A QUANTITATIVE EXPLORATION OF ENGINEERING STUDENTS' PROFESSIONAL IDENTIFICATION (RESEARCH-PAPER)

C. Sanna[1]
Norwegian Univeristy of Science and Technology
Trondheim, Norway
0000-0002-1084-6013

P. Wallin[2]
Norwegian Univeristy of Science and Technology
Trondheim, Norway
0000-0001-6222-8543

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ABSTRACT

In today's fast-moving world, we must continuously adapt to changes in all areas of life, and the ability to do so is increasingly highlighted as a key skill particularly for engineering graduates. At the same time, research shows that having a stable professional identity, and identifying with one's field is important for aspects such as job-satisfaction and productivity, in addition to overall well-being. However, research of higher education have been critizised for apparently viewing professional identity and employability as synonymous, and an end 'goal' of education, rather than exploring the continuous processes of professional socialisation that take place in the everyday practices of universities. Accordingly, we ask: what affects engineering students' professional identity constructions *while* they are students?

To explore the proposed research question, a quantitative survey instrument measuring professional identification, as well as previously identified related aspects has been constructed. In the research literature, there is little consensus on how to measure professional identity quantitatively, thus, developing a comprehensive measure that can provide insight into these processes is the focal point of the study. Subsequently, the data material consists of 271 engineering students at the Norwegian University of Science and Technology.

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[1] C. Sanna, Camilla.sanna@ntnu.no

[2] P. Wallin, patric.wallin@ntnu.no

1   INTRODUCTION

In today's ever changing world, flexibility is highlighted as key competency in both education and the working life. Within the field of engineering education, flexibility is important for teachers and academics when educating the engineers of tomorrow while at the same time handling the fast-paced developments of technology and modes of communication. In addition, educators have to balance between contributing to students constructing clear professional identities, all the while they have to aid them in developing the highly requested flexibility. [1] In this context, engineering education has been subject to various changes and reforms due to the experienced mismatch between the scientific focus of universities, and the multifaceted demands of professional practice, with the links between engineering degrees and the realities of an engineer's working life are often put at the forefront of engineering education. [2]

On a more general level, research literature emphasises how constructing stable senses of selves and being able to separate oneself from others is fundamental for how we lead our lives. [3] For adults, the workplace and one's professional identity therefore becomes perhaps the most influential source for the ongoing negotiations of identities and (self-)perceptions. [4] Consequently, higher education emerges as a significant arena for adults' identity constructions, especially in terms of professional socialisation and identification. [3, 5] From a sociocultural perspective, identity is both social and personal, as well as dynamic and ongoing, embedded in the surrounding contexts, and can be viewed as the result of dynamic mediation and negotiation between individual behaviours, social contexts and cultural structures. [4] 'Professional identity' thus, reflects the sense identification to or with a profession or field, on both a personal and social level. [3] Research on professional identity also shows that a strong sense of belonging to one's field and identification with one's professional 'group' can affect several aspects of life, such as general wellbeing and self-esteem, as well as job-satisfaction and work performance. [5, 6] However, Daniels and Booker argue that higher education research generally puts too much emphasis on professional identity as an end 'goal' rather than exploring the ongoing socialization in the everyday practices of university students. [5]

Keeping the growing interest on students' professional identities in mind, we find it interesting to approach identity construction and negotiation processes from an engineering education research perspective. Based on the previous line of reasoning, there appears to be a need to explore these processes of professional identification through the experiences of students. In accordance with a dialectal pluralistic perspective, one can argue that it would be advantageous to employ both qualitative and quantitative measures to attain a comprehensive understanding of such a complex phenomenon. However, as there appears to be a lack of quantitative instruments examining professional identity, especially within sociocultural theoretical frameworks, the aim of the current paper is to present such a quantitative measure, in addition to exploring students' professional identification the research question: what affects engineering students' professional identity constructions *while* they are students?

2   METHODOLOGY

2.1 Development of the instrument

Informed by a dialectal pluralistic perspective, it is believed that employing a variety of approaches is useful to research complex social phenomena, such as professional identification. The questionnaire is part of a larger mixed methods research project on students' professional identities with a planned sequential explanatory design. Thus, in developing the survey instrument, a key aim was to have an open and broad approach to be able to explore an array of possible connections and relationships to be delved deeper into through later qualitative approaches. In this regard, it was important to establish a clear theoretical understanding of the phenomena at the 'heart' of the project, harmonious with both quantitative and qualitative approaches.

