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Data Descriptor

The Importance of Measuring Students' Opinions and Attitudes

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Abstract: The data presented in this article are related to a research carried out at the University Rey Juan Carlos in Spain. Chemical Engineering taught as a subject across three Energy Engineering-based degree streams was evaluated for two academic years. Student insight on course development, their own expectations and results, and the evaluation system were explored via a 33-item survey, receiving 47 full responses. The present contribution provides the full responses obtained from students to the survey administered. The received data were studied applying thorough statistical analyses used to infer conclusions. The full set of data are made public here independently from the research article.

Dataset: Part of the data are presented here and the full responses obtained are deposited in DOI: 10.17632/c7hdf4jpyn.3.

Keywords: student insight; midterm exam; exemption exam; chemical engineering; energy engineering; European higher education area

1. Summary

A chemical engineering course was studied. In the assessment system, two midterm exams coexisted with a final exam. After the first academic year covered in the study, only 30% of the students passed the subject, which was considered low. In this context, and taking into account that students learn more effectively with positive perceptions and attitudes towards and activity [1], a modification in the evaluation method of the present course was conceived. The change was made after performing a survey and observing students' positive perceptions towards a modified assessment method that includes midterms and an exemption on the final exam for students who pass said midterms.

Two cohorts of students were considered in this study (year 1, 2012/13 and year 2, 2013/14). Three degree streams, Energy Engineering (E1), Energy Engineering-Industrial Engineering double degree (E2) and Energy Engineering-Environmental Engineering double degree (E3) were considered. This chemical engineering subject is taken during the second year of the three streams. There are no prerequisites to take this subject.

Once academic year 1 was complete, the survey was sent, via email, to the 99 students who had studied the subject. Fifty-five responses were received, among which eight were incomplete and thus were not considered for further evaluation.

The survey comprised 24 items presented 33 questions grouped in six wider topics. Unless otherwise stated, all items proffered responses on a five-point Likert scale with possible answers ranging from 1 (lowest) to 5 (highest).

The data presented in this article are related to the research article entitled "Students' performance and perceptions on continuous assessment. Redefining a chemical engineering subject in the European higher education area" [2].

The value of the data lies in three main points:

The complete answers to the survey items can be used by other researchers to confirm the conclusions presented and to compare the statistical parameters obtained with other surveys.

More than 1800 data cells have been deposited in a single Excel file ordered by respondent (rows) and survey item (column), so the file can be used directly by most statistical packages used to treat data.

The open answers given by students can be used to evaluate the analysis content of answers performed and to fully study their feedback.

The exam example and point allocation to six different exams in two academic years are interesting to evaluate the assessment method.

2. Data Description

The continuous evaluation method used in this subject was defined as follows, indicating the points earned out of a total of 100. Pass mark (%) of each item is included if applicable:

- Practical case 1: mass and energy balances (5 points; no pass mark).
- Practical case 2: reaction kinetics (5 points; no pass mark).
- Lab report in groups. Each group of four students attends the labs together and does a joint report on four of the following six experiments (10 points; 40% pass mark): (1) kinetics (ethyl acetate saponification), (2) catalyst preparation, (3) rheology, (4) determination of effective diffusion coefficients, (5) mass balances (Maple software by Maplesoft; Maple 14 version), and (6) energy balances (Maple software).
- Individual lab exam (10 points; 40% pass mark).
- Midterm Exam 1: Part 1, lessons 1, 2 and 3 (15 points; no pass mark).
- Midterm Exam 2: Part 2, lessons 4 and 5 (15 points; no pass mark).
- Final exam: consisting of two exams analogous to the midterms (20 points each part; 40% pass mark each exam).

Table 1 presents a detailed list of the type of questions included in each exam conducted during years 1 and 2. In addition, the points allocated to each question are also included.

An example of an exam is also presented. It was delivered to students as the midterm for the second part of the subject during year 1.

