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Career entry motivations and teaching perceptions of science preservice teachers: a comparison of trends between Finland and South Korea

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ABSTRACT

Many countries are facing a shortage of science teacher candidates; thus, it becomes increasingly important to understand science preservice teachers' (PSTs') career entry motivations because it plays an important role in attaining and retaining talented science teachers. This study therefore aims to explore and compare science PSTs' motivations and perceptions about the teaching profession in different contexts and to understand the role of gender and study subjects regarding motivation. Data collected for this study from two countries, Finland and Korea, are analysed using latent mean analyses. According to the results, Korean PSTs indicate a lower level of confidence and satisfaction in their career choice than their Finnish counterparts. Female PSTs, when compared with male PSTs, perceive themselves to have lower levels of ability and interest in teaching and view a science teaching career as more difficult and demanding. Finally, the results show that biology major PSTs possess higher altruistic motivations than those with other science majors. Findings of the current study suggest that (1) science teacher candidates benefit from studying pure science before becoming involved in a teacher training programme, and (2) PSTs' motivations and perceptions, especially females' and non-biology PSTs', need to be carefully monitored.

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Introduction

The worldwide teacher shortage has notably become a concern in recent years due to teachers leaving their profession and too few wanting to become teachers (Sims & Jerrim, 2020), a situation that is more critical among science subject teachers (Feder, 2022;

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Han & Hur, 2022). Considering the impact that the field of science can make on our lives and economies, gaining a deeper understanding of individuals' motivations for choosing a science teaching career is particularly significant not only for recruiting high-achieving and motivated science teacher candidates into teacher training but also for equipping future citizens with the appropriate scientific knowledge and skills. Therefore, the current study aims to investigate the career entry motivation of science preservice teachers' (PSTs') noting initial motivations of PSTs have been reported as highly correlated with their career aspirations (Watt & Richardson, 2008) and academic achievements during their training programme (Camarero-Figuerola et al., 2023). Although previous studies have explored science teacher motivations (e.g. Kılınç et al., 2012), few studies have compared PSTs' motivations in different countries. Moreover, while studies suggest that the teachers' gender and teaching subjects can potentially influence their initial motivations (e.g. Eick, 2002; Goller et al., 2019), the effects of gender and teaching subjects on science PSTs' motivations remain under researched. Accordingly, this study focuses on science PSTs' motivations in Finland and Korea as these teacher education systems reflect the characteristics of various education systems worldwide. For instance, Finnish teacher education is based on a five-year (bachelor + master) degree programme, while Korean teacher education requires a four-year bachelor's degree. Finnish science teachers also need to master two or more subjects (such as biology/geology or physics/chemistry/mathematics), whereas Korean science teachers are only required to complete one science subject. Despite their differences, Finland and Korea are encountering similar challenges in science teacher education: Finland faces a teacher shortage, especially in physics and chemistry, while Korea is experiencing a gradual decrease in the popularity of the teaching profession. Other nations can, accordingly, find valuable insights that may be applicable to their own circumstances by closely examining these two countries. Given the fact that cultural roots can specifically affect science teachers' motivations (e.g. Robertson & Jones, 2013), this paper analyses the effects of sociocultural aspects, such as recognition of the teaching profession, gender, or teaching subjects, on science PSTs' motivations in different countries.

Literature review

Theoretical framework

Motivation is generally defined as 'the reason why people decide to do something, how long people are willing to sustain the activity and how hard they are going to pursue the activity' (Han & Yin, 2016, p. 3). In line with this, teacher motivation is defined as something that determines 'what attracts individuals to teaching, how long they remain in their initial teacher education courses and subsequently the teaching profession' (Sinclair, 2008, p. 37).

