to the characteristics of the scientific work. Teachers need a minimum experience in the area of knowledge to achieve a correct adaptation of the problem with data to the problem without data.

The implementation of the methodology was implemented through an app called BINQUI. This app was a tool for internal use designed exclusively for the participants of this experience. Several screenshots of it can be seen in the Fig. 2.

4.3 Measuring instruments

In order to know if the targets have been achieved, it will be necessary to collect a series of data that allow the results evaluation of the proposed activity. In this way, to assess the degree of achievement, the use or non-use of the App will be evaluated as a variable (considering if it has been downloaded or not). A relation between this variable and the student academic result of the student will be sought (evaluating both the subject pass and the final grade).

4.4 Reliability and validity of the measuring instruments.

This paragraph encompasses an explanation about how the different variables have been measured to guarantee their validity and reliability.

(a) **BINQUI**. It means if the student used the app named as ''BINQUI'' for the exam preparation. The value of this variable is collected directly from the interface of the App Manager'', which guarantees the validity (measures what you want to measure) and reliability (accuracy of measurement).
(b) **PuntuacBinqui**. It means the total points that the student obtained in the App Binqui, so it has a directly relation with the intensity of the use of BINQUI. This variable has no validity or reliability problems.
(c) **Aprobado**. It is a polytomous variable; it takes a value of 0 if the student did not pass the subject, it takes a value of 1 if the student passed the exam and it takes a value of 2 if the student did

