REMIE
Multidisciplinary Journal of Educational Research

Hipatia Press
www.hipatiapress.com

Instructions for authors, subscriptions and further details:
http://remie.hipatiapress.com

Unequal Partnerships in Higher Education: Pedagogic Innovations in an Electronics within Physics Degree Course

Maddalena Taras[1], Francisco M. Gómez and Juan B. Roldán [2]

1) Faculty of Education & Society, University of Sunderland, United Kingdom.
2) Faculty of Science, University of Granada, Spain.

Date of publication: February 15th, 2014
Edition period: February 2014 - June 2014

To cite this article: Taras, M., Gómez, F.M. & Roldán, J.B. (2014). Unequal Partnerships in Higher Education: Pedagogic Innovations in an Electronics within Physics Degree Course. *Multidisciplinary Journal of Educational Research*, *4*(1), 35-69. doi: 10.4471/remie.2014.02

To link this article: http://dx.doi.org/10.4471/remie.2014.02

REMIE – Multidisciplinary Journal of Educational Research, Vol. 4 No. 1 February 2014 pp. 35-69

Unequal Partnerships in Higher Education: Pedagogic Innovations in an Electronics within Physics Degree Course

Maddalena Taras
University of Sunderland

Francisco M. Gómez
University of Granada

Juan B. Roldán
University of Granada

Abstract

This cross-European research partnership reports on supporting pro-active learning and teaching. The two-part project firstly explored student beliefs about electronics within a physics degree and secondly, the use of peer assessment of a *Mathematica* notebook to develop understandings of standards and quality. Student beliefs were explored because of the negative perceptions tutors thought students brought to the Engineering course within the Physics degree. The results showed that tutors' fears were unfounded and that the students were highly motivated. Secondly, through peer assessment of a notebook, students developed critical understandings of standards and quality. Generally, students valued the content support and appreciated both the work of their peer and how this helped their own understanding.

Keywords: partnership, Europe, assessment, student beliefs

2014 Hipatia Press
ISSN: 2014-2862
DOI: 10.4471/remie.2014.02

Hipatia Press
www.hipatiapress.com

REMIE – Multidisciplinary Journal of Educational Research, Vol. 4 No. 1 February 2014 pp. 35-69

Partenariados Desiguales en la Educación Superior: Innovaciones Pedagógicas en el campo de la Electrónica en el Grado de Física

Maddalena Taras
University of Sunderland

Francisco M. Gómez
University of Granada

Juan B. Roldán
University of Granada

Resumen

Esta investigación realizada por un partenariado transeuropeo se centra en el apoyo proactivo de la enseñanza y el aprendizaje en la educación superior. Este proyecto consta de dos partes. Primero se exploraron las creencias de los estudiantes sobre la electrónica en el grado de Física para, después, usar la evaluación por pares del manual *Mathematica* para desarrollar la comprensión de los estandares y calidad. Las creencias de los estudiantes se exploraron teniendo en cuenta las percepciones negativas que los tutores pensaban que tenían los estudianties del curso de Ingeniería en el grado de Física. Los resultados destacaron que los miedos de los tutores eran infundados y que los estudiantes se mostraban altamente motivados. Segundo, a través de la evaluación a pares del manual, el alumnado desarrolló una comprensión crítica de los estandares y su calidad. Generalmente, el alumnado valoró el apoyo sobre el contenido y apreció tanto el trabajo de sus compañeros y como éste les había ayudado en su comprensión.

Palabras clave: partenariados, Europa, evaluación, creencias del alumnado

2014 Hipatia Press
ISSN: 2014-2862
DOI: 10.4471/remie.2014.02

This paper reports the research developed within a cross-European partnership between English and Spanish academics working within different subject areas and disciplines. The rationale is explained as is the context and support from the literature.

Originally this project was conceived to develop students' involvement and participation in assessment in order to develop students as partners in learning in higher education (HE) and increase their independence and autonomy: this became the second part of the research. However, during the discussions while developing the project, it became clear that the tutors of the Spanish university were very concerned about their students' perceived negative beliefs about the electronics component within the physics degree. The level of concern was deemed high enough to warrant the decision to explore why it was that students had such a negative opinion of electronics: this became the first part of the research.

Project Context

This paper reports a collaborative research partnership between academics working in a southern Spanish University and an academic working in the north east of England. The Bologna agreement has rationalised and promoted the importance of cross European understandings, collaborations, equivalences and parities in educational processes and outcomes. This paper reports a success story of a collaboration which supports the Bologna principles and aims.

The academics participating in this study met at a European education conference and subsequent to the Spanish academics' presentation of supporting students in creating notebooks. The Spanish team, not being experts in research on learning and teaching in HE, felt that they could not continue their learning research, but discussions led to a decision to work together. Considering that it would be pity that the lack of experience should curtail such enthusiasm and energy in the desire to explore learning and teaching, she offered to support future developments. Although having no understanding of their subject, the UK lecturer volunteered her greater expertise in learning and teaching to explore how their innovation could continue and what could be appropriate. And so an international collaborative project was born.

Communication is central to all aspects of educational development and the first decision which the researchers had to make was how this process would take place. Although email was used to send documents and ideas, most of the strategies and decisions for and during this research were negotiated and discussed via Skype. This was a very efficient medium which permitted clarification of many if not all areas of misunderstanding. Clarification would have been much more difficult and time consuming had it all been done through written emails for example.

Their complementary expertise provided a balanced dynamic, with a lot of synergy to exploit. So, a joint strategy was designed. This involved much from both camps both in subject discussions and in process implementation.

