The effectiveness of Resources created by Students as Partners in explaining the Relevance of Mathematics in Engineering Education

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Abstract

First-year engineering students often struggle to see the relevance of theoretical mathematical concepts for their future studies and professional careers. This is an issue, as students who don't see relevance in fundamental parts of their studies may disengage from these parts and focus their efforts on other subjects they think will be more useful to them. In this study, we surveyed engineering students enrolled in a first-year mathematics subject on their perceptions of the relevance of the individual mathematical topics taught. Surveys were administered at the start of semester when some of these topics were unknown to them, and again at the end of semester when students had not only studied all these topics but also watched a set of animated videos. These videos had been produced by higher-year students to explain where they had seen applications of the mathematical concepts presented in first year. We notice differences between the perceived relevance of topics for future study and for professional careers, with relevance to study rated higher than relevance to careers. We also find that the animations are seen as helpful in understanding the relevance of first-year mathematics. The majority of students indicated that lecturers with students as partners should work collaboratively to produce future videos.

Keywords: Students as partners, relevance of mathematics, applications, videos

Introduction

As the foundation to science, information technology and engineering, mathematics is often service-taught to students not majoring in mathematics. Since these students have not chosen mathematics as their focus, they may not be as motivated to study this discipline as students undertaking mathematics majors [1]. In the worst case scenario less motivated students see mathematical study as unnecessary or a distraction to their major area of study. However, actively engaging students in learning mathematics when they are in the first-year of their studies is important as the mathematical concepts they learn will be built on hierarchically throughout their tertiary education.

To overcome student perception that the topics taught in first-year mathematics subjects are not relevant, we started the "Maths Relevance Project". The project involved higher-year students from engineering and multi-media disciplines as partners in the production of resources to explain the relevance of mathematics in engineering, under guidance from academic staff. While the engineering students working on the project could see where they had used first-year concepts beyond first year, the multi-media students working on the project possessed sufficient skill sets to produce high quality and engaging animated videos on the content discussed with the engineering students.

Our research on this project has previously focused on evaluating interviews with the project students and focus groups with first-year students. We have discussed how students thought they would explain the relevance of mathematics to first-year students, how the first-year focus groups students perceived the first two videos, and who (first-year students, higher-year students or teaching staff) should produce such resources [1]. We also investigated how the project students approached their brief and how the cross-disciplinary collaboration changed their approach [2]. In addition we have explored critical factors in establishing a successful project with students as partners [3].

In this paper, we focus on perceptions of the target group for these resources – students enrolled in first-year engineering mathematics. We surveyed students at the start of the semester, released five animations at the time they were studying the topics covered in the animations (with shorter surveys attached to each animation), and surveyed students again at the end of semester. We analyse student responses from the first and final surveys, with a particular focus on the change of perception of the relevance of individual topics between start and end of semester. We examine whether the videos have contributed to this change and if the fact that students created the videos made a difference to respondent perception.

All animations, and a film that was produced by the latest cohort of project students, are available as open educational resources under a Creative Commons (BY, ND, NC) license, and we encourage readers to download these videos[2] for their students, or undertake similar projects and contribute their resources to the open domain.

Literature Review

Mathematics is often taught in a theoretical way, without large numbers of tailored practical applications for students who major in disciplines other than mathematics [1]. While students know there must be a reason they need to study mathematics, they may not be able to see this reason without additional guidance or until after they have completed the mathematical studies component of their degree [4]. Assisting students to see the relevance of mathematics to their studies and their future careers has the potential to increase motivation and interest in the subject, leading to better educational outcomes. Students want to know how the often abstract concepts they are studying are related to their discipline. In an analysis of feedback from 605 fourth-year engineering students on the content of mathematics subjects in their degrees, Guner [5] found that almost 13% of the suggestions by respondents were related to the necessity of adjusting the mathematics subjects according to the particular needs of the different engineering departments. Prospective engineers in this study wanted to learn mathematics topics that they would encounter and use in their professional lives [5]. Connecting mathematics to the real world may also assist with motivation to learn mathematical concepts. Pomales-Garcia and Liu [6] believe that mathematics lectures conducted with examples from real life are crucial for students. If engineering students do not see the importance of mathematics to their studies or their future professional practice, then regardless of what approach to curriculum is employed, student interest is likely to be low [7]. It follows that if interest is low, then performance and attainment will suffer. Flegg et al. furthermore suggest that mathematics lecturers should emphasize the relevance of mathematics at every opportunity.

Coupland et al. [8] and Flegg et al. [7] have undertaken studies on the relevance of mathematics for engineering students in an Australian context. Flegg et al. surveyed 27 students at the end of their first semester at the university. These students were drawn from the 193 engineering students that completed a mathematics subject also taken by applied mathematics major students. This first-year subject covered content such as multiple integrals, vector calculus and partial differential equations. Following the survey, 5 students were interviewed, and this was followed by another questionnaire completed by 34 students. Flegg et al. found that the majority of students either agreed or strongly agreed that mathematics is relevant to their future career and study. The interviews showed that some students had "formed an identity in relation to a field of engineering", and were able to link

[2] https://commons.swinburne.edu.au/s/maths_relevance

the mathematics to this field. In the surveys, however, it became clear that not all students were able to do so, and that engineering mathematics students from different backgrounds perceive the importance of mathematics differently. Flegg et al. suggest that it is important to make the links to other engineering fields more explicit. First-year students in particular have some difficulty in seeing the relevance of mathematics to future studies – and this is where explanations of the relevance of mathematics may be very useful.

