Exploring Congruency between Engineering students' Professional Role Preference, Competences and Career Choice

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ABSTRACT

Self and professional awareness are important factors when choosing a profession that is congruent with one's interest and competences. This study investigated the quality of professional role choice of 55 Belgian final-year engineering students. We examined congruency between vocational interest, self-perceived strengths and weaknesses and career aspirations. Through mixed methods, three professional role outcomes were measured: role preference (job interview), role competence (questionnaire) and job role (job vacancy selection). We used the Professional Roles Model for Future Engineers (Craps et al. 2018) as theoretical framework and evaluated (1) the alignment between the role preference and competency profile (aligned, fluid, unaligned) and (2) the consistency with the chosen job vacancy (consistent, inconsistent).

The results indicated that the role preference could be aligned with the self-perceived competency profile for 43% of the students (N=23). However, the difference with the Unaligned was small (N=20). Almost a fifth (N=11) did not have an outspoken

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competency profile and could be aligned to all roles. Remarkably, most of the Unaligned preferred to work in an innovative role. The majority of the students (87%) preferred a job vacancy consistently with the role preference or competency profile. Interestingly, only 8 students (15%) obtained a one-to-one congruency between the role preference, competences and job role. Unaligned students seemed to select a job vacancy in accordance with their competency profile, rather than with their role preference. Further research is required to investigate the contribution of professional awareness, the alignment with the actual career behaviour and the correlation with background variables.

1 INTRODUCTION

Research has demonstrated that a better understanding of one's professional identity not only has positive consequences for student learning and study choices [1-3], but also increases employability and job satisfaction [4-7].

Professional identity development involves an interaction between the expectations related to a specific professional role and the needs and aptitudes of the student preparing for that role [8]. However, this argument presumes that students have enough information about (a) their own competences, preferences and personality and (b) the professional roles and role requirements.

This study contributes to the contemporary debate on the pivotal role of engineering identity in that it explores to what extent a better understanding of the professional roles contributes to the quality of role choice. The quality of role choice refers to the evaluation by the student of a fit between his/her aptitudes and occupational wishes on the one hand and the learning tasks on the other hand [9]. In this study, the quality of role choice will be operationalised by role congruence. More specifically, we will examine (1) to what extent students' professional role preferences align with their self-perceived professional competency level and (2) whether they make potential career choices consistent with their preferred role.

This study is part of a larger research project that investigates to what extent professional role awareness support career development learning of engineering students.

2 BACKGROUND

2.1 Role congruence and role confidence

According to Holland's Theory of Vocational Choice, people will search for work environments where they can optimally use their competences and express their values and attitudes [10]. For example, an investigative type who is likely to be precise, analytical, curious, and intellectual, will search for an investigative environment that enables and facilitates this type of behaviour. More congruency between personality and career leads to greater job satisfaction and success [5]. This implies that engineering students must be aware of both their personality (e.g., interests, strengths

and weaknesses) and the job type (e.g., professional role, wage, job autonomy) they choose to apply for.

Thornton and Nardi (1975) describe four stages in the process of professional role identification, which ranges from idealised perceptions of the professional role to making the role more congruent with one's own values and goals [11]. The final stage – the personal stage in which they internalise a professional role – is often not reached by the time students graduate. One essential reason is that they lack experiences in the professional role, but they may also lack 'sense making' opportunities in their education in which students learn to connect information about professional roles with their skills and knowledge and with their needs and ambitions [4,11]. However, earlier research has reported that when students are able to align their competences with those essential in a professional role, they will experience feelings of role congruence and increase their perception of role fit which will make them more confident in a professional role. For example, Cech et al. (2011) examined two dimensions of professional role confidence: expertise confidence referring to the confidence in the competences required in the job, and career-fit confidence referring to the confidence that a career path is consonant with the interests and values [2].

The course in which the current research activity is conducted, aims to make students more aware of and more confident in their professional competences and interests. Based on a reflection exercise of interests and competences, students were instructed to search for a job vacancy. The course and research activity will be further explained in the Method Section.