1. (2 points) The diameter of an pipeline suffers a reduction from 5 m to 2 m according to Figure 1. Identify the non-zero components of the tangential stress in the cylindrical coordinate system indicated. Assume that the circulation regime is laminar (1 point).

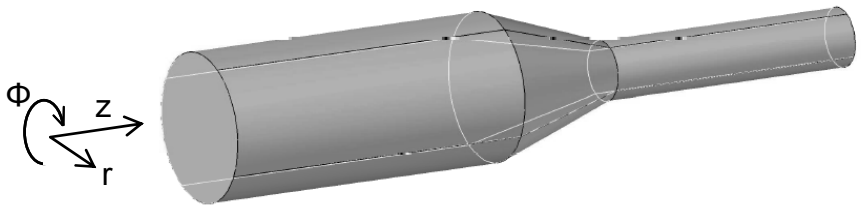

Figure 1. Diameter reduction in a pipeline.

2. (1 point) In a visit around the Chemical and Energy Technology Department, you stop to observe a reactor used to obtain kinetic data. It consists of a 5 cm diameter glass column into which a silica-based catalyst has been introduced filling it up to a height of 30 cm. The catalyst is packed with a bed porosity (ε) of 0.6. Is this an integral or differential reactor?

Table 1. Midterm and final examinations performed during years 1 and 2 and detail of points allocated to each topic (out of 10).

Year	Exam	Phase Equilibria			Mass Balances		Energy Balances		
		Liquid-Gas Eq.	Gas Solubility	Liquid-Liquid Eq.	w/o Chemical Reaction	w/ Chemical Reaction	w/ Chemical Reaction	w/ Phase Change	Combined Balances (Mass & Energy)
1	Midterm 1			2	4				4
	Final 1		2			4		4	
	Final 1.2	2			4		4		
2	Midterm 1		2					4	4
	Final 1	2			4			4	
	Final 1.2			2		4			4

Year	Exam	Transport Phenomena			Kinetics and Catalysis			
		Momentum	Energy	Mass	Classical Kinetics	Enzimatic Kinetics	Catalysis	Reactors
1	Midterm 2	2			2 + 2	1.5	1.5	1
	Final 2			3	1.5 + 2	1.5	2	
	Final 2.2	1	3		3 + 1.5			1.5
2	Midterm 2		3		2.5 + 0.5	1	2	1
	Final 2	2	2		1.5 + 1.5			3
	Final 2.2	1	1.5	2	3 + 1.5		1	

3. (2 points) In a batch reactor, a first order reversible reaction A ⇆ R is carried out in the liquid phase. The starting mixture has a concentration of 0.5 mol A/L, with no R. The equilibrium conversion is of 66.7%, and a conversion of 33.3% is reached in 8 min. Obtain the kinetic equation.

4. (2 points) The thermal decomposition of hydrogen iodide to hydrogen and iodine was described by Bodenstein in 1899, with the rate of reaction values being listed in Table 2. Calculate the complete kinetic equation of this reaction taking into account the influence of temperature on the kinetic constant:

Table 2. Rates of reaction at different temperatures for the thermal decomposition of hydrogen iodide.

T (°C)	k (cm^3/mol·s)
508	0.1059
427	0.00310
393	0.000588
356	$80.9 \cdot 10^{-6}$
283	$0.942 \cdot 10^{-6}$

5. (1.5 points) Nitrogen physisorption data at 77 K have been obtained for three porous materials, obtaining the isotherms presented in Figure 2. Based on the classification established by the IUPAC (Types I to VI), what type of isotherms is each one of them?

