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How students use learning opportunities in a first-year, Electrical Systems unit

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Abstract

This paper presents a preliminary analysis of answers to a survey taken by 118 first-year student engineers to find out how they engaged with the learning opportunities offered in an electrical systems unit. Answers were correlated against student demographics. Correlations confirm what other studies have found: some resources are more useful than others for different cohorts, while none of the resources are considered useful by all. This leads to the conclusion that in the face of increasing diversity, almost everything we try to support student learning will be effective for some students, while nothing will be 100% effective for all. There are no 'silver bullets'.

Keywords: *Student engagement; Student demographics; Learning opportunities; How students learn.*

1. Introduction

The higher education sector is constantly evolving to cater for the needs of diverse cohorts. For example, the COVID pandemic forced universities to step out of their comfort zones to explore alternative ways to create and deliver content. For some students this transition had long-lasting negative effects in their ability to engage in learning activities (Wester et al., 2021).

For learning to occur, students need to engage in learning activities. It is for teachers to provide an assortment of such activities to increase the quality and frequency of students' engagement. But some students are difficult to motivate. Student feedback shows that no matter how hard teachers try to provide learning opportunities for all, some students will be dissatisfied with the quality and effectiveness of the teaching methods. This could be discouraging for teachers, specially those who are in the early stages of their academic career (Stroebe, 2020).

This paper presents preliminary results of a study aiming at figuring out which of the learning resources offered to students in a first-year, electrical systems unit[1] were the most effective and frequently used. The use of eight teaching resources by students from different demographics was captured in the survey. The survey was taken by 118 students, which represents 25% of the total cohort. Answers reveal that students from different demographics engage differently with teaching materials. All resources were used by some, while none of the resources was used by all. This leads to the conclusion that teachers should keep doing their best at preparing materials in different formats knowing that some students will benefit from them, even if teaching evaluations do not capture this fact.

2. Background

Curriculum design plays a pivotal role in shaping the learning experiences of students. Designing a learner-centered curriculum requires considering the diverse backgrounds and abilities of students (Biggs, 2014; Huba & Freed, 2000), while integrating interdisciplinary content, real-world applications, and aligning learning outcomes with the needs of the workforce (Broo et al., 2021). Understanding these factors is crucial for educators seeking to create inclusive and effective curriculum that caters to the diverse needs of students while supporting their transition from teenagers to adults (Ortega-Sanchez, 2023).

The increasing diversity in student cohorts within higher education institutions has become a central theme in educational research. Cultural, socioeconomic, and academic diversity among students presents both challenges and opportunities for educators. Hurtado & Guillermo (2012), emphasize the positive impact of diverse student cohorts on critical thinking, problem-solving, and creativity. However, challenges related to equity, inclusivity, and providing tailored support must be addressed to ensure all students can thrive in their academic journey.

Since students have diverse learning preferences and styles, exploring various teaching modalities is necessary. Cognitive, social, and constructivist theories highlight the importance of adapting teaching methods to accommodate different learning styles (McLeod, 2024). Also, a deeper understanding of the cognitive processes involved in learning is essential for effective teaching. Cognitive science research highlights the significance of factors such as working memory, metacognition, and motivation in the learning process (Kaufer, 2011; Macrine & Fugate, 2022).

From a pedagogical perspective, active learning strategies, flipped classrooms, and collaborative learning have been explored as effective methods to enhance student engagement

[1] Units are called subjects, modules or courses in other parts of the world. In this paper a course (Bachelor of Electrical Engineering) comprises units (Calculus, Electrical Systems, Chemistry for Engineers, etc.).

and comprehension. Moreover, technology integration and experiential learning have emerged as valuable tools to address the diverse learning preferences of students (Nilson, 2016). Sankey & Gardiner (2010) emphasize the significance of incorporating multimodal approaches that engage students through visual, auditory, and kinesthetic experiences, allowing for a more inclusive and effective learning environment.

3. Method

The results presented in this paper are a sub-set of a study aming at understanding the experience of first year engineering students. A quantitative correlation analysis was used to investigate how students from different demographics engaged with different learning activities.

