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A Demographic Picture of Academics Teaching on Engineering Programmes in Ireland and their Approaches to Teaching (ATI).

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A demographic picture of academics teaching on engineering programmes in Ireland and their Approaches to Teaching (ATI).

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ABSTRACT

This paper presents the results of an online survey (n=293) carried out on academics teaching on engineering programmes in Ireland in 2017/18. The primary purpose of the survey was to provide a selection pool for interviewees in a separate phenomenographic study, however the survey also provided some interesting findings. Previously, there has been little published data on the diversity of personnel teaching on engineering programmes in Ireland and this paper aims to provide an insight.

In addition to collating the demographics of the survey respondents, and their background experiences in academic and industry, the Approaches to Teaching Inventory (ATI) [1] was also used as part of the survey. The results show that the respondents were more likely to use a Conceptual Change/Student Focussed Approach (CCSF) to teaching than an Information Transfer/Teacher Focused (ITTF) approach in the context of the modules they considered. Finally, diagrams are presented which show relationships between the Approaches to Teaching (ATI) responses and the level of programme being taught, the length of academic experience and any academic qualifications in teaching.

A study of demographics and attitudes of engineering staff was undertaken in Australia in 2010/11 [2] and we hope that both these results may encourage other countries to undertake a similar survey so that we may compare and contrast between different countries in order to better understand the diversity of our engineering academic community.

1 INTRODUCTION

The paper reports on an aspect of a larger phenomenographic study which aims to describe the qualitatively different ways that academics approach teaching professional skills in engineering programmes in Ireland. As part of the selection process for interviewees for the phenomenographic study, an online survey was circulated to all academics teaching on engineering programmes in Ireland. The main aim of this survey was to undertake purposive sampling of interviewees, but some of the data collected also provided some interesting findings in relation to general demographics of academic educators and their approaches to teaching, both of which are presented here.

1.1 Demographics

A phenomenographic study aims to identify the qualitatively distinct ways in which people conceptualise or experience a particular phenomenon. A phenomenographer looks for variation and hence seeks to interview a varied range of people. In this case, the researchers aimed to interview academics teaching on engineering programmes in Ireland, but realised very quickly that there was no central database of academic profiles nor published material which could be used to select appropriately differing interviewees and hence an online survey was used for this purpose. Ireland is not alone in the dearth of information about engineering academic staff and work undertaken by Cameron, Reidsema and Hadgraft [2] sought to collate similar information in an Australian context. The purpose of their study was to identify challenges, opportunities and barriers for change management within engineering education, but they collected demographic information, previous industry experience and they also used extracts from the ATI to highlight attitudes to teaching.

Although it was not the main aim of the Irish survey, the demographic results are nevertheless considered worthy of publication, to showcase the diversity of those teaching on engineering programmes in Ireland.

1.2 Analysis

It is important to bear in mind that no statistical analyses have been carried out within this study, all results presented are based on a comparison of frequency counts.

2 ACADEMICS' APPROACHES TO TEACHING PROFESSIONAL SKILLS

One aspect of diversity that was interesting from the aspect of the phenomenographic study, was how academics differ in their teaching practice. The theory of academic approaches to teaching provides a lens through which to consider this aspect. Prosser, Trigwell and Waterhouse [3] purport that the academic's conception of teaching has a direct influence on how the students learn and have created an Approaches to Teaching Inventory (ATI) survey instrument [1,3,4]. This instrument was used within the survey and highlights how an academic approaches teaching in a particular context. The research work that led to the creation of the Approaches to Teaching Inventory resulted from a phenomenographic study of first year university science teachers [3,4]. The analysis yielded five qualitatively different approaches to teaching (A-E), which are summarised in *Table 1.*

Table 1. Approaches to teaching (from Trigwell, Prosser and Taylor, 1994 [4])

	Strategy		
Intention	Teacher-focused	Student/Teacher Interaction	Student focused
Information transmission	A		
Concept acquisition	B	C	
Conceptual development			D
Conceptual change			E

Approach A: A teacher-focused strategy with the intention of transmitting information to students.
Approach B: A teacher-focused strategy with the intention that students acquire the concepts of the discipline.
Approach C: A teacher/student interaction strategy with the intention that students acquire the concepts of the discipline.
Approach D: A student-focused strategy aimed at students developing their conception.
Approach E: A student-focused strategy aimed at students changing their conceptions.