Research Context

The original aims and discussions to work together were based on a desire to build upon the previous year's work which had supported students in creation of their own *Mathematica* (a commercial software to simplify performing complex calculations) notebooks in order to provide teaching materials for other students but also to develop their own personal expertise during the process (Taras *et al.,* 2010).

However, during discussions into how best to organize the work and select the students for this research, it became clear that the Spanish tutors were very concerned about another aspect pertaining to their work in supporting their Physics degree students in this obligatory Electronics module.

Good, efficient support of learning has as a premise an understanding of learner needs and beliefs at a number of basic levels: one of these often neglected aspects is learner beliefs concerning the subject (Prosser and Trigwell 1999). The Spanish tutors were convinced that the students had not understood the value and primacy of electronics in their Physics degree: this they believed was a handicap for them and their students as the latter would be less motivated and view their module as less important than their other Physics modules. A consequence of this belief was that the tutors would devote considerable time and effort, particularly in the first weeks of their course, to convincing students of the centrality of Electronics for Physics. They saw this as valuable time wasted which could have been used to support learning.

Therefore, the research project was divided into two parts: firstly, to explore the students' perceptions of the importance of the electronics component of the physics degree and by understanding why to find strategies to counteract these beliefs and secondly, to develop the evaluative skills of students by using 'notebooks' developed by previous year's students.

Learning, teaching and assessment beliefs

The principle of seeing students as instruments in their own learning is in accordance with current theories of learning and teaching which move beyond the metaphor of transfer of learning into an empty vessel (Hager and Hodkinson 2009; James 2006). The complex and individual nature of personal experiences, contextual differences and anomalies in shared understandings further mitigates against a limited and narrow view of learning particularly in a HE context where we are dealing with adult and experienced learners (Haggis 2009, Dysthe 2008). In order to conceptualize an inclusive and ethical learning, teaching and assessment process which is in accordance with current thinking, learners should be an integral part of an aligned curriculum and decisions pertaining to it (McArthur and Huxham 2013).

Therefore, this paper is placed squarely within beliefs that learning, teaching and assessment are part of a communicative, dialogic and leaner inclusive view of ethical and inclusive pedagogy. Within this interrelated and aligned view of pedagogy, there is also the observation that it is often assessment practices which are excluded and sidelined within pedagogy as they are often still seen as the exclusive preserve of tutors (Taras 2010, Tan 2009, Nicol and McFarlane-Dick 2005, Rust et al 2005).

Contextual Background

This research is considered particularly appropriate in the context of this electronics-within-a-Physics degree in a Spanish university course. However, the general principles of exploring student beliefs and developing their evaluative skills are relevant for all subject areas in different contexts.

It was felt that the attitude of the majority of the students at the Spanish university in the first electronics course which is a mandatory element in the Physics degree was not only passive, but lacked interest and motivation. Staff believed that students did not value the importance of electronics for physics, particularly as some of the students in previous years had complained that this subject is not included in similar degrees in other universities. Electronics is a complex topic that is considered to be at the boundary of the contents that typically belong to a physics degree. Consequently, their motivation in relation to electronics was felt to be generally low (Prosser and Trigwell 1999).

In order to change this, a set of tasks were developed to create a pro-active response. Therefore, during the first year of implementing these tasks, it was proposed to develop the programming of notebooks in *Mathematica* to implement students' analytic capacities and perform the calculations needed to describe the electronic devices explained in the course. This was not an obligatory activity and to 'reward' students 2 points on a 10 point scale were awarded to the final qualification mark. This research was successful, and more students than expected wanted to be involved (Taras *et al.* 2010). Sixteen groups asked to participate making a total of 33 students. From these, ten groups (21 students) completed the task. All the groups had two members except one having three. This produced additional teaching material for future use. The following year it was thought that it would be interesting to use the notebooks in class as teaching material.

Since the notebooks were a new teaching tool it was felt that their assessment by the new students would be interesting as it would help develop pro-active, agentic learners (Taras 2013, Tan 2009). Taylor and Robinson (2009). It was in this context that the Spanish lecturers got in touch with their colleague from the UK who agreed to help them in setting up the peer and self-assessment processes.

Research Aims

This project has two aims within an electronics engineering course: firstly, it asks why students of physics undervalue the obligatory electronics component of the physics degree, when the staff believe it is central to the fundamental and basic understandings to support the degree: also, where do students' erroneous beliefs have their origin. Staff felt that every year they waste valuable time and energy convincing students of the importance of the electronics component. Therefore, a deeper understanding of the why will be an important means of resolving this issue.

Secondly, staff wished to develop the evaluative skills of students by using the best notebook developed by the previous year's students. By focusing on the evaluation of this notebook, the aims are to develop both peer assessment of students' work and also self-assessment by students of how this evaluative experience impacts on their own understandings and learning journeys (Havnes and McDowell 2008).

Project Part 1

The first part of the research has the following objectives:

1. to explore the students' perceptions of the importance of the electronics component of the physics degree because the staff believe students think it has little value when they think it is central
2. to build on students' understandings of the subject in order to convince them of the central importance of the electronics component of the physics degree

It focuses on two research questions:

1. What are the students' perceptions of the importance of the electronics component of the Physics degree?
2. What are the students' understandings of the subject in order to convince them of the central importance of the electronics component of the physics degree?

Research Method

A questionnaire (Appendix 1) was developed to help students reflect on their understandings and opinions of the importance of the electronics component of the physics degree. The answering of this questionnaire was obligatory, completed in class and took approximately half-an-hour to complete. It was in English although also translated into Spanish.

These data provided both qualitative and quantifiable data concerning student' views on electronics in general and the course they were about to follow in particular. It will also permit the tutors to adapt their initial teaching weeks to focus on the issues discovered.

