REFINE
Researching Futures in Engineering

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ENGINEERING AND LEARNING GAIN: TEACHING AND LEARNING AT UNIVERSITY

24th September 2018

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ROYAL ACADEMY OF ENGINEERING

Engineering Education Systems that are Fit for the Future conference
Systems approach to creating the global workforce of the future

Outline

- Brief overview of research evidence
- What we know about students before they come to university
- What we know about students at university
  - Overview of methods
  - Results on teaching and learning
- How can we inform policy and practice

REFINE
Researching Futures in Engineering

Previous Research Informing Policy and Practice (Impact)

1. **Decision-Making for Degree-Taking:** Who or what influences students to study for a degree in engineering at a Russell Group university?
2. **Futures in Engineering:** Engineering-Related Aspirations and Anxieties
3. **Teleprism:** "Mathematics teaching and learning in secondary schools: the impact of pedagogical practices on important learning outcomes" (www.teleprism.com)
4. **TransMaths:** "Mathematics learning, identity and educational practice: the transition into Higher Education" (www.transmaths.org*).*
5. **TLRP:** 'Keeping open the door to mathematically demanding programmes in Further and Higher Education'. (www.transmaths.org)
6. **Maths Anxiety Review:** A systematic review and meta-analysis of existing research related to maths anxiety, including a case study of engineering. (www.mathsisok.com)

What we know about students before they come to university?

Student 1:

Interviewer: So what about engineering? Do you think you have to do maths in that?

Sergio: I don't know. I don't want to do maths. If the engineering I choose has maths, then I'm not going to choose it because I want engineering that's more doing, not writing. I don't want to write anything in engineering.

Student 2:

Matthew: I dropped maths to do 'Use of Maths'. But if I could go back and did one thing differently in the whole of college I would have stuck with maths. 'Cos now, thinking about it, I would have done accountancy, maths and physics and now that I've… I would've had to do further maths this year. I think that was the big, big influence on why I didn't end up doing, pursuing a career in physics, or engineering, or anything …

Interviewer: Do you regret that?

Matthew: That is a huge regret.

TLRP Interviews (Further and HE)

Socio-demographic/Family Influences

- Parents/family were highly influential in pupils' decisions about what they wanted to do after Year 11
- Who will influence or inspire your decisions about what you want to do after Year 11?

	Year 7	Year 8	Year 9	Year 10	Year 11	All 5 years
My parents	79%	78%	74%	71%	67%	75%
My teachers	41%	36%	37%	34%	37%	38%
My friends	29%	27%	26%	24%	27%	27%
My siblings	34%	30%	29%	26%	23%	29%

Teleprism (Year 7-11 pupils i.e. 11-16 year olds)

Harris & Pampaka, 2016

Socio-demographic/Family Influences

Parents remain influential although not always in a positive way.

Those students who have relatives (fathers, uncles, grandfathers) who are/were engineers are more knowledgeable about the subject and are also more prepared to go into engineering than their peers.

Anxiety over A-level maths and/or the maths they may need in the future to pursue a career in engineering are a cause for concern for some students and may therefore negatively influence their aspirations to study engineering.

TLRP (Sixth form students i.e. 16-18 year olds)

We were encouraged to go into engineering but everyone was like "what's engineering?" It is encouraged already but there's too little information. I was at a girls' school where I was fine doing physics but when I talked to anyone else they were like, "What, physics, that's unexpected?" I really didn't like that. I think it should be just more of a "Fine, let people do what they want" rather than, "Oh, you're actually doing engineering".

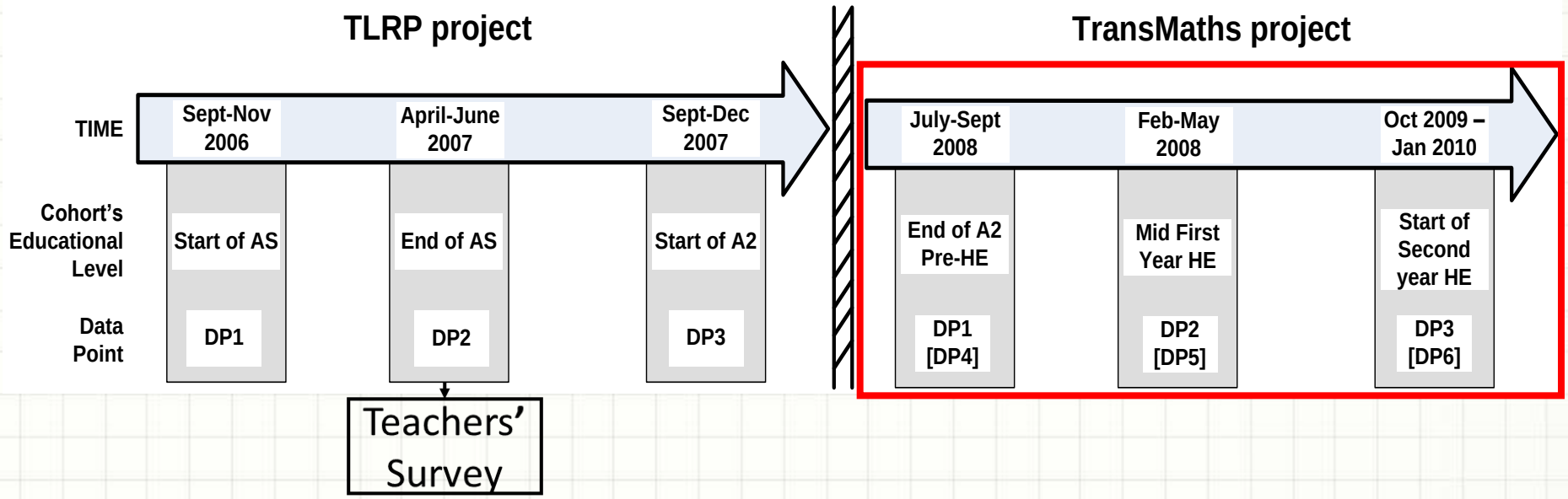
Female non-engineering student

Decision Making for degree taking
(First year university students: engineering and those with suitable qualifications to have studied engineering)

Learning Engineering at University

- Evidence from
  - TransMaths Projects (10 years ago)
  - Learning Gain Pilot study (current)

The TransMaths Project(s) Design



- Mixed Methodology: Case studies, Interviews (Students, teachers, lecturers), Surveys
- UK 1778 students (5 universities, various STEM/nonSTEM courses)

How did you get into engineering?

It was maths made real, intelligible and you could see it in a way that you don't normally. And the project I went into as a work experience week. I was on site all week and it was what I, it combined everything I love doing. I love organisation, I love maths, I love that sort of big project sort of level thing and it combined all of those and it was, that's what made me think 'wow' this is what I want to do.

Female student
Civil engineering

My Dad got me into it so erm from when I was young, he would always be doing a lot of home-based electronics. He enjoyed it so I sort of saw him do it, saw the things that he did and things like that…
There was a lot of reading as well, I get inspired a lot from books and stuff and films, yeah Ironman. So there's a lot of culture.

Male student
Electrical & Electronic Engineering

[Decision-Making for Degree-Taking Students interviewed towards the end of their first year]

Engineering students at the beginning of their degrees

Student 1:

Halim I'm looking forward to my course, I definitely am looking forward to my course. I'm looking forward to what it's going to bring me, erm, what I'm going to learn. Because I find that it's like I don't know if you, if you were to like it because it's with automotive. I'm going to be learning car, car technologies. Erm I'm, you know, I'm a typical sort of boy. I like cars, I like football, you know.

Student 2:

Stuart: I don't see the relevance. I mean I actually do enjoy maths sometimes as well but I just do not see the relevance of it. If they gave us some examples about why it might actually be useful then fair enough but just seeing somebody write a formula on a board and then going, "solve that", you're like, 'Why? What possible point is it gonna have to me in the future?'. . .

Int: I see. So you need it to be relevant to your future career?

Stuart: Yeah relevant,

Engineering and Maths

Student 3:

Joshua: Usually, yeah. They don't tell you how to do it. It's up to you which method you use. Sometimes, if it's a more difficult one, they'll put a hint in brackets afterwards and say how you could do it, but usually it's not telling you how to solve it.

Interviewer: And is that easy for you? Or, how easy is to make the link?

Joshua: Well, it's better, because you don't want to just be told how to solve these particular problems because the aim of engineering is solving normal problems. So if you're told how to do it, you're not learning how to do engineering, you're just learning how to do maths. So I don't think it would be better to do it any other way.

Student 4:

Ellie: I don't think like, in the first semester it was emphasised how important maths is to the engineering subjects. I think it was treated far too, treated far too separate. I know like obviously maybe for like numbers and things, they have to put us in with the [other engineering disciplines] for maths but I don't know if that's a very good idea, because it's like, I think it should be much more combined. I didn't expect when I came here that my maths would be like, it's just a separate subject. I thought it would be completely applied to what I was doing and it wasn't.

What the lecturers think about engineering

Peter, Lecturer in Maths and Engineering

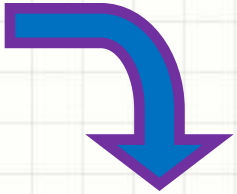
I think it's a shock for some students. I think some students think they're going to come and spend a lot of time in the laboratory and make things with flashing lights and transistors, and that's all they're going to do, but actually electronic engineering is very deep, mathematically difficult, you know, rock hard engineering course, and it's getting harder, not easier. The breadth of the curriculum gets constantly wider and the impact it has on society is only growing year by year, not diminishing.

Learning Gain Design

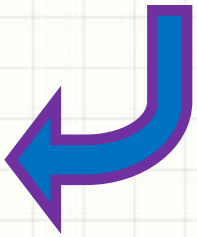
- Mixed Methods (Grades, Surveys, 'tests', interviews)
- Longitudinal (& Cross-sectional)
  - Start of Year 2016-17 (DP1)
  - End of 2016-17 (DP2)
  - Start of 2017-18 (DP3)
- Various academic disciplines (Social Sciences, Engineering, Chemistry, Economics, Nursing)

A common methodological and analytical framework

Instrument/Questionnaire Development



Constructing and Validating Learning Outcomes Measures (Rasch Model)



Analysis (Descriptive and Modelling)

Example Items/Questions

Subject Choice

B2 How significant were the following factors for your **subject choice**?

