Identifying Potential Secondary School Teachers among Science University Students: A Latent Profile Analysis

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ABSTRACT

The STEM teacher shortage in secondary education makes it important to investigate who is interested in becoming a STEM teacher, so that recruitment initiatives can be adjusted to these students’ characteristics. A latent profile analysis on data from 905 STEM university students identified two types of students with teaching aspirations. The first type (14%) consisted of undecided students who were interested in many careers, had high social interest, and wanted to work in a nice environment with much social contact. The second group (12%) was interested in research, science communication, and teaching. This group had high intellectual and social interest, and wanted to be intellectually challenged. Both groups had high teacher self-efficacy. Implications for teacher education recruitment are discussed.

KEYWORDS

Teacher recruitment; STEM; career aspirations; vocational interests; work values; self-efficacy

Introduction

The mathematics and science teacher shortage in secondary education is a serious problem in many countries worldwide, such as the United States, the United Kingdom, the Netherlands, and many other European countries (Adriaens, Fontein, Den Uijl, & De Vos, 2016; Kearney, 2016; Sutcher, Darling-Hammond, & Carver-Thomas, 2016). This shortage is problematic because the demand for highly educated employees in STEM (Science, Technology, Engineering, and Mathematics) fields are ever-increasing, most notably in information technology and engineering (Xue & Larson, 2015). Enthusiastic STEM teachers play a crucial role in raising secondary school students’ scientific curiosity and interest, hereby increasing the chances that they will opt for science majors (Hall, Dickerson, Batts, Kauffmann, & Bosse, 2011). However, the STEM teacher shortage forces schools to hire underqualified or even unqualified teachers, to increase the student–teacher ratio, to have teachers teach more lessons, and to even cut electives from the curriculum (e.g., computer science in the Netherlands) (Schellevis, 2017; Sibieta, 2018; Vloet, Den Uijl, & Fontein, 2017). As a consequence, high-quality education in secondary school STEM subjects are at risk.

There are multiple causes of the STEM teacher shortage: the retirement of a large proportion of the current teacher population, high attrition of early career teachers, and the low enrollment in STEM teacher education (Organisation for Economic Co-operation and Development [OECD], 2018; Royal Netherlands Academy of Arts and Sciences...
In this study, we focus on the problem of low enrollment in STEM teacher education programs in university, first of all, because the shortage of university-educated teachers is especially urgent (KNAW, 2017). This shortage of university-educated teachers is problematic, since only university-educated teachers are qualified to teach in the upper grades of secondary education. Also, as Carlo et al. (2013) argue, teachers educated at the master’s degree level are ever more desirable because teachers’ roles and responsibilities are increasingly complex and demanding. Moreover, the master’s degree plays a role in raising the status of the teacher profession (Carlo et al., 2013). Finally, by focusing on enrollment at the university level, there is a large, clearly demarcated and relatively easily accessible pool of potential teacher education candidates, namely all students who are pursuing STEM degrees at university.

Most research into motives for teaching focuses on pre-service and in-service teachers (Kyriacou & Coulthard, 2000). As a consequence, knowledge of why people opt for a career in teaching is limited to the motives and views of people who already chose to become a teacher or at least to pursue teacher education. As such, we have very little knowledge on undergraduates’ interest in teaching (Kyriacou & Coulthard, 2000; Moin, Dorfield, & Schunn, 2005). In order to combat the teacher shortage and increase the enrollment in STEM teacher education, we need to know more about the characteristics of potential teacher education candidates, i.e., those students who are eligible to enroll in teacher education programs as well as interested in the teaching profession. After identifying such target groups, recruitment efforts could be tailored to the characteristics of these groups.

**Literature review**

Social-cognitive career theory (SSCT), rooted in Bandura’s (1989, 1997) general social cognitive theory, posits that several factors play an important role in influencing educational and career choices, and subsequently performance and satisfaction (Lent, Brown, & Hackett, 1994). Three central factors in SSCT are interests, outcome expectations, and self-efficacy. Individuals who choose a major or job in line with their interests, that leads to outcomes they find valuable (e.g., a certain income, status, challenge), and in which they have to perform tasks in which they feel competent are more likely to perform well and to be satisfied with their major or job than individuals whose interests, outcome expectations, and self-efficacy are less congruent with the chosen major or job. The SSCT model has been validated in multiple empirical studies (e.g., Lent et al., 2003, 2005; Lent, Lopez, Lopez, & Sheu, 2008). Therefore, our study follows social-cognitive career theory and focuses on STEM students’ vocational interests, outcome expectations (reframed as work values), and self-efficacy.

**Vocational interests**

To study STEM students’ interests, we use Holland’s (1997) theory of personality types and environments. The central thesis of Holland’s theory is that people’s achievement (in a specific job or specific educational program) is influenced by the congruence between their personality type and the (work or educational) environment (Holland, 1997). Both an individual’s personality and an educational or professional environment can be
described by six vocational interests: realistic, investigative, artistic, social, enterprising, and conventional (Holland, 1997). Realistic interest refers to working with things (e.g., machines, equipment). Investigative interest is about exploring and understanding scientific phenomena, about developing new knowledge. Artistic interest revolves around creativity and expression. Social interest is an interest in working with people, e.g., teaching and counseling. Enterprising interest concerns activities such as negotiating, selling, and persuading. Last, conventional interest is about a preference for routines, procedures, and structured activities. When an individual’s interests match the type of behavior needed in the educational or professional environment that person is in, Holland speaks of person-environment congruence or fit. Research has corroborated Holland’s theory of fit: Students who are pursuing a major that is congruent with their interests perform better than students whose interests are not congruent with their major (e.g., Feldman, Smart, & Ethington, 1999; Le, Robbins, & Westrick, 2014; Nye, Su, Rounds, & Drasgow, 2012).