In the context of curriculum renewal, Coupland et al. [8] surveyed 111 engineering students in their second or fourth year of their five-year degree about their perception of the relevance of individual topics covered in the two mathematics subject they had completed in first year. The survey asked students to rank each topic as "not relevant", "somewhat relevant", or "very relevant". Civil engineering students tended to provide the lowest ratings, while mechanical engineering majors gave the highest ratings. The fourth-year students also rated the relevance of the mathematical topics higher than the second-year students. Coupland et al. discussed a range of changes made to increase student understanding of the relevance of the mathematics they are studying. For example, the lowest ranking topic "Riemann sums" is now introduced by a structural engineer talking about deflection in beams, with the mathematics lecturer stepping in when calculation of an integral is required and explaining how this integral is initially set up as a Riemann sum. This lecture is very popular with students, and is an example of successful collaboration between engineering and mathematics lecturers.

A range of approaches of demonstrating the relevance of mathematics have been described in the literature, mostly focusing on engineering applications. Overviews of these approaches may be found in [1, 9]. There is also literature on involving students as partners in the production of videos or podcasts [10] or other forms of curriculum design and improvement, with Bovill, Cook-Sather and Felten [11] arguing for the inclusion of students as partners supported by a theoretical framework. Strong evidence that students not only enjoy being involved, but also benefit significantly when they participate actively in such productions in a mathematics context is provided by Croft, Duah and Loch [12]. Other examples of the involvement of students as partners in mathematics curriculum work from the UK are described by Hernandez-Martinez [13] and Cooper [14]. However, we have been unable to find research that investigates the impact of student produced materials to explain the relevance of mathematics, apart from our own work, see [1].

The Maths Relevance Project

The Maths Relevance Project was initiated to explain the relevance of mathematical topics taught in first-year mathematics to engineering students enrolled in these subjects. It takes a novel approach by engaging students as partners in the production of resources for their peers. In the first round, two engineering students (a civil engineer and a mechanical engineer), together with three animation students, all in third or fourth year of their degrees, received summer term scholarships to "make mathematics relevant". They produced two animations: One focusing on improving the aerodynamics of a car, lasting 8 minutes, and a 6-minute animation on the mathematics required in the construction of a high-rise building. Each of the animations covers a range of mathematical concepts that are taught in the first two engineering mathematics subjects at the university.

In the second round, three engineering students (one biomedical engineer and two robotics/mechatronics students) together with three animation students produced four shorter animations. The four topics covered were the use of matrices to move a robotic arm, differential equations to calculate blood alcohol level, integration in cruise control, and vectors in electrocardiograms (ECGs).

Research on this project completed so far has focused on analysing perceptions of the project students, with some feedback included from a focus group with first-year students for whom the animations were produced [1, 2].

This Study

In this paper, we report on first-year students' perceptions of the relevance of topics covered in first-year engineering mathematics at the start of their first semester at the university. These students have just joined the university. We then compare these to student perceptions at the end of semester, after the students have studied the material and watched animated videos produced as part of the Mathematics Relevance Project to explain the relevance of some of the topics. We are particularly interested in the effectiveness of the animations in explaining the relevance of first-year mathematics topics.

At the start of semester 1 2015, all 560 students enrolled in Engineering Mathematics 1 ("Maths 1", covering functions and graphs, differentiation, integration and an introduction to vectors and matrices) were invited to participate in a series of seven surveys spread throughout the semester. Students were identifiable to the researchers by their email addresses to allow matching of responses, however it was made clear to the students that none of the research team were involved in teaching the subject and that participation was voluntary without consequences on grades. A number of prizes were drawn from all survey respondents to encourage participation. The first survey was held at the beginning of the semester and the final survey was administered at the end. The first and final surveys asked the students to judge the relevance of each of the mathematical concepts taught in the subject for future studies or for their careers. This allowed us to gauge changes in perceptions of relevance from the start to the end of semester.

Although participation in all surveys gave students the chance to go into the draw to win a larger prize, the number of students responding to the surveys decreased throughout the semester. There were 96 responses submitted for the first survey and 22 for the final survey. Only 20 responses were used in the comparison between the first and final surveys as one respondent had not participated in the first survey, and another response was incomplete.

Research Questions and Methodology

In this paper, we analyse quantitative and qualitative data from the student surveys to understand student perceptions of the relevance of individual topics covered in first-year mathematics at the start of semester. For those students who responded to both the first and last surveys, we compare their responses to see if there has been a change. Following this, we analyse qualitative data from student responses to establish if the student produced animations may have contributed to this change. The style of our survey, listing individual topics covered in mathematics subjects and asking students to comment on their perceived level of usefulness, is similar to the approach taken in Coupland et al. [8]. However, while Coupland et al. survey students in second and fourth year, we apply survey questions at two points in the semester to the same first-year students and gain the advantage of being able to compare how the perceptions change.

In particular, we address the following four research questions:

1. At the start of semester, how do students find the topics to be covered in the semester relevant to their future careers and studies?
2. Does this perception change by the end of semester?
3. Have the videos assisted the students to see the relevance of first-year mathematics to their future studies and their careers?
4. Did it make a difference that students produced the videos?

Results and Discussion

1. At the Start of Semester, how do Students find the Topics to be covered in the Semester relevant to their future Careers and Studies?

The first survey included the question “Please select how relevant you think the below topics covered in Maths 1 are for your future studies and career”. Possible responses were “very relevant”, “somewhat relevant”, “not relevant”, “don’t know the topic yet” and “not sure”. These possible responses were also used by Coupland et al. [8]. Nineteen topics covered in the first-year mathematics subject were listed for students to rank. A total of 96 students responded to the first survey. We equated relevance rankings with numerical values (“very relevant” (3), “somewhat relevant” (2), and “not relevant” (1)), in a similar manner to Coupland et al.. Using this method, the mean across all topic areas was 2.37 for the relevance to future studies, and 2.17 for the relevance to future careers. Figure 1 shows how the students perceived relevance of mathematics for each of the topics covered. The perceived relevance to their future studies is shown in the top row for each topic, and the relevance to their future careers in the bottom row. “Very relevant”, somewhat relevant” and “not relevant” responses are distinguished in each bar. The blank gaps filling the horizontal space up to 100% represent combined responses to “I don’t know the topic yet” and “not sure”.