	Not significant at all	Somewhat significant	Significant	Very significant	Don't know
Career aspiration / ambition	☐	☐	☐	☐	☐
Childhood dream	☐	☐	☐	☐	☐
Being good at the subject	☐	☐	☐	☐	☐
Enjoying the subject	☐	☐	☐	☐	☐
Interest in the subject	☐	☐	☐	☐	☐
The value of the degree for future earnings/salary	☐	☐	☐	☐	☐
Influence of school	☐	☐	☐	☐	☐
Influence of family	☐	☐	☐	☐	☐
Influence of friends	☐	☐	☐	☐	☐
Other reason, please explain:	☐	☐	☐	☐	☐

[ ]

Example Items/Questions

Maths needed and confidence

C2 What Mathematics is **needed** for your course?
How confident are you with this maths?

	Is this needed?			How confident are you with this maths?			
	Yes	No	Unsure	Not confi-dent at all	Somewhat confident	Confident	Very confident
Calculating/estimating	☐	☐	☐	☐	☐	☐	☐
Using ratio and proportion	☐	☐	☐	☐	☐	☐	☐
Manipulating algebraic expressions	☐	☐	☐	☐	☐	☐	☐
Proofs/proving	☐	☐	☐	☐	☐	☐	☐
Problem solving	☐	☐	☐	☐	☐	☐	☐
Modelling real situations	☐	☐	☐	☐	☐	☐	☐
Using basic calculus (differentiation/integration)	☐	☐	☐	☐	☐	☐	☐
Using differential equations	☐	☐	☐	☐	☐	☐	☐
Using statistics	☐	☐	☐	☐	☐	☐	☐
Using complex numbers (e.g. imaginary numbers)	☐	☐	☐	☐	☐	☐	☐

Example Items/Questions

Transition to University and Feelings

C3 Please tick the appropriate box for each statement in the table below to indicate the way in which your experience at university is different from your experience at school/college.
Then choose your feelings about each change.

What is different between university and school/previous experience?	**How do you feel about it?** *(circle appropriate face)*		
	Negative	Mixed	Positive
I have to do ☐ more / ☐ less / ☐ about the same amount of independent study at university.	☹	😐	☺
I am treated ☐ more / ☐ less / ☐ equally like an adult at university.	☹	😐	☺
I have ☐ more / ☐ less / ☐ about the same amount of responsibility for my own learning at university.	☹	😐	☺
The work is ☐ harder / ☐ easier / ☐ about the same at university.	☹	😐	☺
I have access to ☐ better / ☐ worse / ☐ about the same quality of resources/equipment at university.	☹	😐	☺
The pace of the course is ☐ faster / ☐ slower / ☐ about the same at university.	☹	😐	☺
Learning is ☐ more / ☐ less / ☐ about equally 'in depth' at university.	☹	😐	☺
Teachers have ☐ more / ☐ less / ☐ about the same control over my work at university.	☹	😐	☺
I have ☐ more / ☐ less / ☐ about the same opportunity to ask questions at university.	☹	😐	☺
I have ☐ more / ☐ less / ☐ about the same opportunity to discuss ideas and problems at university.	☹	😐	☺
The language used is ☐ more / ☐ less / ☐ about equally formal at university.	☹	😐	☺
Teaching is ☐ more / ☐ less / ☐ about equally personal at university.	☹	😐	☺
I have a ☐ more active / ☐ less active / ☐ about the same social life at university.	☹	😐	☺
I find it ☐ easier / ☐ harder / ☐ about the same making friends at university.	☹	😐	☺

Example Items/Questions

Disposition to Complete Course

C4 We also want to know how you feel about completing your chosen degree subject. Please rate your agreement with the following statements:

	Strongly disagree	Disagree	Agree	Strongly agree	Don't know
I am happy with the grades I have received so far.	☐	☐	☐	☐	☐
I am certain I will complete my degree course.	☐	☐	☐	☐	☐
I am considering dropping out of my degree course.	☐	☐	☐	☐	☐
Financial reasons may make me stop my course.	☐	☐	☐	☐	☐
I am working towards a first-class honours degree.	☐	☐	☐	☐	☐
I might change my course/subject or degree Programme.	☐	☐	☐	☐	☐
I would take a job rather than complete my course if a good job was on offer.	☐	☐	☐	☐	☐
I might consider taking time off or interrupting my degree course for a while.	☐	☐	☐	☐	☐

Example Items/Questions

Expectations about teaching/learning activities

C5 Please tell us how much of your study time do you expect to be spending on the following activities during this academic semester? How do you feel about this?

	Never	Rarely (montly)	Often (weekly)	Almost always	How do you feel about it? *(circle appropriate face)* Negative	Mixed	Positive
Study on your own	☐	☐	☐	☐	☹	😐	☺
Being taught on a one-to-one basis	☐	☐	☐	☐	☹	😐	☺
Being taught in a small group (up to 10 students)	☐	☐	☐	☐	☹	😐	☺
Being taught in a classroom/seminar (11-50)	☐	☐	☐	☐	☹	😐	☺
Being taught in a large lecture group (>50 students)	☐	☐	☐	☐	☹	😐	☺
Do laboratory work (e.g. experiments)	☐	☐	☐	☐	☹	😐	☺
Do computer-based projects (e.g. analysis, simulations)	☐	☐	☐	☐	☹	😐	☺
Engage with online material and resources	☐	☐	☐	☐	☹	😐	☺
Work with fellow students during organised sessions	☐	☐	☐	☐	☹	😐	☺
Work with fellow students outside lectures or tutorials	☐	☐	☐	☐	☹	😐	☺
Work-related placement	☐	☐	☐	☐	☹	😐	☺
Other activities, please tell us:	☐	☐	☐	☐	☹	😐	☺