In the last decade, Holland’s theory has also been applied to teacher education research (Kaub, Karbach, Spinath, & Brünken, 2016). High social interest is a main characteristic of teachers (Denzler & Wolter, 2009; Kaub et al., 2016; Klusmann, Trautwein, Lüdtke, Kunter, & Baumert, 2009; Neugebauer, 2013). In addition, high investigative interest has been found among secondary school mathematics and science teachers (Henoch, Klusmann, Lüdtke, & Trautwein, 2015; Kaub, Stoll, Biermann, Spinath, & Brünken, 2014). Kaub et al.’s (2014) study found evidence for Holland’s assumption of person-environment fit. They reported that the level of fit between student teachers’ vocational interests and the teaching profession was related to satisfaction with the teacher education program, pedagogical interest, self-efficacy, and aspects of (mental) health. Moreover, an earlier study by Kaub et al. (2012) showed that science student teachers with lower social interest were less satisfied in their first year of study. Finally, in line with SCCT (Lent et al., 1994), which emphasizes the link between interest and career choice, and in line with Holland’s (1997) proposition that individuals tend to choose majors and careers that match their vocational interests (self-selection), Henoch et al. (2015) found that students with higher social interest were three times more likely to choose teacher education than students with lower social interest. High social interest thus seems an important characteristic of successful teacher education candidates.

Work values

Outcome expectations are beliefs about the consequences of given actions (Lent et al., 2008). Job-related positive outcomes that are important to an individual can be perceived as work values. Work values (or job or career values) “refer to the importance individuals place on different job characteristics and to the kind of rewards they seek to attain in their jobs” (Lechner, Sortheix, Göllner, & Salmela-Aro, 2017, p. 52). Work values can be categorized into intrinsic values (i.e., inherent to the work itself such as challenge and autonomy), extrinsic values (i.e., aspects that are a consequence of the work), interpersonal values (i.e., aspects related to contact with other people, interpersonal relationships at work), and altruistic values (which refer to valuing helping others and contributing to society) (Twenge, Campbell, Hoffman, & Lance, 2010). Like interests, work values are related to educational and career choice (Balsamo, Lauriola, & Saggino, 2013), job
satisfaction (Dawis, 2002), and job performance (Judge, Thoresen, Bono, & Patton, 2001). This means that, when choosing a career, students will take into consideration the values they find (most) important and will refrain from choosing a career that they feel will not meet these values. For example, students who attach great value to extrinsic values such as status and income could be less attracted to teaching, because they might perceive teachers’ status and salary to be low (Research Centre for Education and the Labour Market [ROA], 2017). In contrast, students who hold altruistic values in high regard may be attracted to teaching, as they feel that as a teacher they can help others and contribute to society (Watt & Richardson, 2007). There is hardly any research available on student teachers’ work values, but the literature on student teachers’ motives to choose teaching as a career shows that (in developed countries) intrinsic and altruistic motives are the most important and that extrinsic motives only play a small role (Bergmark, Lundström, Manderstedt, & Palo, 2018; Heinz, 2015). This could mean that university students with high intrinsic and altruistic work values may be more interested in teaching than students with mainly extrinsic work values. Current university students can be classified as millennials (born after 1980, Papavasileiou & Lyons, 2015). Research on millennials’ work values reveals that, in general, they want a job that is interesting, wish to work in a social work environment, and want a healthy work–life balance (Kuron, Lyons, Schweitzer, & Ng, 2014). As such, intrinsic (interesting work), extrinsic (work–life balance), and interpersonal work values (social environment) all seem important. The literature, however, is not conclusive on the relative importance of these values: Whereas some studies found that millennials attach the most importance to extrinsic values, other studies revealed that either intrinsic or social values were ranked highest (Papavasileiou & Lyons, 2015). A consistent finding is that millennials do not attach a lot of value to the prestige and status of a job (Papavasileiou & Lyons, 2015). Due to the importance of work values in the process of choosing a career and their effect on work engagement and career and life satisfaction (Lechner et al., 2017), it is valuable to investigate which work values university STEM students hold in high regard.

**Self-efficacy**

Self-efficacy refers to the individual’s belief in her or his ability to successfully perform certain behaviors (Bandura, 1997). Self-efficacy influences educational and career choices: Individuals will estimate their own capabilities in relation to a certain educational program or job and compare these to the requirements of that educational program or job. If they perceive their self-efficacy in certain skills as low, they will be less interested in programs and jobs that require these skills (Betz & Hackett, 1981; Rottinghaus, Larson, & Borgen, 2003). Moreover, self-efficacy is related to persistence, so individuals with high self-efficacy are more likely to endure in the face of challenges and to exert more effort (Bandura, 1989). As a result, we expect that STEM undergraduates’ level of self-efficacy in secondary school teaching will be positively related to their interest in a career as a teacher. Moreover, following Bandura’s theory (1989), students high in teacher self-efficacy at the start of a teacher education program likely are better able to manage the demands of the program (e.g., persisting in the school practicum which can be highly challenging). While much is known about preservice teachers’ teacher self-efficacy (for an overview, see, for example, Zee and Koomen (2016)), STEM undergraduates’ teacher self-efficacy has—to the best of our knowledge—not
been investigated. It is likely, though, that STEM undergraduates’ self-efficacy in teaching is related to their interest in a teaching career, in the same way as undergraduates’ research self-efficacy is related to their aspiration for a research career (Adedokun, Bessenbacher, Parker, Kirkham, & Burgess, 2013) and their entrepreneurial self-efficacy to their intentions to pursue an entrepreneurial career (Shinnar, Hsu, & Powell, 2014). Hence, we will measure STEM university students’ self-efficacy in secondary school teaching to investigate how it is related to their interest in a teaching career. To be able to put these scores into perspective, we will also measure their self-efficacy in working in the industry and in research. By doing so, we will obtain a more comprehensive picture of the relationship between self-efficacy and interest in different STEM careers.