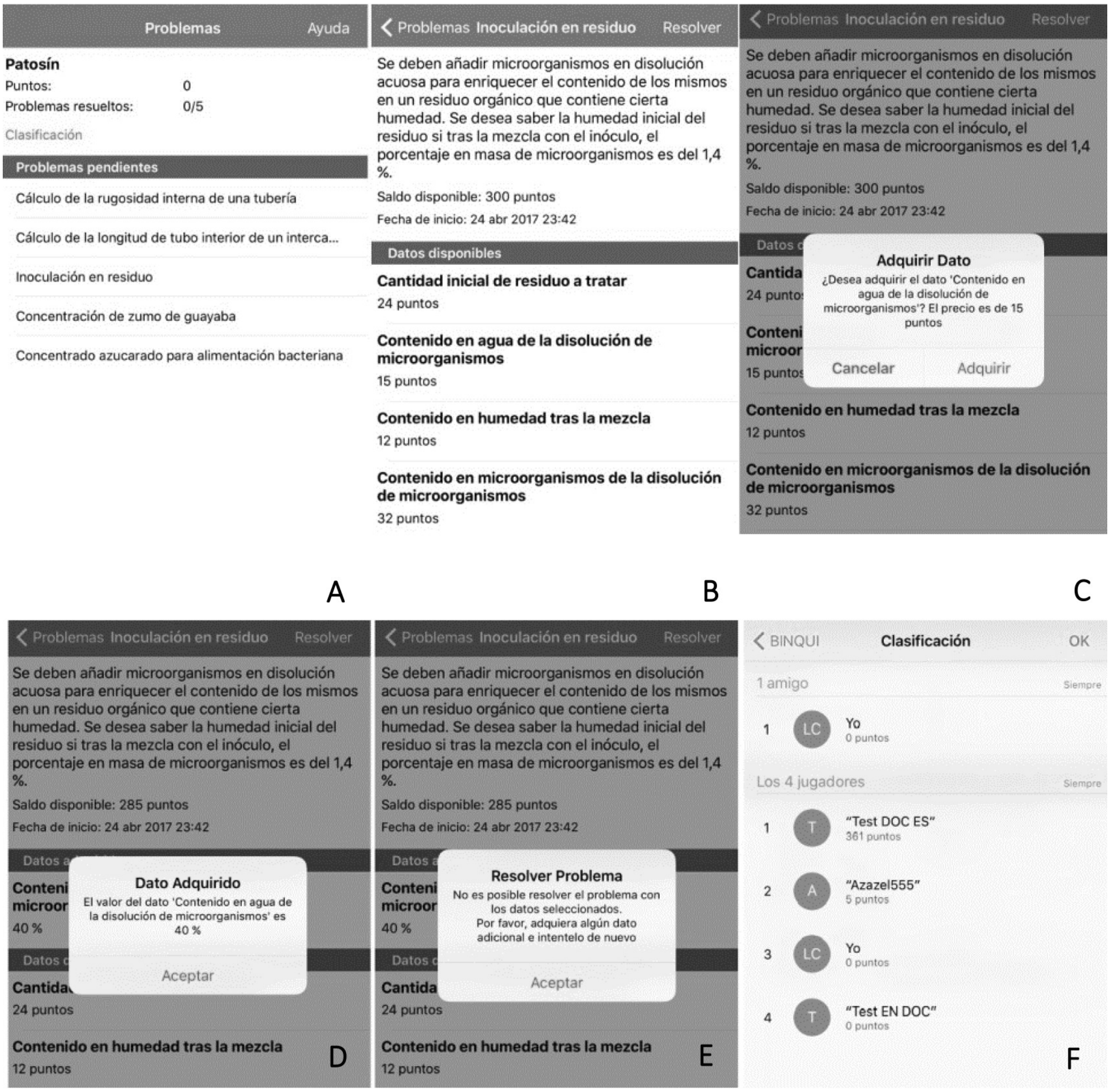

Fig. 2. Screenshots of the app used to develop the PWD methodology. Main screen with the student profile as well as the different problems to solve (A). An example of problem statement as well as the available data to buy (B), how to acquire a data (C), numerical data of the variable that has been purchased (D), error screen with the problem is solve in a wrong way or without the minimum data (E) and a ranking of the different students that have resolved the purposed problem (F).

not do the exam. This variable has no validity or reliability problems.

(d) **NotaExam**. It is categorical variable related to the mark obtained by the student in the subject. Again, it has no validity or reliability problems.

4.5 Analysis of critical points and risks in the achievement of the goals.

The realisation of the project implies a risk in terms of acceptance by the students, since it represents a radical change in the way of approaching the study of their university classes. The critical points referred to the students are listed below:

- Lack of confidence in the teacher.
- Absence of participation.
- Lack of seriousness.
- Lack of maturity of certain students.
- Other aspect not considered.

Therefore, the development of the proposed tasks is related to a series of risks. Once these risks have been identified, strategies that minimize their impact or even prevent their appearance, can be defined. The management of the work carried out has been based on the PDCA continuous improvement cycle and the UNE 166002 R & D Management Standard.

For the critical points identification, periodic meetings were established between the teacher and a representation of the students in order to know both opinions about the development of the activities. Likewise, to resolve the identified critical points, actions are proposed to be carried out in order to solve any problems.

4.6 Control of the work program

It was carried out by means of graphs and flow diagrams. These compare the values obtained with the prefixed ones. Each phase was analysed separately. In the same way, the interdependence and integration between the activities was studied. Within the follow-up stages, it was essential to perform an analysis to know if the proposed goals had been achieved in each completed task.

Within the periodic follow-up meetings (between teacher and students), progress was made in the application of the proposed new methodology. Likewise, the type/level of problems identified (serious or minor) was determined; providing the appropriate environment for the successful achievement of the proposed objectives.

5. Results and discussion

A free and without advertising App was created. It was called "BINQUI". Each student, after download and log in, had 200 starting points. A series of PWD related to the subject linked to this project were presented. They had to decide, among all the data offered by the application, what were really necessary to solve them. The acquisition was related to a decreasing in the points achieved by the students (the more data they requested, the more points they spent). Once the problem was solved, a ranking of players for that exercise was available. The first position was for the student who, having solved the exercise, spent less points. It should be noted that in equality of points, the winner was the one that found the correct answer spending less time. It is necessary to clarify that App use was optional.

Analysed the behaviour of the app, it can be said that it would be convenient to offer more problems for the different areas as well as differing degrees of difficulty with the goal that the students practice more with this methodology. Besides, it English translation would make it more accessible. All the above modifications are being considered for the new version of the App.

Two students groups according if the employed or not the App were done. The variables used in this work were the shown in Table 1.