Student details

The respondents in the study were two groups of students in their fourth year of a physics degree. The total number of students was 57 and they were divided equally into about 30 students in each group. More than half of the students are new to electronics. Approximately 30-40% of them could have had experience of subjects connected to electronics because either they were repeating the course or they had transferred from other degrees, such as electronics engineering or telecommunication engineering (this latter case is the less common).

Electronics is taught in the fourth year of a five-year physics degree. This subject is complex since several of the topics explained in the previous years in the degree are involved (thermodynamics, electromagnetism, statistical mechanics, quantum physics, etc.). Electronics has obviously an engineering approach to the content since the link to the microelectronics industry is very important. This approach is completely new for the students of physics, and therefore, paves their way with difficulties derived from a technology oriented viewpoint.

Questionnaire Results

A.- Questionnaire to analyse students' opinions on the inclusion of an electronics course within the physics degree.

This section of the project presents the data collected from the questionnaire (Appendix 1) which reflect students' understandings and opinions of the importance of the electronics component of the physics degree. The percentage number of students answering the questionnaire was 61% (35 students of 57) and answers are as follows.

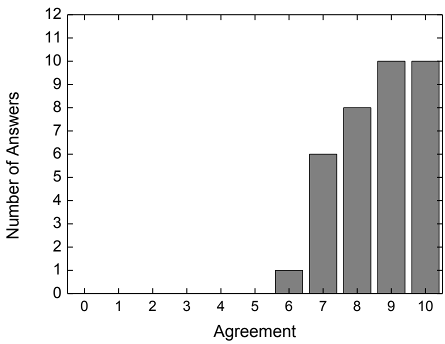
Question 1. Have you ever followed a course in electronics before?

The first item in the questionnaire was related to the students' previous knowledge of electronics and the results show that students in the course studying electronics for the first time were 68% and 32% had studied it previously.

In this section, unless otherwise stated, the results refer to 35 students answering and they show the number of answers for each student level of agreement. In the qualitative data, citations of individual students are reported within quotation marks ("..."). At the end of the citation, the numbers in brackets represent the level of agreement; therefore, (8/10) means the student agreed at the level 8 out of a possible 10.

Question 2. Explain what you think is the importance of electronics for society.

Regarding question 2, the students assessed very highly the importance of electronics for society. Graph 1 shows the bar chart with the data, and it is clear that all the students attached a high degree of importance to electronics and its importance for society.



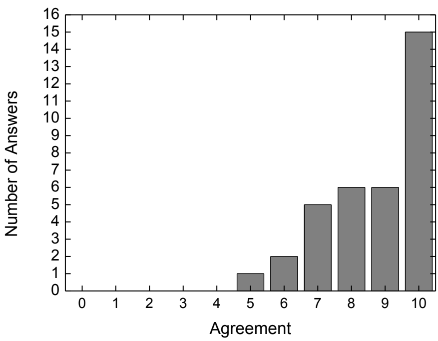
Graph 1. Importance of electronics in society for Physics students.

In the comments, 20 out of 35 pointed out the importance of electronics for the technological development of society, or to understand the way current technology works.

> "Technology is everywhere in our society" (6/10).
>
> "The way society is structured, electronics plays a fundamental role in our environment. Thousands of electronic devices make our life easy" (8/10).
>
> "Electronics is essential for society, since all the technological developments in the second half of the 20th century were based on the improvement of electronics" (10/10).
>
> "It's very important because most of modern devices are electronic ones. Also it is necessary for computation, which is the coolest thing designed by humankind" (10/10).

Question 3. Explain what you think is the importance of physics for society.

Question 3 dealt with the interest of physics for society. Similar results were found. In this case the highest mark was given more times than in the previous question, 43% (15/35) answered "10", and the spread of the data was slightly higher.



Graph 2. Importance of Physics for society for Physics students.

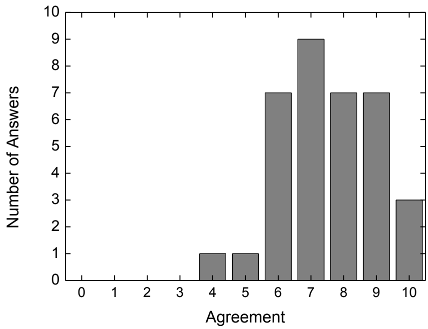
Students argued about the importance of physics for society not only for the technological process, but also in fields such as energy efficient production and uses, and the understanding of the behaviour of the natural world. It was clear from this question that they think physics could solve not only technological problems, but also to act as a perspective from where humankind can see its entire existence. A slightly greater interest in physics as a whole is perceived in comparison with electronics.

> "[Physics] allows us to satisfy human beings' wish for knowledge, and in some cases this is useful for our welfare" (6/10).
> "Physics gives an explanation for everything we observe even though we are not aware of it" (8/10).
> "For instance, one of the main issues for society nowadays is the lack of energy resources, and this is a topic studied by physics. With this, I say everything" (10/10).

It is interesting to see the differences between the results obtained in questions 2 and 3. The students considered that physics is more important for society than electronics, although the differences were not paramount. This difference may have several interpretations: i) students might be indicating that they consider electronics as an interesting topic, but physics it is more important for society just on the grounds on their personal interest (they study physics, not electronics. Probably students in the electronic degree would think the contrary); ii) students might be indicating that they really consider electronics as a part of physics, so question number 3 includes implicitly question number 2, and therefore the marks of the whole field (physics) are higher than a section of it (electronics); iii) they might be considering that electronics is a completely different topic, but still important for society. In accordance to the rest of the answers in the questionnaires we think the reasons behind these results are decreasing in likelihood from i) to iii).

Question 4. To what degree do you consider a physicist needs a background in electronics. Explain this please.