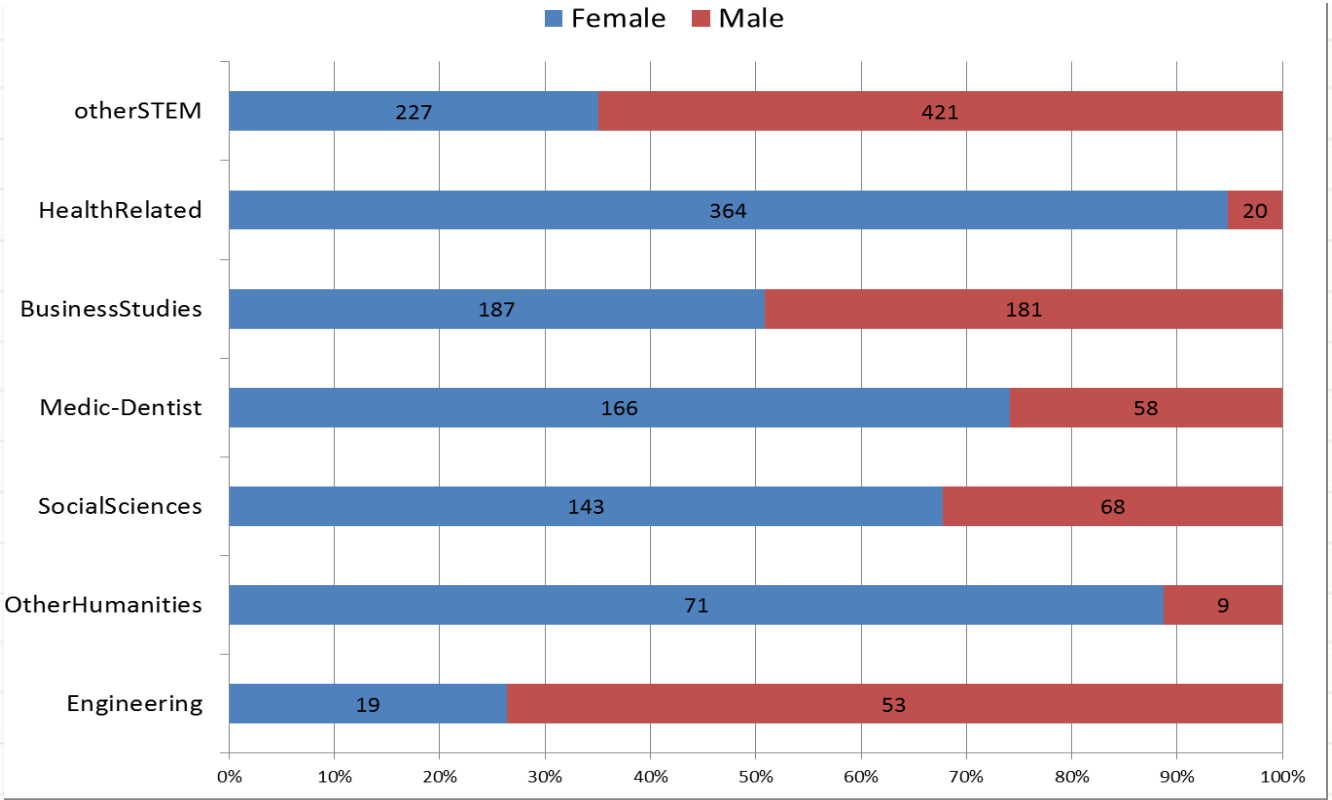
Sample Size

DP1

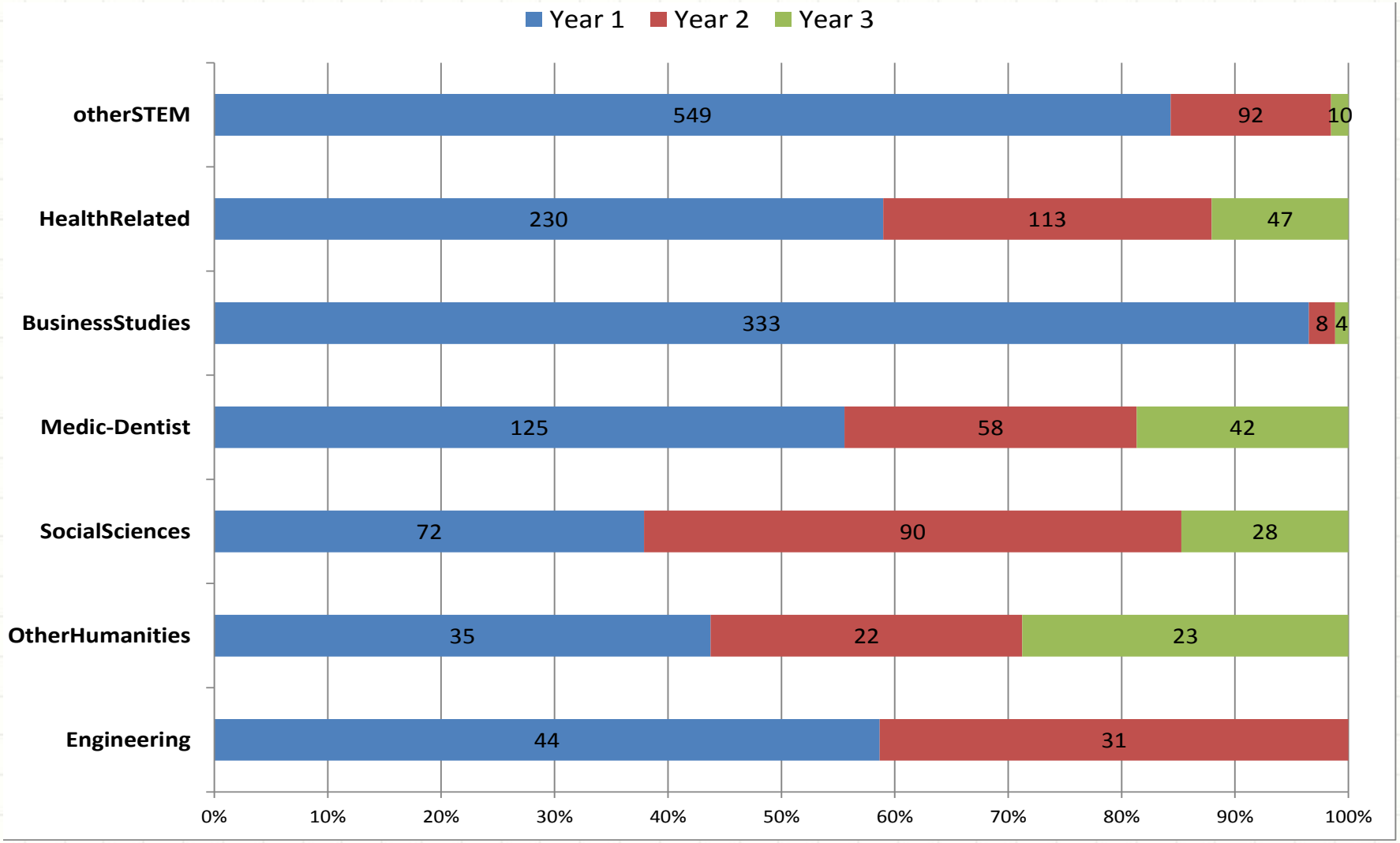
Table 1. Sample description, by gender and subject groups.

Subject groups	Year 1			Year 2			Year 3			Total
	Female	Male	All	Female	Male	All	Female	Male	All	
Health related	86	13	99	37	13	50	2		2	151
Humanities	229	187	416	19	1	20	20	2	22	458
STEM related	87	178	265	2	5	7		3	3	278
Total	402	378	780	58	19	77	22	5	27	887

All ~ 2000 cases



Sample Size – All by Year group



A common methodological and Analytical Framework

Instrument/Questionnaire Development

Constructing and Validating Learning Outcomes Measures (Rasch Model)

Analysis (Descriptive and Modelling)

Measurement Approach

- 'Theoretically': Rasch Analysis
- 'In practice' – the tools:
  - Winsteps software
- Interpreting Results:
  - Fit Statistics (to ensure unidimensional measures)
  - Differential Item Functioning for 'subject' groups
  - Person-Item maps for hierarchy
  - Qualitative checks (Interview data)

Measuring Alternative Learning Outcomes – Example 1: Confidence in Soft skills

	Not confident at all	Somewhat confident	Confident	Very confident	Don't know
Independent study [1]	1	2	3	4	
Listening in lectures [2]	1	2	3	4	
Taking notes in lectures [3]	1	2	3	4	
Working on team projects [4]	1	2	3	4	
Doing laboratory work [5]	1	2	3	4	
Researching topics [6]	1	2	3	4	
Computer-based learning [7]	1	2	3	4	
Large group learning [8]	1	2	3	4	
Working/discussing in small groups [9]	1	2	3	4	
Solving problems as they arise [10]	1	2	3	4	
Critical thinking [11]	1	2	3	4	
Oral presentations [12]	1	2	3	4	
Writing reports [13]	1	2	3	4	
Analysing and interpreting data [14]	1	2	3	4	
Managing your time efficiently [15]	1	2	3	4	
Resolving conflicts with others [16]	1	2	3	4	
Carrying out risk assessments [17]**	1	2	3	4	
Keeping lab note books [18]**	1	2	3	4	

Example: Item fit statistics

to check for unidimensionality

Table 2. Item measures and fit statistics for a potential construct of confidence in learning at HE.

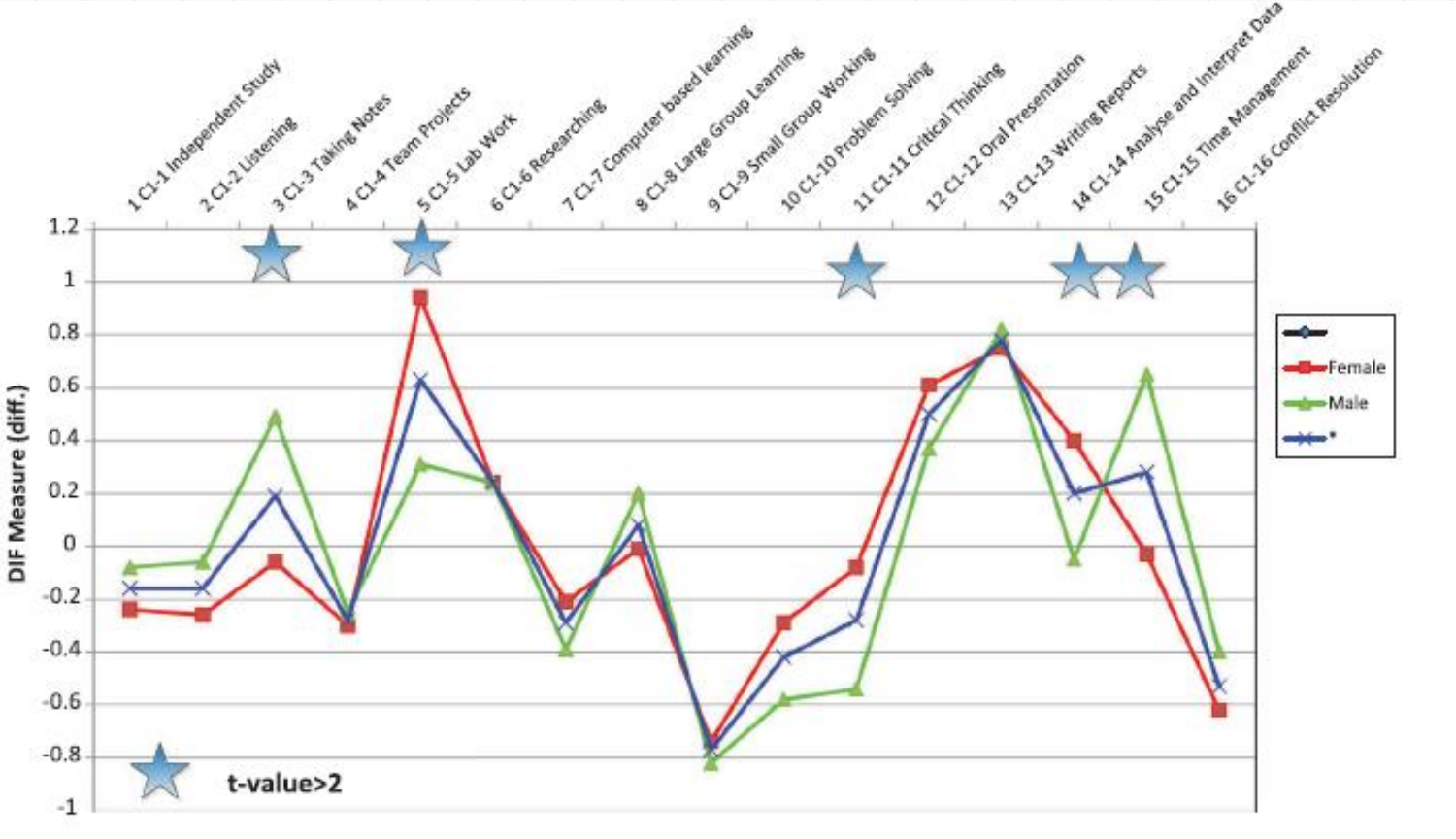
Item entry number and name	Total raw score	Observed count	Measure	SE	Infit MNSQ	Infit ZSTD	Outfit MNSQ	Outfit ZSTD
(1) Independent study	2482	901	−.16	.05	1.00	.1	1.03	.6
(2) Listening	2481	901	−.16	.05	.99	−.2	1.00	.1
(3) Taking notes	2325	899	.19	.05	1.05	1.1	1.09	2.0
(4) Team projects	2482	884	−.28	.05	.83	−4.1	.83	−3.8
(5) Lab work	1706	715	.63	.05	1.56	9.8	1.54	9.4
(6) Researching	2273	886	.24	.05	.79	−5.0	.79	−5.0
(7) Computer based learning	2492	885	−.29	.05	1.02	.4	1.02	.4
(8) Large group learning	2316	878	.08	.05	.82	−4.3	.83	−4.1
(9) Small group working	2722	898	−.77	.05	.89	−2.4	.88	−2.7
(10) Problem solving	2563	891	−.42	.05	.65	−8.8	.66	−8.3
(11) Critical thinking	2501	890	−.28	.05	.81	−4.6	.81	−4.5
(12) Oral presentation	2184	898	.50	.05	1.34	7.0	1.35	7.2
(13) Writing reports	2041	888	.78	.05	1.00	.1	1.01	.2
(14) Analyse and interpret data	2313	896	.20	.05	.76	−5.9	.77	−5.5
(15) Time management	2279	897	.28	.05	1.34	6.9	1.35	7.1
(16) Conflict resolution	2524	863	−.53	.05	1.18	3.7	1.23	4.6
Mean:			.00	.05	1.00	−.4	1.01	−.2
SD:			.42	.00	.24	5.0	.24	5.0

Notes: Person: Real separation: 2.28; Reliability: .84.
Item: Real separation: 8.10; Reliability: .98

(Pampaka et al., 2018)