[Figure 1 near here]

It can be seen that there is a distinct group of topics where the majority of students either answered “I don’t know the topic yet” or “not sure”. This group comprises the Taylor and Maclaurin series, L’Hopital’s rule, the Newton-Raphson method, Riemann sums and Gaussian elimination. The current Victorian (Australia) syllabus for Mathematical Methods (the prerequisite for this university subject) covers the topics Functions and Graphs, Algebra, Calculus and Probability and Statistics. As such, students are likely to be familiar with terms and topics such as functions, graphs, limits, integration and differentiation, but not necessarily with other topics such as series representations. When asked “Please tell us what you think about the relevance of mathematics in general for your future studies and for your career”, one student responded “It’s honestly too early for me to tell and I'm not familiar with some of the concepts mentioned”.

The students perceive that the topics taught in Maths 1 are more relevant to their future studies than their future careers, with error analysis an outlier with respect to the response “very relevant”. In addition, “not relevant” was chosen more so for careers than for future studies. This may be due to the lack of familiarity with the topics as well as uncertainty about the specific career they will undertake when they have completed their studies. Students may think that there is a reason why they are learning certain topics in their studies, but they cannot make the connection with professional work. Some students commented “I also don't know much about the sorts of math that is required for certain fields of engineering.”, “While I feel that mathematics will be relevant to my career, I don't yet feel informed enough to make a very accurate guess at what particular skills will actually be the most used.” and “I would think that it would be rather important in future studies, and possibly in my future career”. There is also an assumption that students wouldn’t be required to study subjects that they won’t use throughout their degrees, whereas they recognise that a career will involve some degree of specialisation. One student responded “I trust that all of the mathematics taught in first year will have relevance and more to build on further into study.”

The topics that received the highest response of “very relevant” with respect to future careers were Graphs and Curves, Vectors and Error Analysis. These topics should be very familiar to first-year students as they are taught in the prerequisite secondary school level mathematics subject. These topics also have direct application to simple engineering problems that may have been encountered prior to starting university. These topics were among those mentioned specifically by the students: “Perhaps one day working in a research field of biomedical science, knowledge of graphs and charts (I assume) will be an important part in this career direction” and “Maths, especially the study of graphs, functions and learning how to differentiate and integrate by all different methods is vital to become a civil engineer as these components are all used in the external world to create bridges, dams, tunnels etc.”

2. Does the Student Perception of Relevance change by the end of Semester?

We expected perceptions of the relevance of mathematics to change during the semester as the students become more familiar with the material covered, and ideally also because of the student-created animations that were provided to the students. To measure any change in perception, we limited the data to students who had responded to the relevant question in the first survey “Please select how relevant you think the below topics covered in Maths 1 are for your future studies and career”, and the same question repeated with the same answer options in the final survey. This limited our dataset to 20 students who responded to both surveys. We directly compared any changes to their perceived relevance over the semester. The number of respondents in this group was too low to perform meaningful statistical significance tests. A comparison of the responses with regards to their future studies is shown in Figure 2 and a comparison with regards to students’ future career is shown in Figure 3.

[Figure 2 near here]

[Figure 3 near here]

For the majority of the topics covered in Maths 1 there is a positive shift in the perceived relevance of the topics towards “very relevant” or “somewhat relevant” responses. When considering only the “very relevant” responses, it can be seen that there is a marked increase in perceived relevance in all but two of the topics. In the end of semester survey students were asked “Has your attitude towards studying mathematics changed since the start of semester? If so, please provide more information.” While 30 percent of the students felt there was no change from the beginning to the end of the semester, 60 percent did note a change in their attitude to study, but also to the perception of what they were learning. Responses included “Yes, as I can now see where the things I learn can be used” and “… this has also shown me just how important maths is in engineering and has given me more motivation to study the maths.”

Not surprisingly, the topics that recorded mostly responses such as “I don’t know the topic yet” or “not sure” in the first survey (the Taylor and Maclaurin series, L’Hopital’s rule, the Newton-Raphson method, Riemann sums and Gaussian elimination), had much more positive responses at the end of semester. However, of these the Taylor and Maclaurin series, L’Hopital’s rule, the Newton-Raphson method still had between 15 and 20% of respondents classify them as “not relevant” for their future careers at the end of semester. While students did not seem to be able to judge relevance of certain topics at the start of semester, it appears that by the end of semester many of them had formed an opinion.

A similar result can be seen for the perceived relevance to future career shown in Figure 3. There has been a positive shift in the perceived relevance towards “very relevant” or “somewhat relevant” responses for the majority of the topics covered.

The topics of the Taylor and Maclaurin series, L’Hopital’s rule, the Newton-Raphson method, Riemann sums and Gaussian elimination have all had much higher responses for relevance at the end of semester. The Taylor and Maclaurin series, L’Hopital’s rule, the Newton-Raphson method recorded only “I don’t know the topic yet” or “not sure” responses in the first survey. Like the relevance to future studies results, these three topics also recorded the highest percentage of “not relevant” responses at the end of semester. The abstract and more theoretical nature of these topics may have resulted in students not perceiving them as relevant to their future studies or their future careers.