Teacher motivation research has received more attention after Watt and Richardson introduced a systematic theoretical framework to study teacher motivations named the Factors Influencing Teaching Choice (FIT-Choice) model (Richardson & Watt, 2006; Watt & Richardson, 2007). The FIT-Choice model is based on the Expectancy-Value theory (EVT; e.g. Eccles, 1983), which proposes that career choices (among other academic plans, choices, and performances) are explained by the expectancies and values, which an individual attaches to these. Following the basic ideas of EVT, Figure 1 shows

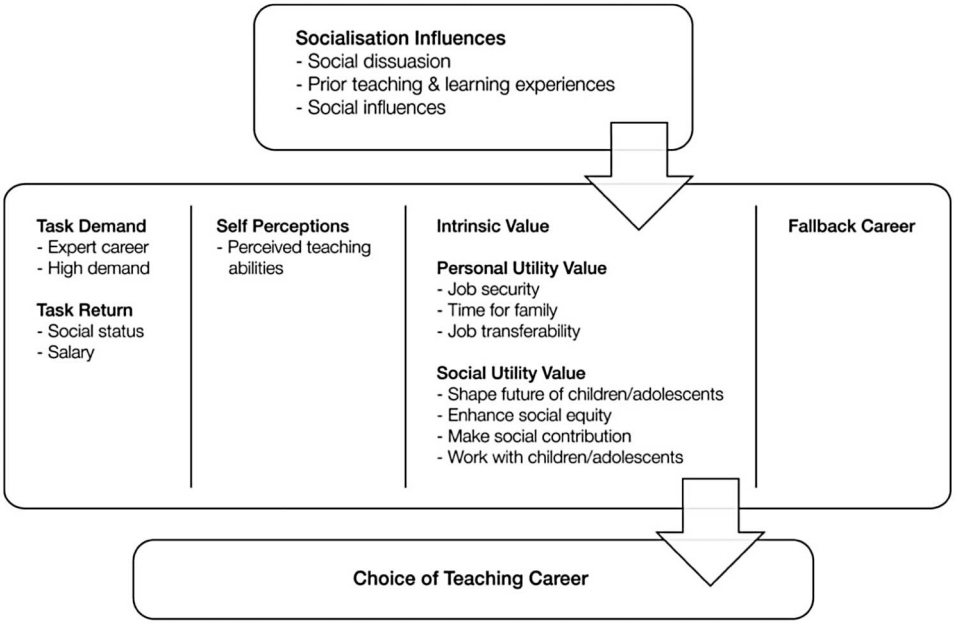

Figure 1. Conceptual framework of the FIT-Choice model by Watt and Richardson (2012, p. 187).

the FIT-Choice model and scale which include several motivations and perceptions. According to the model, Socialisation Influences consisting of perceived social dissuasion, prior teaching and learning experiences, and social influences affect their perceptions and motivations. Perceptions about teaching profession are critical elements of the FIT-Choice model and are measured in terms of whether the teaching profession is seen as an expert career and as highly demanding (Task Demand) with high social status and salary (Task Return). Self-Perceptions are related to perceived teaching abilities while Intrinsic Value refers to a personal interest in teaching. The three different dimensions of Personal Utility Values are related to job security, time for family, and job transferability that the teaching profession provides, while the four different dimensions of Social Utility Values include the possibilities to shape the future of children or adolescents, enhance social equity, make a social contribution, and work with children or adolescents. In addition, teaching as a Fallback Career choice is also included under motivations in the FIT-Choice scale making it a comprehensive and coherent framework to guide the systematic investigation of why people choose a teaching career. The model and scale, which are designed to allow comparative measurements of teacher motivations across the world, have been used in numerous studies in different countries and educational contexts to better understand the motivations for becoming a teacher (for more details, see Watt & Richardson, 2012).

Career entry motivations and their relationship with gender and teaching subjects

According to the studies using FIT-Choice scales, altruistic and intrinsic motivations are the key elements that attract prospective teachers to the teaching profession across

multiple contexts (Watt & Richardson, 2012), although cultural backgrounds are shown to be a deciding factor in prospective teachers' motivations to become a teacher (Goller et al., 2019; Watt & Richardson, 2012). However, at the same time, several studies have reported gender differences in career entry motivations (e.g. Eick, 2002; Tomšik, 2015; Watt et al., 2013). Additionally, teaching subjects are found to be one of the prominent predictors of teachers' motivations to teach (e.g. Han et al., 2018; Kılınç et al., 2012; Watt et al., 2013). With this in mind, the following sections focus on reviewing studies related to motivational differences between gender and teaching subjects.

