European Journal of Teacher Education

ISSN: 0261-9768 (Print) 1469-5928 (Online) Journal homepage: www.tandfonline.com/journals/cete20

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To cite this article: Sebastian Franz, Sina Fackler & Jennifer Paetsch (2024) Profiles of pre-service teachers' personality traits and cognitive abilities: Relations with graduation and teacher self-efficacy, European Journal of Teacher Education, 47:4, 638-657, DOI: 10.1080/02619768.2022.2114896

To link to this article: https://doi.org/10.1080/02619768.2022.2114896

Published online: 24 Aug 2022.

EUROPEAN JOURNAL OF TEACHER EDUCATION
2024, VOL. 47, NO. 4, 638–657
https://doi.org/10.1080/02619768.2022.2114896

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Profiles of pre-service teachers' personality traits and cognitive abilities: Relations with graduation and teacher self-efficacy

Sebastian Franz[a], Sina Fackler[b] and Jennifer Paetsch[c]

[a]Competencies, Personality, Learning Environments, Leibniz Institute for Educational Trajectories (LIfBi), Bamberg, Germany; [b]Children and Child Care, German Youth Institute (DJI), Munich, Germany; [c]Chair of Evaluation in Teacher Education, University of Bamberg, Bamberg, Germany

ABSTRACT

The present study investigates the effect of pre-service teachers' cognitive abilities and personality traits on graduation and teacher self-efficacy using data from the German National Education Panel Study (N = 5 520). Applying latent profile analysis, we found four different profiles of pre-service teachers based on high school grade point average, reading and maths achievement as well as the Big Five. Our results show that the profile with low cognitive abilities and low extraversion is negatively associated with graduation and teacher self-efficacy. Conversely, high cognitive abilities in combination with high extraversion are positively related to both aspects of university success. The findings provide novel evidence on the identification of at-risk students in teacher education and have implications on the selection of teacher candidates as well as targeted support offers.

ARTICLE HISTORY
Received 14 December 2021
Accepted 11 August 2022

KEYWORDS
Initial teacher education; pre-service teacher education; higher education; achievement; teacher self-efficacy; personality traits

Introduction

Concerning the study success of pre-service teachers, pre-entry characteristics of teacher candidates play an important role in research on teacher education. This interest has been triggered by a need to better understand the requirements of pre-service teachers during initial teacher education as plenty of pre-service teachers do neither graduate nor enter the teaching profession (OECD 2005).

Students' personal characteristics could provide information about a successful development during teacher-education training. In particular, cognitive abilities and personality traits are often used as admission criteria (Casey and Childs 2007) as their predictive validity in terms of teacher performance has been demonstrated (Klassen and Kim 2019; Klassen et al. 2017). To efficiently guide teacher candidates, identifying factors that contribute to achieving academic outcomes, such as graduation and teacher self-efficacy (TSE), is important (Rots, Aelterman, and Devos 2014; Rots et al. 2007).

Research shows that pre-entry characteristics such as cognitive abilities (e.g. measured by competence tests or grades), motivation, and personality traits are predictive for

CONTACT Sebastian Franz sebastian.franz@lifbi.de Leibniz Institute for Educational Trajectories (Lifbi), Wilhelmsplatz 3, 96047 Bamberg, Germany

graduation from higher education (HE) (Kappe and van der Flier 2012; Trapmann et al. 2007a; Trapmann et al. 2007b). Cognitive abilities refer to the skill to acquire knowledge and are the most promising predictor of academic achievement in HE (Richardson, Abraham, and Bond 2012). Moreover, teachers' personality traits have been found to be significantly related with career adaptability as well as student achievement and student well-being (Eryilmaz and Kara 2017; Eryilmaz 2014).

Furthermore, studies demonstrate that dispositional traits like cognitive abilities, extraversion, agreeableness, and openness to new experience are associated with (teacher) self-efficacy (Judge et al. 2007, 2013; Perera, Granziera, and McIlveen 2018). TSE is a crucial outcome in teacher education as it is not only related to students' academic achievement (Caprara et al. 2006; Klassen and Tze 2014), occupational commitment (Klassen and Chiu 2011; Chesnut and Burley 2015), commitment to finishing a teaching degree (Pfitzner-Eden 2016a) but also burnout (Fives, Hamman, and Olivarez 2007).

However, literature has been limited to addressing the additive effect of personality traits and cognitive abilities by using a variable-centred approach (Rockoff et al. 2011). For a more holistic understanding of the role of personality and cognitive abilities in pre-service teacher outcomes, a person-centred approach is essential (Perera, Granziera, and McIlveen 2018).

This study explored profiles of pre-service teachers based on their expression of the Big Five personality traits and cognitive abilities applying latent profile analysis (LPA). More specifically, the study investigated the association of the profile membership with the probability to graduate within a six-year period and TSE. The results provide arguments for evidence-based admission criteria for teacher education and help to identify at-risk students who need individual support.

Theoretical background

The amount to which pre-service teachers graduate is an important factor of the quality of initial teacher education (OECD 2005), as graduation is a necessary condition for the entrance into the second practical preparatory phase of teacher education (Cortina and Thames 2013).