The ATI was revised in 1999 and the wording of some of the inventory items was updated to accommodate more flexible learning situations than those of first year university science teachers [1]. The original five sub scales were reviewed and a two factor subscale was now proposed, representing two fundamentally different approaches to teaching; Information Transmission / Teacher Focused Approach (ITTF) and Conceptual Change/Student Focussed Approach (CSSF).

2.1 Recent research – Approaches to Teaching Inventory

The original ATI was developed with first year physics and chemistry science teachers and the limitations of the research were highlighted as being relational and not necessarily the same for all disciples and contexts. It has since been used in a range of situations to relate approaches to teaching to other aspects of the teaching environment such as class size and teaching workload [5], impact of a teaching development programme [6], and disciplinary content [7,8,9]. Mean values of the CCSF and ITTF approach scales were analysed per discipline in these studies and showed statistical differences between discipline groups. Higher CCSF scores were found in the 'soft' disciplines (arts, humanities social science etc,) compared to the 'hard' disciplines which have a greater use of the ITTF approach (engineering, science, medicine) [9].

2.2 ATI – Criticism of conceptual foundation and procedures used

There has been criticism about the use of the ATI in scenarios where it was not originally intended and in the conceptual foundation and procedures which were used in its development [10]. For example, it is postulated that in two of the five categories, only one teacher's voice may have been used to support the construct and since the gender of the 24 teachers was not identified, it is likely that 80-90% of interviewees were male and the scope of variation one could extract with such a gender bias is questioned [10].

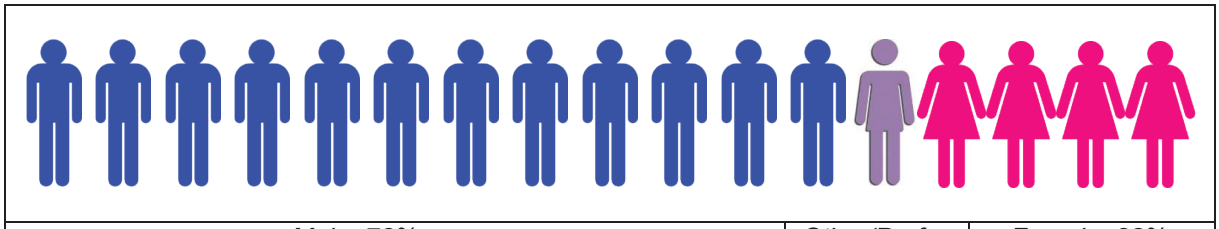
2.3 Survey circulation

The survey was distributed to academic staff teaching on engineering programmes in all Higher Educational Institutions (HEIs) in Ireland. Staff listings were obtained from published staff contact details on each of the HEIs websites and this gave an estimate of approximately 1,000 relevant academic staff. Responses totalled n=273 giving an approximate response rate of 27%.

Whilst it is difficult to say whether the respondents are a representative sample, responses were received from each of the HEIs contacted and there was a varied range of discipline profile, academic qualifications, industry experience and age. Perhaps the only anomaly is that only 12.6% of those contacted to complete the survey appeared to be female based on their name, but as the results show in the next section, 22% of respondents were female. This is perhaps explained by the fact that the researcher is also a female engineering academic and female respondents may have been more likely to respond to a survey circulated by a fellow female engineer.

Fig. 1 and *Table 2* show the breakdown of gender and age of respondent profiles. The majority of respondents were male (n= 197) and 16 respondents selected "Other /

Prefer not to say". No respondent indicated an age of less than 25, and less than 8% of respondents indicated an age of below 35 years old.



Male: 72%	Other/Prefer not to say: 6%	Female: 22%

Fig. 1. Gender identification selected by respondents

Table 2. Age of respondents

Age	<25 years	25 – 34 years	35-44 years	45-54 years	55 or older
Number of respondents (%)	0 (0%)	21 (7.7%)	84 (30.8%)	114 (41.8%)	54 (19.8%)

2.4 Educational Qualifications

Respondents were asked to select all of their academic achievements. This was to identify those members of staff who had gained a PhD and those who had undertaken an educational qualification such as the Postgraduate Diploma in Third Level Learning and Teaching. *Figures 3 and 4* indicate the percentages of respondents who have gained various qualifications and those whose qualifications are in 'Engineering', 'Engineering and Education' or 'Other'. There was a wide range of qualification types selected by respondents with 87% (n=268) having an engineering qualification of some type. Respondents who answered 'Other' (n=39) indicated qualifications in the following broad categories; Science and Mathematics (n=23), Architecture and Construction (n=10), Business / MBA or Economics (n=3), Arts and Sociology (n=3).