Differential Item Functioning

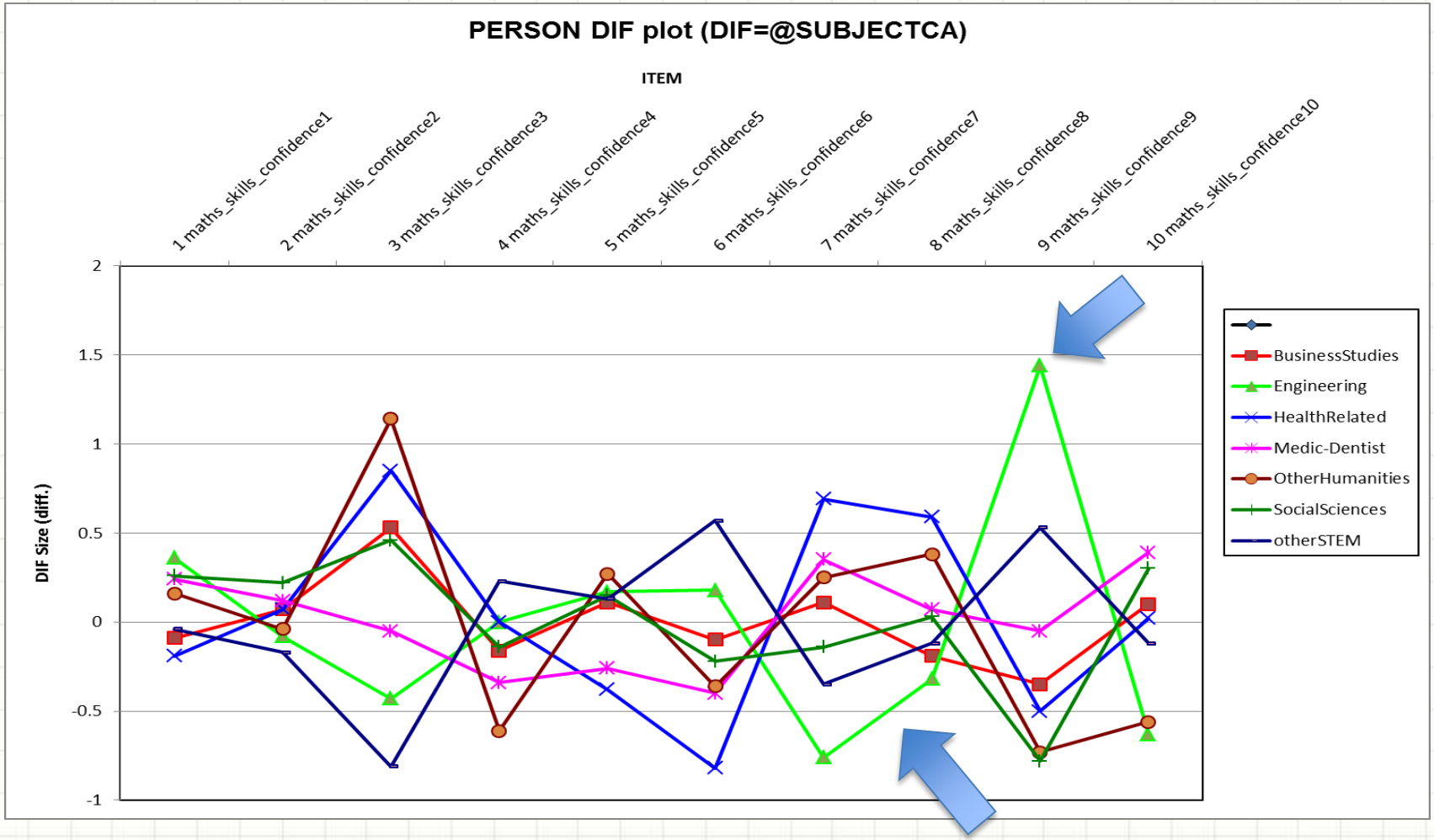
To ensure measurement invariance across groups



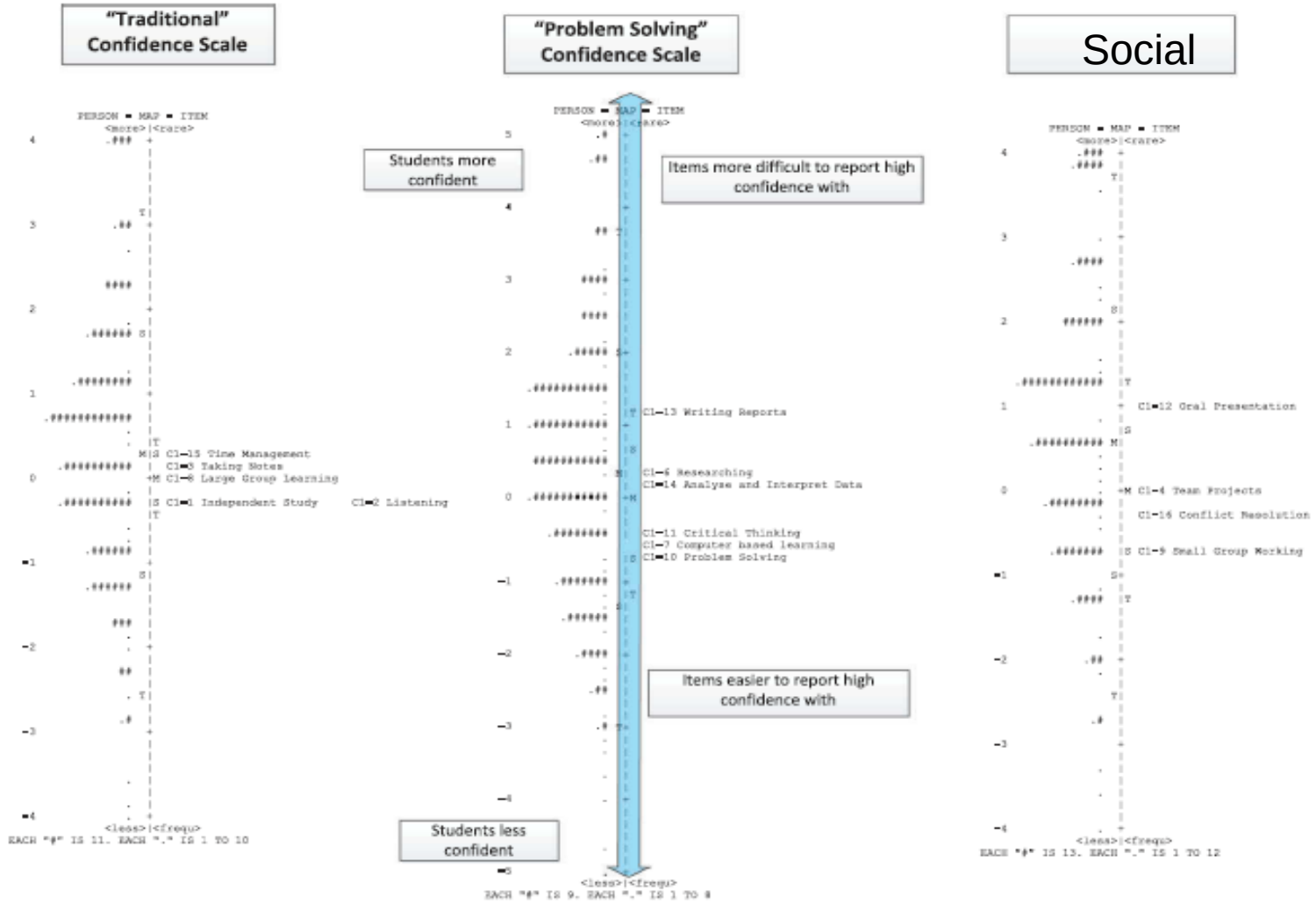
(Pampaka et al., 2018)

Other DIF evidence

- 9=Statistics, 7= using basic calculus, 8=differential equations



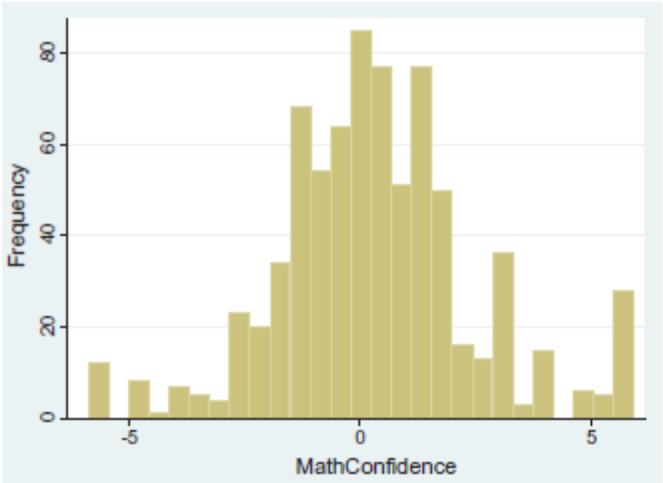
Item-Person Maps

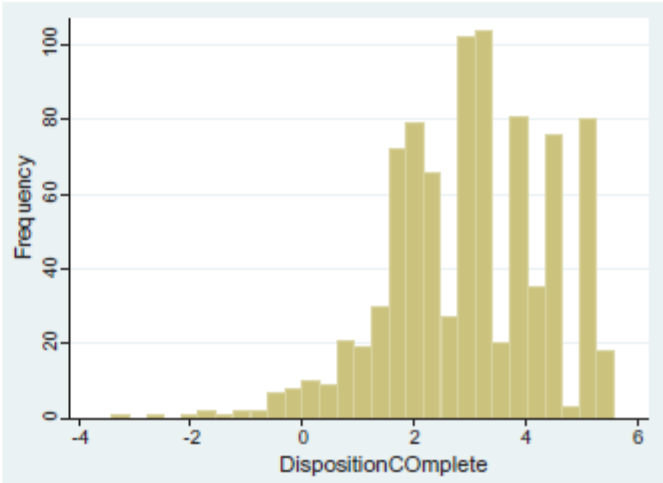


(Pampaka et al., 2018)

Some of the constructed Measures

Variable Name	Description
Confidence[a] – traditional	Confidence in one's ability to engage with traditional (transmissionist) learning at university
Confidence – social	Confidence related to social and interpersonal skills/learning styles
Confidence – problem solving	Confidence related with learning involving research, problem-solving and critical thinking
Maths Confidence	Confidence in using maths for their course
HE Disposition complete	Disposition to finish their chosen course (the higher the score, the higher the disposition)
Perception of Transitional Gap	Students perception of the extent of the differences between pre and university experiences (the higher the score the bigger the gap)
Positivity on Transition	Students feelings about this gap (the higher the score the more positive the students felt about the transition)