Furthermore, TSE is viewed as a crucial outcome for students starting into a professional career as teachers (Kunter et al. 2013; Pfitzner-Eden 2016a). TSE describes teachers' beliefs about their own capacities with regard to specific tasks in the teaching context, such as interactions with children, successfully conveying knowledge, or providing a stimulating and positive classroom climate (Tschannen-Moran, Woolfolk Hoy, and Hoy 1998). Therefore, TSE is seen as an indicator of pre-service teachers' preparedness for teaching (Tschannen-Moran and McMaster 2009; Pfitzner-Eden 2016a; Rots, Aelterman, and Devos 2014).

Great individual and societal costs are incurred when pre-service teachers do not graduate or begin a teaching career (OECD 2005). Thus, identifying the factors that contribute to explaining pre-service teachers' academic success is important. In the following, empirical findings of the prognostic value of students' individual characteristics for graduation and TSE are presented.

Predicting graduation in higher education

Students' cognitive abilities have frequently been found important for successful graduation in HE (Raju and Schumacker 2015). More specifically, studies have demonstrated the

predictive value of high school grade point average (HSGPA) and admission test scores for academic achievement (e.g. Richardson, Abraham, and Bond 2012) and graduation (Reason 2009; Burton and Ramist 2001; Schmitt et al. 2009). HSGPA illustrates the previous level of individual achievement and quality of learning experiences, whereas admission test scores are often used to measure students' cognitive abilities.

There is evidence that predictions of graduation are more precise when accounting for personality traits in addition to cognitive abilities and previous achievement (Richardson, Abraham, and Bond 2012; O'Connor and Paunonen 2007). This finding is explained by the reduced variation in university students' cognitive abilities (Richardson, Abraham, and Bond 2012), thus students differ mainly in terms of their personality. The Big Five (Costa and McCrae 1992) are a prominent conceptualisation of personality. Openness to new experience, conscientiousness, extraversion, agreeableness, and neuroticism reflect behavioural tendencies as well as habits that are associated with academic success (O'Connor and Paunonen 2007).

Conscientiousness is the most powerful personality trait for predicting academic achievement in HE even after controlling for cognitive abilities (O'Connor and Paunonen 2007; Poropat 2009; Richardson, Abraham, and Bond 2012). This finding is in line with other studies which found conscientiousness to be associated with achievement orientation, self-discipline, and motivation to perform well (O'Connor and Paunonen 2007; Richardson, Abraham, and Bond 2012; Trapmann et al. 2007a).

Current meta-analyses showed that openness to new experience and extraversion are not associated with achievement in HE to the same degree as conscientiousness, with effects being either small or not significant (Kappe and van der Flier 2012; O'Connor and Paunonen 2007). In fact, students who are highly open to new experiences tend to need more time to graduate (Kappe and van der Flier 2012) but do not have a higher probability to drop out of their studies (Trapmann et al. 2007a). Extraversion has been found to be related neither to retention nor to time until graduation (Trapmann et al. 2007a; Kappe and van der Flier 2012).

Predicting teacher self-efficacy: the role of cognitive abilities and personality traits

Although TSE is deemed to be an important outcome of teacher education, findings of predictors for TSE are scarce (Pfitzner-Eden 2016a; Klassen and Chiu 2010).

TSE is based on cognitive processes of self-perception and interpretation of prior experience (Gist and Mitchell 1992). Taking into account that teaching is a complex and intellectually demanding task (Byrnes, Kiger, and Shechtman 2003; Bardach and Klassen 2020), high cognitive abilities might encourage pre-service teachers to deal with teaching requirements and to evaluate and reflect on their teaching experience during practical training, which may result in higher TSE (Tschannen-Moran, Woolfolk Hoy, and Hoy 1998). Empirical studies confirmed the predictive validity of cognitive abilities on academic and job-related self-efficacy (Judge et al. 2007; Phillips and Gully 1997).

Not only cognitive abilities but also personality traits contribute to the individuals' perceptions and interpretations of situations, including the classroom context (Kaplan 1996). Therefore, pre-service teachers' personalities play an important role in the formation of TSE (Jamil, Downer, and Pianta 2012). The teaching profession is highly communicative and interactive and requires decisiveness and myriad social interactions (Byrnes,

Kiger, and Shechtman 2003). Hence, it can be assumed that extraversion, which is associated with good communication skills, the provision of social support, and performance in jobs with interpersonal interactions (Barrick and Mount 1991), contributes to the development of a higher level of TSE. In contrast, high neuroticism, which is associated with emotional instability and weak job performance (Judge et al. 2013), seems likely to negatively affect teachers' successful coping with the demands of both teacher education and teaching (Frenzel et al. 2018). This might lead to lower TSE.