Starting from a sociocultural and discursive perspective on identity, possible quantitative operationalizations were explored. First, we attempted to translate and employ the Professional identity Scale Questionnaire (PISQ-5d) by Mancini et al., however through the pilot study it became apparent that it did not work as intended in our context. [7] The subsequent revision of the instrument and analysis of the results (e.g. factor analysis and correlation matrix) also showed that there were some ill-fitting aspects of the instrument. The further development of the instrument included revising the conceptualisations, operationalisations and measures to better suit the specific context and participants. For instance, changing the main dependent variable from 'professional identity *status'* to a two-folded measure for professional identity through measuring 'professional *identification*' an 'professional *commitment'* with the latter being greatly based on some of the items from PISQ-5d that had consistent results in the pilot study. The former measure is based on an adaption of Mael and Ashforth's scale for Organizational Identification. [8] In addition, a single-item social identification measure (SISI) ('*I identify with engineers'*) has been included as research has highlighted consistent high validity and reliability across a broad range of social groups [9, 10]. It is the SISI that is at the centre of this paper, while the other measures will be analysed later on. However, we believe that the SISI encaptures the previously presented perspective of identification with a social group as a key aspect of professional identity, thus being suitable for the scope of this paper.

In addition, students from academic disciplines found it difficult to relate to and respond to items including 'neutral' term for professional identification such as 'a professional' in the pilot study. Consequently, each questionnaire was adjusted to fit the field and ensure that the participants understood the questions, e.g., '*engineers', 'chemist'* or *'sociologist'.* This also impacted the method of distribution which will be explained in the next section.

2.2 Sample and distribution

The target group of the project as a whole is 'students at the Norwegian University of Science and Technology (NTNU)'. However, as noted in the previous section we were

not able to produce a 'general' questionnaire that we could distribute to all students at the university and had to adapt each questionnaire to the given programme. NTNU is also a relatively large university with close to 45 000 students and more than 330 programmes, and thus selecting a number of programs to focus on appeared appropriate.

Additionally, based on the pilot survey we changed the previously intended method of distribution. Before the pilot, the plan was to distribute the survey digitally through informal forums run by the students themselves, i.e., Facebook-groups, group-chats etc. to make the project as participant driven as possible. However, in the pilot, the response rate of the group targeted through this approach was 18,75% (N = 21), while the response rate of the group in which we conducted the focus group who had time during their lecture to respond was 100% (N = 12). Of course, there are most likely other aspects influencing these response rates, nevertheless the main method of distribution was changed from predominantly student-driven, to recruiting lecturers and faculty to aid in the distribution. To ensure the informed consent of the participants, as well as the convenience for all parties, the distributors received an information document, a short information film, a direct link to the survey and a QR-code that was linked to the survey, making it possible to show on a PowerPoint or other presentation devices.

As a result, 522 students from 50 different study programmes have participated in the survey. Due to the nature of the distribution method, in addition to most lectures being non-obligatory and the low attendance after COVID-19, as well as several courses consisting of students from an array of different programmes, it is challenging to make any claims about the response rate. Subsequently the number of students reached might not be equivalent to the number of students enrolled in the programme nor the specific subject of the lecture in which the questionnaire was distributed in. As the focus of this paper and conference is engineering education, the results are based on the 271 engineering students that have participated in the survey so far, and not the remaining 251 students.

2.3 Operationalizations and varibles

To measure students' professional identification, we have employed the SISI to explore wether the students' identify with engineers. As stated, previous studies have highlighted the strong validity and reliability of this measure across samples and contexts. [9, 10] Despite this recognized scientific quality of the measure, we discussed changing from 'I identify *with*' to 'I identify *as*', however, due to the full project including other measures for identification and commitment in addition to the SISI we chose to keep it as is to see whether they would complement oneanother or overlap. Preliminary results show a significant (p = <.001) moderate correlation between the single-item measure and the composite measure of identification (.30), indicating that they to some degree are related to oneanother. In addition, using 'with' instead of 'as' is believed to encaptur the social aspect of the previously presented understanding

of professional identity, while also pointing to it being an internal identification with a social group, thus fitting well with the aim of the paper.

Furthermore, we have included composite variables of intrinsic and extrinsic motivation based on the works of Skatova and Ferguson, and Ryan and Deci. [11, 12] The measures consist of four and three items, with the factor analysis proving a high degree of inner reliability for both variables with factor loadings ranging from .649 to .867, and Cronbach's alfa .741 and .728 respectively. In addition to these composite variables, we asked the students about their previous work and/or volunteer experiences, and whether they found it relevant for their degree, as well as praxis as a part of their programme.

3 RESULTS

3.1 Participants

As mentioned, the data consists of 271 engineering students from 21 of NTNU's 32 engineering programmes. The distribution of participants across programmes is varied, with the larger groups being Bachelor's degree in Civil Engineering (16,3%), Electrical Engineering (10,0%), Mechanical Engineering (11,4%) and Master's degree in Industrial Economics and Technology Management (9,2%). Due to the varied number of participants from each programme, we will not differentiate between programmes in this paper, but rather uncover similarities and important factors for engineering students as one group. However, we also acknowledge that there could be important distinctions between programmes, which we hope to be able to explore further in the future. On the note of the future research, we also intend to perform comparative analyses between engineering programmes and programmes of other professions and disciplines at a later time to gain a more comprehensive understanding into these processes of socialisation and identification.