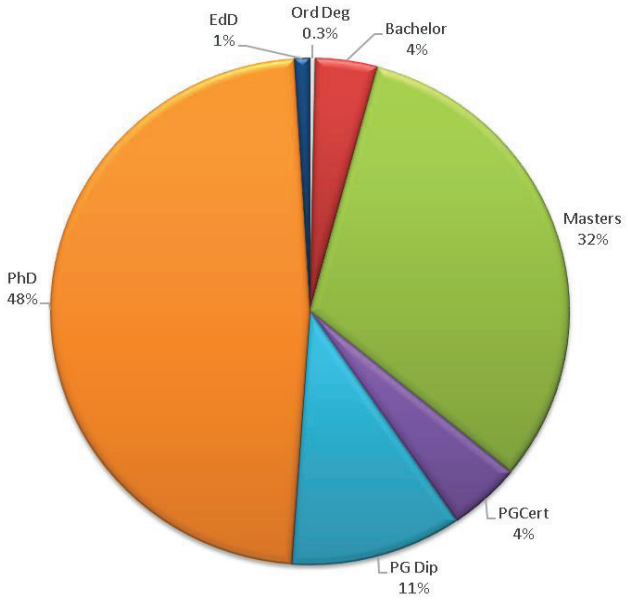


Fig. 3. Highest Level of Qualification

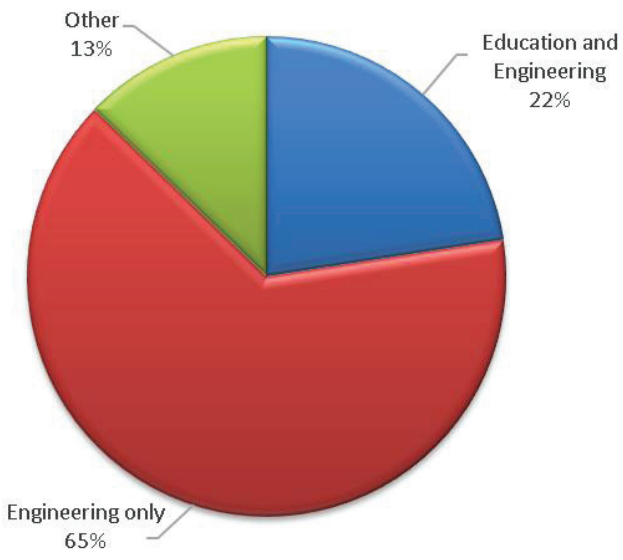


Fig. 4. Types of qualification gained

There was also a wide range of additional qualifications noted for those who selected 'Engineering' as a primary qualification. These included specialist subject areas such as regenerative medicine and software engineering, however 26 of the engineering respondents (8.5%) also indicated they had obtained either an MBA or Business/Management qualification.

2.5 Academic Experience

Respondents were asked to indicate the length, type and number of teaching hours they work in order to obtain a good range of interviewees with a selection of academic experience. *Figures 5 and 6* show the variation in responses to length of time working in academia and type of role selected.