There is strong empirical evidence supporting the relation between extraversion and TSE of pre-service (Jamil, Downer, and Pianta 2012; Senler and Sungur-Vural 2013) and in-service teachers (Djigić, Stojiljković, and Dosković 2014). In addition, a number of studies have illustrated a positive association of agreeableness and conscientiousness with TSE (Senler and Sungur-Vural 2013; Djigić, Stojiljković, and Dosković 2014). However, the relationship between neuroticism and TSE remains unclear. Some researchers found a negative association (Jamil, Downer, and Pianta 2012), whereas others could not report any significant association between both constructs (Senler and Sungur-Vural 2013).

A person-centered approach to pre-service teachers Individual characteristics

Recent research demonstrates that dispositional factors like cognitive abilities and personality traits are associated with graduation and TSE as facets of pre-service teachers' professional development (Richardson, Abraham, and Bond 2012; Bardach and Klassen 2020; Kunter et al. 2013). However, this literature has been limited to variable-centred approaches that address the additive effects of cognitive abilities and personality traits on teacher education outcomes. This type of analysis is based on the assumption that all individuals in the sample belong to a single population and have the same set of parameters, expressed as average relations across a given sample (Morin et al. 2016). Thus, the variable-centred approach ignores the possibility of unobserved heterogeneity in the sample, even though combinations of traits may shape latent homogenous subpopulations of individuals (Herman, Hickmon-Rosa, and Reinke 2018).

Within the person-centred approach, individuals with similar patterns on personal features are grouped together (Morin et al. 2016). In this case, the person-centred approach has the advantage of analysing the combination of cognitive abilities and personality traits, which can provide a more complete understanding of the ways in which pre-service teachers' dispositions influence their career advancement.

Previous studies that found profiles based on personality traits assigned teachers to four different groups whereby the level of extraversion and neuroticism seem to be the key indicators for the profile membership (Perera, Granziera, and McIlveen 2018). The profile with the lower neuroticism than average was associated with preferable outcomes, e.g. self-efficacy for student engagement and instructional strategies as well as job satisfaction.

Research question and hypotheses

The purpose of this study is to identify pre-service teacher profiles based on cognitive abilities and personality traits at the beginning of their studies and examine how these profiles are associated with pre-service teachers' graduation and TSE.

It is assumed that due to individual differences; groups of pre-service teachers can be identified who have similar cognitive abilities and personalities. This implies that the homogenous groups differ from one another in the way that certain characteristics are high and others are low. Concerning student outcomes, we expect that graduation and levels of TSE would differ as a function of profile membership while controlling for sociodemographic information and study programme characteristics. In detail, we specify the following hypotheses:

H1. Profiles of pre-service teachers based on HSPGA, reading, and maths achievement as well as their personality traits based on the Big Five will be identified.

H2. Pre-service teachers in profiles characterised by high cognitive abilities and high conscientiousness have a higher probability of graduation than students in other profiles.

H3. Pre-service teachers in profiles characterised by high cognitive abilities, high extraversion, and low neuroticism have higher TSE than students in other profiles.

Methods

Sample

Data is drawn from the first-year student cohort of the German National Educational Panel Study (NEPS; see Blossfeld and Roßbach 2019), a nationwide random sample that aims to depict educational pathways through the life course. The participants entered HE in the winter term 2010/11. The last measurement point used for the analyses was in 2017, which results in an observation time of about six to seven years. Pre-service teachers were over-sampled, resulting in a larger sample size.

Participants were surveyed about every six months. In addition to retrospective questions about participants' school history, the study collected information on biographical events related to participants' university study programmes, such as graduation as well as several measures of demographic information, attitudes, personality traits, and achievement.

We excluded all students with missing values for teacher type or school track and students with missing values in all indicators for cognitive abilities and personality traits from our analytical sample. The resulting sample consists of 5 520 pre-service teachers.

Sociodemographic characteristics are presented in Table 1. Among the participants, 17% intended to work in elementary school, 17% at lower secondary school (*Haupt-/Realschule*), 55% at upper secondary school (*Gymnasium*), 6% at vocational schools and 5% at special education schools.

About 30% of participants were studying a subject combination including one subject in the fields of science, technology, and engineering or mathematics (STEM), and 14% were studying two or more STEM subjects.

Table 1. Descriptive statistics.

	N	M/%	SD	Min	Max	Percent Missing
Sociodemographic Characteristics						
Age	5 520	20.42	2.65	17	64	–
Female (ref. male)	5 520	75%	-	0	1	–
Academic background (ref. no academic background)	5 520	43%	-	0	1	–
Migration background (ref. no migration background)	5 520	4%	-	0	1	–
Cognitive Characteristics (Wave 1)						
High school GPA	5 323	2.30	.58	1.00	3.80	3.57
Mathematical competence	2 009	−.19	1.14	−5.03	3.91	63.61
Reading competence	2 010	.00	.85	−2.46	4.18	63.59
Personality Traits (Wave 3)						
Extraversion	4 258	3.87	.79	1.00	5.00	22.86
Agreeableness	4 259	3.70	.52	1.67	5.00	22.84
Conscientiousness	4 259	3.85	.76	1.00	5.00	22.84
Neuroticism	4 259	2.73	.79	1.00	5.00	22.84
Openness	4 259	3.67	.88	1.00	5.00	22.84
Outcomes (up to Wave 12)						
Graduation	3 284	0.68	.47	0	1	40.51
TSE (Wave 9)	2 905	2.71	.31	.90	4.00	52.63

Measurements

Control variables

Analyses were controlled for sex, migration background, academic background, number of STEM subjects, and school type, as these variables have been found to be associated with academic achievement at university, programme completion as well as TSE (Fackler and Malmberg 2016; Decker and Rimm-Kaufman 2008; Bohndick 2020). Table 1 shows the descriptive statistics.