A common methodological and analytical framework

Instrument/Questionnaire Development

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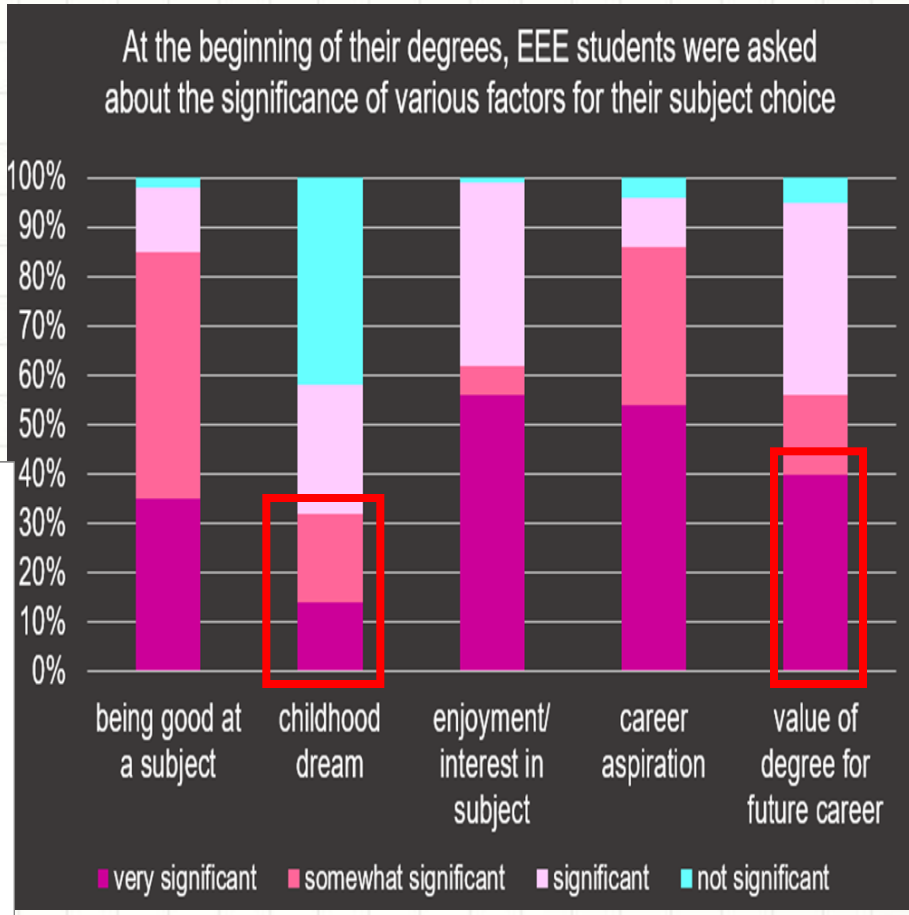
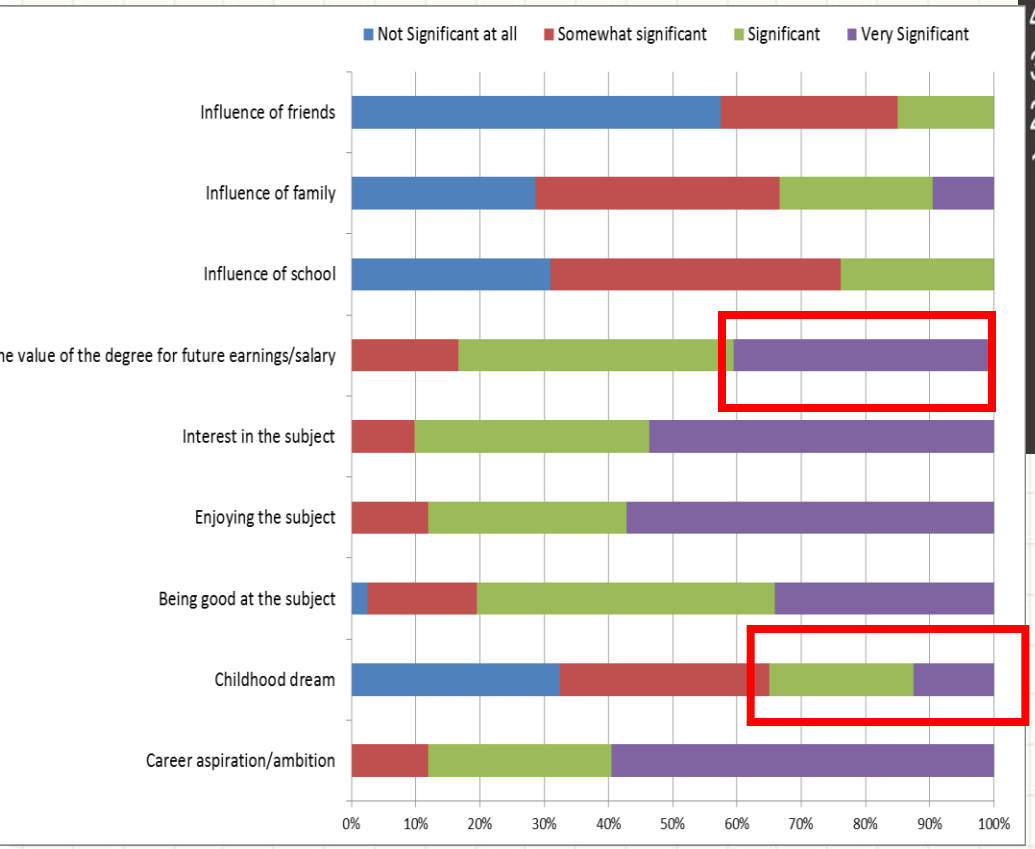
Analysis (Descriptive and Modelling)