**This study**

Choosing an educational or a career path is never a choice made in isolation. Rather, it is a choice from a number of possible alternatives that are compared using relevant criteria and information (Gati, Fassa, & Houminer, 1995). The issue that is often connected to the STEM teacher shortage is the availability of alternative careers that are regarded as more attractive than teaching (Carver-Thomas & Darling-Hammond, 2017; Sibieca, 2018). Therefore, even though there may be a considerable number of students who are interested in teaching, likely these students are at the same time also interested in a career in industry, research, etc. These combinations of career aspirations can differ per person, e.g., someone may be interested in both industry and research, while someone else may have high aspirations in industry, but not in research. To take into account such simultaneously endorsed career interests and differences in the combinations of sectors students find attractive, we use a person-centered approach in our study. With this approach, we aim to detect latent groups of students who share the same combination of career aspirations. The benefit of this person-centered focus is that we will be able to identify if there are groups that aspire to teach and if so, which career aspirations teaching has to compete with. Moreover, we can investigate whether there are different groups—or types—of students who have teaching aspirations: After identifying groups of students with similar career aspirations, we will compare them based on (1) background characteristics; (2) vocational interests according to Holland’s (1997) theory; (3) work values; and (4) self-efficacy in working as a secondary school teacher, in industry, and in research. Our research questions are:

1. What latent groups can we identify among STEM university students based on their career aspirations? Which group aspires or which groups aspire to teach in secondary school?
2. Does the group or do the groups that aspire to teach differ from other groups on the background variables gender, nationality, university, year of study, and field of study?
3. Does the group or do the groups that aspire to teach differ from other groups on their vocational interests, work values, and self-efficacy in different jobs?
Method

Participants

Nine hundred and five STEM students from two research universities and one university of technology completed at least 66% of a questionnaire about their career aspirations, interests, work values, and self-efficacy. The students’ characteristics are displayed in Table 1. The majority was male (65%). Since many STEM programs in the Netherlands are being taught in English, the survey was conducted in English, so international students could also complete the survey. Still, the vast majority of the sample were Dutch (79%). We included students in bachelor’s (undergraduate) and master’s (graduate) programs, because teacher education is an option for both groups: Bachelor’s degree students can pursue a two-year master’s degree in teacher education (a combination of content-based courses and teacher education courses and an internship at a secondary school) after completing their bachelor’s degree. Master’s degree students can pursue a one-year teacher education program (teacher education courses and internship) after having completed a master in a STEM field. Thirty percent of the students in our sample were in the second year of their master’s degree. 16%, 19%, 17%, and 19% were in the first, second, and third year of their bachelor’s degree and the first year of their master’s degree, respectively. Regarding the field of study, almost half of the students were studying engineering (e.g., aerospace engineering or civil engineering). Fifteen percent were studying physics, and 14% computer science. For all other fields, the percentage of students in the sample was 10% or less.

Instruments

Career aspirations

The first part of the questionnaire asked the participants to indicate how interesting they would find working in several sectors on a scale from 1 (definitely not interested) to 5 (definitely interested). The following sectors were included: industry, research at the university (i.e.,

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1We used a threshold of 66% because this meant students had completed a sufficient number of questions for their data to be used. Eighty-eight percent of the students completed the entire questionnaire.

2A good command of the Dutch language is an entrance criterion for teacher education programs in the Netherlands. Completing the teacher education program results in a teacher qualification in the Netherlands only. Hence, it is highly exceptional that international students enter a teacher education program. Despite this, we decided to include international students in our study because we were interested if international students would have different career aspirations than Dutch students.

3Three percent of all students in the sample were already pursuing teacher education. Despite our strong focus on students who are not teacher education students (see p. 4 of the Introduction), we did include this small number of teacher education students for three reasons. First, including them makes our sample of university science students more representative, because there are always some students who chose teacher education. Excluding these students might underestimate science students’ interest in science. Second, including science teacher education students can serve to validate our results, because we would expect these students to be part of a group or multiple groups that consist of students that have strong teaching aspirations. Third, including teacher education students gives us the means to compare these students with students who are very interested in teaching but are not (yet) pursuing teacher education. This could point to possible critical barriers to pursue teacher education.
pursuing a PhD), research at a research institute, science communication, teaching a STEM subject in secondary education, and entrepreneurship (i.e., starting your own company).

Vocational interests
Vocational interest was measured with items based on Holland’s (1997) career theory. We used a German instrument, the FEBIS (Fragebogen zur Erfassung beruflicher Interessen für die Studienberatung; Putz, 2011, p. 256). To translate the items correctly to English, we used the back translation procedure. For each of the six vocational interests in Holland’s theory—realistic, investigative, artistic, social, enterprising, and conventional interest—five activities were listed (in a randomized order). Students had to indicate how they felt about doing that activity on a scale of 1 (dislike a great deal) to 5 (like a great deal). By averaging the scores on the five items per interest, we obtained students’ scores on the six interests. For sample items and Cronbach’s alphas for every interest, see Table 2.