Cognitive abilities

To assess cognitive abilities, we used HSGPA and mathematic and reading achievement. HSGPA was retrospectively collected, achievement tests occurred in the first wave. In the German educational system, grades range from one to six, where one is the best and six the worst. Students' grades were reversed and standardised, meaning that higher values indicate higher cognitive abilities.

Reading comprehension was measured with five different text types involving realistic and age-specific themes as well as diverse task types (Gehrer et al. 2013).

The maths test measures practical everyday life mathematical competencies (Neumann et al. 2013). A broad range of items was included both thematically as well as in terms of mathematical demands (e.g. mathematical problem solving).

Maths and reading tests (Wave 1) were scaled by NEPS standards using an item response model. For each person, a WLE (Warm's weighted maximum likelihood estimate) was estimated with a mean of zero and a standard deviation of one (Pohl and Carstensen 2013). The test items have good item fit, are measurement invariant, and have an acceptable to good reliability (see Pohl, Haberkorn, and Hardt 2014; Gerken and Schnittjer 2017). Due to the study design, only around one-third of the students completed the achievement tests.

Personality traits

The Big Five were measured with a shortened version of the BFI-10 (Rammstedt and John 2007). The dimensions openness to experience, neuroticism, conscientiousness, and extraversion were measured with two items each, while agreeableness was measured with three items (Wohlkinger et al. 2011). The Big Five were first measured in the third wave; about one and a half years after the participants began their studies at university. This led to around 23% missing values for these items (see Table 1).

As the Big Five are relatively stable over time (Cobb-Clark and Schurer 2012), the results should not be biased by using full information maximum likelihood (FIML) to account for the missing values.[1]

The constructs' reliability measured with Spearman-Brown coefficient varies from low to moderate (openness to new experience: r = .55; neuroticism: r = .55; conscientiousness: r = .59; extraversion: r = .73). The consistency of the three items measuring agreeableness seems questionable, with Cronbach's α = .34 and was, therefore, excluded from the analysis. Although the reliabilities of the subscales are intermediate, the measurement shows high convergent validity with longer scales, for instance, the revised NEO personality inventory (Rammstedt and John 2007).

Graduation and teacher self-efficacy

A binary variable indicates whether a student had already graduated teacher training with a master's degree or state examination within six years. Since the standard period of study in teacher education varies between four (for primary, lower secondary, and special school) to five years (upper secondary and vocational school), we expect the majority of pre-service teachers to have graduated within this six-year-period. The graduation status of people who neither did graduate nor participated in the last panel wave were coded as missing values.

TSE was measured using the 10-item scale by Schwarzer and Schmitz (1999). The measurement of TSE took place about five years after students began initial teacher education, which is at the end of their studies or in the first years of preparatory phase (wave 9). Internal consistency was acceptable (α = .73).

Statistical analyses

Table 2 represents the analytical steps. LPA was used to identify the number of profiles that best describe the association between students' cognitive abilities and their personality traits. Data analysis was performed using Mplus (Muthén and Muthén 2014), with 500 initial random starting values and 100 replications to find the global instead of a local maximum (Nylund-Gibson and Choi 2018). To deal with the missing values, the full information maximum likelihood approach (FIML) implemented in Mplus was employed.

Table 2. Analytical steps.

1st step	LPA
2nd step	compare profiles
3rd step	(logistic) regression with profile membership as predictors for graduation/TSE

To identify the best-fitting model, three fit indices suggested were calculated: Bayesian information criterion (BIC), sample-adjusted Bayesian information criterion (SABIC), and approximate weight of evidence criterion (AWE). It is advised to select the latent profile model that has the lowest values on these information criteria, with BIC providing the most reliable indicator (Nylund et al. 2005; Nylund, Asparouhov, and Muthén 2007). We also report the entropy, which is an indicator for the precision of classification, although models should not be selected based on this criterion (Tein, Coxe, and Cham 2013). An entropy value close to one implies a higher classification precision.

Additionally, the fit between two nested models were compared using the Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR-LRT) and bootstrapped likelihood ratio test (BLRT). If the p-values of these likelihood difference tests are not significant, the model with one less profile is supported (Nylund-Gibson and Choi 2018).

The membership probabilities for each participant and latent profile were calculated and then assigned to the profile with the highest probability. Afterwards, the associations between profile membership, and programme completion and teacher self-efficacy were analysed with regression analysis using Stata 16 (StataCorp 2019).