As can be seen from Figure 1 over half of the participants are first-year students (66,3%), while less than 20% are third to fifth year-students of their current programme. This might to some degree be explained by the method of distribution, as physical lectures and mandatory subjects are typically more prevalent during the first two years of the programmes, while the later years

Figure 1. Year on programme
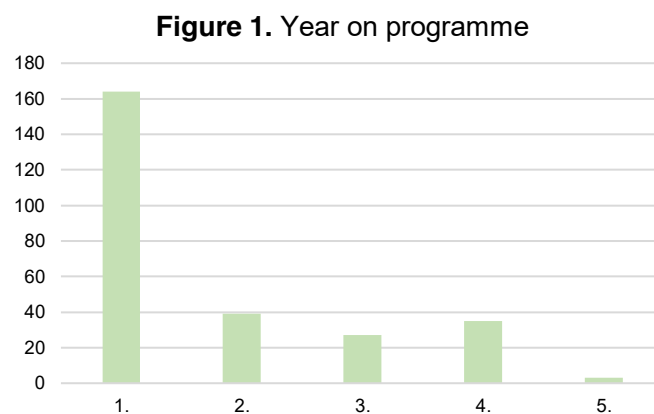
often contain more independent work, i.e., Bachelor's or Master's thesises. There are some limitations to having such a clear majority of students in the beginning of their degrees, as one can argue that the process of socialisation and establishing a sense of identification is dependent on experiences that one can argue students are gradually exposed to throughout their time at university. Furthermore, it could

complicate the comparative analyses between students from the different years due to the differences in respondents. However, having a large number of first-year students participating opens for the possibility to perform a longitudinal analysis in the future. In addition, despite the majority of participants being first year-students (61,2%), only 41% state that they are currently doing their first year at university overall. Thus, several of the first-year students have some previous experience in higher education, which might affect the results.

As expected, the majority of engineering students are male (66,4%), with 33,2% female respondents, and 0,4% of respondents identifying with another gender identity. This is in accordance with official numbers from NTNU which shows that the amount of women in three-year engineering programmes were approximately 22% in 2019, while it was closer to 38% in in the five-year programmes. [13] Furthermore, the official statistics have not included a category for other gender identities, and even though the number of respondents is too low to explore analytically we argue that it is important to include the option of a third gender to ensure the inclusion of the entire student body.

In terms of age, most participants are between 20 and 26 years old (94,4%), with the mean age being 22,9 years old (median = 22, mode = 21). This is somewhat low compared to the national average of Norwegian students of approximately 28 years old. [14] However, the latest numbers informing the national averge are from 2016, where it is highlighted that a majority of students take several years off school before beginning higher education. One of the most noticeable effects of the recent pandemic however, have been that less people take one or more gap-years from education after finishing upper secondary school, and that more people enter directly into higher education. Thus, the national average might be lower in 2022 than it was in 2016, making the discrepancy between our participants and the student body in Norway as a whole less extreme than it might appear.

3.2 Distribution of the dependent variable

As is visible in Figure 2 the students' responses to whether they identify with engineers are slightly positively skewed, with 40% either somewhat or fully agreeing, and 28,6% either somewhat or fully disagreeing. Whereas, about a third (31,4%) are neutral to the statement, neither agreeing nor disagreeing. This could again indicate that there are some socialisation processes within the enigeneering education programmes at NTNU that contribute to students identifying with engineers.

Figure 2. SISI distribution
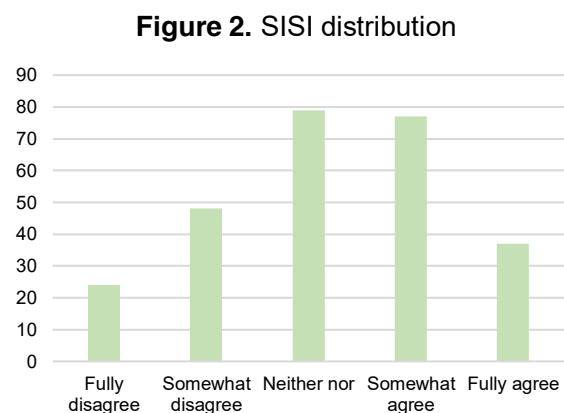
Furthermore, Figure 3 highlights the average score of identification dependent on year on programme. We can see that first- to third-year students on average answer neither nor (2,03, 3,13 and 3,19 out of 5 respectively), while the average fourth year student somewhat agrees (3,97) and the average fifth-year student fully agrees (5,0). This could suggest that engineering students identify more and feel a stronger