The following sections present the analysis of answers to the following research questions:

1. Of the teaching materials available in the unit, which are used the most and the least?
2. Are materials used differently by students with different demographic profiles?

To find the answers to these questions students completed an online, anonymous survey that included the following items.

1) How often did you use the additional resources (PDF's with solved problems, videos to complement labs, videos to complement tutorials, recommended books)? (Options: Never, Very sporadically, Only for difficult topics, Some every week, Very frequently)

2) Rank the following learning opportunities by how much they facilitated your learning, with #1 being the most useful: Weekly lecture videos, PDF's with lecture slides, Weekly quizzes, Laboratory work, Weekly tutorials, Pre-tutorial videos, Supplementary lab and tutorial videos, Document with solved problems.

3) Which of the following describe you best. Tick all that apply: School leaver, Mature student, Domestic student, International student, Have a paid job, Living with parents, Grew up in a city, Grew up in a rural environment, Have a University Special Support Plan (Curtin Access Plan, CAP), Elite athlete, Fly-In Fly-Out worker, Parent with small children, First in family to attend university, Culturally and Linguistically Diverse (CALD).

4. Results and discussion

Answers to the survey were statistically analysed by cohorts. In the tables that follow columns represent cohorts, where ***n*** is the number of students who identified as part of that cohort (answers to question 3). Cells have been colour-coded to highlight the highest number in every

column (yellow), the highest number in every row (pink), and the highest both in the row and column (green).

4.1. Additional resources' frequency of use

In addition to scheduled teaching activities (lectures, laboratories and tutorials), students had access to resources whose use was not compulsory, but recommended. Table 1 shows how often students engaged with these additional resources (answers to question 1 in the survey).

Table 1. Students' engagement with additional resources. Columns present percentage of students in different cohorts who selected the corresponding frequency of use.

Frequency of use	All	School Leaver	Mature Student	Domestic	Intl	Paid Job	Lives w parents	City	Rural	CAP	Parent w Children	First Fam	CALD
n	118	69	17	77	32	57	68	47	17	6	5	19	22
Never	8.5	11.6	0.0	9.1	9.4	7.0	7.4	4.3	17.6	33.3	0.0	10.5	13.6
Very sporadically	16.9	17.4	5.9	20.8	12.5	14.0	16.2	21.3	17.6	33.3	0.0	26.3	9.1
For difficult topics only	34.7	30.4	64.7	33.8	31.3	45.6	35.3	36.2	29.4	16.7	80.0	26.3	36.4
Some every week	22.0	21.7	17.6	22.1	18.8	19.3	23.5	21.3	23.5	16.7	20.0	26.3	18.2
Very frequently	16.9	18.8	11.8	14.3	28.1	14.0	17.6	17.0	11.8	0.0	0.0	10.5	22.7

According to table 1, most students used the additional resources only for difficult topics. Note the high percentage of international students who used the resources "very frequently". This may indicate that this cohort is more committed to their education.

The high percentage of students who declared "never" or "very sporadically" accessing additional resources is concerning. 30% of Domestic students and 35% of students from rural backgrounds fall in this category.

International students have the highest percentage of engagement with additional resources. 47% declared to have engaged with the resources "some every week" or "very frequently". This might indicate that international students, who pay higher fees than domestic students, are more motivated, or feel more pressure, to engage with available learning opportunities.

Because of the low number of responses from students with support plans (CAP) (6) and parents with small children (5), percentages are not considered statistically significant and have been included in this paper for completeness only.

4.2. Use of teaching materials by cohorts

To understand how useful students found the teaching materials in the unit, they were asked to rank the resources according to how much each one supported their learning. Tables 2 to 4 summarise the answers for resources ranked 1, 2 and 3 respectively; 1 being the most useful.

Table 2. Percentage of students who ranked resources as number 1, the most useful.