Question 4 tried to look into the connection they could find with their studies and electronics. The results are depicted in Graph 3. The higher spread in the results gives the impression of a diversity of opinions on this point. Not everybody agrees to the same degree on this issue, although they all concluded that knowledge of electronics is relevant for a physicist. Few answers were below 6 in the degree of agreement, just 6% (2/35).



Graph 3. Importance of electronics background for a physicist.

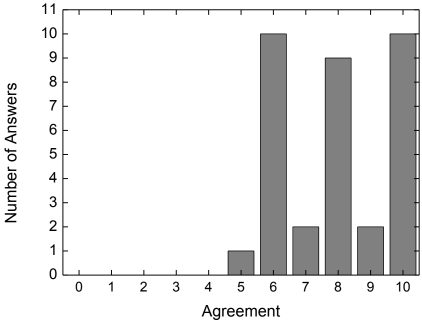
In the qualitative data they argue that electronics is necessary, one even says that a physicist should know a little bit of everything (why not electronics?). Some of them declare that having a background in electronics is useful in order to find a future job. There are also comments about the need to know how the measurement equipments actually work, since most of them are based on electronics, and a physicist definitively needs to use them for experimental tasks. However, this last issue does not appear very frequently in the answers. (11 people argued this from the total 35) They mostly think of electronics as related to engineering, learned mainly with the purpose of developing new devices, but not with the purpose of understanding measurement processes.

> "It depends on what the physicist is going to work in. But it's useful" (5/10).
>
> "Physics is wide enough to consider it absolutely indispensable to know electronics. I have marked it with a 7 since I do consider it necessary to have a basis in electronics" (7/10).
>
> "A physicist needs a strong background in electronics because working in a lab, using detectors for experiments require a knowledge of basic electronics" (9/10).

Question 5. To what degree do you consider electronics is a part of physics. Explain this please.

The results had a relative high dispersion in the answers, as shown in Graph 4. Further, 34 students answered instead of 35, showing that not everybody has an opinion or are sure about this. There are three dominant sets of answers: one agreeing with the highest mark of 10 (29.4% of the students, 10/34), a second one assigning 8 (26.5% of the students, 9/34), and a third one of equal importance to the first with just 6 (29.4% of the students, 10/34). These results could be explained because electronics is a discipline in itself.

There are degrees where students learn about concepts of electronics without paying special attention to the physics from which they originate (mainly in engineering). This may have led to the students of the last group thinking that electronics is something different to physics. The fact is that electronics arose from physics, and there are many fields (quantum electronics, for example) that are purely physics and are not suitable to be included in the current engineering curriculum. This is probably the reason why about a third of the students gave an answer of 10.



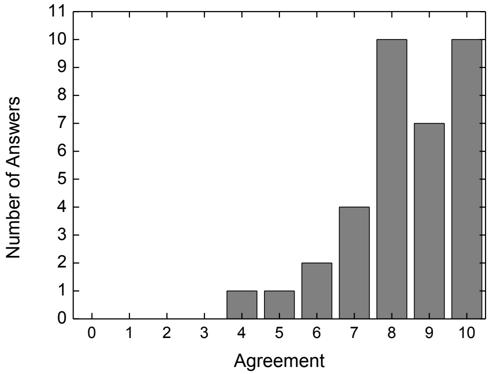
Graph 4. Agreement with electronics being a part of physics for physics students.

They think electronics is a part of physics, but their feeling is that electronics has become a completely new discipline, so it should be considered as a new field. Other students think electronics is in fact an important part of physics, although not basic physics.

> "It is really important as a part of it [physics]. However, I think they are very dissimilar entities, so it is hard to study them at the same time" (6/10).
>
> "Electronics, as far as I know, derives from physics. Electronic engineers require solid backgrounds in physics to understand their field. Nevertheless, electronics have grown so much in the last decades, so it could be considered as an independent field, we should not forget its basis and foundations though" (8/10).
>
> "I consider all progress in electronics is based on basic physics ideas. For example, you need to understand the basics of a semiconductor in order to apply it to the electronic industry" (10/10).

Question 6. To what degree do you think that research in physics should be theoretical. Explain this please.

The results are depicted in Graph 5. 77% of the answers (27/35), that is, most of them were above 7.



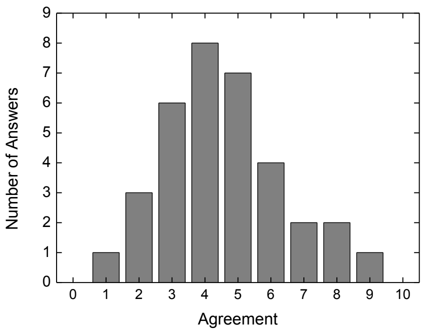
Graph 5. Degree of importance of theoretical research in physics for physics students.

They argue that theory is the tool to guide the development of research: the difficulties of doing an experiment with no knowledge of "what is going on" within the physical systems illustrate the centrality of theory. Some students assert that "when you know what you should look for, it is easier to find it", where theoretical knowledge is crucial. However, students also believe that theory alone is not sufficient but that it has to be intertwined with experimental research so that they support each other. They also comment that sometimes theory goes far beyond the real world, looking like a mathematical map.

> "We can't have theoretical research without experimental research" (4/10).
>
> "Theoretical research is the basis. It is, therefore, very important. Nevertheless it requires experience to obtain its formal structure" (8/10).
>
> "Basic research plays a fundamental role in development of new technologies" (10/10).

Question 7. Do you think that there is a balance between theory and practice in physics? Explain this please.

