Not always a nerd: exploring the diversity in professional identity profiles of STEM students in relation to their career choices

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ABSTRACT

Although there is a high demand of highly educated professionals in the technical sector, only about 50% of the graduates from a study program in science, technology, engineering and mathematics (STEM) opt for a career in the technical sector. Professional identity has been shown to influence students' career choice. STEM students whose professional identity is more in line with their future profession are more likely to commit to a career in the technical sector. At the same time, stereotyping can lead less prototypical students to leave the technical sector. However, little is known about the diversity in STEM students' professional identity and how this is related to their career choices. Based on a survey-study among 743 STEM-students, we developed five profiles of STEM students' professional identity called the *nerd*, the *status seeker*, the *hipster*, the *security seeker* and the *loner*. These profiles were significantly related to the strength of identification with their future profession and intended career choice. Results indicate that while there is much variation between STEM students' professional identity, more stereotypical, male students are still more likely to aim for a career within the technical field.

Conference Key Areas: Gender and diversity, attractiveness of engineering education, continuing engineering education and lifelong learning.

Keywords: STEM students, professional identity, career choice, career commitment

INTRODUCTION

As the Dutch economy relies heavily on the technical sector, the economic success of the Netherlands is dependent on the inflow of highly educated science, technology, engineering, and mathematics (STEM) students. And while the number of graduates in technical study programs has increased in recent years, only about 50% of them continue to work in a technical profession after graduation [1]. This is even more remarkable as there are low unemployment rates in the technical sector and therefore many opportunities for graduates to find work. As of now, little is known about why so many STEM students opt for a career outside the technical sector.

One concept that influences students' career choice is *professional identity* [2]. Professional identity can be described as a set of personal traits, values, interests, and competences relating to that person's profession [3]. Research has shown that a strong and well developed professional identity increases the likelihood that students choose a job in their field of study [4]. Additionally, when the representations of a certain profession are more congruent with a student's professional identity, they are more likely to be committed to and continue on in a career in that profession [e.g. 5]. Therefore, it can be expected that students with traits that are more in line with the stereotypical representations of professionals in the technical field, such as being male, being a nerd, are more likely to aim at a career in a technical profession than their less stereotypical counterparts. Thus, presenting students examples of more diversity within the technical community and the professional identity of their (future) peers can increase their chance to take up and remain in a career towards the technical field. However, little is known about the diversity in STEM students' professional identity and how this is related to their career choices.

In the present study, profiles of STEM students' professional identity are identified to highlight the breadth of variety of professional identity of STEM students. Additionally, these profiles of professional identity of STEM students are linked to the degree to which they identify with their future profession and their intended career choice.

1 THEORETICAL FRAMEWORK

1.1 Professional identity

Professional identity has been described as the relevant traits, believes, and motives a person holds about themselves in a professional role. In this definition, there is a strong focus on the individual and his or her personal believes, which are presumed to be stable in a person's life [6]. Contrary to that, there are also researchers who support a more socially oriented view on professional identity. They define professional identity as "the degree to which employees identify themselves with the profession that they practice and its typical traits" [7, p.211]. This take on professional identity as the communality between individuals in a certain profession can result in stereotypes, for example that a typical STEM student is a white male, who is shy and highly intelligent. This process of stereotyping can have as a result that young people who are suited for a profession in the technical sector feel that they do not belong between their prospective peers as they do not possess certain stereotypical traits or values of a profession. Whether professional identity is seen as a personal or social construct, researchers agree that a distinction can be made between the strength of professional identity and the content. The content of professional identity contains five dimensions, namely an individuals' interests, competences, values, personality and goals. The

strength of professional identity describes the degree to which an individual feels their relevant traits fit the traits of a certain profession [8].