Work values
Next, we presented 33 job characteristics to the students. We asked them to indicate on a 5-point Likert scale how important these characteristics would be for them in their future job. The characteristics were partly based on the FIT (Factors Influencing Teaching)-Choice scale (Watt & Richardson, 2007), a scale that lists job characteristics specific to teaching that could motivate someone to become a teacher (e.g., making a social contribution and job security). However, as the FIT-Choice scale focuses on the characteristics of a career in teaching, some characteristics did not make sense in

| Table 1. Characteristics of the sample. |
|-----------------------------------------|
| Characteristic                         | Number | Percentage |
| Gender                                  |        |            |
| Male                                    | 580    | 64.7       |
| Female                                  | 317    | 35.3       |
| Nationality                             |        |            |
| Dutch                                   | 716    | 79.2       |
| European                                | 102    | 11.3       |
| Non-European                           | 86     | 9.5        |
| University                              |        |            |
| University of technology                | 635    | 70.2       |
| Research university 1                   | 181    | 20.0       |
| Research university 2                   | 88     | 9.7        |
| Year of study                           |        |            |
| Bachelor year 1                         | 140    | 15.5       |
| Bachelor year 2                         | 174    | 19.2       |
| Bachelor year 3                         | 156    | 17.2       |
| Master year 1                           | 168    | 18.6       |
| Master year 2 or 3                      | 267    | 29.5       |
| Field of study                          |        |            |
| Biology                                 | 57     | 6.3        |
| Chemistry                               | 89     | 9.9        |
| Computer science                        | 127    | 14.1       |
| Mathematics                             | 23     | 2.6        |
| Physics                                 | 133    | 14.8       |
| Engineering                             | 402    | 44.8       |
| Multiple fields                         | 43     | 4.8        |
| Already pursuing a teacher education master’s degree | 25 | 2.8 |

*In the sample, 24 students were in the third year of a 3-year master’s program, pharmacy. *b These students are either pursuing degree programs in multiple fields, e.g., both physics and mathematics.
non-teaching jobs, such as having had inspirational teachers and wanting to work with children. These characteristics were omitted and general job characteristics were added, e.g., wanting to have flexible working hours, a healthy work–life balance, and a nice and comfortable work environment. We used exploratory factor analysis in SPSS to come to a set of interpretable higher-order work values. The factors were: intellectual challenge, status, comfort, career advancement, security, and social contact. Following the categorization of work values into four higher-order constructs as discussed in the Literature Review above, intellectual challenge can be seen as an intrinsic value; status, comfort, career advancement, and security can be classified as extrinsic values; and social contact is an interpersonal value. We did not find a factor in our data that referred to altruistic values. Sample items and measurement information of the work values can be found in Table 2.

Self-efficacy

Last, we measured student’s self-efficacy in three different sectors: industry, research, and secondary school teaching. For every sector, we showed the students some typical behaviors in jobs related to that sector and they had to indicate how confident they were that they could successfully execute these behaviors, on a scale of 1 to 5. The items to measure self-efficacy in the industry were based on the Entrepreneurial Self-Efficacy scale (De Noble, Jung, & Ehrlich, 1999). Self-efficacy in research was based on the profile description of a PhD student according to the Dutch university job classification system (Association of Universities in the Netherlands [VSNU], 2017). Teaching self-efficacy is measured with the Teacher Self-Efficacy scale from Friedman and Kass (2002). Measurement information is displayed in Table 2.

Table 2. Overview of measures of vocational interests, work values, and self-efficacy.

| Measure                     | Sample item                                                                 | Number of items | Cronbach’s alpha |
|-----------------------------|------------------------------------------------------------------------------|-----------------|------------------|
| **Vocational interests**    |                                                                              |                 |                  |
| Realistic                   | Installing machines and preparing them for use.                              | 5               | .84              |
| Investigative               | Analyzing research results.                                                   | 5               | .79              |
| Artistic                    | Making drawings or taking pictures.                                          | 5               | .78              |
| Social                      | Giving people advice when they have problems.                                | 5               | .64              |
| Enterprising                | Negotiating business and contract conditions.                                | 5               | .75              |
| Conventional                | Making precise protocols of processes or procedures.                         | 5               | .75              |
| **Work values**             |                                                                              |                 |                  |
| Intellectual challenge      | I want to be involved in my field on a high intellectual level.              | 5               | .75              |
| Status                      | My future job should have a high status.                                     | 5               | .83              |
| Comfort                     | I want to work very hard. (reverse-coded)                                    | 6               | .74              |
| Career advancement          | My future job should have good opportunities for career advancement.        | 5               | .76              |
| Security                    | My future job should quickly lead to a permanent position.                   | 3               | .69              |
| Social contact              | I want to meet many people.                                                   | 5               | .76              |
| **Self-efficacy**           |                                                                              |                 |                  |
| Industrial/entrepreneurial  | I think I can discover new ways to improve existing products.               | 7               | .82              |
| skills                      |                                                                              |                 |                  |
| Research skills             | I think I can write well-structured papers for academic journals.           | 8               | .88              |
| Teaching skills             | I think I can tie my teaching with my students’ everyday interests.          | 7               | .86              |

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**Background information and achievement**

In addition to the degree program and year the students were in, gender, and nationality (Dutch, European, or non-European), we also asked students to indicate their current achievement level. Grades in the Netherlands are given on a scale of 1 to 10, where 5.5 or higher is sufficient. We asked both bachelor’s and master’s students to indicate their GPA (four categories: lower than 5.5; 5.5–6.9; 7–8.4; 8.5–10). In addition, bachelor’s students were asked how many credits they had obtained so far, ranging from 1 (less than half of the credits that could be obtained so far) to 6 (more credits than strictly necessary). Since a substantial part of STEM master’s programs consists of working on a thesis or project, for which the credits will only be granted at the completion of this, we did not ask them about credit obtainment. Instead, we asked them to indicate their progress, on a scale from 1 (“I have a delay and will not finish my master’s program on time”) to 4 (“I am ahead of schedule”).