Results

Latent profile analysis

HGPA, maths, and reading achievement as well as self-reported Big Five were indicators for the LPA to calculate the optimal number of profiles for pre-service teachers at the beginning of their studies. Eight models were estimated to determine the best solution based on model fit. The information criteria BIC and SABIC (see Table 3) do not provide a distinct solution indicating the best model, since their values decrease with the number of profiles. However, the four-profile model has the lowest AWE as well as the highest entropy, and all other p-values of VLMR-LRT of models with more than four profiles are insignificant on a five percent level. The graphical representation (see Figure 1) provides further evidence of the four-profile solution since its slope decreases at a weaker rate from this point on (Morin et al. 2016). Thus, based on numerical and graphical inspection of the fit indices as well as theoretical considerations, we decided on the four-profile solution.

The entropy of the four-profile solution is rather small (.534), indicating that the profiles are not well separated from each other. Nonetheless, the diagonal of the average latent profile probabilities exceed .7, which can be seen as a rather clear delineation of profiles

Table 3. Fit statistics and classification coefficients.

n	K	LL	npar	BIC	SABIC	AWE	BLRT p	VLMR-LRT p	Entropy
5 520	1	−33 225	14	66 570	66 526	66 733	0	0	–
5 520	2	−32 843	22	65 875	65 805	66 130	0	0	.505
5 520	3	−32 717	30	65 693	65 598	66 042	0	.040	.469
5 520	4	−32 581	38	65 490	65 369	65 931	0	0	.534
5 520	5	−32 516	46	65 428	65 281	65 962	0	.196	.5
5 520	6	−32 466	54	65 398	65 226	66 025	0	.129	.511
5 520	7	−32 420	62	65 373	65 176	66 094	0	.312	.518
5 520	8	−32 373	70	65 348	65 126	66 161	0	.095	.497

Note: N = sample; K = number of profiles; LL = log likelihood; BIC = Bayesian information criterion; SABIC = sample-adjusted Bayesian information criterion; AWA = approximate weight of evidence criterion; BLRT = bootstrapped likelihood ratio test; VLMR-LRT = Vuong-Lo-Mendell-Rubin likelihood ratio test.

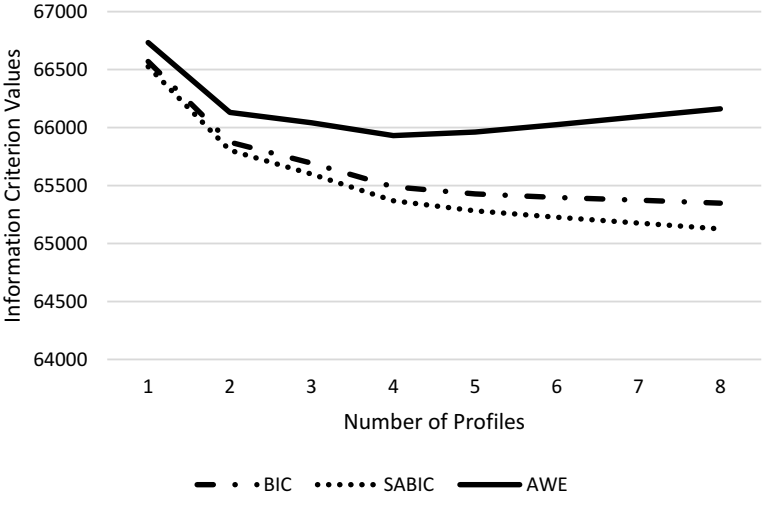

Figure 1. Plot of information criterion values.

and relatively accurate profile assignment (Nagin 2005). This result supports the first hypothesis.

Figure 2 presents the mean scores and illustrates the characteristics of each of the four profiles. The profiles have a clear pattern, although the personality traits conscientiousness and openness to experience do not seem to differ much across profiles. Instead, the profiles can be crystallised by the indicators for cognitive abilities as well as extraversion and, to a somewhat lesser extent, neuroticism.