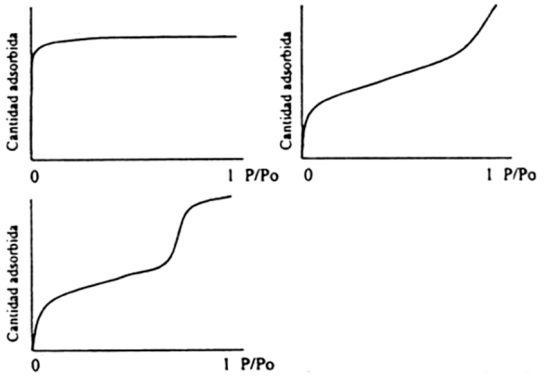

Figure 2. Nitrogen adsorption-desorption isotherms at 77 K.

Which of these materials would you use for the following applications? Justify your answer:

(a) Selective adsorption of hydrogen from a hydrogen–butane mixture.

(b) Functionalization by grafting, loading the highest possible number of molecules of an organometallic compound (length of 3 nm) containing nickel.

(c) Immobilization of very large enzyme complexes.

6. (1.5 points) The reaction from S to R is catalysed by an enzyme that presents substrate inhibition. Write the reactions that take place in this process and their reaction rate equations taking into account both equilibrium and irreversible reactions.

The full writing of the survey items is presented in Table 3. The numerical coding used to perform correlation analyses with non-numeric factors (gender, degree, etc.) is shown in Table 4. It has to be emphasized that the main value of the dataset is in questions 23 and 24.

Table 3. Full write-up of items surveyed.

Number of Item	Question
1	Age [(1)]
2	Gender
3	Degree studying
4	How many times have you been enrolled in this subject? (including the present year)
5	In your opinion, what is the difficulty of your degree as a whole? 1. Very easy 2. Somehow easy 3. Neither easy nor difficult 4. Somehow difficult 5. Very difficult
6	And what is the difficulty of the "Chemical Engineering" subject? 1. Very easy 2. Somehow easy 3. Neither easy or difficult 4. Somehow difficult 5. Very difficult
7	How frequently do you attend lessons in this subject? 1. Almost never (0–25%) 2. Sometimes (25–50%) 3. Often (50%) 4. Very often (50–75%) 5. Almost always (75–100%)
8	When you attend the lessons: how frequently do you take notes? 1. Almost never (0–25%) 2. Sometimes (25–50%) 3. Often (50%) 4. Very often (50–75%) 5. Almost always (75–100%)
9	After each lesson, hoy frequently do you understand the concepts explained? 1. Almost never (0–25%) 2. Sometimes (25–50%) 3. Often (50%) 4. Very often (50–75%) 5. Almost always (75–100%)
10	What is the difficulty of the problems solved in class? [(2)] 1. Very easy 2. Somehow easy 3. Neither easy or difficult 4. Somehow difficult 5. Very difficult
11	When the teacher uploads problem sheets before solving them in class, how often do you do them before by yourself? 1. Almost never (0–25%) 2. Sometimes (25–50%) 3. Often (50%) 4. Very often (50–75%) 5. Almost always (75–100%)
12	When the teacher leaves problems unsolved and proposes them as homework, how often do you try to solve them? 1. Almost never (0–25%) 2. Sometimes (25–50%) 3. Often (50%) 4. Very often (50–75%) 5. Almost always (75–100%)

Table 3. *Cont.*

Number of Item	Question
13	How often do you look for new sources of problems (books, etc.)? 1. Almost never (0–25%) 2. Sometimes (25–50%) 3. Often (50%) 4. Very often (50–75%) 5. Almost always (75–100%)
14	What are your study habits in this subject? (from continuous day-to-day study to last-minute preparation) 1. I am up to date with work. 2. I study mostly one-two weeks before the exam. 3. I study mostly one-two days before the exam.
15	What do you think was your own preparation before midterm exams? [(2)] 1. I did not take the exam. 2. Low 3. Average 4. High 5. Very high
16	If the existing midterm exams replaced the final exam (exempting-midterms): Would you have prepared more the midterm exams? 1. Yes 2. No
17	If the existing midterm exams replaced the final exam (exempting-midterms): Do you think the subject would be easier to pass/achieve higher marks? 1. Yes 2. No
18	What do you think it was your own preparation before final exams? [(2)] 1. I did not take the exam. 2. Low 3. Average 4. High 5. Very high
19	In general, do you think that the time given during exams is enough? 1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree
20	What is the difficulty of the problems proposed in the exams? [(2)] 1. Very easy 2. Somehow easy 3. Neither easy or difficult 4. Somehow difficult 5. Very difficult
21	According to your performance in this course, what mark did you expect to obtain? 1. Not taken 2. Fail (<50%) 3. Pass (50–69%) 4. Very good (70–89%) 5. Excellent (90–100%)