Figure 3. SISI distribution by year
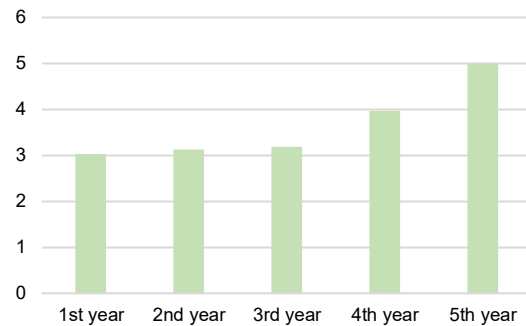
sense of belonging to the field of engineering throughout their time as students, which indicates that the socialisation process does in fact depend on the time spent at their programme. It could also suggest that the way the programmes at NTNU are structured support students' professional identification, and/or provides them with the necessary tools and experiences to feel ready for the professional life. However, it is once again important to note the low number of responses from fourth and fifth year students, and that we have to perform more complex analyses to claim anything about what influences these scores, as well as the statistic significance.

3.3 Findings

The findings presented in the below section is based on a bivariate analysis with Pearson correlation, as well as linear regression analysis of the dependent variable (SISI) and the chosen independent variables.

As can be seen in table 1, there are only six out of the 21 correlations that are significant ($p = <.05$). Not surprisingly, one of these are relevant work experience and relevant volunteer experience, suggesting that if a students have had one, they are more likely to have also experienced the other. Furthermore, for the identification measure, year on programme (.28), extrinsic motivation (.13) and intrinsic motivation (.22) were significantly correlated, however with a correlation coefficient below .3, thus indicating a low correlation. Interestingly, the two strongest correlations in the correlation matrix is between year on programme and relevant work experience (.29) and relevant volunteer work experience (.41). In light of the previously mentioned interconnections between engineering education and demands of the working life, it is not too surprising that more experienced students appear more likely to have relevant work or volunteer experience as well.

Table 1   Correlation Matrix

	1.	2.	3.	4.	5.	6.	7.
1. I identify with engineers	-	.28**	.13*	.22**	.09	.11	.08
2. Year on programme		-	.08	.02	-.04	.29**	.41**
3. Extrinsic Motivation			-	-.11	.09	-.11	-.07
4. Intrinsic Motivation				-	.03	.11	.07
5. Praxis					-	-.05	-.06
6. Relevant work						-	.23**
7. Relevant volunteer work							-

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed)

Furthermore, the regression analysis showed that our model is significant ($p = <.001$) and explains about 11.8% of the variance in students' identification (.118). Table 2 shows all the coefficients and related significance.

Table 2   Linear Regression Analysis

	B Coefficients	Sig.
Year on programme	.23	.022
Extrinsic Motivation	.17	.023
Intrinsic Motivation	.43	<.001
Praxis	.13	.195
Relevant work	.07	.661
Relevant volunteer work	-.08	.624

Based on the correlation analysis, we expected at least three significant relationships in the regression analysis, which was confirmed, as the only significant variables were year on programme, extrinsic motivation and intrinsic motivation – the same as in the correlation matrix. Unlike in the correlation analysis, intrinsic motivation (.43) appears to have the distinctly strongest influence, with a moderate correlation, and year on programme (.23) and extrinsic motivation (.17) having weak correlation coefficients. These results might change or paint a slightly different picture if we performed a hierarchal regression analysis, but this has not been done as of today. In the context of the proposed research question, we can argue that motivation and years spent at their programme affects students' professional identification. Still, we cannot make any claims based on the presented research about whether the students are intrinsically and/or extrinsically motivated *before* starting their degrees or if the universities provide them with tools or experiences that facilitate and strengthen their motivation which further impacts their professional identification. On the other hand, since year on programme is significant in the regression analysis as well, the university appears to provide *something* that contribute to engineering students identifying with engineers.

However, in line with the dialectal pluralistic perspective established previously, these relationships and the related 'how's' and 'why's' should probably be explored further through e.g., qualitative interviews to gain an even more comprehensive understanding of these processes.

4   SUMMARY AND CONCLUSIONS

To conclude, it appears that the single-item measure of social identification could be a useful tool in measuring students' professional identification, however more research within this context is probably needed. Furthermore, the analyses show that students motivation, both intrinsic and extrinsic, are influencial when measuring their identification with engineers, in addition to how long they have studied at a programme. Interestingly, work praxis as a part of the study programme, previous relevant work and volunteer experience did not come out as having a significant impact on the students professional identification, despite the engineering programmes at NTNU continuously highlighting the importance of their close-knit relationships with the working life. However, as the regression analysis shows that the engineering students appear to identify more with engineers the further along in the programme they are, there must be something during their time at university which facilitates this gradually increasing identification. What exactly this is, will have to be explored later on.

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