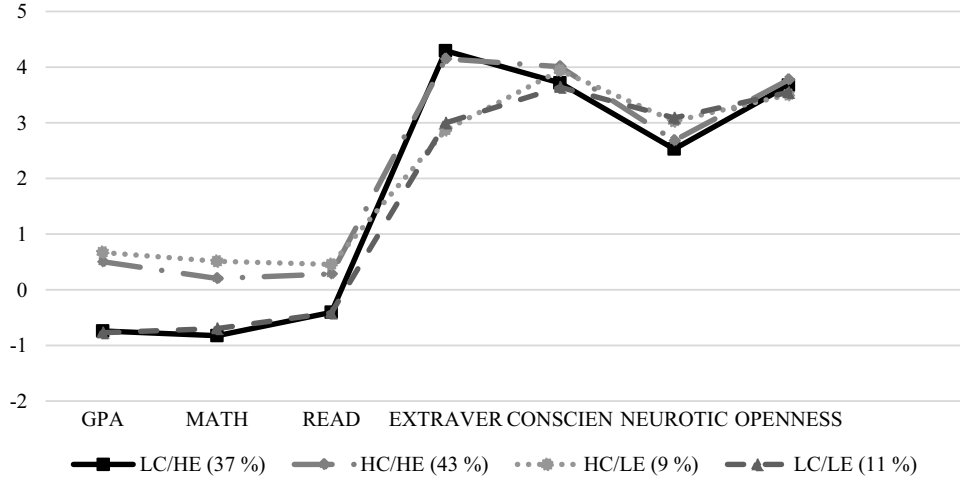

Figure 2. Profiles of pre-service teachers based on their cognitive abilities and the big five. Note: Different scales: GPA ranges from 1–4; maths and reading are on an IRT scale; the Big Five range from 1–5. GPA = high school grade point average; MATHS = competence in mathematics; READ = competence in reading; EXTRAVER = extraversion; CONSCIEN = conscientiousness; NEUROTIC = neuroticism; OPENNESS = openness to new experience.

The first profile, which we named 'low cognitive abilities/high extraversion (LC/HE)', includes 39% of the pre-service teachers. A lower HSGPA and lower scores on the reading and maths tests as well as higher extraversion characterise this profile. A somewhat larger number of pre-service teachers (43%) fell into the second profile, 'high cognitive abilities/high extraversion (HC/HE)', encompassing high scores on cognitive abilities and high values on extraversion. About nine percent of the pre-service teachers have high cognitive abilities and lower values in extraversion and score slightly higher in neuroticism compared to their fellow students. We thus labelled this third profile 'high cognitive abilities/low extraversion (HC/LE)'. The fourth profile 'low cognitive abilities/low extraversion (LC/LE)' contains about 10% of the sampled pre-service teachers. Students with poor HSGPA and test scores, low values in extraversion, and high values in neuroticism belong to this profile.

Differences between profiles regarding graduation

To investigate which profiles are predictive for graduation of teacher education programme, logistic regression with AME was applied. Due to panel attrition and missing data on the outcome variable, we could not use the full sample for these analyses. In the analysed sample, about 54% of the pre-service teachers completed their programme within the survey period.

As the results show (see Table 4), pre-service teachers who fell into a profile characterised by high cognitive abilities have a ten to eleven percentage higher probability of graduating from teacher training 6 years after enrolment. This finding supports the second hypothesis.

The probability of programme completion in the LC/HE profile did not differ from those assigned to the LC/LE profile. The explained variance of the model is rather low.

This effect remains stable when controlling for school type, the number of STEM subjects, sex, age, migration background, and college-graduate parents, with slight changes for HC/HE and HC/LE. The probability of programme completion among students in the HC/HE and HC/LE profiles increases by about three to four percentage points.

Differences between profiles regarding teacher self-efficacy

To examine the association between profile membership and TSE regression models with robust standard errors were estimated. Tests for normality of residuals (via graphical representation, e.g. kernel density plots) and multicollinearity (all variance inflation factors were lower than 2.1) indicate that the requirements of linear regression analysis are fulfilled. Table 5 shows the results, with LC/HE as the reference category. The coefficients for all profiles are negative. This indicates that belonging to the reference category LC/HE is the most beneficial profile for high TSE. Furthermore, the HC/LE profile seems to be the most disadvantaged in terms of self-efficacy, as membership in this profile is more negatively related to TSE than the profiles HC/HE and LC/LE. This finding somewhat corresponds with the third hypothesis.

Besides, when considering the control variables that predict profile membership, the directions of the coefficients remain stable and only change slightly.

Table 4. Results of logistic regression predicting graduation within six years.

	Model 1	Model 2
Reference: LC/HE		
HC/HE	.11*	.14*
	(.02)	(.02)
HC/LE	.10*	.13*
	(.03)	(.03)
LC/LE	−.04	−.05
	(.03)	(.03)
Ref: primary		
Lower secondary		−.07*
		(.02)
Upper secondary		−.28*
		(.02)
Vocational		−.26*
		(.04)
Special education		−.01
		(.03)
Ref.: no STEM subject		
One STEM subject		.01
		(.02)
Two STEM subjects		.05*
		(.02)
Female (ref. male)		.08*
		(.02)
Age		−.01*
		(.00)
Migration background		−.08
		(.05)
Academic background		.01
		(.02)
Pseudo-R^2	.0133	.0855
N	3 284	3 248

Note: Average marginal effects (AME) reported; robust standard errors in parentheses; * $p < 0.05$.

Discussion

The purpose of this study was to determine profiles of pre-service teachers based on their cognitive abilities and the Big Five. Moreover, associations between the identified profiles and graduation and TSE were investigated. Our findings substantially contribute to the understanding of the interplay between individual characteristics and success in initial teacher education. Whereas previous studies showed that cognitive abilities and the Big Five are separately predictive for success in teacher education, this study examined how different combinations of pre-service teachers' cognitive and personality characteristics are associated with university outcomes. The present study advance previous findings on cognitive and personality profiles of teachers (Holzberger et al. 2021; Perera, Granziera, and McIlveen 2018). The paper provides important insights for teacher education, especially for the understanding of the relationship of cognitive abilities and personality traits with graduation and TSE. Furthermore, the findings have practical relevance for admission criteria of teacher education programmes, monitoring and support during studies.