Four variables were employed. One of them, of a dichotomous nature, functions as an independent variable (called "BINQUI") and the other three, related to the degree of participation within the

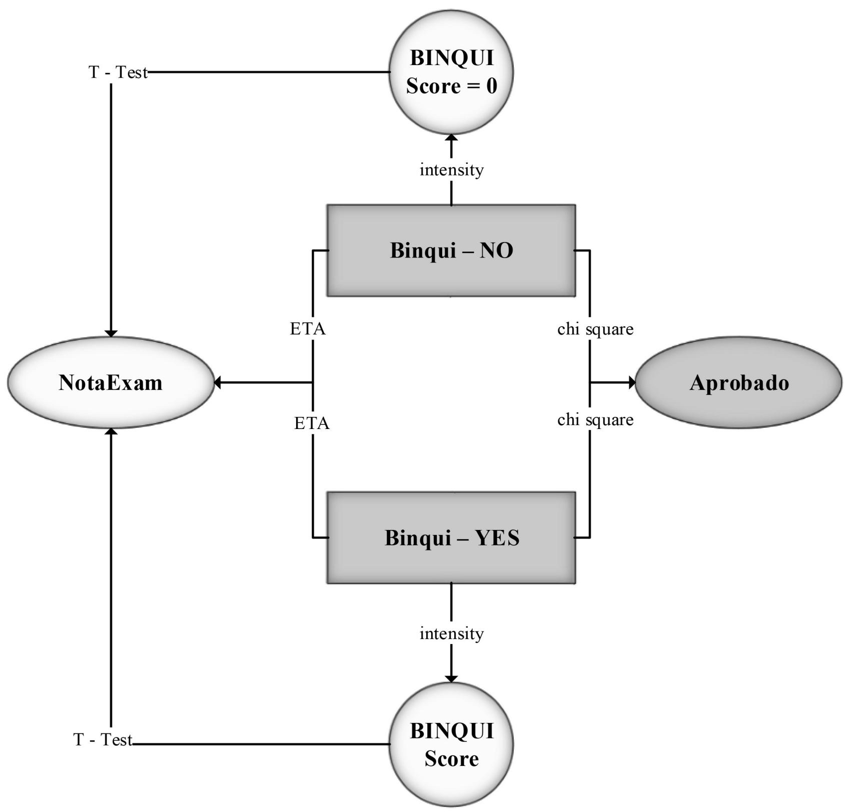

Fig. 3. Sequence of steps used in the statistical analysis. Quantitative variables are in white background and non-quantitative ones in grey.

Table 1. Operationalized variables used in the study

Variable	Name	Scale	Value
Download BINQUI	BINQUI	Dichotomous variable	0: no 1: yes
Intensity of the use of BINQUI	PuntuacBinqui	Quantitavie	0–2000
Pass the subject	Aprobado	Polytomous variable	0: no 1: yes 2: not submitted
Score of the subject	NotaExam	Quantitative	0–10

BINQUI designed application and the academic results, are two dependent variables of a quantitative type ("PuntuacBinqui" and "NoteExam"). The third is of the polytomic type ("Approved"). The quantitative or qualitative characterization of the variables will be fundamental to decide which will be the statistical test that will allow validating or not the different working hypotheses. A summary of the steps followed for the statistical analysis can be seen in Fig. 3.

5.1 Descriptive statistics of the variables considered.

Before introducing the variables considered in the different bivariate statistical tests, a study of the descriptive parameters is carried out. These studies are based on the independent variable considered BINQUI, the quantitative variable "NotaExam" and for the qualitative variable Approved. These last two are the variables that will allow us to conclude if the use of the PWD methodology in a gamification environment through the use of BINQUI improves or does not improve the academic results of our students. Table 2 shows the descriptive statistics for the quantitative variable.

Related to the "NotaExam" variable, only one of the analysed cases was considered as atypical. The explanation may be in the fact that this variable also considered the students who were presented to the exam with the only intention to see it. For its part, "PuntuacBinqui" descriptive measure the intensity with which the student has used the proposed new methodology (PWD). This was measured by the score obtained in the App when solving the proposed problems.