**Procedure**

The online survey was open from the end of March until August 2018. It was spread to students via e-mail by the directors, coordinators, or secretaries of educational programs at the three universities. The e-mail to the participants was written by the researchers and consisted of a clear description of the survey and the goals of the study. Anonymity and confidentiality of all collected data were guaranteed. Before starting the survey, all participants had to give their informed consent. We allotted some vouchers among all students who completed the survey.

**Statistical analyses**

Our first research question was whether we could identify groups of students who had similar career aspirations. This was done by using the six questions about career aspirations—interest in working in industry, in research at the university, research at an institute, science communication, teaching at secondary school, and entrepreneurship—as indicator variables in a latent profile analysis (LPA). LPA is a model-based, person-centered analysis that tests which number of groups fits the data best. We fitted six models (a 2- to a 6-class solution) in Mplus 7. The fit of each model was assessed by Akaike’s information criterion (AIC; Akaike, 1987), the Bayesian information criterion (BIC; Schwartz, 1978), adjusted BIC (ABIC), the Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMRT; Vuong, 1989), and the entropy statistic. Lower values of the AIC, BIC, and ABIC are proof of a better fitting model (Flaherty & Kiff, 2012). The VLMRT compares models for \( k \) and \( k-1 \) classes. If the ratio test results in a significant \( p \)-value, the \( k \) class model is a better fit than the \( k-1 \) class model (Tofghi & Enders, 2008). Higher entropy indicates less classification error (Collins & Lanza, 2010). However, in addition to statistical fit, one should also critically assess the interpretability, meaningfulness, and practical utility of the class solutions (e.g., Marsh, Lüdtke, Trautwein, & Morin, 2009; Pastor, Barron, Miller, & Davis, 2007). This was done by examining the face validity of the best fitting solution and the percentages of students in each class—as classes with a very low number of students may not be practically useful.

The other research questions focused on comparisons between the identified groups with regard to their interest in a career as a secondary school teacher, their background
variables, achievement level, vocational interests, work values, and self-efficacy. To compare the groups, after the LPA had determined which a number of classes fit the data best, we assigned students to the class for which their probability of membership was highest. With analyses of variance (ANOVAs) and post hoc comparisons (Bonferroni), we investigated differences between the latent groups on the variables of interest in this study.

Results

Fit statistics

Table 3 shows the goodness-of-fit measures that we used to determine the number of groups that provided the best fit to our data. We chose a 5-class solution, because the VLMRT p-value was significant, which indicates that the 5-class solution was a better fit than the 6-class solution. Moreover, when assessing the five groups that this solution distinguished, we found that these groups differed from each other in meaningful ways and had face validity. In addition, even the smallest group, with 12% of the students, was sufficiently large to have practical value.

Latent group descriptions, including background and achievement characteristics

The names we assigned to the groups reflect the preferred sectors they wished to work in. Figure 1 shows the scores on the LPA indicator variables (i.e., career aspirations) for each group. Table 4 shows significant differences between groups on career aspirations.

The industry and entrepreneurship (IN-EN) group consisted of students who aspired a career in industry or as an entrepreneur. Their interest in other careers was very low. Twenty percent of all students were in this group. The second group was the research (RE) group. In this group, interest in working in research, especially at university, was very high. These students’ aspirations in industry were also above average. This group consisted of 28% of the sample and is the largest group. Third, the industry (IN) group (26% of the sample) had high interest in industry, and lower aspirations in other careers. In contrast to the IN-EN group, however, they were also rather positive about working as a researcher outside the university, for example, in a research institute. The fourth group was labeled the Undecided group (14%) because these students had the least clearly distinguished career aspirations of all groups: They scored around the average on all sectors. Their interest in communication and teaching was somewhat higher than their interest in other sectors. The fifth group—the research, communication, and teaching (RE-CO-TE) group—had high interest in careers in research, communication, and teaching. Their aspirations in industry and entrepreneurship were below average. This group was the smallest group, consisting of only 12% of the sample.

Table 3. Model fit indices.

| Model | Number of free parameters | AIC | BIC | Adjusted BIC (ABIC) | VLMRT p-value | Entropy | Percentage of students in smallest group |
|-------|----------------------------|-----|-----|---------------------|---------------|---------|-----------------------------------------|
| 2-class | 19                         | 16,736.74 | 16,828.05 | 16,767.71 | <.001 | .81 | 48.17 |
| 3-class | 26                         | 16,558.50 | 16,683.45 | 16,600.88 | .06 | .77 | 22.58 |
| 4-class | 33                         | 16,323.72 | 16,482.31 | 16,377.50 | <.001 | .83 | 12.51 |
| 5-class | 40                         | 16,248.43 | 16,440.66 | 16,313.62 | <.01 | .78 | 11.74 |
| 6-class | 47                         | 16,192.12 | 16,417.99 | 16,268.72 | .50 | .79 | 6.31 |
There were substantial differences in students' interest in a career as a teacher between the IN-EN, the RE, and the IN groups on the one hand and the Undecided and the RE-CO-TE groups on the other hand. The former groups had very low interest in teaching, whereas the latter groups had an average (Undecided group) and above average (RE-CO-TE group) interest in teaching. As such, hereinafter we will use "teaching groups" when we refer to both the Undecided and the RE-CO-TE group. In total, the teaching groups consisted of 26% of the students in the sample.