2.2 Professional Roles Model for Future Engineers

The professional roles described by Hofland et al. (2015) and further developed by Craps et al. (2018) in the Professional Roles Model for Future Engineers (PREFER-model) were used in this study to examine vocational interest and self-perceived level of professional competences. The model represents three professional roles independent of discipline: Operational excellence (focus on process optimization & increasing efficiency); Product leadership (focus on radical innovation & research and development); Customer intimacy (focus on tailored solutions for specific clients). The roles specifically focus on early career engineers and are flexible in use since several roles can be combined in one job. The model has been thoroughly validated with both industry stakeholders and engineering students [12,13].

The PREFER-model describes competency profiles per role reflecting the professional competences engineering graduates need to possess at a Master's level in order to be successful in one of the professional roles [13,14]. For example, persuasiveness and perseverance are essential in a product leadership role, whereas networking and capacity for empathy are crucial in customer intimacy. Engineers working in the role of operational excellence need, amongst others, a positive critical attitude and must excel in work management. In essence, as different jobs have different requirements, the PREFER-model aimed to identify which competences are essential in each

professional role. It should be noted that the competency profiles do not include (basic) competences required for all engineers but only comprise competences of which industry seeks an excellent level.

2.3 Research questions

This study zooms in on a unique aspect of career development learning: that of alignment with professional roles, and how alignment might be associated with the quality of role choice. The latter concept is operationalised by the construct of role congruence. Following Hirschi, Niles and Akos (2011), role congruence is defined as the similarity between a student's vocational interest, professional competences and career aspirations [15].

One dimension of our analysis considers alignment of a student's role preference (vocational interest) with his/her self-perceived professional competency level. The second dimension of our analysis is forward-looking, considering consistency with the preferred career choice (career aspirations). We developed categorical labels from Aligned to Unaligned and from Consistent to Inconsistent, as detailed in the Method Section.

This paper reports on the first part of a case study investigating whether a better understanding of the professional roles contribute to a higher degree of role congruence. Following research questions were formulated:

RQ 1 *How aligned are engineering students' professional role preferences with their self-perceived professional competency levels?*

RQ 2 *How do Aligned students differ from Unaligned with respect to their preferred career choice?*

3 METHOD

3.1 Sample

The sample comprised 55 final-year students (16% female) of the master's programmes in Electronics-ICT and Electromechanical Engineering Technology at KU Leuven. The proportion of female students in these programmes ranges between 6,50% and 8,33%, and is as such lower than in our sample. The research was performed in the first semester of the academic year 2018-2019 (November 2018). All participants were informed and have consented to be part of this study.

3.2 The Engineer as a Professional Communicator

The research was conducted in the master's course Management and Communication. One part of the course, called '*The Engineer as a Professional Communicator'*, focuses on the understanding of the differences between the technical communication skills used by engineers and the way of thinking and communicating in the business world.

A practical exercise of learning how to translate these insights in a professional win-win communication, was a fictional job application process. Students were instructed to translate a critical self-analysis into a unique selling proposition. They analysed their personality and professional skills through various competence and personality tests (e.g., Myers - Briggs), searched through different recruitment channels, critically analysed job offers and responded to one vacancy appropriately. They were allowed to make minor changes in the job requirements to make the job vacancy more tailored to their profile. Finally, the students engaged in a role play simulating a job interview.

From each individual student, the lecturer received a portfolio including the critical analysis of their personality and qualities, the chosen job vacancy, a resume and a cover letter. In the role play job interview, the lecturer acted as an HR representative of the company that was offering the job they responded to.

3.3 Role congruence

To measure role congruence, professional role outcomes per student were collected through the job interview (vocational interest or professional role preference), a questionnaire (professional competences in terms of self-perceived role competency profile) and the job vacancy (career aspirations or preferred career choice). Fig. 1 illustrates the theoretical framework that is developed based on the three role comparisons. The research questions focus on the congruency between the three role outcomes.