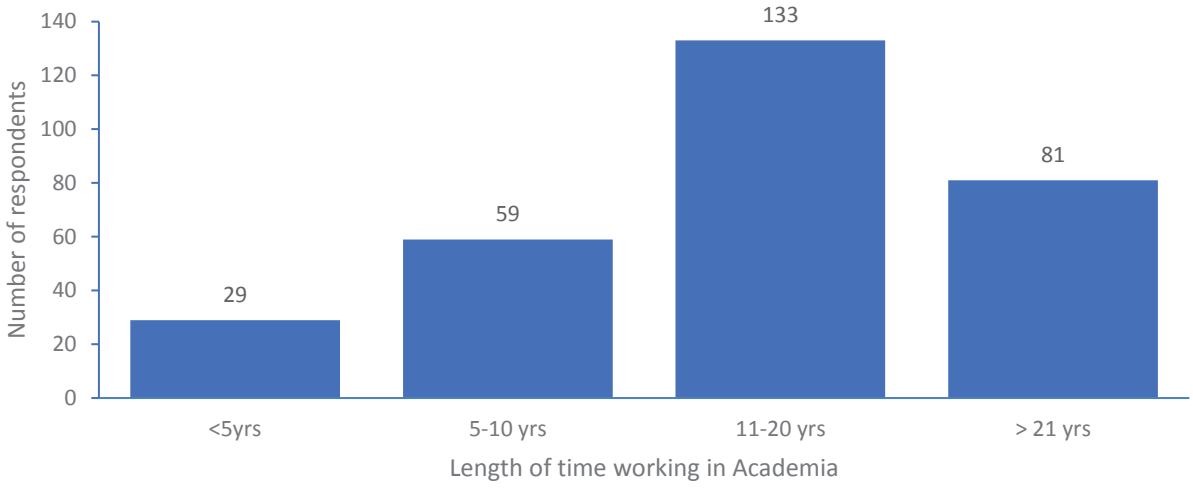


Fig. 5. Length of time working in academia

Type of role	Percentage of respondents	Graphical interpretation
Mainly Administration / Management	11% (n=32)	
Mainly Research	14% (n=43)	
Mainly lecturing	75% (n=221)	

Fig. 6. Type of role in academia selected

Third level education in Ireland is typically delivered within both Universities and Institutes of Technology (IOT). Respondents from each sector were asked to indicate their teaching hours and *Figure 7* shows the disparity between each sector with the clear majority of respondents in the IOT sector teaching greater than 15 hours per week. This is typically 6-10 hours per week for the University sector, 35% of which consider themselves 'mainly researchers' compared to only 5% of IOT staff selecting this option.

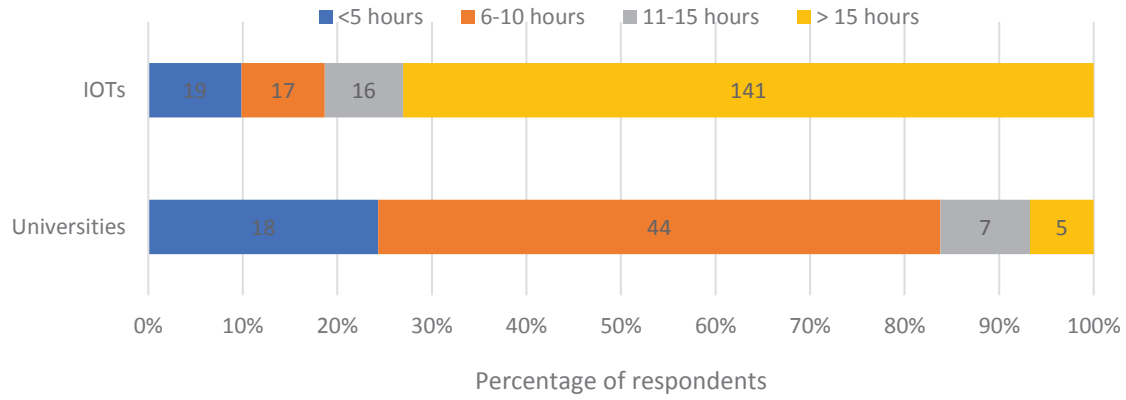


Fig. 7. No of teaching hours differentiated by University and IOT.

2.6 Industry Experience

Respondents were also invited to comment on their previous industry experience, the type of role they held and whether they were involved in the recruitment or training of new graduates. Many respondents have held roles in industry, as indicated in *Figure 8,* with 34 academic staff still working or consulting in industry.