Figures 4 and 5 show how students’ perceptions have changed over the semester. The horizontal axis lists all topics, while the vertical axis indicates the percentage of students for each combination of change between start and end of semester responses. Responses that change from “not relevant” to “somewhat relevant”, “not relevant” to “very relevant” and “somewhat relevant” to “very relevant” are considered positive changes and are included above the vertical axis. Responses that change from “somewhat relevant” to “not relevant”, “very relevant” to “somewhat relevant” and “very relevant” to “not relevant” are considered negative changes and included below the central axis. If there was no change (i.e. “somewhat relevant” in the first survey and “somewhat relevant” in the second survey) or if either the first or final survey result was “Don’t know topic yet” or “not sure” the result was not included. Sections highlighted in blue show topics that were directly covered by the Maths relevance videos (see next section).

[Figure 4 near here]

[Figure 5 near here]

From Figures 4 and 5 it can be seen that there is an increase in perceived relevance for the majority of the topics taught, however the topics of Error Analysis and Inverse Functions recorded strong decreases in perceived relevance for future studies, overshadowing positive increases selected by other students. This requires further investigation, perhaps via student focus groups. The most notable increases in perceived relevance were for the integration topics and the matrices topics, however there were also a number of students who recorded a decrease in relevance for these topics. For future careers, there was no improvement in the perceived relevance for error analysis. We wonder if the more mathematical approach to teaching error analysis, that is starting with the theory rather than concrete applications, maybe meant that what little relevance students may have seen before studying this topic at university, did not match what they were learning. These are all speculations of course, as once again a more in-depth investigation is needed.

The study by Coupland et al. (2008) asked students to rate the relevance of two first-year mathematics subjects when the students were in their second and fourth years when undertaking the subjects Engineering Practice Review 1 (EPR1) and Engineering Practice Review 2 (EPR2). The average ratings by the students are included in Table 1 below. The results from our study where we asked students to rate the relevance are included in Table 2.

[Table 1 near here]

[Table 2 near here]

An increase in perceived relevance is noted for both studies. For our study this is not surprising given that the students may have only a vague understanding of the topics at the beginning of semester while at the end of semester they have been exposed to the topics taught and learnt their theoretical application. However, it can also be seen that there is a large difference between the recorded average relevance ratings for the two studies, the Coupland et al. results are lower than those of our study. Given that the students are at different stages of their degrees, participating in different surveys at different universities, it is understandable that there is a difference in the average relevance ratings and these results should not be directly compared. However, we can draw the conclusion that as the students gain more experience both in their mathematical subjects and in their degrees (including industry experience) they rate first-year mathematical subjects as having a higher relevance.

3. Have the Videos assisted the Students to see the Relevance of first-year Mathematics to their future Studies and their Careers?

In order to gauge the effectiveness of the maths relevance videos in assisting students to see the relevance of first-year mathematics to their future studies and future careers students were asked "In general, were the videos useful to explain the relevance of the mathematics you learn in Maths 1 for your future studies (future career)?" The results are shown in Table 3. For 84% (75%) of students the videos were useful in explaining the relevance.

[Table 3 near here]

Columns shaded in blue in Figures 4 and 5 highlight those topics that had corresponding videos (integration, vectors and matrices). The topics covered by the integration and matrices videos recorded the greatest increase in perceived relevance for future studies and the topic covered by the matrices video had the greatest increase in perceived relevance for future career. Introduction to matrices was thought to be very relevant to future studies by 25% of respondents at the beginning of the semester. This increased to 45% at the end of the semester after teaching and video viewing. A larger increase was seen in perceived relevance to future careers with only 25% of students viewing introduction to matrices as very relevant at the beginning of the semester but 55% reporting that they believed the topic was very relevant to their future careers at the end of the semester.

Students were asked to comment on the video they thought best explained the relevance of mathematics. Responses included "I had no idea of the importance of matrices until this" and "I had honestly never realized how matrices applied to practical work until I saw this video..." This indicates that the animations have been effective in explaining the relevance of selected mathematical topics.

4. Did it make a Difference that Students produced the Videos?

One of the survey questions on the end of semester survey asked students "Does the fact that fourth-year students made these videos make a difference to you?" and provided "yes" or "no" as answer options as well as a text box for students to explain their choice. The 20 responses were split, with 10 "no" responses and 10 "yes" responses. Most of those who responded "no" agreed that content was more important than authorship, as "it shouldn't matter who made them as long as the information is relevant". One student commented that "whilst informative, they could've had more 'authority', like if the videos were produced with companies in that area". On the other hand, many respondents who had selected "no" explained the benefits of student-produced material, such as "I can see how the relatability may positively influence some students", and, "students with experience are certainly the best people to make the videos as they have years of experience behind them and can assertively convey their experience to younger students." The students who thought that it does make a difference to them that students produced the videos commented on how much more experience the fourth-year students had than they themselves had at this point, with one writing "It shows me where I'm heading and the level of understanding I will reach", whilst not being "so old they have forgotten what it's like as a first year". One student wrote "It also gives the study a bit of a community feel, which is nice." This essence of this comment was repeated by several students: "They have been in my shoes, so they know what it is like to not completely understand why all this maths is relevant."

We also asked the students "Who should produce videos like this", with options "Teaching staff", "First-year students", "Final-year students", or "A combination of the above". The majority of 17 out of the 20 students responded that it should be a combination of the above, with one student selecting "teaching staff" and two students opting for "final-year students". Explanations for the combination of contributors were the different insights each group would bring, which would appeal to a wider range of students. The combination would also ensure "relatability" as well as "quality of information", and result in "interesting" and "factual" material. One student wrote "teaching staff so all information is correct, final-year students so they can explain it in a way for first-year students to understand and first-year students to watch the finished video and make sure it is understandable." Others commented in similar ways, allocating tasks to the different groups. These results are similar to our earlier findings [1] that showed that students were quite open to the concept of collaborations in resource development between staff and students, and in fact agreed that students should be in charge not staff, with staff guiding student work to ensure quality outcomes.