Aspirations / Choosing Engineering

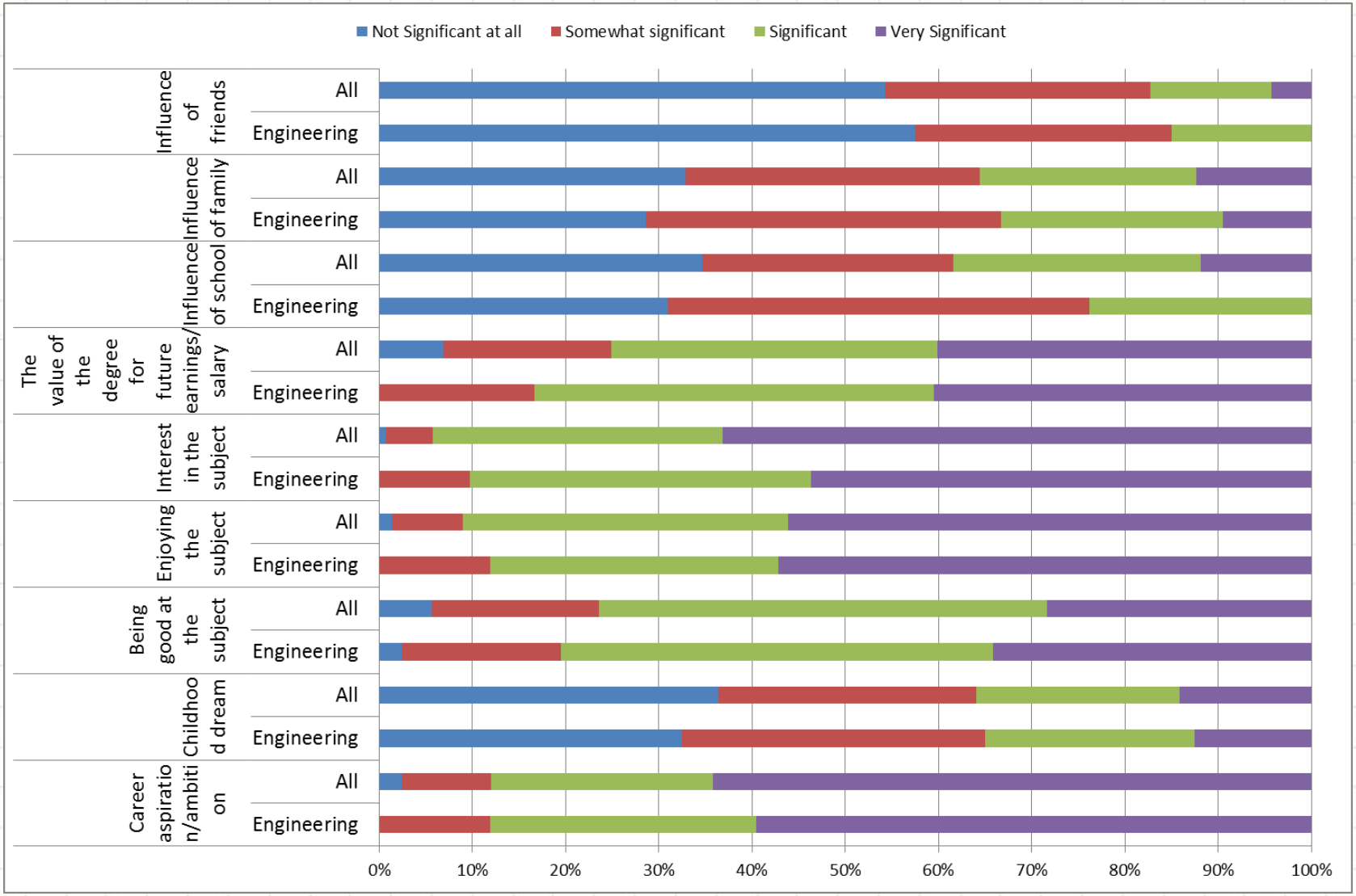
10 years ago



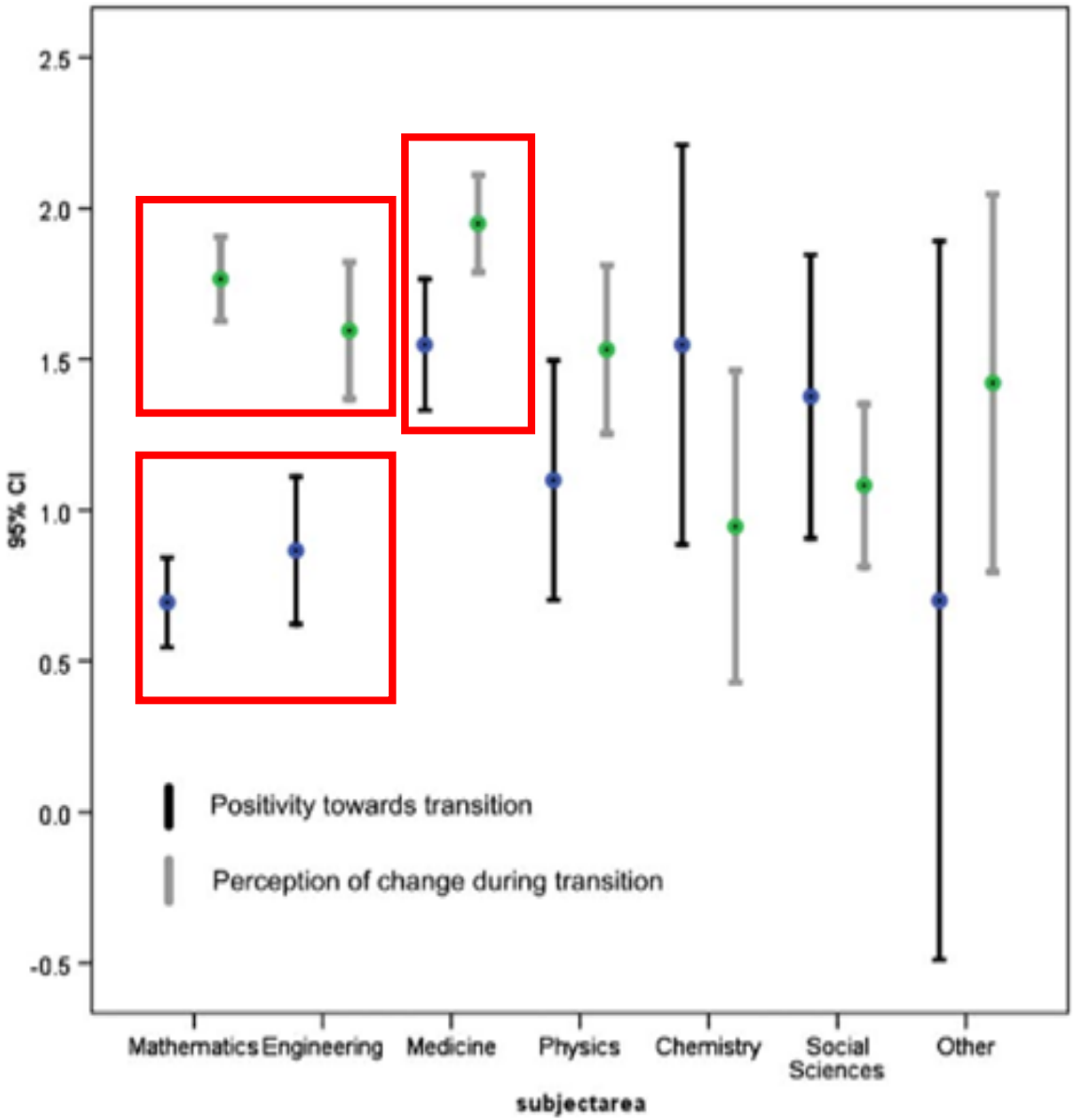


Today

Engineering vs. All Students



Students Perception of the Transition and feelings about it



Students studying engineering and mathematics courses perceived a large gap in their transition and they seem also to be less positive about it compared to other groups, especially the students studying medicine who reported larger gap but also significantly more positive feelings.

Figure: mean-error plots for the measures of 'perception of change/ gap' and 'positivity of feelings' towards transition by course

Generic Skills @ DP1 (start of 2016-17)

Table 5: Distribution of students' responses for their confidence in general skills

Item name	Frequency bars	Not confident at all	Somewhat confident	Confident	Very confident	Don't know
Working/discussing in small groups		24 (3%)	169 (21%)	376 (48%)	215 (27%)	4 (1%)
Resolving conflicts with others		42 (5%)	169 (21%)	357 (45%)	184 (23%)	37 (5%)
Solving problems as they arise		25 (3%)	218 (28%)	393 (50%)	142 (18%)	10 (1%)
Listening in lectures		54 (7%)	219 (28%)	391 (50%)	123 (16%)	1 (0%)
Critical thinking		38 (5%)	227 (29%)	365 (46%)	147 (19%)	9 (1%)
Computer-based learning		53 (7%)	214 (27%)	346 (44%)	162 (21%)	14 (2%)
Working on team projects		34 (4%)	243 (31%)	353 (45%)	141 (18%)	12 (2%)
Independent study		45 (6%)	266 (34%)	345 (44%)	131 (17%)	2 (0%)
Large group learning		57 (7%)	270 (34%)	354 (45%)	84 (11%)	20 (3%)
Analysing and interpreting data		51 (6%)	304 (39%)	347 (44%)	80 (10%)	6 (1%)
Keeping lab note books		16 (11%)	49 (34%)	60 (42%)	18 (13%)	1 (1%)
Taking notes in lectures		75 (10%)	293 (37%)	325 (41%)	92 (12%)	3 (0%)
Managing your time efficiently		110 (14%)	274 (35%)	293 (37%)	106 (13%)	7 (1%)
Researching topics		67 (8%)	323 (41%)	296 (38%)	89 (11%)	14 (2%)
Oral presentations		152 (19%)	279 (35%)	226 (29%)	128 (16%)	5 (1%)
Carrying out risk assessments		15 (10%)	69 (48%)	48 (34%)	9 (6%)	2 (1%)
Writing reports		143 (18%)	344 (44%)	232 (29%)	57 (7%)	14 (2%)
Doing laboratory work		143 (19%)	199 (26%)	179 (23%)	95 (12%)	155 (20%)

Working on team projects:

(overall 63% of students were confident/very confident in this area)

Simeon: So we had a buggy project which was very good and we were put in a team of five people and we ended up being two people building the buggy and three people sitting watching. And again, I felt that my skills are practical so making holes and measuring and building stuff, making a PCB, that was perfect. But it's hard to grade and I understand from a professor's standpoint, how do you grade something that is basically a product and especially compare a product with another product. You need to have a standardized method of doing it but that's the only thing.

Doing laboratory work:

(overall 35% of students were confident/very confident in this area)

Godwin: Oh yes, for sure. I enjoyed my labs, especially in my third year. That was because I was more involved and I remember having grades of like 87, so higher grades in my third year. Labs are interesting especially when you understand what's going on. If you don't understand, well…

Independent study:

(overall 64% of students were confident/very confident in this area)

Simeon: I think for me understanding and analysing things, the ability to understand and learn that's the two things that have become a strength of mine especially learning subjects that I have no clue about. So 'learning to learn' as the professor called it. We are being taught how to learn. So just because we have a subject and we don't think is going to be useful, that's not the point. The point is to learn something just for the sake of understanding how to learn.

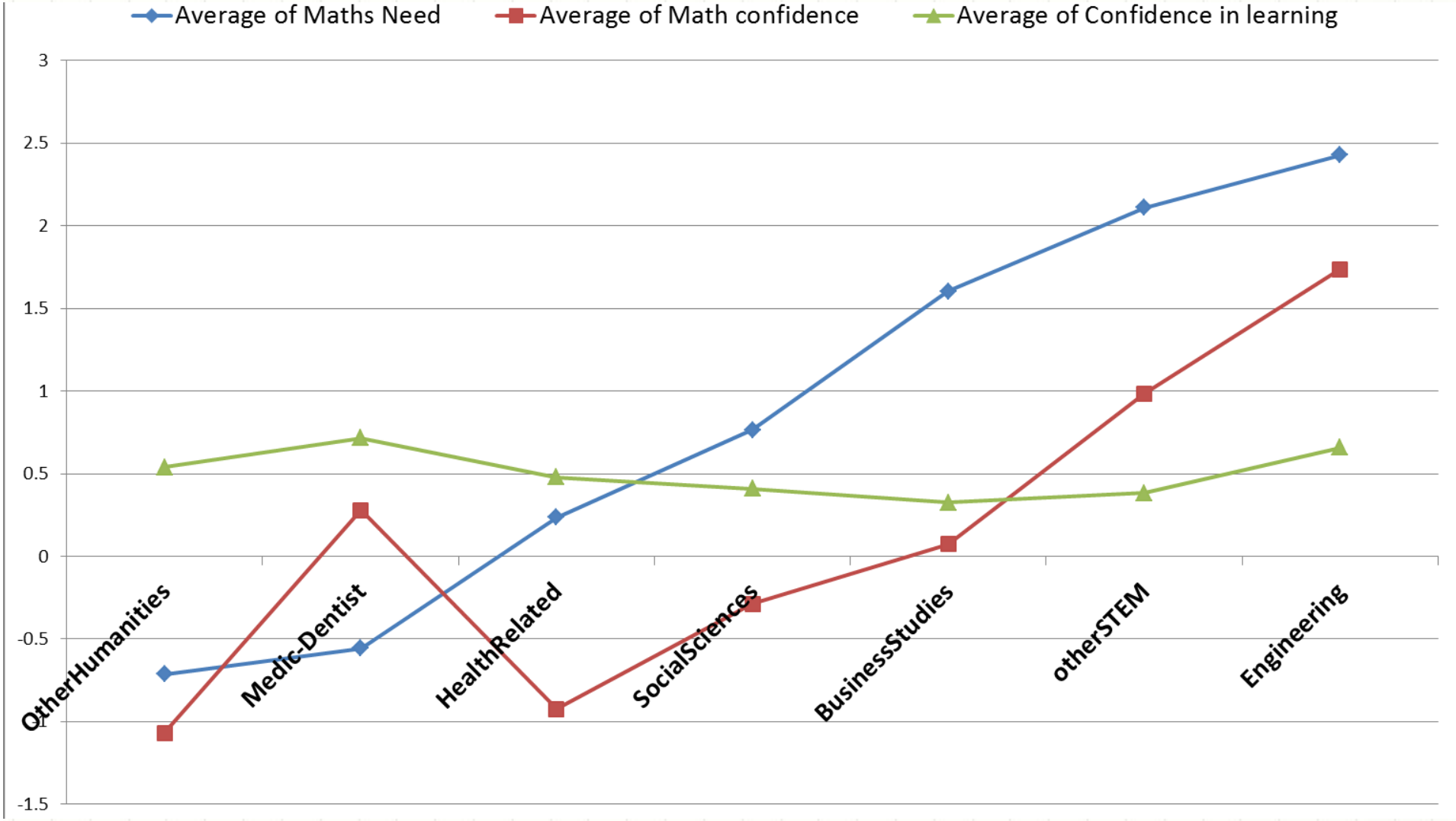
Researching topics:

(overall 49% of students were confident/very confident in this area)