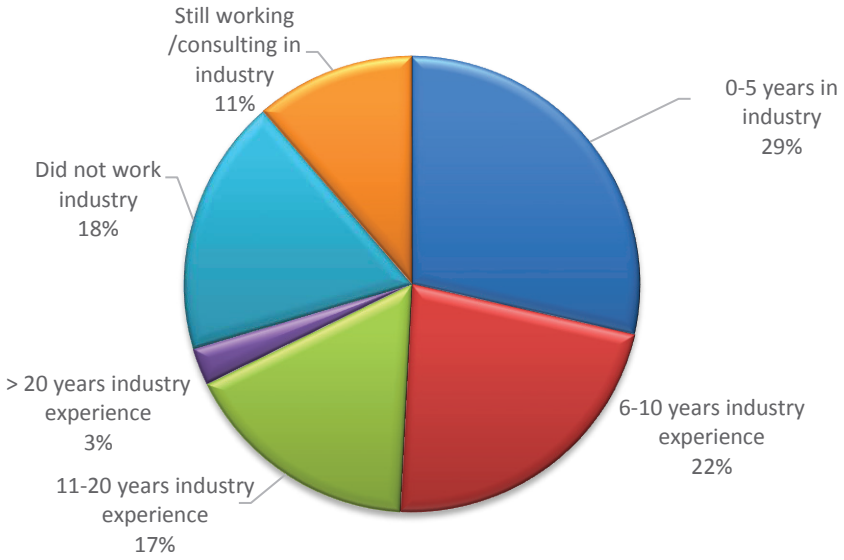


Fig. 8. Range of industry experiences noted by survey respondents.

The University sector holds proportionally more of the 53 respondents who have never worked in industry (38% of University responses compared to 13% of IOT responses). Conversely, approximately the same percentage (12%) of IOT staff and University staff are still working or consulting in industry. It is important to consider here that academic staff who are undertaking research projects with industry input may have answered the "still working / consulting in industry" option in this question.

2.7 Membership of professional bodies

Approximately 60% of respondents indicated that they were members of professional bodies, of which 38% are members of Engineers Ireland. Of the Engineers Ireland Members, more than half are Chartered Engineers or Fellows as indicated in *Figure 9.*

In order to become a Chartered Member, applicants must show evidence of specific objectives, many of which are aligned to practicing as an engineer. Those with Chartered or Fellowship membership therefore, would typically indicate a level of industry engagement and experience. Seventy-six percent of respondents indicated that they had contributed to an Engineers Ireland Accreditation in the past 5 years.

Type of Engineers Ireland Membership	Percentage of respondents	Graphical interpretation
Fellow	14.0% (n=16)	
Chartered Member	41.2% (n=47)	
Ordinary Member	40.4% (n=46)	
Associate Member	2.6% (n=3)	
Other (Graduate, Student, Affiliate)	1.8% (n=2)	

Fig.9. Type of membership of Engineers Ireland noted by survey respondents.

3 FINDINGS IN RELATION TO SPECIFIC RESEARCH QUESTIONS

The survey findings were also reviewed to assess the research questions;

- What is the relationship (if any) between approaches to teaching and the level of programme being taught?
- What is the relationship (if any) between approaches to teaching and educational qualifications of respondents?
- What is the relationship (if any) between approaches to teaching and educational experience?

3.1 Scoring of Approaches to Teaching Inventory

The Approaches to Teaching Inventory [1] used in the survey included 16 questions with statements pertaining to how an academic might approach teaching. The outcomes can show whether an academic has a Conceptual Change / Student Focussed (CCSF) approach or an Information Transmission/Teacher Focussed (ITTF). The respondent was asked to consider just one module, the one with which they have most contact time and so it is acknowledged that the responses are contextual; that responses for a different module may give a different score. The questions were in the form of statements, for example; “In teaching sessions for this subject, I deliberately provoke debate and discussion”, or “It is important to present a lot of facts to students so that they know what they have to learn for this subject” [1]. Respondents select from 5 options from ‘only rarely’ (scored as zero) to ‘almost always’ (scored as 4). Hence the lower and upper bound scores are zero and 32, as each inventory scale has 8 associated questions.

All responses were scored and the results for the CCSF and ITTF calculated for each respondent. The following plot (*Figure 10*) shows the range of scores with each point representing the CCSF and ITTF score for one respondent. Whilst statistical analysis was not carried out, the trend line indicates that when one becomes more aligned with a Conceptual Change/Student Focused model, the score on the Information Transfer/Transmission Focused reduces.