Conclusion

In this study, we have established that overall, the first-year engineering students found the mathematics topics covered in the semester relevant to their future careers and studies. Topics which were perceived to be low in relevance at the beginning of the semester – Taylor Maclaurin series, L'Hopital's rule, Newson-Raphson method, all showed increased scores in terms of relevance at the end of the semester. It is possible that students were less familiar with these topics at the start and, once they had been exposed to more information during lectures and tutorials, they could see the relevance to their future studies and careers. The topic of error analysis appears to be an outlier, with students indicating that they don't think it is of relevance to their future careers or studies. Perhaps another student-produced animation on this topic might improve this situation.

We have also found that students seem to think overall that the mathematical topics taught in a standard first-year engineering course are more relevant to their future studies than to their future careers. This is not ideal, as mathematics seems to be seen as the necessary "evil" to gain a degree, but have much less relevance in "real life". This topic is clearly worth deeper investigation, and requires follow-up focus groups with students. With respect to their future careers, the students seem to have picked the more theoretical topics as less relevant, perhaps indicating the more practical nature of their most likely careers as engineers, rather than mathematicians.

The videos which described specific topics – cruise control as application for integration, ECG using vectors and rotating a robotic arm using matrices - were well received by students. For all of the topics covered by animations there were increases in perceived relevance over the semester. We therefore deem the videos successful in assisting the students to see the relevance of first-year mathematics to their future studies and their careers.

While student responses were split half way on whether it mattered that students had produced the videos, the actual comments provided indicated that there is significant benefit if students are the producers as they have recently experienced first-year mathematics. The students suggested that students and staff should coproduce materials .

For this study, only five of the now seven animations were included. A film has also been produced since, bringing seemingly abstract questions on a practice exam to life. The compositions of student teams were changed from the first two rounds of the project, to ensure at least one female student was included, and a first-year student was added to the team. Future work will focus on the evaluation of this change to the teams. We also plan to investigate further why some topics are seen as more relevant than others, particularly when distinguishing between the relevance to future studies and future careers.

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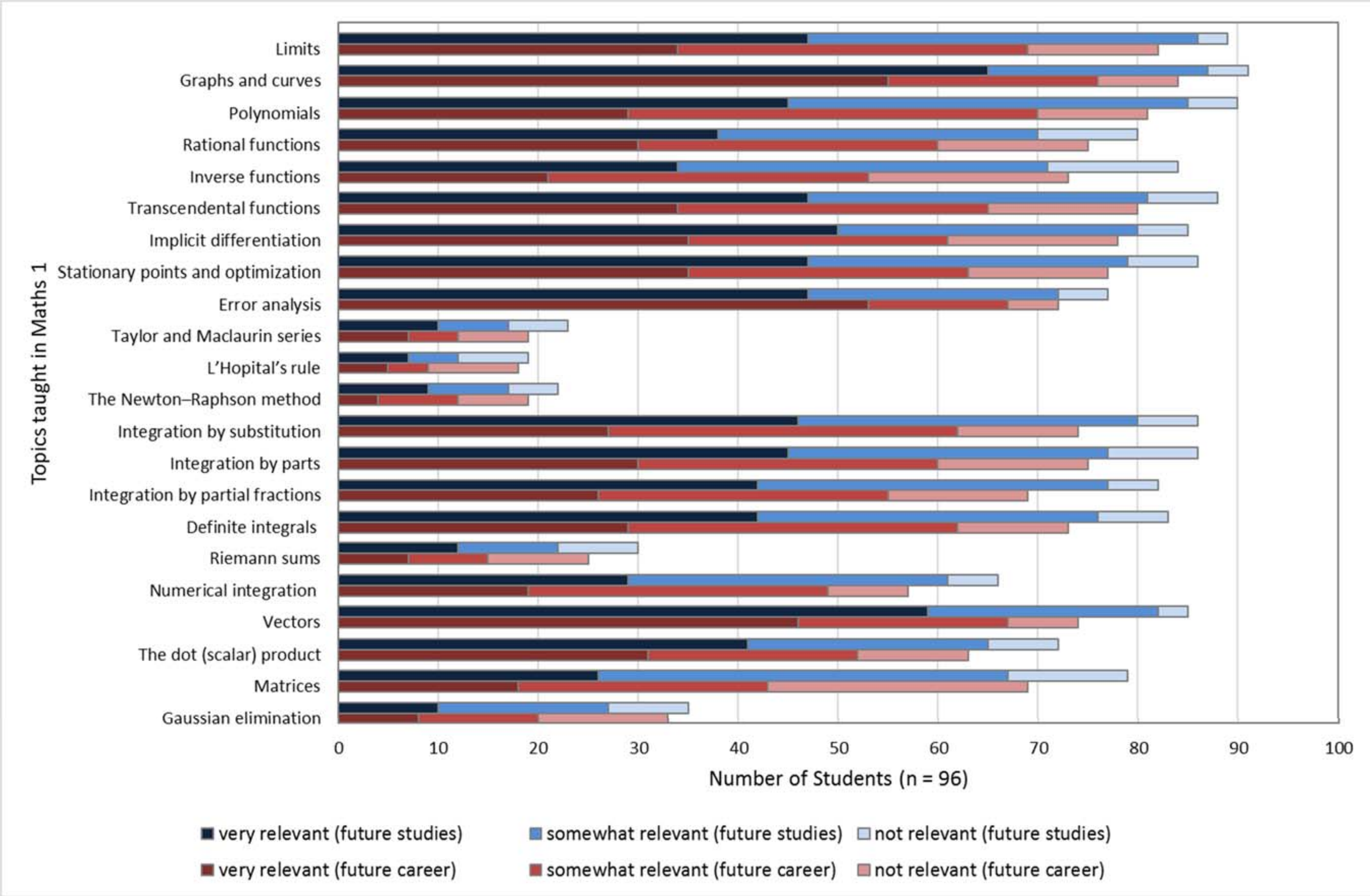

Figure 1: Perceived relevance of mathematics topics to future studies and future careers by engineering students at the start of semester (n=96).