Research on professional identity often focusses on how students or professionals develop a professional identity, that is to say how do students or professionals develop and shape their professional identity in time and which factors influence that process. Much less research is done on what the content of professional identity of students and professionals in a certain field is. Additionally, research on professional identity is most often performed in the medical or educational [3] field. However much less research has been done in the technical field and little is known about STEM students' professional identity. Moreover, research on the content of professional identity is often done in qualitative research on a small scale, whereby the content is measured in various manners. Large scale quantitative research that produces generalizable results on the content of professional identity of people in a profession is scarce [3].

1.2 Professional identity and career choice

Research shows that from a young age on, professional identity influences a person's life. Research on high school students shows that a well-defined strong professional identity improves students' school grades, their motivation to learn and how well thought out their career choices are [4]. In addition, research on STEM students has shown that university students who start their degree with lower levels of a match between their professional identity and their future profession or students with a strong but ill-defined professional identity (i.e. students who feel a strong commitment towards a certain profession without much knowledge of what that profession entails), are more likely to quit their studies. However, this need for a person's professional identity to be in line with the perceived characteristics and traits of a certain profession can pose a difficulty for people with less stereotypical traits of a certain profession. People who do not possess these stereotypical traits are much less likely to embark on a career towards a career in the technical field [e.g. 5]. However, the interest of less-stereotypical individuals in a career in the technical field can be increased when they come into contact with less stereotypical professionals who work in the technical sector. A study on university students showed that reading about a broad range of professionals in the technical sector with more or less stereotypical traits increased students' perceived communalities with professionals in the technical sector and increased the likelihood of choosing a path towards a technical career [5].

1.3 Research questions

Based on the literature review as described above, the goal of this research is to identify differences in the content of professional identity and to link these different profiles to the strength of identification with their future profession and their intended career choice. As such, three research questions were formulated:

1) What profiles of STEM students can be distinguished, based on their professional identity?
2) How do professional identity profiles influence the degree to which STEM students identify with their future profession?
3) How does professional identity influence STEM students' intended career choice inside or outside the technical sector?

2 METHOD

2.1 Participants

Last-year students from all technical study programs of two Dutch higher education institutions, one university, one university of applied sciences, were invited to take part in the study. About 3500 students received an invitation via email from their study advisor. In total, 816 students started to fill in the questionnaire (response rate 23.3%). Students with more than 10% missing answers, as well as students who indicated they were enrolled in a non-technical study program were excluded from data analysis. This resulted in the data of 743 students being included in the current study (34.2% female, 59.0% male, 6.9% unknown). The average age was 22.66 years old (*SD* = 2.78). Of the participants, 367 (49.4%) were enrolled at a university, while 338 (45.5%) were enrolled at a university of applied sciences (5.1% unknown).

2.2 Measures

To measure the professional identity of STEM students a new instrument, called the "Career Compass", was developed. Within the Career Compass preexisting, validated scales were used to measure the four dimensions of professional identity: interests [9], competences [10, 11], values and goals [12 - 15], and personality [16, 17]. This resulted in 178 items that were presented to the participants. Participants were asked via a 7-point Likert scale, ranging from 1= *not at all* to 7= *very much*, to what degree an item applied to them. Confirmatory factor analysis was performed on all five dimensions of professional identity. Model fit indices indicated sufficient fit for all dimensions of professional identity.

Next to the content of professional identity, the degree of identification with students' future profession was measured with six items [18], an example item being "*I feel good about becoming an engineer",* measured on a 7 point Likert scale. Finally, students' intended career choice was measured with two open questions, in which students were asked to name 1) an organization they would like to work for and 2) a job they would like to perform. Answers were coded by two independent raters as either technical (e.g., technical industry) or non-technical (e.g., hospital, financial industry). Interrater-reliability was assessed by the Cohen's Kappa which was deemed sufficient at a value of 0.68.

2.3 Analyses

In order to develop professional identity profiles of STEM students, k-means clustering was applied. ANOVAs were used to decide on the model best representing reality.

The professional identity profiles and career choices were related to the strength of identification using ANOVAs. Chi-square analysis were used to relate the professional identity profiles to the intended career choice.