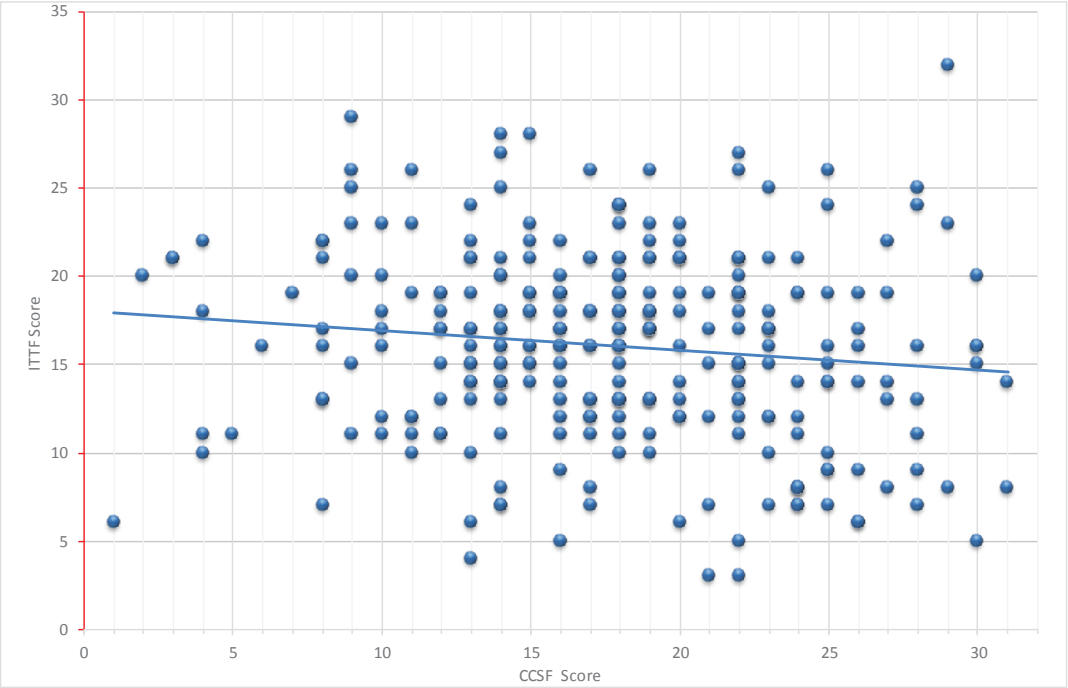


Fig.10. CCSF and ITTF scores for each respondent.

Figure 11 shows the CCSF and ITTF histograms overlaid with distribution curves, based on frequency. In this instance both scales have been scored positively. This result shows that on average there are higher CCSF scores meaning people tend to score higher on the CCSF scale compared to the ITTF scale. This suggests that most engineering academics in this sample are more inclined towards a Conceptual Change / Student Focussed model of teaching approach, albeit within the midrange of the scale and contextual to the module they considered when answering the question.

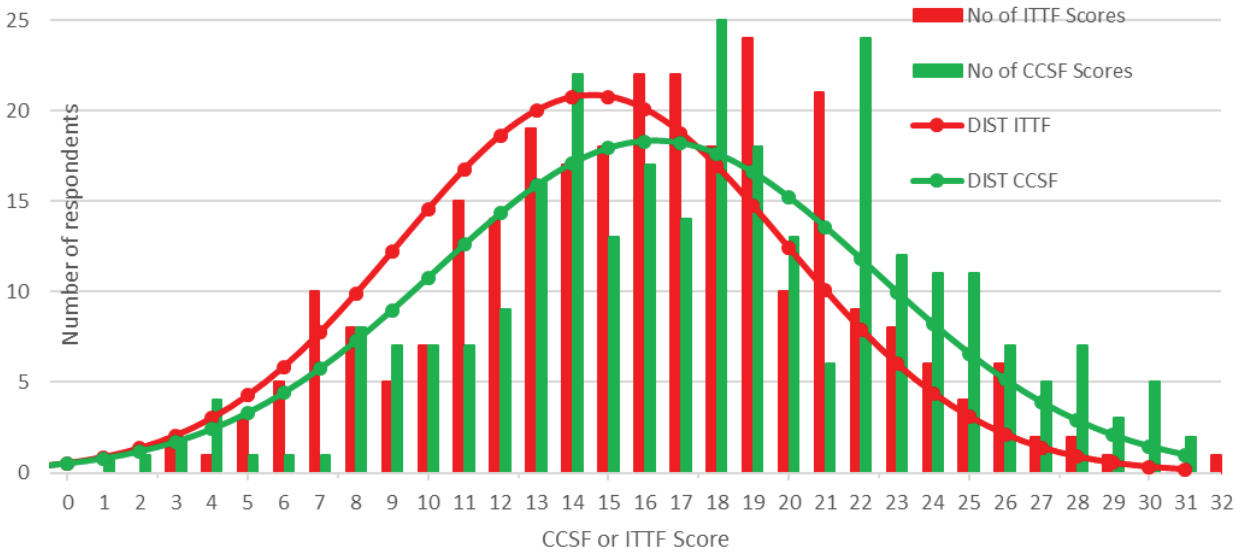


Fig.11. Histogram showing the number of each CCSF and ITTF scores.