Gender and a teaching profession

Girls have traditionally envisaged a teaching career more than boys (OECD, 2018); accordingly, the teaching profession has been widely dominated by women at the pre-primary and primary stages of education (Tomšik, 2015) and also at the lower secondary education level (OECD, 2019). Similarly, women are more likely to study the social science disciplines, such as education, in higher education, whereas men are more likely to study the technology or engineering disciplines (Vicente-Molina et al., 2018). A gender balance, however, is more visible in science education (Watt et al., 2013), probably due to its unique positioning between science and education, where science is typically more favoured by males and education more favoured by females, further indicating that the motivations to become a science teacher may vary depending on gender. For instance, Watt et al. (2013) report that while male teachers are more motivated to choose teaching as a fallback career, female teachers indicate stronger motivations to work with children, an intrinsic career value, and possess positive prior learning experiences. Tomšik (2015) also identifies that female student teachers assign more value to family benefits as their motive to choose a teaching career than their male counterparts. This gender difference can be explained by the gender socialisation theory (Zelezny et al., 2000), according to which our personal characteristics are shaped by gender social norms and expectations. Women or girls are expected to be the primary caregivers of their children and family in many cultures, while men are the breadwinners (Frome et al., 2006). Likewise, parental caregiving often involves prioritising children's needs over one's own (Swain et al., 2012), which can also be a potential reason why women become more altruistic than men and look for careers that provide a family-friendly environment (Dietz et al., 2002). However, only a limited number of studies have examined the effect of gender on students' motivations to enter the science teaching profession. For instance, the qualitative study by Eick (2002) has shown that although both female and male teachers express working with students as the important motivation, 'women [identify] more closely with the nurturing and teaching role of their jobs, while men [identify] more closely with the shaping of youth and coaching role of their jobs' (p. 366).

Relationship between teaching subjects and motivations

With respect to the effect of teaching subjects, multiple studies have reported differences between science and non-science subject teachers' motivations (e.g. Kılınç et al., 2012; Watt et al., 2013). For instance, Kılınç et al. (2012), comparing the motivations between the Turkish science and non-science PSTs using the FIT-Choice scale, report

that the science PSTs indicate significantly lower motivations than the non-science PSTs, except in the 'fallback career' factor. Thus, the authors conclude that the science teachers are 'those who [do] not achieve sufficient scores to gain entry to the more prestigious scientific university degrees leading to professions that provide higher material gains and social status' (p. 217), assuming that they are less intrinsically motivated and choose the teaching profession as a fallback option. Similarly, Han et al. (2018) report that students with high mathematics skills are more likely to pursue careers, other than teaching, which offer higher returns. Nevertheless, although there have been studies investigating the differences between science and non-science teachers' motivations, it has not, to the best of our knowledge, been widely studied whether the teaching motivations among science teachers (both pre- and in-service) differ by the teaching subjects, such as biology, physics, or chemistry. For instance, life-oriented disciplines such as biology studies are reported to be preferred by females (or by males pursuing communal goals) in many countries, while thing-oriented disciplines such as physics are more preferred by males (Kang et al., 2019). Thus, it can be assumed that PSTs focused on biology may indicate higher altruistic motivations than PSTs focused on other science subjects. The current shortage of science teachers also varies between the subjects. For instance, while there has been a surplus of biology teachers, acute teacher shortages in physics and chemistry have been found during the last decades in the US (Feder, 2022), which can be associated with the difference in motivation based on the teaching subjects and gender. The current study accordingly aims to disentangle the unique roles played by gender and teaching subjects in career entry motivations using samples from Finland and Korea.

Context of the study: Finnish and Korean science teacher education systems

Previous studies have continuously reported on the effect of sociocultural environment on teaching motivations (Goller et al., 2019; Robertson & Jones, 2013; Watt & Richardson, 2012). Thus, an insight into how the teaching profession has been recognised and prepared in each country is essential to have a better understanding of teaching motivations in different contexts. Finnish and Korean science teacher education systems are accordingly compared in this review section with a focus on admission into the teacher training programmes, the structure and implementation of the programme and entry to the teacher workforce after graduation in each context. Table 1 shows a summary of the comparison.