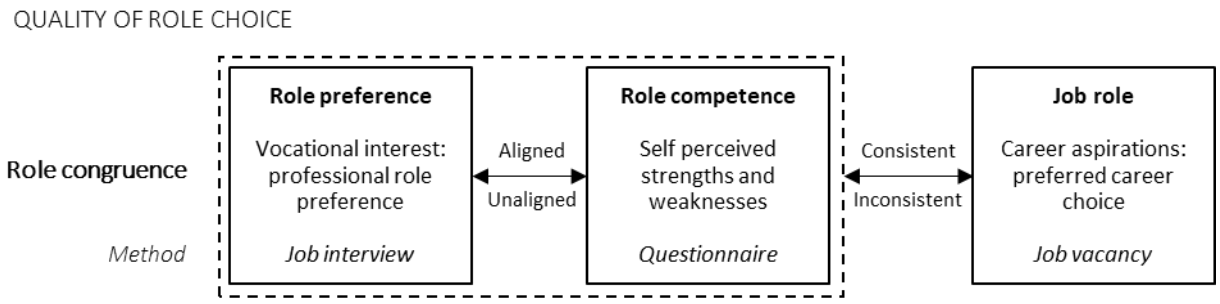

Fig. 1 Theoretical framework of the current study

- ***Measurement Role preference***

During the job interview, a question was asked related to professional role preference. Students could pick one of the three possible answers implicitly referring to the three professional roles. This means that the interviewer did not refer to the roles, nor the competences. The students were invited to defend their choice in order to clarify their preference. The role preference question was derived from a set of questions from a validated test aimed at aligning students to the professional roles of the PREFER-model [16]. A question could be for example: "*Thinking of some projects you have been involved in, what part was typically your favourite part of the project? Brainstorming and designing; execution and implementation; communication with stakeholders and presentation of preliminary results or final output*." We labelled this outcome as *role preference.*

- ***Measurement Role competence***

After the job interview, participants were asked to complete a competence questionnaire, containing the 19 competences of the PREFER-model (each with a brief definition). Students were requested to rate their self-perceived skills levels for each of the competences on a five point Likert scale. Role scores were calculated by aggregating the scores of the competences belonging to the same professional role. In case of a missing value on one of the competences, no role score was calculated (3,03%). In this way, we obtained 3 scores per participant - one for each professional role - between 7 and 40. The minimum and maximum score depended on the number of competences included in the competency profile of the professional role (*Table 1*).

Table 1. Maximum and minimum score per competency profile

Competency profile	**N competences**	**Min. score**	**Max. score**
Product leadership	7	7	35
Operational excellence	8	8	40
Customer intimacy	8	8	40

If a particular role deviated by one standard deviation from the other two, this role was attributed as the dominant role. An example of this role attribution, labelled *role competence*, is illustrated in Table 2 (SD≥3.0, see *Table 3*).

Table 2. An example of role competence outcome

Student	**Score $_{PL}$**	**Score $_{OE}$**	**Score $_{CI}$**	**Role competence***
Student1	21	22	26	CI
Student2	18	24	25	OE + CI

**PL = product leadership, OE = operational excellence, CI = customer intimacy*

- ***Measurement Job role***

The preferred career choice, labelled *job role,* was operationalised by the job vacancy the students opted for. The students were free to select any job advertisement from any recruitment channel.

The 55 chosen vacancies (one per participant) were independently positioned in the PREFER-model by three researchers. They assigned the vacancies to one or more professional roles, based on the job description and job requirements. Through interrater reliability, emphasizing the similarity between the 'judges' [17], the outcomes were compared and each job vacancy was finally assigned to one or more professional roles indicated by at least two researchers. The interrater reliability was calculated with Cohen's kappa with k between 0 (the agreement between reviews rests entirely on chance) and 1 (complete agreement). k>0.60 indicates substantial agreement.

- ***Level of alignment***

The level of alignment was determined by the role preference and the role competence. Based on a categorization adopted by Rüde et al. (2018) in their research of alignment between job plans and postgraduation outcomes, three groups were identified:

Aligned, Fluid and Unaligned students [18]. Students who rated their strengths in terms of professional competences in accordance with their preferred professional role, were identified as *Aligned*. For example, if a student had a preference for role X and the role competence was assigned to role X and Y, the student was classified as Aligned. A one-on-one alignment between the role preference and role competence was identified as *Exclusively aligned.* In case there was partial alignment, a student was classified as *Inclusively aligned*.