Table 5. Results of regression predicting teacher self-efficacy (wave 9).

	TSE	TSE
Reference: LC/HE		
HC/HE	−.06*	−.05*
	(.01)	(.01)
HC/LE	−.17*	−.16*
	(.02)	(.02)
LC/LE	−.10*	−.10*
	(.02)	(.02)
Ref.: primary		
Lower secondary		−.03
		(.02)
Upper secondary		−.05*
		(.02)
Vocational		−.12*
		(.03)
Special education		−.02
		(.03)
Ref.: no STEM subject		
One STEM subject		−.02
		(.01)
Two STEM subjects		−.00
		(.02)
Female (ref. male)		−.01
		(.01)
Age		.00
		(.00)
Migration background		−.01
		(.03)
Academic background		−.02
		(.01)
Intercept	2.76*	2.74*
	(.01)	(.06)
R^2	.0271	.0344
N	2 950	2 950

Note: Robust standard errors in parentheses; * $p < 0.05$.

Pre-entry characteristics of pre-service teachers: four profiles

Applying a person-centred approach, this study identified four different profiles of pre-service teachers based on their cognitive abilities and personality traits (H1). The number of profiles is comparable to previous findings on profiles of pre-service teachers. Identified profiles have either high cognitive abilities and high or low levels of extraversion or low cognitive abilities with either high or low extraversion. High extraversion always goes hand in hand with a lower value of neuroticism and vice versa. However, the personality traits openness to experience and conscientiousness did not differ between profiles.

This implies that pre-service teachers are a homogenous group regarding openness and conscientiousness but differ substantially in terms of extraversion, HSGPA, reading, and maths achievement. This is somewhat surprising since previous studies have often shown a high correlation between conscientiousness and achievement (Richardson, Abraham, and Bond 2012). This result must be interpreted with caution, as the validity and reliability of the Big Five measurements are limited.

Referring to Klassen and Kim (2019) who suggest that teachers should not only be selected based on cognitive but also non-cognitive factors, our findings imply that extraversion and neuroticism are the crucial personality traits as pre-service teachers seem to be rather homogenous with the other personality traits.

Predicting graduation

We expected the profiles with high cognitive abilities and high conscientiousness to be positively related to graduation (H2). The results showed that students who were more likely to graduate from teacher education within the survey period had a higher probability of falling into classes characterised by high cognitive abilities (HC/HE, HC/LE). This finding is consistent with preceding research on academic achievement in HE and indicates that the previous achievement is the best predictor of academic success in teacher education (Richardson, Abraham, and Bond 2012; Burton and Ramist 2001; Trapmann et al. 2007b). However, no clear relation between conscientiousness and graduation could be revealed, as profiles do not differ in this personality trait.

Differences in personality traits do not seem to be related to graduation or even compensate for low cognitive abilities. This may have two reasons: On the one hand, the profiles only differ in terms of neuroticism and extraversion, which are not key factors for graduation from university (Kappe and van der Flier 2012). Conscientiousness is much more important for graduation, but the level of this personality trait did not differ meaningfully across profiles. On the other hand, personality traits only play a minor role in HE compared to other individual features like motivation, self-esteem, and sense of belonging (Bohndick 2020; Schneider and Preckel 2017; Richardson, Abraham, and Bond 2012). Additionally, the quality of the instructional methods as context factors impact the probability for graduation (Severiens and Schmidt 2009; Georg 2009). The results indicated that school type as well as the number of STEM subjects predict programme completion, which indicates that contextual factors related to the study programme matter. The low pseudo-R^2 indicates that other factors could play a more important role in completing teacher education programmes, such as quality of teaching and student engagement, which were not part of our analysis.

Predicting teacher self-efficacy

We expected profiles characterised by high cognitive abilities, high extraversion, and low neuroticism to be positively related to TSE (H3). Our findings, however, show that all profiles are negatively associated to TSE in comparison to the profile with low cognitive abilities and high extraversion. Extraverted pre-service teachers might be more enthusiastic and consequently get better feedback from the students they teach, leading to higher TSE (Pfitzner-Eden 2016a).

Cognitive abilities only play a minor role in the development of TSE according to our findings. The differences between the HC/HE and LC/HE profiles were very low. Therefore, against our theoretical assumptions, cognitive characteristics appear to be not strongly associated with teacher self-efficacy.

Since the explained variance in the respective models was rather low, profile membership is not very closely associated with teacher self-efficacy. This suggests that pre-service

teachers' success in terms of TSE might also be associated with other individuals factors not included in the present study, such as motivational and self-regulatory characteristics (Kunter et al. 2013). Learning opportunities during studies and practical experience, also play an important role in the development of TSE (Pfitzner-Eden 2016a).

Limitations and future research

This study also has a few limitations that should be mentioned. We used graduation within the survey period of approximately six years as indicators for academic success in this study. Due to panel attrition, missing data, and implausible values, we could only take the most recent information provided by participants into account. Hence, the results may be slightly biased, as students who are prone to drop out are more likely to stop participating in the panel study (Liebeskind and Vietgen 2017; Zinn et al. 2018).