Question 7 was the lowest assessed item and the results are depicted in Graph 6. It is also the one with the biggest spread, demonstrating a high diversity of opinions. Moreover, not everybody answered this question. The balance between theory and practice is an issue that should be considered, since a high percentage of the students (53% marked below 5, 18/34) seem to be disappointed with the way the connection is made.



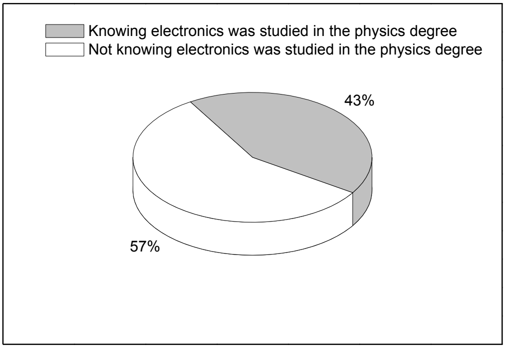
Graph 6. Opinion about the balance between theory and practices in the physics degree.

Students do not think there is the right balance between theory and practice in the physics degree as a whole and the electronics course in particular. Further, the high spread in the results show a lack of agreement between them. They are more critical on this issue, and the most repeated arguments are the lack of coordination between practical work and theory (they claim that sometimes they have to carry out practices for what they do not know the theory), and the existence of irrelevant practices where they do not learn anything. The few critical opinions argue that theoretical physics is a consequence of experimental physics, so practices should also be relevant within the degree, and others suggest that practices should be carried out in companies, or far away from the academic field.

> "My personal experience tells me that the theoretical aspects are more emphasized in the studies, and I think we should change the policies and spend more time on the practical aspects" (1/10) .
>
> "Usually, some physics courses have practicals. However, not many of them give the practicals the importance they deserve. Also, many times students have a lab lesson before they learned that in theory class" (4/10).
>
> "I figure out that all we study nowadays in a theoretical way is to be applied in practical situations." (8/10).

Question 8. When you chose to do a degree in physics did you know you would be studying electronics?

Most of the students did not know that electronics was studied within the degree. This is probably connected to the results from question 5, about the relevance of electronics within physics. The wide spread of the data might be due to the fact that most of the students did not expect electronics to be a compulsory part of their studies.



Graph 7. Percentages of students knowing from their first year that electronics was studied in the physics degree (grey) and not knowing it (white).

Question 9. What is your opinion of having an obligatory electronics component in your physics degree?

Finally, in question 9, students comment on whether they agree with the inclusion of electronics within the physics degree. A wide spectrum of answers was found and it is not possible to quantify them as in the previous ones. Nevertheless most of the answers were positive about this item, and the following quotes indicate trends. In general they believe it is good for their curricula and would not exclude it from the degree.

- "I personally do not like electronics, and I'm not good at it. So I struggle with it, especially in practical sessions. However I consider it is interesting to have basic foundations (at least) on electronics. Moreover we may need them when we graduate since physics is such a versatile degree that we do not know the professional field we are going to end working on".
- "Electronics is necessary for any current scientist from my point of view, so I agree on it being an obligatory subject".

- "When I started my studies I did not understand this point well, but as I progress on my degree I realized its importance for the Physics of today".
- "I think it is ok as it is now. Following the assessment I carried out in the above items, I think a physicist must have a base in electronics".

Discussion

As noted above, the staff believed that students attached little value to this electronics course when in reality they think it is central to the Physics degree. Staff had been frustrated because they had felt that a considerable time of the first sessions had been wasted in convincing students when they should know this already.

From the data it is clear that tutors had been mistaken about students' beliefs and understandings of the importance of electronics both for physics and for society. From Question 2 which asks of the importance of electronics for society, both the quantitative and the qualitative data clearly indicate that students all rated the importance of electronics highly for society: they highlighted how electronics had facilitated and improved social functions and communications. In Question 3, they show that they believe that physics has enabled humanity to understand fundamental principles and will enable us to deal with current and future problems on a global scale and therefore that physics is valued somewhat more highly than electronics.

It is however in examining Questions 4 and 5 that we come to answering the crux of the concern which originally troubled lecturers: these two questions explore the relationship between electronics and physics. As noted in the results, both Questions 4 and 5 showed the widest spread of results indicating that this is the area where there is the greatest difference of opinions. Although there are evident links between the two subjects, given the variety of specialisms within each subject area and the relative dependence of each specialism to the other subject, it is not surprising that students relate their requirements to their own personal futures and needs when considering the link. Which aspects of physics are of particular interest to them and their own past experiences are also important factors for them as noted in the qualitative responses. Finally, Question 8 indicates that most of the students were not aware that there would be an electronics course, even less an obligatory one, as an integral part of the physics degree. Managing student expectations is an important aspect of understanding their thinking and reactions.

In addition to the questions exploring student beliefs about electronics and physics, they were asked two questions (6 and 7) about theory and practice in their physics degree. These questions were added after discussions between the researchers in Spain who were explaining the electronics component to the English academic. The latter wondered whether the highly theoretical aspect of the electronics course was a factor, and because of her own personal interest in theory, was keen to explore students' beliefs. The results of these questions are a good indication that there had been excellent communication and a sharing of understandings of the issues involved in the course being researched between Spain and England. These questions produced interesting results. 77% of the answers were above 6 thus indicating that theory is very important to research in physics, however, it is tempered by the understanding that theory and empirical research should go hand in hand in order to inform each other.

Question 7 produces the most polemical results in that firstly, it was the lowest assessed item and secondly, the question with the widest spread and thus the highest diversity of opinion. In addition a high number were dissatisfied with the balance between theory and practice taught on the physics course. Knowing about and understanding where there is dissatisfaction in students is a very important aspect of any course because it reflects good communication with students and also provides pertinent feedback for the future.