Admission into science teacher education programmes

Considering that teaching professionals are highly valued in both Finnish and Korean contexts, the students must prove their competence in science to be accepted into teacher education programmes and graduate as science teachers. In Finland, for instance, students need to receive a specific minimum score on their matriculation examination. The required scores vary from university to university, but in most cases, it is enough to receive a score that places them in the top 40–50 percentile on a mathematics, physics, or chemistry examination (Opintopolku, 2021). According to the latest statistics,

Table 1. Comparison between Finnish and Korean science teacher education contexts.

	Finland	Korea
Entrance	• Relatively easier to enter teacher education programmes than in Korea • Facing difficulties to get enough students to join science teacher programmes	• Very high competition for the entrance • Popularity of a teaching profession is decreasing gradually
Teacher education programme	• 5 years programme (bachelor + master) • One-semester long school practicum • Study at least two science teaching subjects • Study science contents first, and then science education	• 4 years bachelor's degree • 4 weeks of school practicum • Study one science teaching subject • Study science contents and science education simultaneously
Employment	• PSTs individually contact schools to apply for the vacant teaching position • No specific data for science teacher employment is available	• PSTs take the national teacher employment test to become a public school teacher • The acceptance rate of the national test is very low for science teaching subjects

the acceptance rate to the teacher training programme is around 32% in chemistry, physics, and mathematics (Studentum, 2021). However, the true acceptance rates can be higher, because of the discrepancy in the number of students who apply and attend the examination. (For instance, in 2021, out of the 153 students applying to the University of Helsinki, the top university in Finland, only 55 students attended the examinations; 50 of those were accepted to the teacher training programme and only 43 students commenced the programme). A large-scale national survey in Finland has highlighted the existing issues with recruiting science and mathematics teachers. Considering the number of science and mathematics teachers who are expected to retire in the upcoming years, universities are struggling to meet the demands by attracting enough students to their science and mathematics teacher training programmes (Kearney, 2016).

In Korea, students who want to enter college must also show their competence in the specific subject area by successfully completing the annual national college entrance examination. Students who want to enter a teachers' college majoring in science education must be ranked at least in the upper 20% on the national test, although there may be slight differences depending on the colleges. The competition rate for college entrance has been declining during the last five years as the overall school-age population has decreased in Korea, but the acceptance rate for science education programmes has remained very low, at 16.5% (MOE, 2021). Thus, compared to Finland, it seems harder to enter the science teacher education programmes in Korea due to their high competition rate and popularity, which in turn may cause variances in PSTs motivations to choose a teaching career in science in the two countries.

Science teacher training programmes

In Finland, all science PSTs are required to complete a five-year programme, taking first a bachelor's degree (3 years) and continuing their studies to a master's degree (2 years). Students need to study at least two subjects as part of their science studies, as they are required to teach two subjects at secondary school. A popular combination is to study biology and geography. Another popular combination is to study two among physics,

chemistry, and mathematics subjects. It is also possible to study other combinations of subjects, but it may be more challenging to find a job with rarer combinations. Students generally study a major science subject for three years, a minor science subject for one year, and focus on pedagogical study for one year; pedagogical studies cover many areas, including the study of education and teaching methods as well as research into teaching methods. Teaching practice occupies one-third of the pedagogical studies, including a one-semester-long school practicum in Finland (Malinen et al., 2012). Traditionally, students can initially pursue their science studies and later decide whether they want to complete pedagogical studies to become a teacher.

In contrast, Korean science PSTs attend four years of college education and choose one of the four science areas (biology, physics, chemistry, and earth science) when they enter university. During the four years, these students are required to complete about half of their credits for science, science education, and pedagogical studies, including 4 weeks of school practicum. Thus, while the Finnish training programme asks for more commitment from students on both the science content studies and the school practicum, the Korean training programme seems less demanding and offers more freedom to choose subjects other than their major areas.