If they did not have an outspoken preference or competency profile and position themselves in the middle of the PREFER-model (three roles combined), they are categorised *Fluid*. If the role preference and role competence were not congruent, they are classified *Unaligned*.

- ***Level of consistency***

The level of consistency is determined by the preferred career choice. If students opted for a vacancy that is similar to the role preference *or* role competence, we categorize the students as *Consistent.* If not, they are classified as *Inconsistent.*

4 RESULTS

In this study we investigated congruency between the professional role preference (vocational interest), professional competences and the preferred career choice (career aspirations). We first present descriptive results of the three role measurements. Second, we explore to what extent these results are congruent.

4.1 Role preference

During the job interview, students were explicitly asked which role they preferred. The results indicate that role preferences are distributed rather equally over the three roles. (*Table 4*). Only three students replied they would prefer to combine two options (product leadership and customer intimacy). It should be noted that students were asked to indicate what they preferred the most and they might have felt obliged to select only one answer.

4.2 Role competence

Students perceived their competences related to operational excellence to be the strongest (M=22.81, SD=2.895) and the competences related to product leadership the least strong (M=19.00, SD=2.733) (*Table 3*). This was also reflected in the roles that could be assigned to the students based on the sum scores per competency profile (*Table 4*). The operational excellence role was most pronounced (61%, N=33), either uniquely or combined with the customer intimacy role. A fifth of the students (N=11) did not have an outspoken competency profile and were attributed to a

combination of three roles. One respondent was excluded due to non-response to the role competence questionnaire.

Table 3. Mean scores professional competences per professional role

	N*	Minimum	Maximum	Mean	Std. Deviation
Product leadership	54	14	25	19.00	2,733
Operational excellence	54	16	28	22.81	2,895
Customer intimacy	52	16	27	21.54	2,947

** In case of a missing value, no role score was calculated.*

4.3 Job role

All job vacancies could be positioned in the PREFER-model with overall moderate agreement (k=0.57) and substantial agreement per role (k_{PL}=0.69, k_{OE} =0.61 and k_{CI}=0.73). Almost 70% of the vacancies was classified identically by the three researchers. In the remaining cases, disagreements were mostly related to multiple assignments to a role, rather than completely different assignments (N=19).

The majority of the students (63,64%, N=35) choose a job vacancy related to operational excellence (single role or combined with another role), followed by customer intimacy (50%, N=28) and product leadership (29,09%, N=16) (*Table 4*). Vacancies that reflected both the opportunity for technological optimization (operational excellence) and tailored solutions (customer intimacy) seemed also to be appealing to quite some students (N=12).

Table 4. Distribution of role outcomes (N)

	PL	OE	CI	PL + OE	PL + CI	OE + CI	PL + OE + CI	Total
Role preference	15	20	17		3			55
Role competence	1	18	8		1	15	11	54
Job role	4	16	11	7	5	12		55

PL = product leadership, OE = operational excellence, CI = customer intimacy

4.4 Level of alignment

Table 5 illustrates the level of alignment between role preference and role competence. 43% (N=23) of the students could be categorized as Aligned. However, the difference with the Unaligned is small (N=20). Interestingly, the majority of the Unaligned (60%, N=12) preferred a job in the product leadership role while none of the Aligned preferred this role. A fifth of the students (N=11) did not have an outspoken competency profile and were categorized as Fluid.

More than half of the Aligned students (57%, N=13) were exclusively aligned showing a one-on-one outcome for role preference and role competence (9 for operational excellence, 3 for customer intimacy).

Table 5. Level of alignment between role preference and role competence

		Role preference									
		PL		**OE**		**CI**		**PL + CI**		Total	
Role competence	**Aligned**	0	*0%*	12	*52%*	10	*43%*	1	*4%*	23	*43%*
	Fluid	3	*27%*	4	*36%*	3	*27%*	1	*9%*	11	*20%*
	Unaligned	12	*60%*	4	*20%*	3	*15%*	1	*5%*	20	*37%*
	Total	15	*28%*	20	*37%*	16	*30%*	3	*6%*	54	

PL = product leadership, OE = operational excellence, CI = customer intimacy

4.5 Overlap between level of alignment and level of consistency

Table 6 displays the overlap between the level of alignment between role preference and role competence (Aligned/Fluid/Unaligned) and the level of consistency of the preferred career choice (Consistent/inconsistent).