The four profiles that emerged are theoretically plausible, but the fit indices do not provide evidence for only one solution. However, the results nonetheless provide a valuable insight into different combinations of pre-service teachers' personality and cognitive traits. Big Five were measured with a short scale resulting in intermediate reliabilities and limited validity. Due to low Cronbach's alpha, agreeableness, which is an important character trait for teachers (Senler and Sungur-Vural 2013), was not part of the analysis. It would have been valuable to predict profile membership based on this characteristic as well. Longer scales for the Big Five could produce more robust results, but are not feasible in large-scale assessments like the NEPS whose data was analysed in this study.

Moreover, the measurement of TSE took place about five years after students began the teacher education programme and, therefore, not exactly at the time of graduation. Due to only one measurement point, we were not able to map the development of TSE. It may be that TSE already differs between pre-service teachers at the very beginning of their studies. Although TSE is an aspect of teacher professional development, it is only one aspect of academic outcomes in the first phase of initial teacher education at university. Other valid outcomes that should be examined include teachers' beliefs, professional knowledge, and self-regulation skills that play a role in the teaching profession (Kunter et al. 2013). Moreover, measurements of other non-cognitive characteristics such as motivation or self-concept might be useful to further refine the pre-service teacher profiles and gain deeper insights into what distinguishes a promising from an at-risk pre-service teacher.

Conclusion and practical implications

Our results indicate that cognitive characteristics and personality traits predict pre-service teachers' university success in different ways. Profiles encompassing high cognitive abilities are more academically successful for graduation, while personality seems to be associated with occupation-related criteria in terms of TSE. Thus, pre-service teachers who fall into the HC/HE profile seem to be the most successful students, whereas members of the LC/LE profile tend to be rather unsuccessful. Favourably, it appears that around 43% of beginning pre-service teachers belong to the HC/HE profile, which was found to be positively associated with all of the investigated outcomes of teacher education.

These findings have implications for student admissions to teacher education programmes. Our findings indicate that the common practice of using HSGPA as an admissions criterion for teacher education programmes seems quite justified. Pre-service teachers in the profiles with high cognitive abilities have higher success in teacher education. Moreover, considering personality traits is useful to identify at-risk subgroups of students, because students' variation in cognitive abilities might be rather low (Casey and Childs 2007). Taking not only cognitive abilities but also personality traits into account seems to be a worthwhile approach for the identification of at-risk students in teacher education.

In Germany, the most often used admission criterion for teacher education is the HSGPA. However, recruitment in teacher education differs between European countries, e.g. Denmark almost every student is accepted for teacher education programme, whereas Finland is very selective as they additionally use entrance tests, observed clinical activity replicating school situations as well as interviews (Reimer and Dorf 2014; Sahlberg 2010). Therefore, it seems important to replicate the results of the current studies in other countries to see if similar profiles based on cognitive ability measures and personality traits can be explored. Our findings hint that using interviews or aptitude tests as admission criteria in addition to selection based on previous achievement is beneficial to explore the personality of teacher candidates.

Conversely, identifying pre-service teachers at-risk makes it possible to better support them during their studies. Self-assessments including questions regarding personality traits could be included within teacher education programmes to prevent dropout and reassure students of their professional choice.

Interventions and tutoring for this at-risk group can either seek to influence their personality development (Roberts et al. 2017) or help them with their studies to improve their academic achievement and reduce their risk of dropping out (Rheinheimer et al. 2010).

Notes

1. We also conducted a sensitivity analysis to investigate whether the results differ with the smaller sample without missing values. No significant differences were determined.

Acknowledgments

This paper uses data from the National Educational Panel Study (NEPS): Starting Cohort First-Year Students, doi:10.5157/NEPS:SC5:12.0.0. From 2008 to 2013, NEPS data was collected as part of the Framework Program for the Promotion of Empirical Educational Research funded by the German Federal Ministry of Education and Research (BMBF). Since 2014, NEPS has been carried out by the Leibniz Institute for Educational Trajectories (LIfBi) at the University of Bamberg in cooperation with a nationwide network.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the German Federal Ministry of Education and Research [B1018A].

Notes on contributors

Sebastian Franz is currently working in the project Teacher Education Panel Study (LAP) at the Leibniz Institute for Educational Trajectories (LIfBi) in Bamberg. He is also a PhD student at the University of Bamberg and researches reasons for withdrawals from teacher education.

Sina Fackler has worked as a researcher in the department of education at the University of Oxford where she also received here PhD and the working unit competencies at the Leibniz Institute for Educational Trajectories. She is currently head of the research unit K2 Education and provision of services of the welfare state at the German Youth Institute in Munich, Germany.

Jennifer Paetsch has worked as a researcher in the Professional School of Education at the Humboldt University of Berlin where she also received here PhD. She is currently holding the chair of evaluation in teacher education at the University of Bamberg.

ORCID

Sebastian Franz http://orcid.org/0000-0002-9425-4196
Sina Fackler http://orcid.org/0000-0003-2952-4046

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