Resource vs cohort	All	School Leaver	Mature Student	Domestic	Intl	Paid Job	Lives w parents	City	Rural	CAP	Parent w Children	First Fam	CALD
n	117	69	17	77	32	57	68	47	17	6	5	19	22
Lecture videos	15.4	15.9	23.5	14.3	21.9	12.3	17.6	21.3	11.8	33.3	20.0	21.1	13.6
PDF's with lecture slides	16.2	18.8	11.8	18.2	9.4	14.0	19.1	19.1	11.8	33.3	40.0	10.5	13.6
Weekly quizzes	8.5	7.2	0.0	10.4	12.5	10.5	11.8	10.6	5.9	16.7	0.0	15.8	13.6
Laboratory work	11.1	11.6	17.6	10.4	21.9	12.3	10.3	6.4	17.6	0.0	0.0	10.5	22.7
Weekly tutorials	23.1	23.2	41.2	26.0	21.9	33.3	22.1	25.5	35.3	16.7	40.0	21.1	27.3
Pre-tutorial videos	0.9	1.4	0.0	1.3	0.0	0.0	1.5	2.1	0.0	0.0	0.0	0.0	0.0
Lab and tutorial videos	4.3	4.3	0.0	3.9	6.3	1.8	2.9	2.1	11.8	0.0	0.0	5.3	4.5
PDF with solved problems	9.4	10.1	5.9	10.4	3.1	10.5	10.3	8.5	0.0	0.0	0.0	5.3	4.5

According to Table 2, tutorial sessions are considered the most useful learning resource by all cohorts. The percentage of mature students who ranked tutorials as number 1 is significantly higher than the percentage in other demographics. This may indicate the need of mature students to make their learning more efficient since tutorials are sessions where they can ask questions.

It is remarkable how lecture videos were not ranked as number 1 by many cohorts. These videos replaced face-to-face lectures during the COVID pandemic, and have remained as the main source of contents. It is clear that students are engaging with alternative resources to learn content.

International students ranked three resouces as the most useful: lecture videos, laboratory work and tutorial sessions. Tutorials and labs are face-to-face activities that are facilitated by an academic. It is possible that international students like attending these activities because they resemble what they experience in high school back in their countries.

Table 3. Percentage of students who ranked resources as number 2, the second most useful.

Resource vs cohort	All	School Leaver	Mature Student	Domestic	Intl	Paid Job	Lives w parents	City	Rural	CAP	Parent w Children	First Fam	CALD
n	117	69	17	77	32	57	68	47	17	6	5	19	22
Lecture videos	17.9	18.8	23.5	18.2	18.8	17.5	20.6	14.9	11.8	16.7	20.0	10.5	18.2
PDF's with lecture slides	12.8	14.5	11.8	13.0	15.6	14.0	14.7	14.9	5.9	0.0	20.0	26.3	18.2
Weekly quizzes	22.2	27.5	17.6	24.7	18.8	26.3	26.5	31.9	23.5	16.7	20.0	10.5	27.3
Laboratory work	6.8	4.3	23.5	7.8	6.3	10.5	4.4	4.3	11.8	0.0	40.0	5.3	9.1
Weekly tutorials	17.1	18.8	11.8	18.2	21.9	15.8	19.1	17.0	11.8	16.7	0.0	15.8	18.2
Pre-tutorial videos	2.6	1.4	0.0	3.9	3.1	1.8	2.9	2.1	11.8	33.3	0.0	5.3	4.5
Lab and tutorial videos	1.7	2.9	0.0	2.6	3.1	3.5	2.9	2.1	0.0	0.0	0.0	0.0	4.5
PDF with solved problems	7.7	4.3	11.8	6.5	9.4	5.3	4.4	8.5	17.6	16.7	0.0	15.8	0.0

In Table 3 weekly quizzes were ranked second more useful resource in the unit, for most cohorts. Weekly quizzes are delivered online and students have 10 days to complete each one. Quizzes are worth 10% of the unit's final mark. They are a low-stakes assessment meant to encourage students to review the material delivered in lectures. It is reassuring to confirm that quizzes are fulfilling its purpose.

Interestly, weekly quizzes were not as useful for mature, international and first in family to attend university students. After tutorials, lecture videos and laboratory work were selected as more useful by mature students. These are the three activities students expect to find in all units, the rest are additional resources for students to use if they wish. Mature students seem to optimise the use of their time by engaging only with activities that cover the content and provide opportunities to ask questions. Table 4 is very similar to table 3. It shows that weekly quizzes were also cited as the third more useful activity.