Table 4. Means and standard deviations of students' career aspirations, by the latent group.

| Aspirations       | Total sample | Industry/Entrepreneurship (IN-EN) | Research (RE) | Industry (IN) | Undecided | Research/Communication/Teaching (RE-CO-TE) |
|-------------------|--------------|-----------------------------------|---------------|---------------|------------|------------------------------------------|
| Industry          | 3.67 (1.14)  | 3.77<sup>a</sup> (1.10)          | 3.57<sup>b</sup> (1.05) | 4.23<sup>b</sup> (1.82) | 3.36<sup>b</sup> (1.21) | 2.83<sup>b</sup> (1.25) |
| Research at university | 3.02 (1.32)  | 1.46<sup>b</sup> (0.51)          | 4.43<sup>b</sup> (0.50) | 2.58<sup>b</sup> (0.52) | 2.08<sup>b</sup> (0.66) | 4.42<sup>b</sup> (0.57) |
| Research other    | 3.25 (1.20)  | 1.81<sup>b</sup> (0.73)          | 4.07<sup>b</sup> (0.85) | 3.29<sup>b</sup> (0.81) | 2.83<sup>b</sup> (1.04) | 4.16<sup>b</sup> (0.87) |
| Communication     | 2.11 (1.14)  | 1.39<sup>b</sup> (0.55)          | 1.65<sup>b</sup> (0.67) | 1.59<sup>b</sup> (0.62) | 3.66<sup>b</sup> (0.57) | 3.75<sup>b</sup> (0.73) |
| Teaching          | 2.25 (1.16)  | 1.93<sup>b</sup> (1.09)          | 1.97<sup>b</sup> (0.88) | 1.85<sup>b</sup> (0.93) | 2.94<sup>b</sup> (1.18) | 3.54<sup>b</sup> (1.07) |
| Entrepreneurship  | 3.08 (1.30)  | 3.45<sup>b</sup> (1.31)          | 2.99<sup>b</sup> (1.27) | 3.20<sup>b</sup> (1.21) | 2.98<sup>b</sup> (1.32) | 2.53<sup>b</sup> (1.27) |

The letters in superscript after the means indicate significant differences. For example, the mean aspiration level for a career in industry for the IN-EN profile reads 3.77<sup>a</sup>. This means that this mean differs significantly (p < .05) from the means of group d (IN), e (Undecided), and g (RE-CO-TE).

There were substantial differences in students' interest in a career as a teacher between the IN-EN, the RE, and the IN groups on the one hand and the Undecided and the RE-CO-TE groups on the other hand. The former groups had very low interest in teaching, whereas the latter groups had an average (Undecided group) and above average (RE-CO-TE group) interest in teaching. As such, hereinafter we will use "teaching groups" when we refer to both the Undecided and the RE-CO-TE group. In total, the teaching groups consisted of 26% of the students in the sample.

Table 5 offers an overview of the background characteristics of the five groups. Female students were overrepresented in the teaching groups, and underrepresented in the IN-EN and IN groups. Compared to Dutch students, European students had lower aspirations in teaching, while non-European students had higher aspirations in teaching. International students were overrepresented in the RE group. Students from the university of
technology could less often be found in the teaching groups than students from the two research universities. Students from the university of technology were overrepresented in the IN-EN and IN groups. Regarding students’ field of study, biology students were substantially overrepresented in the teaching groups—57% of biology students were in the Undecided and RE-CO-TE groups. Students in the field of computer science, mathematics, and engineering were underrepresented in the teaching groups (19%, 17%, and 19%, respectively). Eighty-five percent of all students who were already pursuing a master’s degree in teacher education could be found in the teaching groups. A very large majority of these teacher education students were in the Undecided group. There was no significant association between the students’ year of study and group membership.

Table 6 shows the average achievement levels of the groups. Students in the RE group reported to have obtained more credits in their bachelor’s program, a higher GPA in their master’s program, and more progress in their master’s program than students in the Undecided group.

**Vocational interests per group**

Significant differences between the five groups were found on each of the six vocational interests as proposed by Holland (1997). Most notably, the teaching groups had higher social and artistic interests than the other groups (see Table 7). Second, the RE and RE-CO-
-TE groups had higher investigative interest than the IN-EN, IN, and Undecided groups. In addition, the RE-CO-TE group had higher conventional interest than the IN-EN, IN, and Undecided groups. The IN-EN had higher enterprising interest than the RE group and the IN group had higher realistic interest than the IN-EN and the Undecided groups.

### Work values per group

We compared the groups on the intrinsic work value “intellectual challenge,” the extrinsic work values “status,” “comfort,” “career advancement,” and “job security,” and the interpersonal work value “social contact.” The results, as presented in Table 8, reveal that the RE group and the RE-CO-TE groups valued “intellectual challenge” more than the other groups did. The Undecided group scored particularly low on “intellectual challenge” compared to the other groups. In contrast, the Undecided group valued “comfort” in their job significantly more than the IN-EN, RE, and IN groups. Both teaching groups (i.e., Undecided and RE-CO-TE) and the RE group attached less value to “career advancement” than the IN-EN and IN groups. No significant differences were found regarding the importance attached to “status,” “job security,” and “social contact.” None of the groups reported to care much about the “status,” as this was the work value rated the lowest by all groups. Looking at the top three values of each group, the IN-EN group had the highest score on “career advancement,” the Undecided group on “comfort,” and the other groups on “intellectual challenge.” The teaching groups had “social contact” as a second-most important value, whereas for the other groups it was ranked lower.