Table 3. *Cont.*

Number of Item	Question
22	What mark did you actually obtain? 1. Not taken 2. Fail (<50%) 3. Pass (50–69%) 4. Very good (70–89%) 5. Excellent (90–100%)
23	If you did not obtain the mark you expected, what are in your opinion the causes of the difference? (more than one answer is accepted) 1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree
23.1	Incomplete preparation [3]
23.2	Difficulty of exams
23.3	Severe grading process
23.4	Mental block during the exam
23.5	Some questions of the exam covered concepts that I did not control completely [3]
23.6	Others
24	Do you have any other comment? Evaluation method, course development, etc. [4]

[1] Response limited to a numerical value. [2] Two independent answers were required for each part of the subject. [3] Note that questions 23.1 and 23.5 refer to the same issue but they might be answered differently due to the cause-attribution process. [4] No restrictions. A blank box was also accepted.

Table 4. Numerical coding of non-numeric variables.

Item	Variable	Numerical Coding
2	Gender	0 if man; 1 if woman
3	Degree [1]	1 if Energy Engineering (E1); 2 if Energy Engineering-Industrial Engineering (E2); 3 if Energy Engineering-Environmental Engineering (E3)
11–13	Problems done by students	Sum of responses given to items 11 to 13, each one in a 1–5 Likert scale
16	More preparation in exempting midterms	0 if no; 1 if yes
17	Subject easier with exempting midterms	0 if no; 1 if yes
DIF	Differences between expected and obtained marks	0 if marks have no difference; 1 if they are different

[1] E1, E2 and E3 degrees were ordered according to cut-off marks.

The large amount and comprehensive description of items included in the survey were aimed at obtaining a complete view on the course performance of each student. Thus, when handling the data, it was possible to open up certain discussions while maintaining the anonymity of responses, though it may not look like that for those not well versed on these techniques. Some examples of these discussions are: do students that attend classes respond differently than those who do not attend them? Do students receiving a lower mark than expected have a certain bias when evaluating the aptitudes of the teacher or the difficulty of the exam?

The answers received to item 24 of the survey are presented in Table 5. This item presented an open question and the responses received were used to perform an analysis content in the full paper. The comments were numbered to be consistent with the dataset order; comments by number 10 correspond to the 10th row of data in the dataset. In addition, the complete free comments were collected in Spanish but are presented here and translated to English. Comments have been kept in their original form, so it must be noted that some of them contradict each other or are mistaken regarding several aspects described in the present paper, such as the evaluation method followed, the existence of pass marks, etc.

Table 5. Analysis content of the open-ended answers given to item 24 of the questionnaire.