In Ireland, the National Framework of Qualifications describes the various levels of academic programmes which include a Level 6 Higher Certificate, Level 7 Ordinary Degree, Level 8 Honours Degree, Level 9 Masters Degree and Level 10 PhD [11]. It appears from the results in *Figure 12*, that an ITTF approach can be quite common

when teaching Level 6 and 7 students, which were typically described as large classes within a lecture theatre setting. A CCSF approach was more likely to be used in Level 8 and 9 modules which typically included a mixture of group work, studio classes, tutorials and laboratories. Both Problem Based Learning and Project Based Learning were also mentioned specifically in regard to a CCSF approach. *Figure 12* shows the spread of ITTF and CCSF approaches by Academic Level of programme.

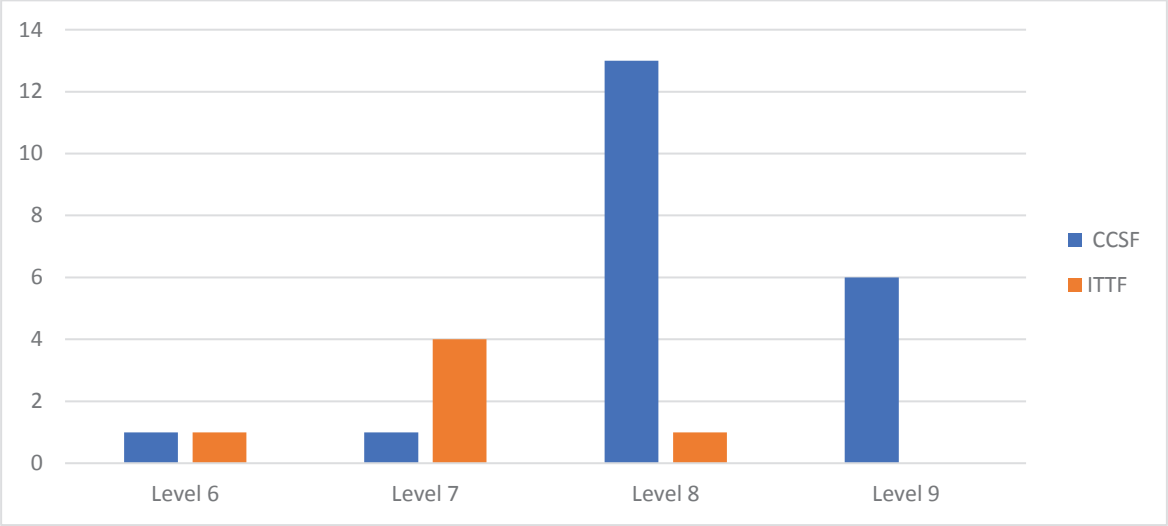


Fig.12. CCSF and ITTF scores for the modules selected by each respondent.

3.2 Approaches to Teaching Inventory scores versus Educational Qualifications

The next question sought to ascertain if there was a relationship between those academic staff with CCSF approaches to teaching and any evidence of an educational training record. Various thresholds were considered within the CCSF scale to identify those academics with a pronounced CCSF score. Table 3 shows the number of respondents who exceeded the thresholds in each of the ITTF and CCSF scales.

Table 3. Number of respondents exceeding various thresholds

Threshold Value	No of respondents who exceeded threshold in ITTF scale	No of respondents who exceeded threshold in CCSF scale
Greater than 20	60	93
Greater than 26	6	22
Greater than 28	2	10
Greater than 30	1	2

On this basis, a threshold value of 26 was chosen as providing a sensible selection of respondents for this question, which resulted in 22 CCSF and six ITTF scores greater than the threshold. Of the 22 CCSF allocations, eight had obtained educational qualifications (36%). Of the six ITTF allocations, two respondents had obtained Educational Qualifications (33%) approximately similar to the CCSF case, suggesting that the mode of teaching may be more attributed to context than knowledge of pedagogical approaches which may be gained through an Educational Qualification.