### Self-efficacy per group

Finally, we compared the groups on their self-efficacy regarding important skills needed in industry and entrepreneurship, research, and as a secondary school teacher (see Table 9). The IN-EN and IN groups had higher self-efficacy in typical industry and
entrepreneurship skills (e.g., identifying needs in the market, improving products) than the RE and RE-CO-TE groups, whereas these latter groups were more self-efficacious in typical research tasks than all other groups. The teaching groups (Undecided and RE-CO-TE) rated their self-efficacy in teaching at a secondary school significantly higher than the RE and the IN groups. The Undecided group was the only group that evaluated their teaching skills higher than their skills in industry/entrepreneurship and research.

**Discussion**

**Main findings**

There is an urgent need for more STEM teachers at the secondary school level (Adriaens, Fontein, Den Uijl, & De Vos, 2016; Kearney, 2016; Sutcher et al., 2016). One way to address this need is to increase the enrollment of STEM university students into teacher education programs, as this enrollment is currently low (KNAW, 2017). By gaining more knowledge on STEM students’ career aspirations, vocational interests, work values, and self-efficacy, recruitment initiatives can be designed specifically to target students who are interested in teaching. Because we expected students to have career aspirations in different combinations of sectors, we used a person-centered approach in our study and identified groups of students who shared similar combinations of career aspirations. Next, we looked into the characteristics of these groups, with a specific focus on the characteristics of the groups interested in a career as a secondary school teacher.
The latent profile analysis identified five distinguishable groups of students. Two of these groups—the “teaching groups,” together consisting of 26% of the students in the sample—showed interest in teaching as a career. This is a substantial percentage, especially when one considers that only a very small percentage of STEM university students actually enroll in teacher education and that there is an urgent STEM teacher shortage (KNB, 2017). The first of the two teaching groups was the Undecided group (14% of total sample). These students had an average interest in multiple careers (industry, research at an institute, communication, teaching, and entrepreneurship). This group can be characterized as students with high social interest—it was the only group that had a social interest as their highest vocational interest—and a relatively low need for intellectual challenge and a relatively high need for comfort and social contact in their future workplace. These students thus hold interpersonal work values in very high regard, and in addition, they care about certain extrinsic values. The Undecided group was the only group that scored higher on their self-efficacy in teaching than on their self-efficacy in research. The profile of the Undecided group seems to fit the teaching career due to the high social interest of the group, because social interest is the main vocational interest of in-service teachers (Denzler & Wolter, 2009; Kaub et al., 2016; Klusmann et al., 2009; Neugebauer, 2013) and pre-service teachers with high social interest are more satisfied in their first year of the teacher education program than those with lower social interest (Kaub et al., 2012). Furthermore, the Undecided group had a high teacher self-efficacy. High self-efficacy, even though it may be an overestimation because they have little or no teaching experience (Hoy & Spero, 2005), is beneficial for students if they start teacher education. High self-efficacy results in more effort and perseverance, a better ability to deal with challenges, and a more positive outlook (Bandura, 1989), which will be a useful asset of a starting student teacher, especially at the start of the school practicum.

The second teaching group was the Research-Communication-Teaching (RE-CO-TE) group (12% of the sample). This group had high aspirations in research, communication, and teaching. Students in this group were very research-minded: Their investigative interest was high, as was their endorsement of the work value “intellectual challenge” and their self-efficacy in working as a researcher. In these findings, we see the link between research self-efficacy and interest in a research career confirmed (Adedokun et al., 2013). Still, this group also had a high social interest, high self-efficacy in teaching, and interest in a teaching career. As such, also regarding teaching, we clearly see the links between interest, self-efficacy and career aspirations as proposed by social-cognitive career theory (Lent et al., 1994). Like the Undecided group, the RE-CO-TE group scored significantly higher than the non-teaching groups on social interest and self-efficacy in working as a secondary school teacher, and they had high scores on the work value social contact. With the goal of attracting students in the RE-CO-TE group to teacher education programs, these are promising features of their profile. In contrast to the Undecided group, however, the RE-CO-TE group could be characterized by high investigative interest. Even though Kaub et al. (2014) found that secondary school STEM teachers—in comparison to language teachers—do have high investigative interest in addition to high social interest, it is clear from the literature that social interest is the most important vocational interest of teachers: Kaub et al. (2012) found that pre-service science teachers with lower social interest were less satisfied in their study program and Henoch et al. (2015) reported that students with higher social interest were substantially more likely to
choose teacher education than students with lower social interest. Another difference with the Undecided group was the RE-CO-TE’s group high endorsement of the work value intellectual challenge. The specific characteristic of the RE-CO-TE group thus seems to be that they want a job that is cognitively challenging.

The work value “status” was rated particularly low by all students in the sample. Although the low status of the teacher is often perceived as one of the main causes of the teacher shortage and policy measures in many countries focus on enhancing the teacher status to attract high-quality recruits (Carlo et al., 2013), our findings did not corroborate the importance of status in making a career choice, so it may not be as likely as often thought that STEM students refrain from choosing the teacher profession due to its low status. The low ratings of status are in line with the literature on millennials’ work values that also shows that young people do not attach great value to status and prestige (Papavasileiou & Lyons, 2015).