Table 4. Percentage of students who ranked resources as number 3, the third most useful.

Resource vs cohort	All	School Leaver	Mature Student	Domestic	Intl	Paid Job	Lives w parents	City	Rural	CAP	Parent w Children	First Fam	CALD
n	117	69	17	77	32	57	68	47	17	6	5	19	22
Lecture videos	12.8	13.0	23.5	15.6	9.4	21.1	13.2	12.8	29.4	0.0	20.0	15.8	9.1
PDF's with lecture slides	10.3	15.9	0.0	11.7	9.4	12.3	14.7	14.9	11.8	16.7	0.0	5.3	13.6
Weekly quizzes	23.1	20.3	35.3	26.0	28.1	26.3	19.1	27.7	23.5	16.7	40.0	31.6	31.8
Laboratory work	13.7	14.5	11.8	16.9	6.3	10.5	16.2	12.8	11.8	50.0	0.0	0.0	9.1
Weekly tutorials	12.0	11.6	11.8	10.4	9.4	7.0	13.2	10.6	5.9	0.0	20.0	15.8	4.5
Pre-tutorial videos	1.7	2.9	5.9	1.3	3.1	0.0	1.5	2.1	0.0	0.0	0.0	0.0	0.0
Lab and tutorial videos	6.8	5.8	5.9	6.5	15.6	8.8	5.9	4.3	0.0	16.7	20.0	10.5	18.2
PDF with solved problems	8.5	8.7	5.9	6.5	15.6	8.8	11.8	10.6	11.8	0.0	0.0	10.5	13.6

4.3. Students' performance in the unit

Figure 1 shows a histogram of the final mark obtained by students in the unit Electrical Systems in Semeste 2, 2023. The low fail rate and the high percentage of students who achieved 70% or more, reflect that students are achieving the unit learning outcomes. Part of this success can be attributed to the quality and diversity of learning activities. The histogram includes all students enrolled in the unit (461), while the survey was responded by 118 only. Since the survey was answered anonymously, it is not possible to analyse the correlation between achievement and engagement in each of the cohorts. That will be addressed in future surveys.

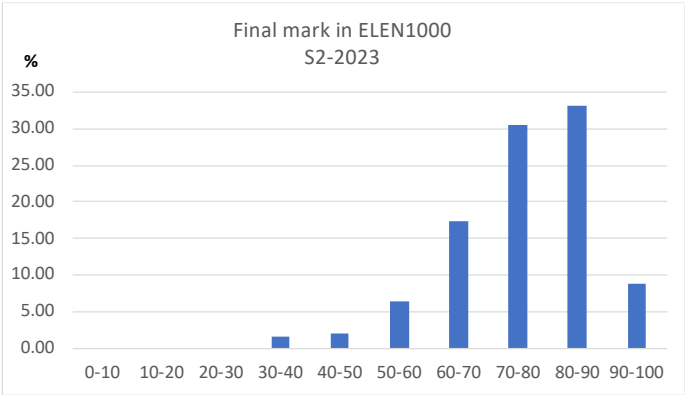

Figure 1.Histogram of final marks in the unit Electrical Systems, Semester 2, 2023.

5. Conclusions and future work

Statistical analysis of answers to the survey on student engagement applied to first year engineering students reveal that students from different cohorts engage differently with the available learning opportunities offered in an Electrical Systems unit. None of the resources came out as universally adopted by all students, however all resources were significantly important for at least one of the cohorts. The good results presented Figure 1, suggest that investing time and resources at developing learning activities in different formats have a positive impact on student learning and performance.

The survey will be applied in future editions of the unit to corroborate findings presented here, and analyse trends over time. Results will be shared with students to demonstrate to them that finding the unit's materials that suit their learning style is important to maximise their learning.

The work presented in this paper is part of a research project investigating the student experience and learning in the common first year of engineering. The project has university ethics approval number HRE2023-0341.

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