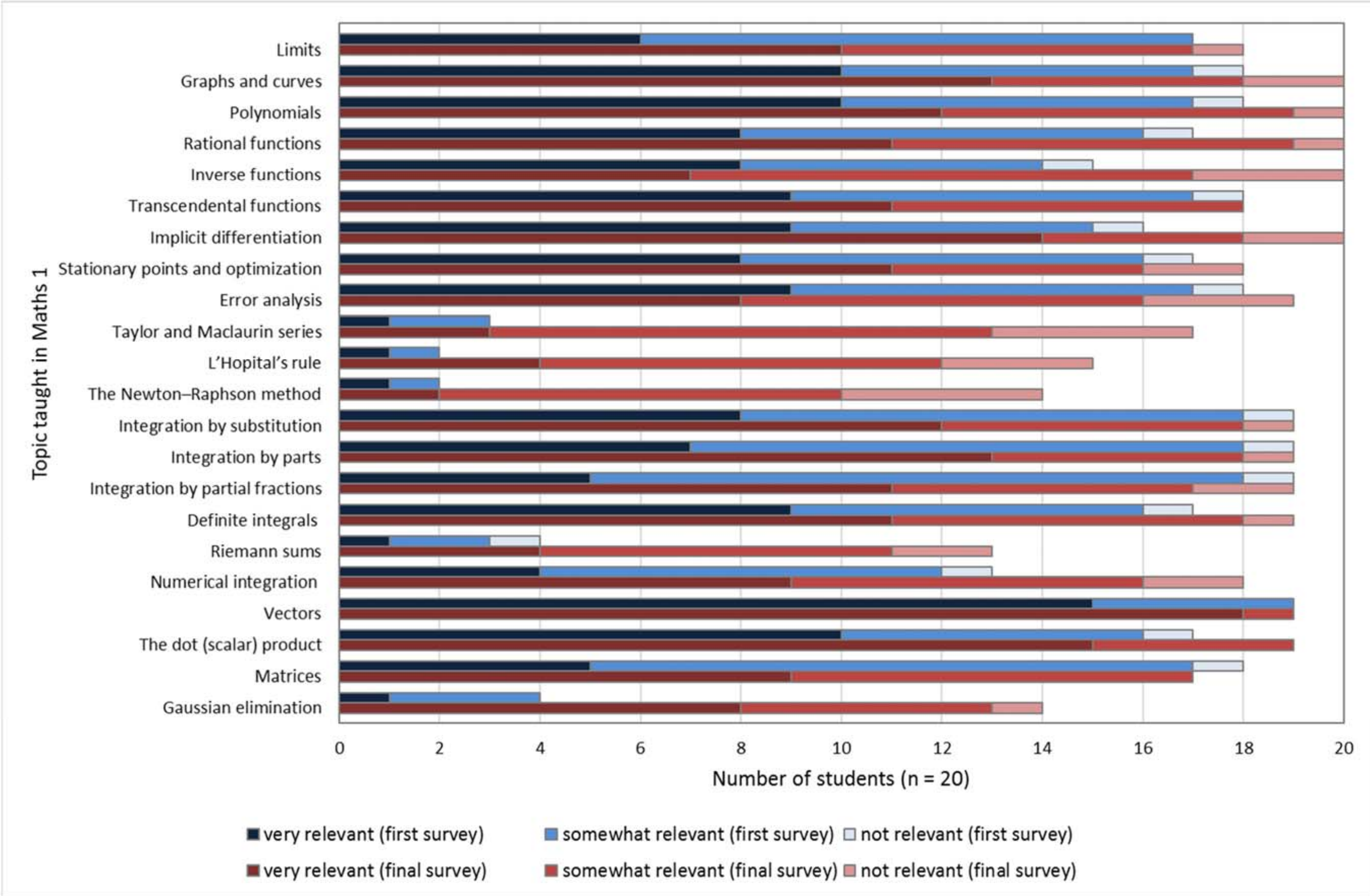

Figure 2: Perceived relevance of mathematics topics to future studies by engineering students at the start and at the end of semester (n=20).