The literature [26–27] also considers the importance of actively participating in the activities proposed by the teachers. Next (Table 3), the statistics of the non-qualitative variables is shown, that is, "BINQUI", which is dichotomous variable and "Aprobado", which is polytomous variable.

It is noticeable the high percentage of students who decided not to participate in the experience of using the PWD methodology by using an App based on gamification, reaching 62.3% of the total of participants. Although it may seem a very high amount, literature [27–28] already indicates cases of reticence on the part of students to accept changes in their modus operandi during the learning process, even knowing the benefits they could find. If we analyse now the percentage of students who have not passed the subject, the Figure rises to 56.5%. Although this Figure is high, it has been usual in the teaching of chemical engineering (area of knowledge to which the subject object of study belongs), as the bibliography shows [29].

Table 2. Descriptive statistics for quantitative variables

			Statistic
NotaExam	**Mean**		2.335
	95% confidence interval of the mean	**Lower**	1.934
		Upper	2.737
	Median		2.000
	Variance		2.163
	Standard deviation		1.471
	Minimum		0.300
	Maximum		5.600
PuntuacBinqui	**Mean**		422.636
	95% confidence interval of the mean	**Lower**	320.482
		Upper	524.790
	Median		298.000
	Variance		2.163
	Standard deviation		87.926
	Minimum		51.000
	Maximum		995.000

Table 3. Frequency table for qualitative variables

		Frequency	Percentage	Valid percentage	Accumulated percentage
Variable: Binqui					
Valid	Not using the App	43	62.3	64.2	64.2
	Using the App	24	34.8	35.8	100.0
	Total	67	97.1	100.0	
Lost		2	2.9		
Total		69	100.0		
Variable: Aprobado					
Valid	Fail	39	56.5	58.2	58.2
	Pass	15	21.7	22.4	80.6
	Not summited	13	18.8	19.4	100.0
	Total	67	97.1	100.0	
Lost		2	2.9		
Total		69	100.0		

Based on these data, the question that arises now is the following: is there any kind of relationship between students who have not used the PWD methodology and students who have not passed the course? This will be studied in the following section.

5.2 Relationship between variables: "BINQUI"—"Aprobado".

It is intended to determine if the use of the BINQUI (app for smartphones) is correlated with the fact that the student passes or not the final exam of the subject (the "passed variable" has been dichotomized in 0: not passed (fail) and 1: passed, considering the students not presented as not passed).

Setting up the null (H_0) and alternative (H_1) hypotheses:
Null hypothesis H_0: the empirical frequencies are statistically equal to the observed ones.

Alternative hypothesis H_1: the empirical frequencies are statistically different from the observed ones.

Justified choice of the statistical test
The two considered variables are nominal and, specifically, they are dichotomous variables defined by two exhaustive and mutually exclusive categories. Therefore, the most suitable statistical test to be considered is the chi-squared test. Moreover, SPSS provides the possibility of carrying out some symmetric and directional trials based on this parameter.

Significance level (α).
Error rate: 0.05.

Definition of the sampling distribution
The sampling distribution is a probability distribution consisting of infinite values of a chi-square distribution, which is obtained from infinite random samples of the same population, all of them having the same sample size than the one of the research problem.

Rejection region or critical region
The rejection region of H_0 is a part of the sampling distribution made up by the values whose probability is lower than or equal to 0.05 whenever the null hypothesis is true.

Statistical test
Tables 4–6 show the statistical test results.

The results confirm that the probability of obtaining by chance the different values of statistical tests is smaller than its critical value, so the null hypothesis is rejected. This is not verified by the Lambda test, although its value is very close to the limit value 0.05 and we could reach the same conclusion assuming a slight increase in the level of significance considered, which would be more than acceptable in social statistics. It is necessary to clarify that although there are 25% of boxes with an inferior count of 5, there are authors [30–31] who allow some flexibility in this point of the test.