Project part 2

The use of peer assessment of a notebook to develop understandings of standards and quality

The second part of the research has the following objectives:

1. To develop the evaluative skills of students by using a 'notebook' developed by previous year's students
2. To develop both peer and self-assessment in students
3. To use the notebook to better understand the physics of the electronic devices described in the course and get familiar with the common physical quantities (voltage, current, etc).

Research Method

The best *Mathematica* notebook was selected from eight produced by previous students. This was provided to the 15 students who volunteered to participate along with an explanation sheet (see section 2 below). The work and how this would support their learning were explained. The questions to be answered were written and explained in class. We were especially interested in evaluating the usefulness of the notebook for these students. The students were asked to evaluate the usefulness of the notebook (as product) and also, to evaluate the usefulness of using the notebook (as a process for checking the different parameters) (see section 2c).

To take part in this activity each student sent an email to their tutor asking to participate. Then, the tutor replied providing general instructions about the activity (common information for all the students), providing input numbers to be used in the notebook (a different set of input values for each student, to avoid copying results from other students and to promote discussion between them), and finally the items that the students should consider to do this activity (common items for all the students).

Student details

The activity carried out in project Part 2 was not compulsory. Therefore, the participants in this activity were fewer than in Part 1. 15 students took part voluntarily from both groups, with a heterogeneous profile in terms of lecture attendance and academic performance. Not everybody understood the purpose of the assessment task, mainly because in the Physics Degree this is not a usual activity, and in one of the cases the student carried out the development of a full notebook instead of assessing the one provided. Finally he did the assessment as requested. Furthermore, two students did not understand the importance of giving a different mark for each item, and they gave a single mark for the whole notebook.

General instructions

As with the questionnaire in Part 1, both an English and a Spanish version of the instructions were produced. The following was provided to the students. "The work to be done consists of a report on the calculations with comments on the values obtained. Please reply explicitly to the questions listed in the questionnaire and other comments (comparison with other results, assessments of the calculations, etc.). All critical comments are valued. Also the student's ability to evaluate the usefulness of this material of their learning and their ability to objectively evaluate other students' work will be assessed in this activity".

Input numbers

Input example given to particular students in this activity. Three input parameters: semiconductor (Silicon or Germanium), impurity concentration in the P region, impurity concentration in the N region.

(English version) Student 1. Example.
Pn junction data.
Semiconductor: Silicon.
Impurity concentrations in the P region: NA= 1016 cm-3.
Impurity concentrations in the N region: ND= 1017 cm-3.

Tasks

(English version)
1-a) Calculate the potential barrier using the notebook.
1-b) Did this calculation help you to understand the concept of "potential barrier" in a pn junction? How?
2-a) Calculate the depletion region width.
2-b) Did this calculation help you to understand the concept of " depletion region" in a pn junction? How?
3-a) Maximum electrical field in the structure.
3-b) Did this calculation help you to understand the concept of "electric field" in a pn junction? How?
4-a) Perform the current versus voltage graphical representation.
4-b) Did this calculation help?
5-a) Calculate the capacitance for an applied voltage of 0.3V.
5-b) Did this calculation help you to understand the concept of "capacitance" in a pn junction? How?

Note for readers: the X-a questions deal with the physical quantities, while the X-b questions focused on the assessment of the students of several notebook's features regarding its learning usefulness on those particular physical concepts.

General assessment of the notebook
(English version)

Now that you have used the notebook, what do you think about the following issues?
Use a scale to asses them
- Design (1 - weak design; 10 - well designed). Explain why.
- Use (1- hard to use; 10 - easy to use). Explain why.
Out of a total of 10, grade the overall quality of the notebook and explain the reasons for grading it in that manner.

Results

As noted above, the tasks evaluate the process of using the notebook in addition to the reflection of the students as to why and what were useful about using the notebook. The questions mixed focus on physical quantities and assessment and learning while using the notebook.

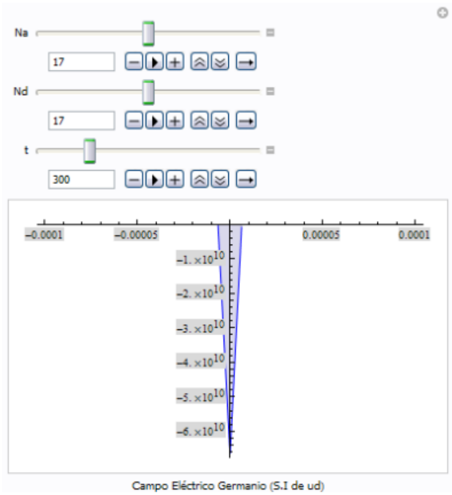
Regarding the questions about physical quantities (questions X-a), all the students introduced the input numbers in the notebooks and they obtained the results in a straightforward manner. They included the output data provided by the notebook in their final reports, and they also modified the data several times to analyse their impact on the physical quantities. Nobody had problems using the notebook. Regarding the mark for this activity, the tutors focused on the scientific quality of the critical comments from each student about each particular output quantity.

Regarding the questions about assessment of the notebook as teaching material, the majority (14 out of 15) of the students believe that the notebook is useful to understand the role played by the input data introduced in each calculation as it is a pictorial representation of a calculation. Two out of 15 students clarified that although they could see the changes, that this did not help to understand the physical concepts because the theoretical framework and principles behind them were not explained in the notebook (although this was not the initial purpose of the notebooks and they had been informed to use it together with the explanations about the quantities in the lectures).

Therefore, students should have understood that the purpose of the notebook was not to become a self-explanatory teaching tool but a complementary tool.