3 OUTCOMES

3.1 Profiles of STEM students

K-means cluster analysis revealed five different professional identity profiles: the *security seeker* (24.2 %), the *hipster engineer* (22.5 %), the *nerdy enginee*r (21.4 %), the *status seeker* (16.6 %) and the *loner* (15.3 %). *Security seekers* are conscientious and conservative persons who values routine and structure and do not seek intellectual stimulation or challenges. They are organized, but score lower on analytical skills. *Hipster* engineers are very social, are interested in fashion and beauty. They find it

important to have a purpose in life, to help others, want to live a healthy life and value their autonomy. They score high on design skills, working in teams and being internationally oriented. *Nerdy* engineers distinguish themselves by having strong analytical and research skills. They are conscientious and rational and find intellectual stimulation very important. They are interested in gaming, while scoring very low on socially oriented interests. *Status seekers* are very extravert, social students who are conscientious and rational. They score high on (self-) management skills and are very analytical. They value status and power and find money important. Finally, *loners* are students who are very introvert and agreeable. They find it important to have a comfortable life and value money, status and power only very little. *Loners* are mostly interested in gaming and score low on social activities, fashion and beauty. While estimating all their competences as quite low, they score especially low on managing others and collaborating with others. In Table 1, the distribution of all students can be found. The differences between men and women was found to be significant ($X^2(4)=121.089$*, p< .05)*: male students were more likely to be classified as status driven, nerdy or loners, while female students were more likely to be classified as hipsters or security seekers*.*

Table 1. Professional identity profiles by gender

	Distribution of profiles n=			Mean strength of identification		
	Overall	Women	Men	Overall	Women	Men
Loner	114 (15.3%)	30 (11.8%)	78 (17.8%)	4.46	4.01	4.67
Security seeker	180 (24.2%)	98 (38.6%)	68 (15.5%)	4.53	4.35	4.72
Nerd	159 (21.4%)	16 (6.3%)	129 (29.5%)	5.08	5.08	5.08
Hipster	167 (22.5%)	89 (35.0%)	71 (16.2%)	4.70	4.64	4.83
Status seeker	123 (16.6%)	21 (8.3%)	92 (21.0%)	4.70	4.29	4.79
Total	**743 (100%)**	**254 (100%)**	**438 (100%)**	**4.70**	**4.45**	**4.85**

3.2 Strength of identification

Analyses of Variances (ANOVA) revealed significant differences between the profiles in the degree to which STEM students identified with their future profession, even after correction for demographic factors (gender, level of education, completed internship, and type of study program) ($F(4, 669)=4.15$, $p=0.00$). Nerdy students scored highest on identification with their future profession, followed by the hipsters and status seekers (see Table 1).

Also, significant differences were found between the degree to which male and female students identified with their future profession (again corrected for demographics). Male students scored significantly higher ($M=4.85$, $SD=1.03$) than female students ($M=4.45$, $SD=1.15$) ($F(1,674)=7.65$ with $p=0.006$).

3.3 Intended career choice

Chi-square analysis revealed a significant relationship between STEM students' professional identity profiles and their intended career choice within or outside the technical sector ($X^2(4) = 25.19$*, p< .05)*. Students who are classified as *nerds* are most likely to pursue a career in the technical sector (64.7%), followed by *loners* (62.0%),