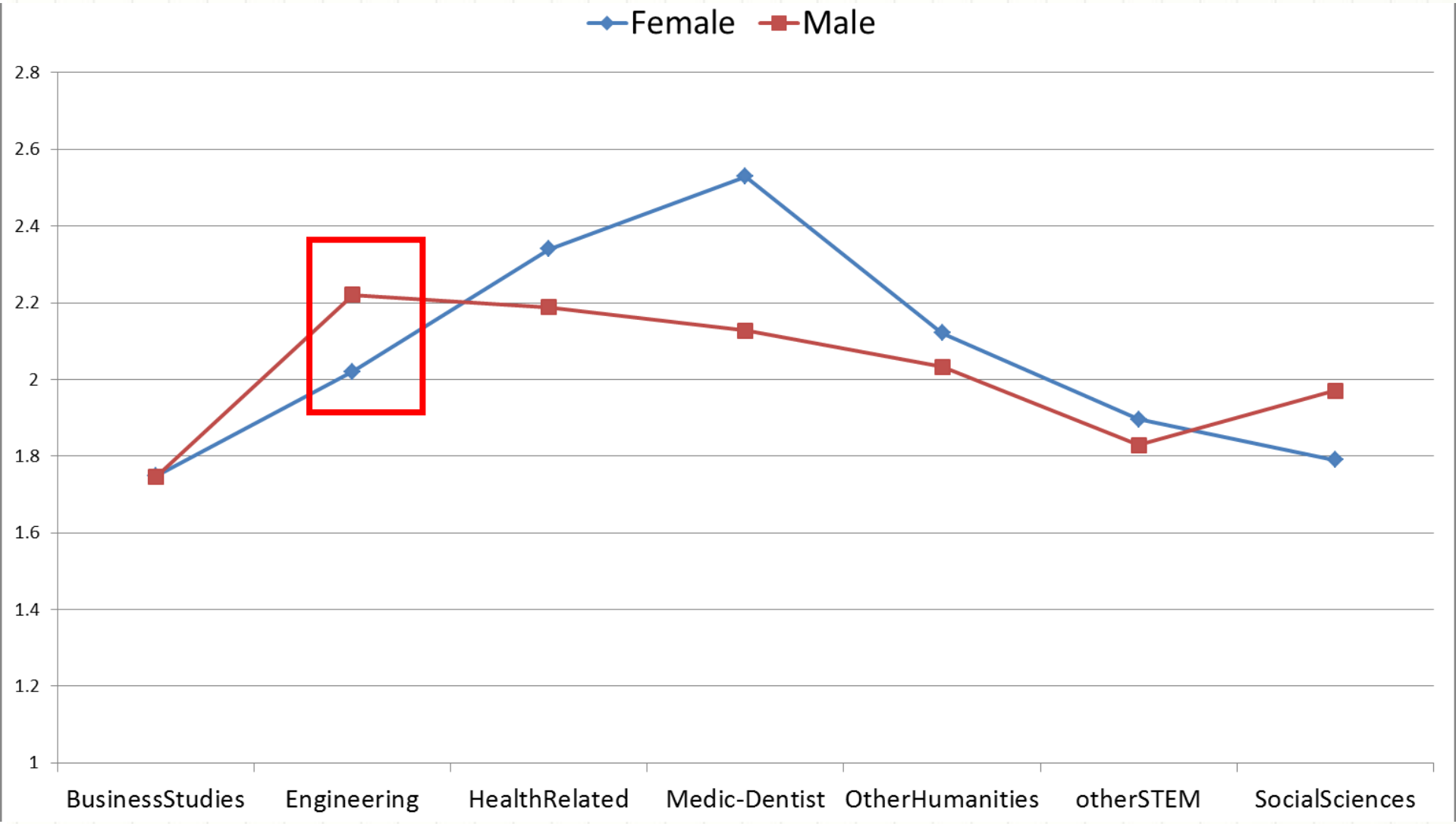
Godwin: I think it's made me a better person. Every day I learn, I'm willing to learn. It's made me humble because it's one thing to want to know something and I've learnt to be humble enough to seek help when I don't have the answers, from anybody.