These statistical results are meaningless if we do not give them a pedagogical interpretation that allows us to know if there is a relationship between the students who have used the PWD methodology (through BINQUI app) and those who have pass the course. In this sense, statistics tell us that the fact

Table 4. Chi-squared test for the variables "BINQUI" and "Aprobado"

		Value	Approximate significance
Nominal	**Phi**	0.480	0.000
	Contingency coefficient	0.433	0.000
N of valid cases		96	

Table 5. Symmetric association tests for variables "BINQUI" and "Aprobado"

			Value	Asymptotic standard error [a]	Approximate T [b]	Approximate significance
Nominal	**Lambda**	Symmetric	1.79	0.083	1.839	0.066
		BINQUI dependent	0.292	0.136	1.839	0.66
		Aprobado dependent	0.000	0.000	[c]	[c]
	Uncertainty coefficient	Symmetric	0.201	0.87	2.177	0.000 [d]
		BINQUI dependent	0.178	0.80	2.177	0.000 [d]
		Aprobado dependent	0.231	0.98	2.177	0.000 [d]

[a] The null hypothesis is not presupposed
[b] Use of the asymptotic standard error that presupposes the null hypothesis
[c] Can't be calculated because the asymptotic standard error equals zero.
[d] Probability of chi-squared of likelihood rate.

Table 6. Directional Tests Eta for the variables "BINQUI" and "NotaExam"

			Value
Nominal by interval	**Eta**	**BINQUI dependent**	0.924
		NotaExam dependent	0.489

of having downloaded the app is not related to approving or suspending the subject. However, and from a learning point of view, this fact does not necessarily imply that the use of the PWD methodology has not had an effect on the students. In this sense, it is decided to cross the "BINQUI" and "NotaExam" to analyse if students have experienced an increase in their academic results.

5.3 Relationship variables: "BINQUI"—"NotaExam".

For this analysis (with a 5% signification level), it was employed a qualitative dichotomous variable (BINQUI) and a continuous quantitative variable (numerical mark). The test to be used to relate both variables will be the Eta test. The results obtained are in Table 6. In it, it can be observed that 92.42% of the variability of the students' qualification is explained by the use of the PWD methodology, a value that is more than considerable and that invites us to think that there really is an important relationship between the grade of the students and the use of the PWD methodology. Although the value does not exceed 95%, references related to social sciences (as is our case) indicate the validity of this degree of dependencies when we find values higher than 70% [32].

One more step could be taken in this study and take into account the fact that a student may have downloaded the application but hardly interacted with it. Since bibliography [33] warns us of the danger of assessing the teaching effect of the use of an ICT only by the mere fact of having downloaded the same, to avoid this risk it is proposed a new statistical test that compares the mark that the student obtains in the application (the higher the score, the greater the use of it), measured with the "PuntuacBINQUI" variable, with the exam final mark, measured with "NotaExam" variable.

5.4 Relationship between the intensity in the use of the PWD methodology and the qualification of the students.

Before proceeding to study the existing correlation between the variables that measure the degree of involvement in the use of the PWD methodology ("PuntuacBINQUI") and the grade obtained by the students ("NotaExam"), we will proceed, as indicated in the Fig. 4, to graphically cross the results of both variables by means of a scatter plot in which the students are differentiated according to the two possible values of the BINQUI variable (yes or no), a total lack of trend is observed among individuals who have a score of zero. In the same, it is appreciated a positive linear trend among those students who have come to use the PWD methodology (although with different intensity) and the grade obtained by them. Therefore, it is interesting to know if there is a relationship between the continued use of BINQUI (the higher the score, the greater the use) and the final grade of the exam. Therefore, it is decided to place the zero in the "PuntuacBinqui" variable as a lost case, since it would not fall within the previous consideration, when also assessing individuals who have not even downloaded the application.

Next, a Pearson correlation analysis (with a 5% signification level) is made between these two variables. Although it is not necessary, but if advisable,