while security seekers are least likely to aim at a career within the technical sector (40.4%). Because of unequal gender distributions over the profiles, separate analyses were carried out for men and women, showing no significant differences between professional identity profiles and intended career choice for either men ($X^2(4) = 4.04$, $p = 0.40$) nor women ($X^2(4) = 4.09$, $p = 0.39$). For a complete overview see Figure 2.
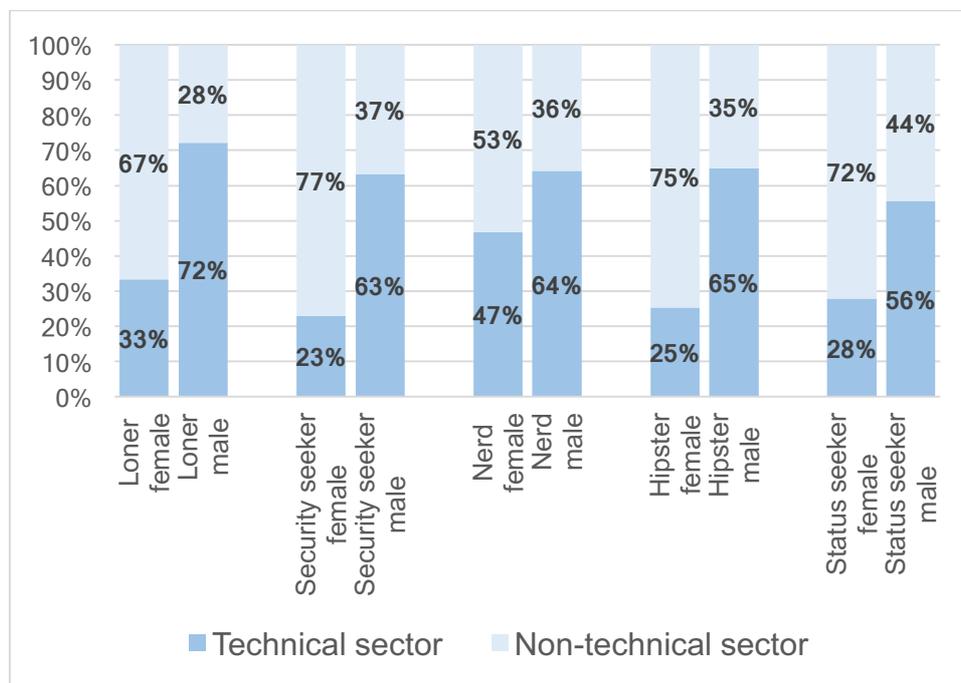
Fig. 2. Intended career choice per professional identity profile per gender

ANOVA showed a significant relationship between STEM students' strength of identification with their future profession and their intended career choice, $F(1, 601) = 59.10$, $p = 0.000$. Analysis of means showed that STEM students who aimed at a career outside the technical sector identified significantly lower with their future professions ($M = 4.43$, $SD = 1.05$) than their peers who aimed at a career in the technical sector ($M = 5.06$, $SD = 0.98$).

4   CONCLUSION AND RECCOMENDATIONS

The research at hand succeeded to identify five different profiles of STEM students, based on their professional identity, thus highlighting the diversity of that population. The profiles range from profiles with more stereotypical characteristics, such as the *nerd* profile to profiles with less stereotypical traits, such as *hipsters*. Further analysis shows that in line with expectations, professional identity does influence the degree to which STEM students identify with their future profession. Likewise, students' career choice is influenced by their professional identity: students with professional identity profiles that entail more stereotypical characteristics such as *nerds* or *loners* are much more likely to aim for a career in the technical sector than students with profiles with less stereotypical traits, such as *security seekers* and *hipsters*. However, the differences between profile in career choice evaporate completely when gender is taken into consideration. Conclusively it can be said that while there is much variation

between STEM students' professional identity, more stereotypical, male students are still more likely to aim for a career within the technical field.

Findings from this study can be useful for (prospective) STEM students, educational institutions and organizations in the technical sector. STEM students may gain more insights into the diversity within the population of STEM students. This increased communality might help them to identify more with their peers and their future profession, which in turn can increase their motivation to study and decrease their chance of leaving the field. Another direction to explore, is how the identity profiles are related to different study programs. Do we see more variation in profiles in one study program and a more homogeneous group in another program? Educational institutions can use the findings to adjust the study program to the needs and interests of different profiles of STEM students. As an example, giving the possibility for more social types of STEM students to work together, or highlighting the benefits for society of working projects in order to motivate students with a *hipster* profile. Finally, organizations in the technical sector can use the developed typology to closely look at their workforce and recruit specific types of STEM students as job adds can be construed to attract specific types of STEM students.

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