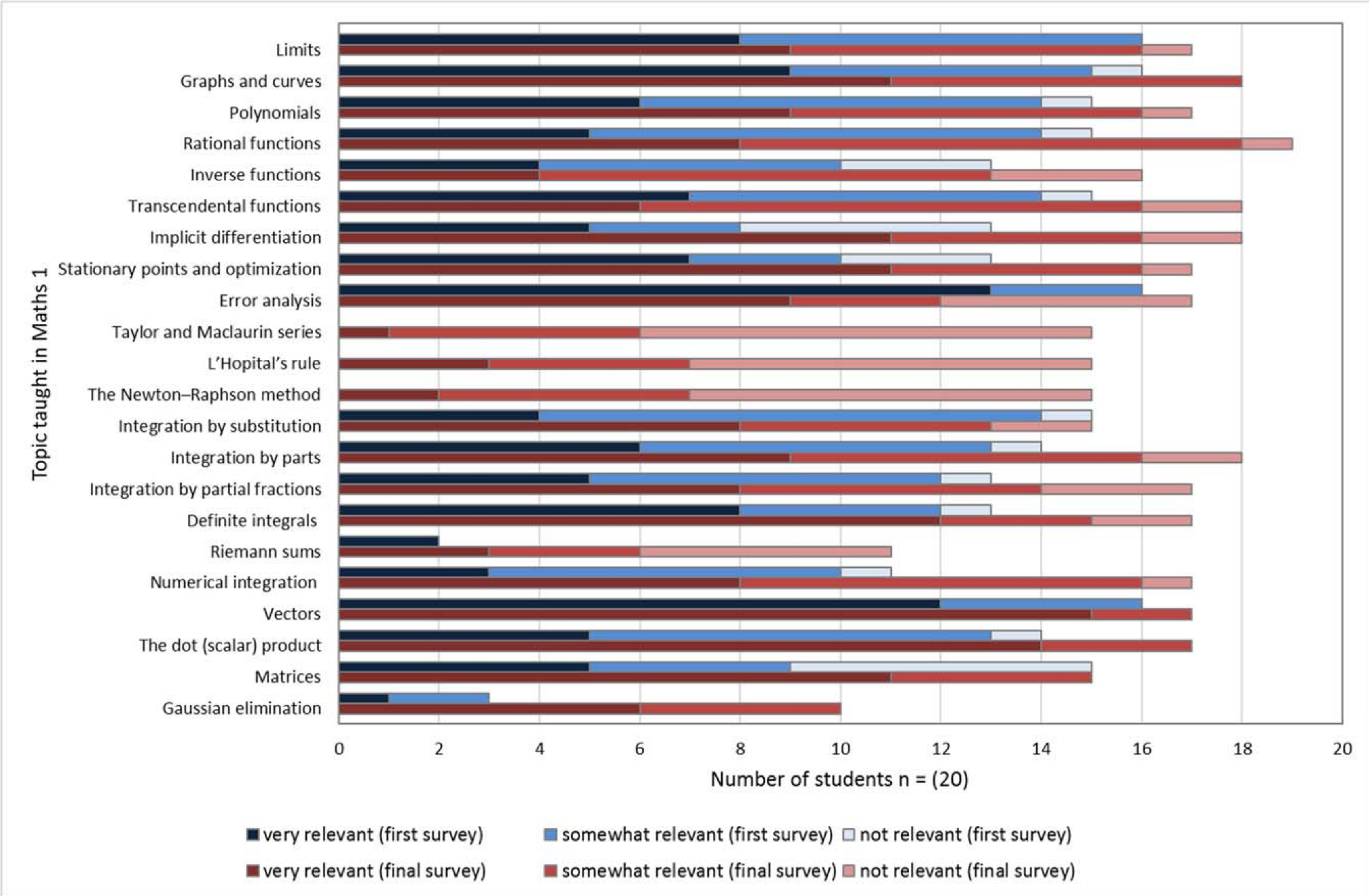

Figure 3: Perceived relevance of mathematics topics to future careers by engineering students at the start and at the end of semester (n=20).