For the sake of clarity it is worth mentioning that, in order to obtain physical quantities in the study of the pn junction, some approximations are widely used. The notebook does not need all these approximations since it can evaluate the expressions numerically, without any simplifications. In this regard, two students commented on the unclear relation between the notebook's calculations and the approximations used to obtain the algebraic formulae. They said that the explanation concerning the approximations employed to obtain some of the mathematical expressions in the notebook should have been given within the notebook, including the numerical comparison between the approximated and not approximated mathematical expressions, to help the evaluation of the accuracy of the approximations. In this manner, they would have been able to know in what cases the use of the approximations was appropriate. Even though their complaints were reasonable, the use of approximations in order to help electronics designers to make quick decisions is a tough issue to be explained in a Mathematica notebook.

The most positive items were the graphical representations. When the information is plotted visually (Graph 8), it is easier to understand. The electric field plots were also positively assessed as well as the current versus voltage plots of the pn junction.



Graph 8. Image from the notebook. The bars introduce the input values. Below is the electric field in germanium for those input parameters vs the position. x = 0 is the position of the junction, being the P region on the left and the N region on the right.

Student found the graphical plots very useful to understand the concepts, more useful than learning by just looking at numbers. The difficulties found in electronics are due to the multidimensionality of the equations which produces the dependence of a physical variable on many different parameters whose influence is difficult to isolate. The notebook facilitates this task, allowing students to "play" with the different data to see their influence on the physical qualities.

Assessment of the whole notebook by students

The following general questions were asked and the results are represented in Graph 9:

Now that you have used the notebook, what do you think about the following issues? Use a scale to assess them.
- Design (1 - weak design; 10 - good designed). Explain why.
- Use (1- hard to use; 10 - easy to use). Explain why.
Out of a total of 10, grade the overall quality of the notebook and explain the grade.

Results of Quantitative Analysis

1. Design of notebook (1 – Poor design; 10 – Excellent design).

Average and Standard deviation (7.9±1.0)

2. Ease of use (1 - Difficult; 10 - Easy).

Average and Standard deviation (7.5±1.3)

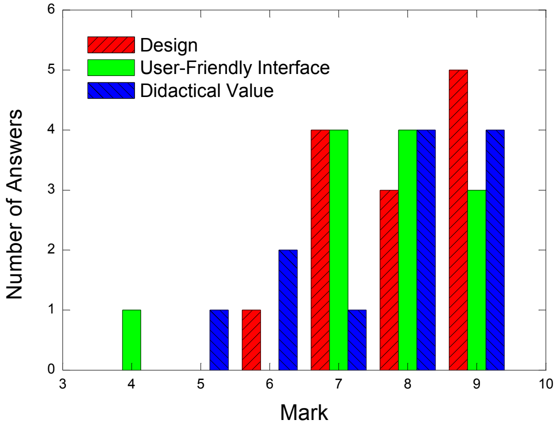
Two out of 14 students complained about the lack of information on how to use the notebook).

3. Didactical value of the notebook

Average and Standard deviation (7.8±1.3)

Although only three students explicitly expressed the capacity to correct some errors that were found students were generally positive about the practice the notebook provided.

Most of the answers were within the interval from mean - standard deviation up to mean + standard deviation.



Graph 9: Assessment of the notebooks from the students. Each type of bar indicates a different concept (quality of design, user friendly interface, didactical value).

In Project Part 2, the students using the notebooks assessed it positively. After working individually on a particular PN junction they assessed the usefulness of the document. Most of the assessments were highly positive. They justified their assessment based on the usefulness of the teaching material to improve their understanding of the quantities considered within it, but also considering the effort by the student who developed it (Taras et al 2010). Students noted, “the capabilities of the notebook for dealing with the theory of the PN junction in a simple fashion is very useful, taking into consideration the complexity of the formulae that theory involves”. Also, “I did a general assessment of the software, always keeping in mind respect for the job carried out by other students [the developers], considering the effort they made to develop this software”.

The most critical students argued that they considered the notebook “as a working tool, but not as teaching material”. They find a lack of explanation of the theoretical basics on which the presented formulae rely. The mean and standard deviation for the assessment was (7.79±1.26) on a scale from 0 (lowest rate) to 10 (highest rate).

Discussion and Implications for future support of learning of the electronics course

Teaching of the subject in the following year did not change in terms of curriculum as a result of this research but it greatly influenced the way the students' motivation was worked on by the tutors. It also influenced the way the tutors presented their subject. Instead of trying to convince the students of the importance of electronics in the degree during the lectures, the motivation was worked on by showing them state-of-the-art electronic issues and highlighting the role of the electronic devices which are studied in the students' subject context.

The authors consider that facing students' and tutors' prejudices about the topics of a subject not only improves the quality of teaching, but also saves time wasted in trying to motivate the students from misconceived understandings which are wrong. What this work shows is that, in order to implement the teaching of a subject successfully, it is very positive to check the students' prejudices and opinions about the topics of a subject (and tutors' opinions of these) instead of taking them for granted. Just as importantly, it also served tutors in that it allowed them to examine and reflect on their own perceived beliefs about students' reactions to their subject. The more we talk with and question our students and ourselves, the better the likelihood of sharing understandings.

Conclusions

This cross-European research project into teaching and learning across subject area specialisms has been a very exciting process although difficult to manage because of the very different knowledge areas of the authors. This research began slowly in November 2010 because of the need to share different contexts and perspectives. The process was also subject to gaps due to work pressures on both sides of the channel but we all feel that this enriched the final result with ideas from very different inspirations.