Respondent	Answers	Coding
2	In my opinion the difficulty of mass and energy problems in the exams did not correspond to the level developed during the classes; the latter was much lower.	C1.2, C3.1
3	I would require a minimum pass mark in the exams of each part of the subject. [1]	C4.4, C5
4	It would be appreciated if the class exercises were in line with those of the exam, thus allowing us to apply what was studied.	C2
4	We did not receive exercises from the teacher to practice at home.[2]	C7
5	It would be okay for class exercises to match those done in class.[3]	C1.2
5	It would also be good if the problems of the first part were sent earlier.	C3.1
6	More teaching hours to do more problems and seminars.	C4.1
6	Exams with similar level to the class.	C1.1
6	Multimedia or visual resources of the most complicated concepts.	C2.2
10	It would be interesting to do exercises in class similar to those that are going to come up in the exam, since the class exercises were very easy compared to those in the exam.	C1.2
10	Regarding transport phenomena and kinetics it would be better to have some slides, since taking notes at high speed makes it difficult to write down all the information and it is difficult to study for the exams.	C3.2, C4.1
10	Finally, regarding the midterm exams, there was not enough time to do them because exercises were very long or time too little to do them. I hope this serves to improve the subject.	C4.3
11	In my opinion, the knowledge acquired during the classes of this subject should be similar to that required in the tests. The problems solved throughout the course should also be similar to those in the exam.	C1.2
12	I believe that a high level of demand by the teachers is positive for our academic formation provided we have the tools to meet these demands. I mean that there should be more class hours, since there are more lessons than in other courses.	C4.1
12	More materials should be provided to the student, like having additional exam-type problems.	C2.1
12	For me, one of the biggest difficulties has been the difference of level in class problems compared to exams.	C1.2
12	The lab exam should be sat after the lab reports are corrected, just in case someone did not know how to do something.	C4.1
12	Finally, I appreciate initiatives like this survey to facilitate and encourage students to give their opinion.	-
13	Especially referring to the last question,[4] I think it would be better to have more problems with final solutions to practice. Since there are not many solved problems, in the end, you learn them by heart, not reasoning. Thus, it would be very positive having many more problems with which to practice, especially problems of similar difficulty to those of the exam.	C2.1
14	I think it would be very useful to do more complex problems in class.	C1.2, C2.1
15	This course covers many topics, and there is not time enough to go through them as it should be done.	C4.1
15	If in the examination there are exercises of a certain level, that level should be acquired with the problems proposed in class.	C1.2
15	The laboratory practices seemed very unproductive, very fast, poorly explained... an overall low performance.	C6

Table 5. *Cont.*

Respondent	Answers	Coding
15	The evaluation criteria seem correct to me, although I do not understand how a person can fail a subject so diverse only by not reaching a minimum pass mark in the lab exam (worth 10% of the points), and, even more, as I said before, with the low performance of the labs.	C4.4
16	The content of the subject should be reduced, since it is excessive for 4 months of class.	C4.1
16	Another important point is to finish completely the class exercises, since leaving some halfway-unresolved does not help the student to solve them during exams.	C4.2
16	Exam exercises should be similar to those done in class. In the exams, the exercises are of an exaggeratedly higher level to those solved in class.	C1.2
16	The lab exam should be deleted, since practices have already been passed (lab reports), they should not be reassessed.	C4.4
17	It would be appropriate for the theory explained and the problems solved to match in both content and difficulty those of the exams.	C1.2
17	I would be grateful if the standard-exercises for better preparation of the exam were uploaded even earlier.	C4.2
19	The problem I have seen in this subject is that the problems of exams were much more difficult than the ones solved in class and therefore it was very difficult to solve them in the short time given. In my opinion, the classes teach you things that are too basic, but since there are many lessons, it is impossible to teach them in depth.	C1.2
19	This subject should be divided into two courses because, otherwise, it is impossible to acquire the knowledge that will be applied in the future. I had a hard time trying to understand the enzymatic catalysis part, at least the problems, although I am aware that is not very important for my degree.	C4.1
20	I believe that it is very necessary to insist to the students in the resolution of exercises additional to those given by the teacher of the subject.	C4.1
20	In addition, the teacher should give us bibliographic sources to obtain problems that allow us to prepare exercises of the same difficulty as those found in the exams, since there is a great difference between the class problems and those of the exams.	C1.2, C2.1
20	In my opinion, I believe that this is the main problem with the marks, in addition to the little time available to teach an extensive and complex subject like this one. Best regards.	C4.1
21	It would be appreciated if the notes of all the lessons were uploaded to the course app. It would facilitate taking additional notes, just expanding the ones already received.	C4.1
23	It is necessary to spend more class time doing exercises.	C4.1
25	To dedicate more hours to the second part of the subject than to the first one, due to the greater complexity of the second. To do more exercises.	C3.2, C4.1
26	Try to make exercises of the exams and those given in class more similar, since the difficulty is very different between them.	C1.2
27	I think it would be necessary to do more problems in class, since the ones done this year are not enough to prepare the subject well.	C2.1
28	To deepen less in chemical kinetics and more in other lessons like transport phenomena or energy balances.	C4.1