3.3 Approaches to Teaching Inventory scores versus Educational Experience

The next comparison sought to confirm if there was a relationship to show that as an academic gains experience through teaching a range of classes under different conditions and on different levels that their approach to teaching moves towards a CCSF approach. *Figure 13* shows the distribution of length of experience against those respondents who have been allocated a CCSF approach or a ITTF approach greater than a threshold score of 20. The threshold of 20 was used in this case to provide a more robust number of data points. However, this also means that in some cases a respondent had both an ITTF score and a CCSF score of greater than 20. In effect they use a combination of the two approaches and they are noted as 'Both' in this graph.

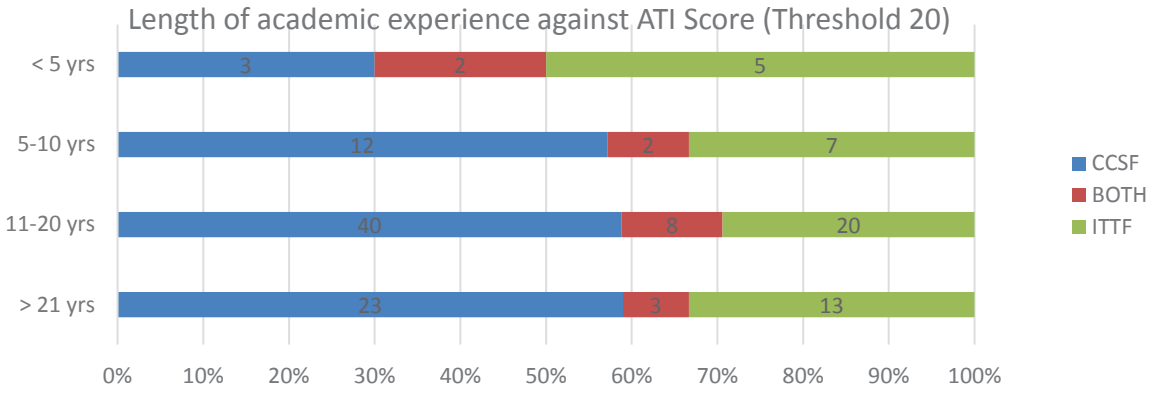


Fig.13. Bar chart comparing those who achieved a (> 20) threshold ITTF and CCSF score against their length of experience in academia.

Whilst the values for members of staff with more than five years experience do not change considerably, it would appear that that those with less than 5 years experience are more likely to have an ITTF approach.

4 CONCLUSIONS AND FURTHER WORK

This paper presents a snapshot of the demographics of academics teaching on engineering programmes in Ireland and provides a basis for ongoing collection of data to show trends in future years. Of particular note is the percentage of female academics (approximately 12% according to the lists provided on HEI websites) but 22% female respondents to the survey. This compares to 17.2% female respondents to the Australian study [2].

The findings in this paper show that there appears to be a contextual relationship to the Approaches to Teaching responses (ATI)and the type and level of academic programme being taught. There is no obvious relationship between evidence of an educational qualification resulting in a tendency towards a CCSF approach, suggesting that the teaching approach may be more aligned to the context of the teaching situation rather than pedagogical knowledge of the lecturer.

It also raises further questions about the relationships between academics' experience in academia and industry and how that influences the approach to teaching used in each context. Whilst conclusions cannot be drawn from the findings presented here, there are several aspects of the teaching context and the academics' experience which can be investigated further in an interview situation, which will inform the main phenomenographic study.

The output of this survey shows a picture of the diversity of academics teaching on engineering programmes in Ireland, and it raises some additional research questions in relation to academics in other countries in Europe and around the world. Further work could include;

- How do Irish engineering academics compare with other academics with regard to gender diversity, academic and educational qualifications and industry experience?
- How do Irish engineering academics compare with other academics with regard to the number of hours they teach and/or their split between teaching and research activity?
- How do Irish engineering academics compare to other engineering academics with regard to the CCSF and ITTF scores noted here?
- Is the relationship between teaching approach (CCSF/ITTF) and level of programme also notable in engineering programmes in other European countries?

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