When we look at the background characteristics of the teaching groups, female students, and students in the field of biology were overrepresented in the teaching groups. This overrepresentation of women and biology students in the groups with high teaching interest might be explained by the nature of the teaching profession: Teaching is a profession that is highly people-focused and offers more opportunity to directly pursue communal goals (e.g., helping people and contributing to society (Yang & Barth, 2015)) than many other STEM professions, such as jobs as engineers or IT specialists. On average, female students have a higher people-orientation than male students (McIntyre & Graziano, 2016; Su & Rounds, 2015; Woodcock et al., 2013) and biology students have a higher people orientation than students in STEM fields such as mathematics and physics (Yang & Barth, 2015). This difference could be an important reason for the presence of a teacher shortage in chemistry, physics, mathematics, and computer science, but not in biology.

Furthermore, it is interesting to note that 17 of the 25 students in our sample who were already enrolled in a master’s program in teacher education could be found in the Undecided group. This means that, although the RE-CO-TE group had even slightly more interest in a teaching career than the Undecided group, only few students in the RE-CO-TE group enroll in teacher education. Likely, teaching loses the competition with a research career and accordingly, these students choose a content-based master’s program instead of teacher education. After all, the RE-CO-TE group had very high research aspirations and in addition seemed suitable for a career in research because they were—together with the RE group—the most successful in their studies (most earned credits, highest GPAs).

Implications for practice

To encourage more STEM students to enroll in teacher education, it is recommended that recruitment initiatives are tailored to the characteristics of those STEM students who are already interested in a career as a secondary school teacher. First of all, we saw that in the

\footnote{To investigate possible bias of the results due to an overrepresentation of teacher education students in the Undecided group, we repeated the analyses without teacher education students. This did not lead to substantial changes in the results.}
two teaching groups, students’ social interest was high as well as their endorsement of the work value social contact. This makes it important to emphasize the social nature of the teacher profession. Second, both teaching groups had high scores on teacher self-efficacy. Recruitment initiatives could use this high self-efficacy in teaching by pressing the urgency for inspirational and high-quality STEM teachers, while in the meantime addressing their high confidence in their own teaching skills (e.g., by using sentences in recruitment like “Are you the one that can inspire the next generation to also choose a science degree?”, “Are you the one who is able to explain to students of all levels why climate change is real?”)

We also found interesting differences between the two teaching groups. This implies that different accents in recruitment are called for. To address the high investigative interest and the need for intellectual challenge of the RE-CO-TE group it may be helpful to explain in what ways a career as a secondary school STEM teacher can be challenging. The Undecided group highly valued comfort in their future job. For them, it could be useful to highlight positive aspects of the teachers’ work environment, such as the frequent holidays and the measures that are taken to lower teachers’ work pressure.

**Limitations**

This study offers useful new insights into STEM students’ motivation to become a teacher, because it focuses on all STEM students and not just on those students who are already enrolled in teacher education or on current teachers, like most studies do (Kyriacou & Coulthard, 2000). Nonetheless, when interpreting the findings it is important to take the following limitations into account. First of all, we only measured students’ career aspirations, vocational interests, work values, and self-efficacy in different professions at one point in time. Consequently, we cannot say anything about possible changes in these variables during the course of students’ education, nor can we make causal inferences.

Secondly, our higher-order work values did not include a measure of altruistic values. Although there were separate items in our work values questionnaire that referred to altruistic values, these did not form a reliable scale. This is an important limitation, because teachers generally hold altruistic values in high regard (Bergmark et al., 2018). As such, it would be interesting to investigate whether the teaching groups in our samples would find altruistic values more important than the students in the other groups. If so, this would provide useful information for recruitment, as recruitment initiatives could then emphasize the altruistic value of the teaching profession.

**Implications for future research**

Career aspirations are based on students’ images of certain professions. It is often claimed that the low status (little respect and value from society and a low salary) of the teacher profession is a reason for the teacher shortage (e.g., Research Centre for Education and the Labour Market [ROA], 2017). In this study, we measured which work values STEM students found important, but not the extent to which they see these work values, like status, intellectual challenge, and social contact, as being met by the teaching profession. Do they view teaching as a career that offers intellectual challenge? Do they perceive the teacher’s work environment as pleasant? The unique characteristic of the teacher profession is that everybody has had years
of experience as a student. Due to this “apprenticeship of observation,” students have a certain image of the teacher profession that influences the preconceptions they have about teaching (Lortie, 1975). Subsequently, these preconceptions determine to what extent they see the teacher profession as an attractive career option for themselves. Therefore, we need more insight into STEM students’ perceptions of teaching as a career.

Furthermore, it would be interesting if comparable person-centered studies would be done in other countries that face STEM teacher shortages. Since our study is the first one that identified two specific types of STEM undergraduates who are interested in teaching, the question can be raised whether these findings are generalizable to other countries, where young people may have different work values (Papavasileiou & Lyons, 2015) and where teacher education is organized in a different way than in the Netherlands. If such studies in other countries would also find a group of undecided students who mainly aspire a career with a lot of social contact in a comfortable work environment on the one hand and a group of students that have a high investigative interest and want to be challenged intellectually on the other hand, promoting the teacher profession as a pleasant as well as an intellectually interesting profession could be seen as an internationally relevant mission to battle the STEM teacher shortage.

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No potential conflict of interest was reported by the authors.

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