Table 5. *Cont.*

Respondent	Answers	Coding
30	Exam exercises should be more similar to those done in class. In my opinion, they are much more difficult in the exams.	C1.2
31	I think that one of the problems of the subject is that little time is dedicated to do problems with an "exam" level of difficulty.	C1.2
32	I would sincerely like to do exam-like exercises in class, because in my opinion, they are completely different and we left the exam with the feeling of being teased.	C1.2
33	To improve the notes of the subject, I suggest uploading explanatory slides for all the lessons instead of making us take notes. Besides, some interesting points are:	C4.1
33	-To do more exercises in class or in seminars including exam-type exercises, that is, of similar difficulty as those of written tests.	C1.2, C4.1
33	-To give longer than one week to do the lab reports in order to be able to better assimilate the concepts and to perform them as best as possible. Doing a better job in the reports would increase our mark in the lab reports and also in the lab exam.	C4.1
35	I think we should do more exercises in class, or at least we should be given more exercise sheets including the results.	C2.1
36	The difficulty I have noticed is that the level of the exercises performed in class does not correspond to the level required in the examination, with the latter being much more difficult and complicated. If exercises that are more complex were performed in the classroom, this would greatly facilitate our learning.	C1.2
37	It would be important to follow less the teaching guide and the lessons that are supposed to be taught, and more the development of the class with respect to the subject.	-
38	Explain better the lesson on kinetics, both the theory and the most complex problems.	C3.2
40	Make basic concepts clearer before dealing with long theory lessons.	C4.1
42	I would like the exercises-exam dynamic not to be like that of the 2012/13 course, i.e., the difficulty of the exercises solved by the teacher in class was simple and that of the exams very high.	C1.2
45	The difficulty of the problems in the exams is much superior to those done in class.	C1.2

[1] This was already done during year 1. [2] Students received extra problems of all lessons except lesson 1. [3] This student was probably referring to class Vs exam exercises. [4] Question 23 regarding the reasons of the difference between expected and obtained marks.

The conceptual analysis was performed by breaking down the 32 responses to item 24 of the survey, as detailed in Table 5 below. A full description of the frequencies observed is also included. The conclusions drawn are not included here, but in the original research paper [2].

Finally, the full data of the survey have been uploaded to an external repository [3], since it is composed of 1800 cells and thus is too lengthy to be included here.

3. Methods

The questionnaire was administered via email with pre-fixed response options (i.e., an option had to be selected from a drop-down list of answers) for all items except item 1 (age) and item 24 (free opinion). An initial remark including informed consent to the use of the data retrieved for educational purposes was added. Data were acquired by using the online tools provided by e-encuesta.com [4]. Responses were collected anonymously. This point is critical for the ethics on publication and was assured by the software used, which is not owned by the author. Data were also not treated by the software.

The responses to the Likert items of the survey were analysed to determine the frequency of each response. For this purpose, R statistical software [5], and, more specifically, the pre-written code in the 'jbryer/likert' package was used [6], with a modification to obtain the number of responses per item.

The correlations among the items were evaluated using a Spearman's rank correlation coefficient employing R statistical software with the inbuilt 'sjPlot' package used to depict the statistics obtained as tiled graphs [7].

The open-ended responses received to item 24 were analysed through a content analysis method. Obtained responses were broken down to single pieces of information containing only one idea and were coded accordingly. The frequency and content of the responses within each code were registered and studied.

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