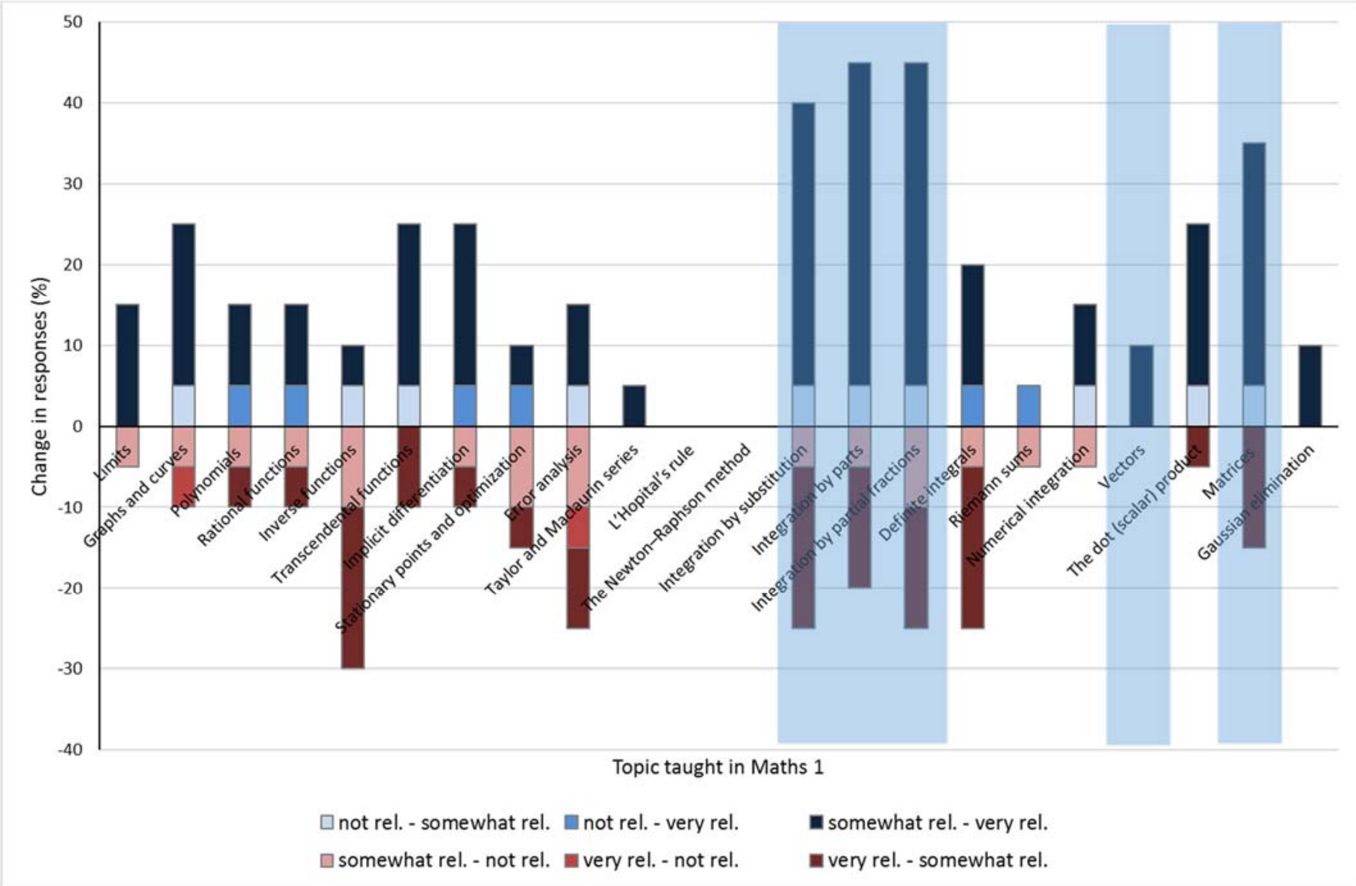

Figure 4: Change in perception of relevance of mathematics topics to future studies by engineering students at the start and at the end of semester (n=20).

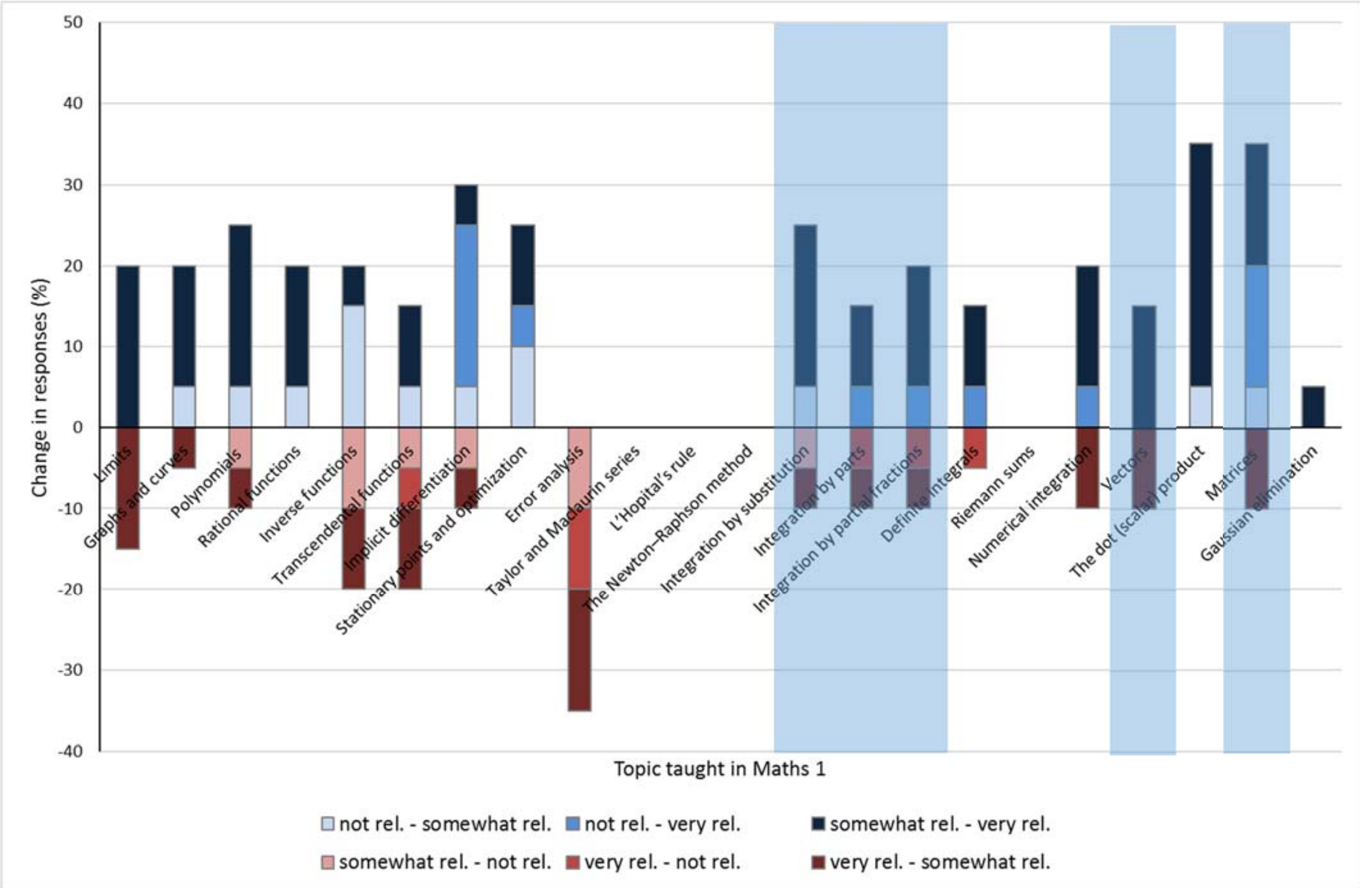

Figure 5: Change in perception of relevance of mathematics topics to future career by engineering students at the start and at the end of semester (n=20).

Table 1 Averages of Student Ratings of Topics by Students' Stage in Degree, Coupland et al. (2008).

Stage in Degree	Mathematical Modelling 1	Mathematical Modelling 2
EPR1 (usually 4th semester)	2.05	1.89
EPR2 (usually 8th semester)	2.28	2.22

Table 2 Averages of Student Ratings of Topics by Students' Stage in First Semester, Swinburne study.

Stage in semester	for future studies	for future career
Beginning of semester	2.39	2.37
End of semester	2.51	2.44

Table 3: Student perception of general usefulness of the videos to explain relevance.

Usefulness of videos to explain maths relevance:	for future studies	for future career
Yes	84%	75%
No	5%	15%
Unsure	11%	10%