Table 6. Comparison between level of alignment and level of consistency

	Consistent		**Inconsistent**		**Total**	
Aligned	19	*83%*	4	*17%*	23	*100%*
Fluid	11	*100%*	0	*0%*	11	*100%*
Unaligned	17	*85%*	3	*15%*	20	*100%*
Total	47	*87%*	7	*13%*	54	

Whereas the difference between Aligned and Unaligned categories was rather small, the majority of the students choose a job vacancy consistent with the role preference or role competence (87%, N=47).

A more detailed analysis of the Aligned students indicated that 8 of the 13 Exclusively Aligned could also be categorized as Exclusively Consistent, 2 as Inclusively Consistent, 3 as Inconsistent. By consequence, only 15% of the outcomes were congruent along the line (Exclusively Aligned, Exclusively Consistent) on the total sample.

The large consistency in the Unaligned category is due to the congruency between role competence and job role. It seems that all 17 students were able to select a vacancy according to their strengths and weaknesses but did not articulate their vocational interest consequently. The smallest group of the sample (N=3) were categorized Unaligned and Inconsistent which means they had different outcomes for role preference, role competence and job role.

5 DISCUSSION

It is assumed that when students are more aware of their professional identity, they will be more motivated and persistent in their study and display higher levels of employability and job satisfaction [5,7,9]. Self and professional awareness are important factors when choosing a profession that is congruent with the students'

interests and competences. This study investigated the quality of professional role choice of final-year engineering students. Through the construct of role congruence we examined whether students could align their vocational interest with their self-perceived strengths and weaknesses, consistently with their career aspirations. Through mixed methods, three professional role outcomes were measured: role preference, role competence and job role.

The proportion of Unaligned students (37%) suggests that more than a third of the final-year engineering students did not express a vocational interest in line with their self-perceived strengths and weaknesses. Especially students who preferred to work in an innovative role (product leadership) struggled to align their interest with their competency profile. On the one hand, this finding emphasizes the importance of supporting career development learning earlier than in a students' last year of university. On the other hand, it should be noted that the programme in engineering technology at KU Leuven is mostly focused on operational excellence. As a consequence, it might not be surprising that students feel most competent in competences related with this role. This was also confirmed by the outcomes of role competence. However, we did not observe similar findings for customer intimacy. Earlier research indicated that students felt least prepared for the role of customer intimacy [13], but only 3 out of 16 students who preferred this role were categorized Unaligned.

Although the proportion of Consistent students (87%) is high, only 8 students (15%) of the total sample displayed full congruency between role preference, role competence and job role. Students appeared to seek more congruency between the job vacancy and their self-perceived strengths and weaknesses than between the job vacancy and their vocational interest. Whether a better understanding of the professional roles contributes to role congruency will be investigated in a follow-up study where the PREFER-model will be explicitly introduced.

The findings should be interpreted carefully against the specific context. In the Management and Communication course, students were urged to critically analyse their professional competence levels and to reflect on this analysis in a portfolio including peer-reviewed feedback. They were instructed to select the vacancy based on those outcomes and were even allowed to rewrite few requirements in order to increase job fit, which might explain the high Consistency score. Although this kind of career interventions has positive effects on career-decision making skills and career knowledge, choosing a job vacancy as an assignment might differ from the actual career choices [9]. A follow-up study on actual career behaviour of young graduates would be recommended for future research.

In line with earlier findings [4,9], the course method with critical reflection and career dialogue seems to be effective. However, a larger sample and a research design with an experimental and control group could enrich the data to draw further conclusions on significant differences between Aligned and Unaligned respondents and background variables such as educational background, grades or gender.

Professional role preference was included in the study by asking only one question during the job interview. More research using validated measurement instruments should be conducted concerning role preference and role competence in large representative samples. It could contribute to the implementation of the Professional Roles Model for Future Engineers in engineering education as a valuable instrument in increasing engineering identity development and career guidance.

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