Sharing expertise and exchanging experiences in order to support our students' learning is an excellent means to reflect on our processes of learning and teaching. This has been a very fruitful collaboration which has contributed to understanding students following an electronics course within a physics degree. It has meant that subsequent to this, tutors could be more focused and efficient in helping their students for the future. Furthermore, it permitted students to develop and reflect on their own learning, and how their peer's work can contribute to it. Importantly, it required them to understand how, why and what aspects of this work was of value and support, thus developing their criticality and assessment skills.

The partnership highlighted tutors' concerns in learning, teaching and assessment which transcend contexts and countries, namely that we worry about how our students think and feel. Negotiating meaning and strategies for the classroom was beneficial in helping lecturers understand potential ambiguities and the problems that faced them and how they supported their students.

References

Berry, R. & Adamson, B. (2011). (Eds.), *Assessment reform in education: policy and practice*. Dordrecht: Springer.

Dysthe, O. (2008). The challenges of assessment in a new learning culture. In A. Havnes, & McDowell, L. (Eds.), *Balancing Dilemmas in Assessment and Learning in Contemporary Education* (pp. 213-224) New York/London: Routledge.

Hager, P. & Hodkinson, P. (2009) Moving beyond the metaphor of transfer of learning, *British Educational Research Journal*, *35*(4), 619-638.

DOI:10.1080/01411920802642371

James, M. (2006). Assessment, Teaching and Theories of Learning. In J. Gardner (Ed.), *Assessment and learning* (pp. 47-60) London: Sage.

Haggis, T. (2009): What have we been thinking of? A critical overview of 40 years of student learning research in higher education, *Studies in Higher Education*, *34*(4), 377-390.
DOI: 10.1080/03075070902771903

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112.
DOI: 10.3102/003465430298487

Havnes, A. & McDowell, L. (Eds.), (2008) *Balancing Dilemmas in Assessment and Learning in Contemporary Education* New York/London: Routledge.

McArthur, M. & Huxham, J. (2013). Feedback unbound: from master to usher. In S. Merry, Price, M., Carless, D., Taras, M. (Eds.), (2013). *Reconceptualising Feedback in Higher Education: Developing dialogue with students* (pp. 92-102). London and New York: Routledge.

Nicol, D.J. and MacFarlane-Dick, D. (2005). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199-218.
DOI: 10.1080/03075070600572090

Prosser, M. & Trigwell, K. (1999). *Understanding learning and teaching: the experience in higher education* Open University Press: Buckingham. Society for Research into Higher Education.

Rust, C., O'Donovan, B. & Price, M. (2005) A social constructivist assessment process model: how the research literature shows us this could be best practice, *Assessment and Evaluation in Higher Education* 30(3), 231-240. DOI:10.1080/02602930500063819

Tan, K. H. K. (2009). Meanings and practices of power in academics' conceptions of student self-assessment. *Teaching in Higher Education*, *14*(4), 361-373. DOI:10.1080/13562510903050111

Taras, M. (2013). Feedback on Feedback: uncrossing wires across sectors. In S. Merry, Price, M., Carless, D., Taras, M. (Eds.), *Reconceptualising Feedback in Higher Education: Developing dialogue with students* (pp. 30-40) London and New York: Routledge.

Taras, M. (2010). Student Self-assessment: processes and consequences, *Teaching in Higher Education*, 15(2), 199-213. DOI:10.1080/13562511003620027

Taylor, C. & Robinson, C. (2009). Student voice: theorising power and participation, *Pedagogy, Culture & Society, 17*(2), 161-175. DOI:10.1080/14681360902934392

Appendix 1

Questionnaire of students' opinion of the place of Electronics in the study of Physics

1. Have you ever followed a course in electronics before? YES NO

¿Has estudiado alguna asignatura de electrónica antes? (Si/No)

2. Explain what you think is the importance of electronics for society.

Explica brevemente qué piensas sobre la importancia de la electrónica para la sociedad.

3. Explain what you think is the importance of physics for society.

Explica brevemente qué piensas sobre la importancia de la física para la sociedad.

4. To what degree do you consider a physicist needs a background in electronics.

Explain this please.

¿En qué grado consideras que un físico necesita una base en electrónica? Argumenta brevemente tu respuesta, por favor.

5. To what degree do you consider electronics is a part of physics.

Explain this please.
¿En qué grado consideras que la electrónica es una parte de la física? Argumenta brevemente tu respuesta, por favor.
6. To what degree do you think that research on physics should be theoretical
Explain this please.
¿Qué importancia le concedes a la investigación puramente teórica en física? Argumenta brevemente tu respuesta, por favor.
7. Do you think that there is a balance between theory and practice in physics?
Explain this please.
¿Crees que hay un equilibrio entre la teoría y la práctica en los estudios de física? Argumenta brevemente tu respuesta, por favor.
8. When you chose to do a degree in physics did you know you would be studying electronics?
YES NO
Cuando elegiste hacer unos estudios en física, ¿sabías que cursarías una asignatura de electrónica? (Sí/No)
9. What is your opinion of having an obligatory electronics component in your physics degree?
¿Cuál es tu opinión sobre tener obligatoriamente asignaturas de electrónica en tus estudios de física?

Maddalena Taras is Senior Lecturer at the Faculty of Education and Society, University of Sunderland, United Kingdom.

Francisco M. Gómez Campos is Associate Professor at the Departmento de Electrónica y Tecnología de los Computadores. Facultad de Ciencias. Universidad de Granada, Spain.

Juan B. Roldán is Associate Professor at the departmento Electrónica y Tecnología de los Computadores. Facultad de Ciencias. Universidad de Granada, Spain.

Contract Address: Direct correspondence to the author at the Faculty of Education and Society, Forster Building, Chester Road, University of Sunderland, Sunderland (United Kingdom). E-mail address: maddalena.taras@sunderland.ac.uk.