Learning Gain Interviews

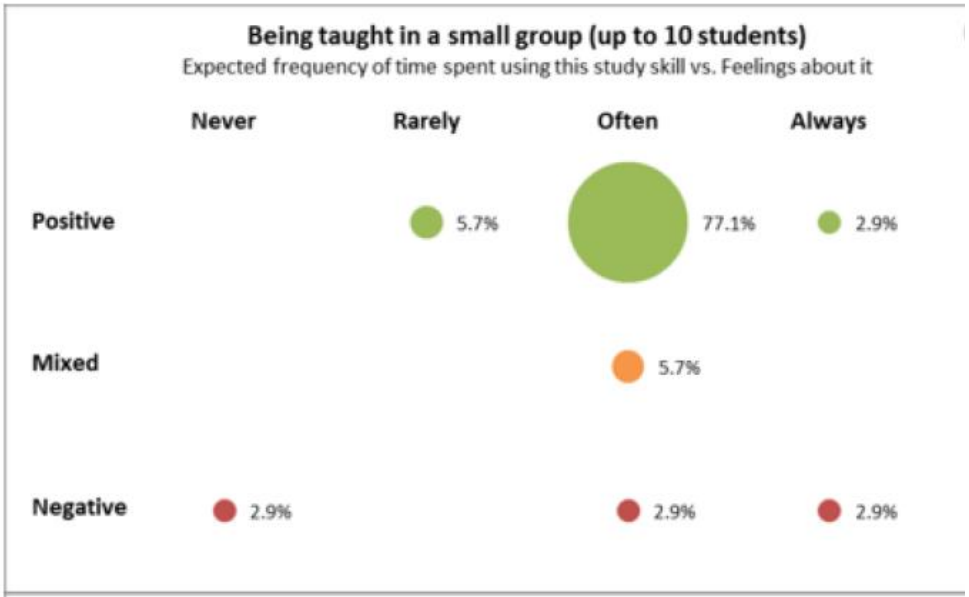
Confidence in learning at Uni and Maths

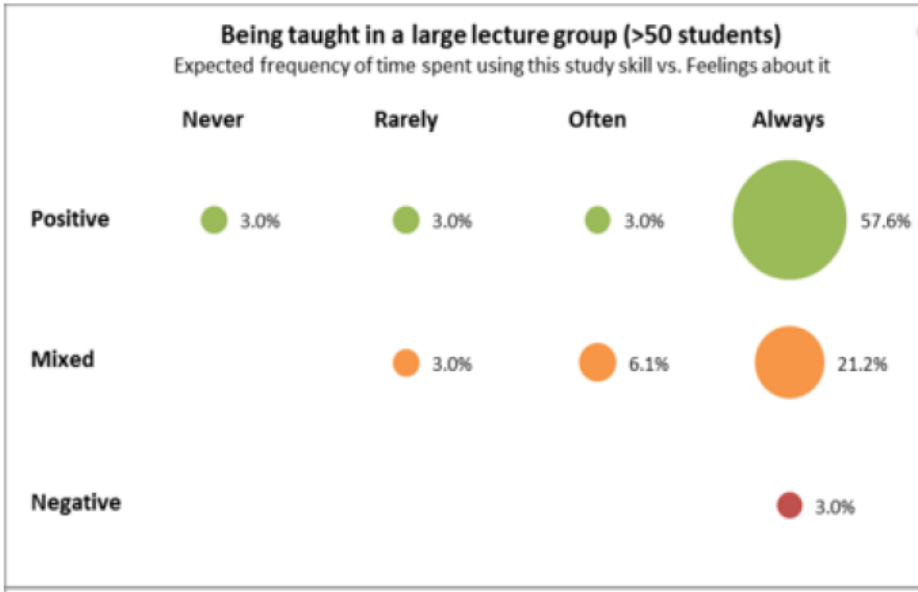


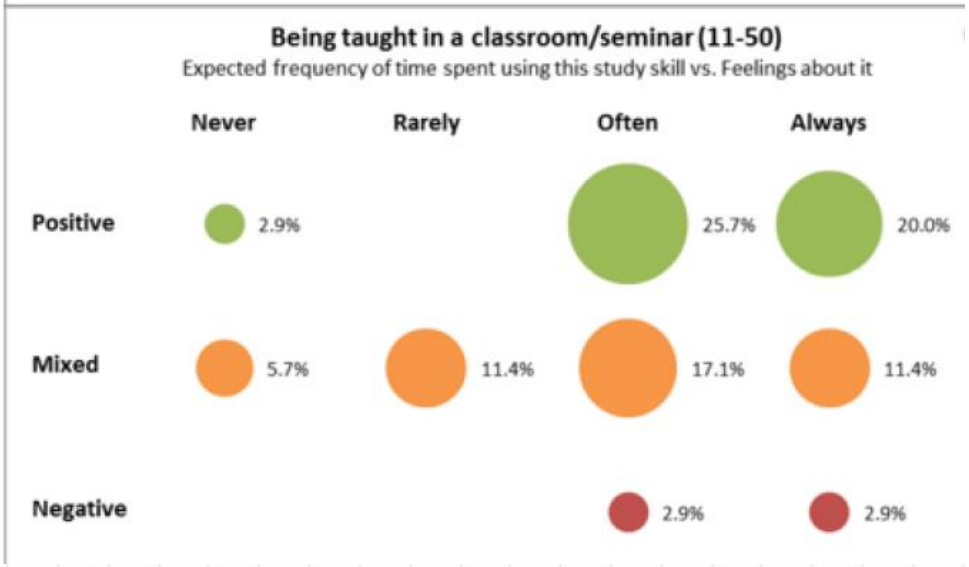
Disposition to complete chosen course

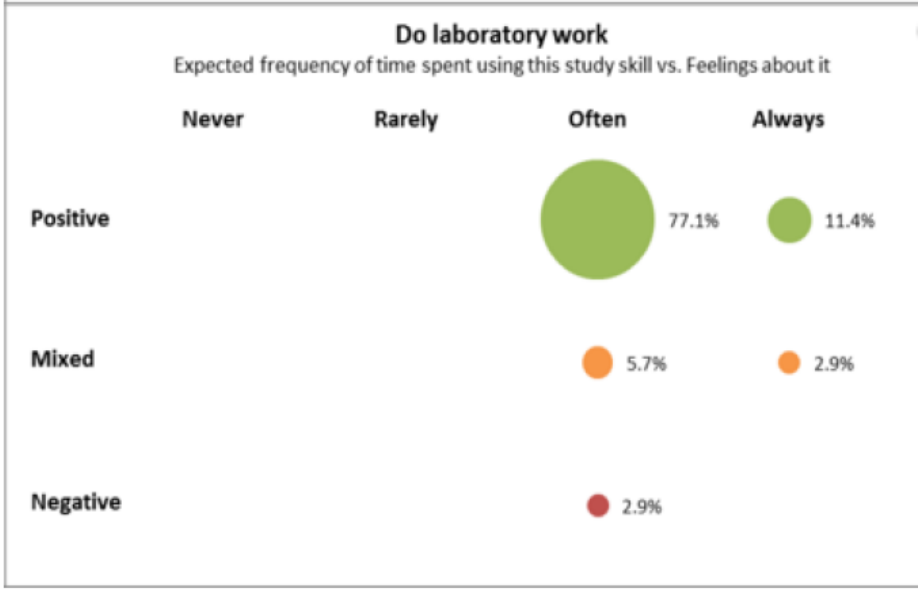


Engineering @DP1









Teaching and Learning experience at University

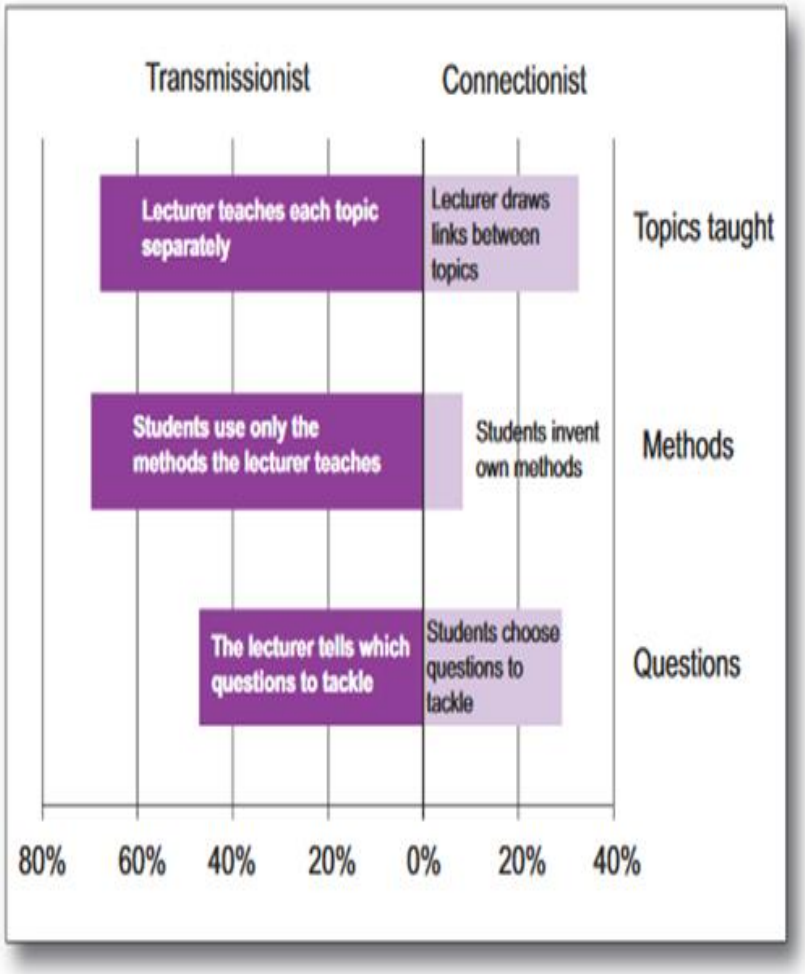


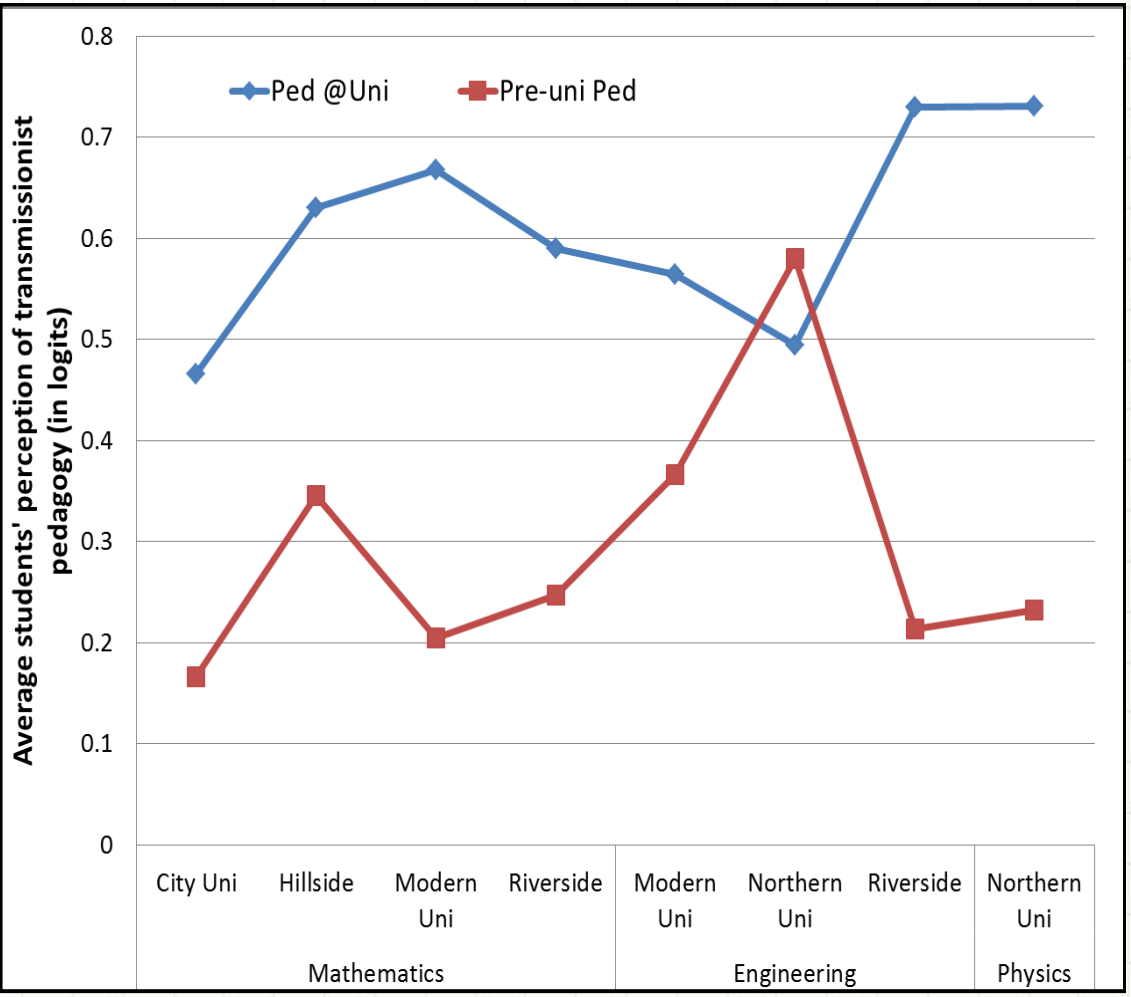
Figure: The reported use of transmissionist and connectionist teaching practices in EEE mathematics courses

The most difficult aspects of the transition between school and university for students to feel positive about are those related to teaching. Engineering students reported that their lecturers and tutors adopted mainly transmissionist (teacher-centred) teaching practices and the figure shows students' responses to a question about the frequency of teaching practices adopted by their lecturers and tutors (i.e. % of 'most of the time' or 'almost always' response options). Our research found that when a more transmissionist pedagogy is adopted, students tend to be less positive about their transition and this generally negative association is also consistent with our qualitative work.

TransMaths

‘They [the lecturers] have to get through a certain amount in an hour’: First Year Students’ Problems with Service Mathematics Lectures

Harris and Pampaka (2015)



Average pedagogical practice before and during first year HE

The over-riding issue reported was that ‘mathematics is not the same as it was at school’ which could be sub-divided into three key areas namely:

- lack of time in lectures
- lack of interaction in lectures
- lack of experience of the approach to maths in university

Further Analysis with such Measures

- Correlations with measures of attainment

	Entry qualification	Year 1 results
Traditional confidence	.04 (415)	.21***(394)
Social confidence	−.04 (415)	−.1* (394)
Problem-solving confidence	−.01 (415)	−.06 (394)
Maths confidence	.16**(374)	.196*** (391)
Disposition complete	.05 (412)	.18*** (393)
Transitional gap	.01 (400)	−.02 (393)
Transition positivity	−.03 (387)	.15** (387)

Note: The cells present the Pearson *r* correlation coefficient, significance (***p <.001**p <.01; *p <.05) and sample size (*N*).

(Pampaka et al., 2018)

Regression Models of Learning Gain

Outcome of Uni (or Year 1) ~ Starting Qualifications + Background Variables + Attitudinal variables + Transition +Teaching Practice + …

	Model LG1	Model LG2	Model LG3
Constant	−.41 (9.39)	4.39 (9.45)	16.12 (9.96)
Entry qualification	0.17 (0.03)***	.17 (.03)***	.15 (.03)***
Gender (Ref: Male)	−1.22 (1.82)	−1.86 (1.92)	−2.82 (1.92)
Subject (Ref: Humanities Course)	−1.179 (1.87)	−2.51 (2.02)	−3.42 (2.07)
Transitional gap	−.37 (0.8)	−.23 (.79)	−.13 (.78)
Positivity about transition	.66 (.88)	.31 (.96)	.16 (.95)
Disposition to complete course	1.82 (0 .71)*	1.52 (.72)	1.35 (.71)
Confidence' Problem solving'		−.47 (.7)	−.14 (.7)
Confidence' social'		−.97 (.61)	−1.34 (.62)*
Confidence' traditional'		1.75 (.73)*	1.95 (.73)**
Maths confidence		.5 (.51)	.64 (.51)
Socio-economic (Ref: Lower)			
Higher			6.87 (2.62)**
Unknown			3.41 (2.81)
Model Fit Statistics	Model LG1	Model LG2	Model LG3
Number of observations	209	208	208
F (degrees of freedom)	8.36 (6, 202)	6.13 (10, 197)	5.96 (12, 195)
Prob > F	<.001	<.001	<.001
R^2	.199	.237	.268
Adj R^2	.175	.198	.223
Root MSE	12.95	12.79	12.59

Note: Model parameters on the top part of the table are presented as: coefficients (standard error) significance (***$p < .001$; **$p < .01$; *$p < .05$).

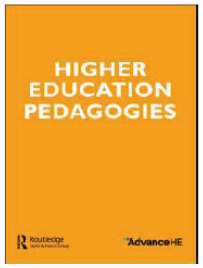
(Pampaka et al., 2018)

Implications for Policy and Practice

- Who is coming into engineering?
- What are the main challenges when they are at university?
- Retention? (e.g. fewer female students?)
- Role of teaching/learning practices?

  – How to change and improve experience?

Relevant Recent Publications



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Validating constructs of learners' academic self-efficacy for measuring learning gain

Maria Pampaka, Daniel Swain, Steven Jones, Julian Williams, Martyn Edwards & Lawrence Wo

To cite this article: Maria Pampaka, Daniel Swain, Steven Jones, Julian Williams, Martyn Edwards & Lawrence Wo (2018) Validating constructs of learners' academic self-efficacy for measuring learning gain, Higher Education Pedagogies, 3:1, 118-144, DOI: 10.1080/23752696.2018.1454264

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'They [the lecturers] have to get through a certain amount in an hour': first year students' problems with service mathematics lectures

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