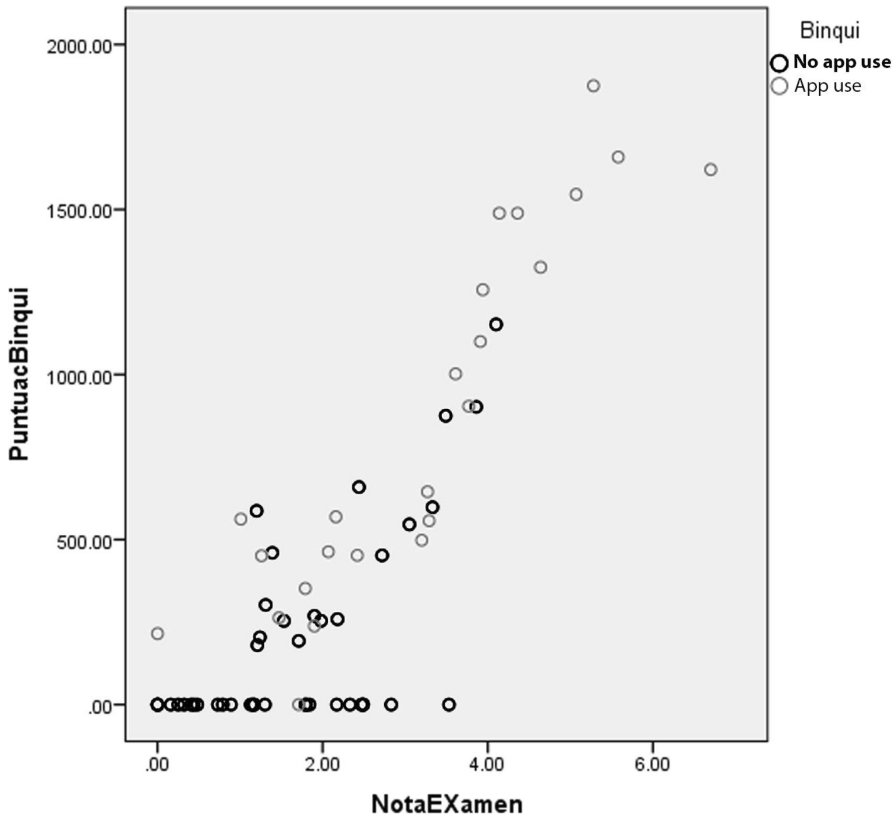

Fig. 4. Scatter plot for the variables "PuntuacBinqui" and "NotaExam".

Table 7. Normality test for "PuntuacBinqui" and "NotaExam" variables

	Kolmogorov–Smirnov test [a]			Shapiro–Wilks W test		
	Statistical	**gl**	**Sig.**	**Statistical**	**gl**	**Sig.**
PuntuacBinqui	0.096	40	0.200*	0.956	40	0.118
NotaExam	0.122	40	0.136	0.964	40	0.236

* This is the lower limit of the true significance
[a] Lilliefors's correction.

Table 8. Pearson correlation coefficients for the variables "PuntuacBinqui" and "NotaExam"

		PuntuacBinqui	**NotaExam**
PuntuacBinqui	Pearson Correlation	1	0.824*
	Sig (2- tailed)	40	0.000
	N		40
NotaExam	Pearson Correlation	0.824*	1
	Sig (2- tailed)	0.000	67
	N	40	

* Correlation is significant at the 0.01 level (2- tailed)

the normality of the same is checked before carrying out the analysis (Table 7).

As shown on Table 8, there is a strong positive association ($p < 0.05$) between the two considered variables of 0.824, explaining 67.9% (rxy^2) of the variability. Academically, it indicates that the greater the intensity or involvement on the part of the student in the use of the PWD methodology with the BINQUI application based on gamification processes, the higher the final grade received by the student, reaching this degree of dependence with a covariance of almost 70%, value more than accepted by the literature related to statistics in the teaching field [34].

6. Conclusions

The introduction of a new learning methodology based on the use of problems without data (PWD) was presented. This way, students approach their professional activity once they finish their university studies. With this methodology university learning process is completed has been done through the design and implementation in the classrooms of an application based on gamification criteria. Hence, it was indicated, in a systematized way, the different stages needed to transform a conventional engineering problem to one that follows the basics of the new proposal methodology. Several statistical tests have been carried out to verify the effect of this methodology about the engineering students qualifications. In this sense, it has been shown that, although there was no direct relationship between the use of it and the fact that students pass or not the subject, it was proven, with a 95% success in terms of significance, that there was an important percentage of the final grade of the student that was explained by the use or not of the PWD methodology. Likewise, the greater the degree of involvement of our students in the use of this methodology, the better was the academic result obtained.

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