Employment after graduation

The graduates in Finland are eligible to apply for science teacher positions in all Finnish schools upon successful completion of their master's degree. However, it is quite difficult for fresh graduates to secure a permanent position on graduation, especially in bigger towns. Rather, graduates commence as substitute teachers or look for short-term teaching contracts for around 1–3 years after graduation. Although science teacher-specific data are not available, a national survey conducted with teachers across all subject areas reported that around 84% of the participants hold permanent positions (FNAE, 2019, pp. 18–19). Considering the shortage of science teachers in Finland, however, it is expected that finding permanent positions may be much easier for science PSTs than for other subject teachers.

Conversely, teacher education graduates in Korea need to apply for the national teacher employment test if they want permanent teaching positions in the public-school sector. The competition is very high in Korea, although it varies depending on the provincial areas. (For instance, the MOE indicates the 2021 acceptance rates as 1 versus 7.49, 7.89, 10.03, and 6.95 for physics, chemistry, biology, and earth science teaching positions, respectively). Accordingly, the employment rate for the graduates from the science education department is low (35%); this even includes graduates working in different fields, such as private companies, in addition to science education (Im et al., 2016). In short, even though Finnish PSTs may face challenges to gain a permanent teaching position immediately after graduation, the case is even harder for Korean PSTs as they face severe competition to achieve a stable teaching career.

Research aims and questions

As reviewed, although previous studies have investigated science teachers' motivations, only a few studies have relied on a comprehensive and theoretically sound

framework such as the FIT-Choice. Additionally, to our knowledge, not many studies have compared the effect of different educational systems and teaching subjects on science teacher motivations. Moreover, the effects of gender on science teacher motivations are inconclusive. Therefore, in adopting the FIT-Choice scale, this study aims to explore science PSTs' career entry motivations in two different countries to present how different training systems affect their motivations. This study also investigates whether teaching different science subjects and the gender difference influences motivations. Thus, it is expected that the findings of this study are able to extend our understanding of the relationship between teacher education programmes and science PSTs' motivations and in turn, provide information as to how to support science PSTs in different teaching subjects and gender groups. Based on these aims, this study examines the following research questions:

RQ1. In what ways do Finnish and Korean science PSTs possess different motivations for choosing teaching and perceptions of the teaching profession?

RQ2. How do female and male science PSTs differ in their career entry motivations and teaching perceptions?

RQ3. How do the different teaching subjects in science education affect the PSTs' career entry motivations and teaching perceptions?

Method

Procedure and participants

Five research-intensive universities in Finland and eleven in Korea were selected for data collection as they were the major universities educating science PSTs in these contexts. The science teacher educators from each university were then contacted to discuss the aims and scope of this research. The educators in Finland distributed the questionnaire to science PSTs online, and 145 PSTs (85 females) voluntarily accepted and completed the online questionnaire. In contrast, the Korean teacher educators at each university printed the questionnaire and distributed to the participants during the class and the completed surveys ($N = 815$; female $n = 426$) were collected through mail delivery. Most of the Finnish participants were undertaking pedagogical studies ($N = 111$), while 30 of them had completed and four were yet to commence the pedagogical studies (one participant did not answer the pedagogy study status). The participants' average age was 25.4, ranging from 20 to 55, with most of them were between 22 and 25 ($n = 110$). Concerning the teaching subjects, 105 participants studied two or three subjects among physics/chemistry/mathematics and 40 studied biology/geography. The Korean sample included freshmen in the first year of their course to seniors in the final year of their course (freshmen = 162, sophomore = 212, junior = 259, and senior = 182). The average age of these participants was 21.41, ranging from 18 to 32, while most of them were between 19 and 23 ($n = 659$). Regarding the teaching subjects, 151, 242, 294, and 128 Korean PSTs studied physics, chemistry, biology, and earth science, respectively.

Measurement

The measurements were the translated version of the psychometrically validated FIT-Choice scale by Watt and Richardson (2007) that had been previously used in Finland (e.g. Goller et al., 2019) and Korea (e.g. Lee & Kim, 2018). The original English and translated Finnish and Korean FIT-Choice scales were shown in tables S7 and S8. Based on the previous literature and preliminary reliability test (Table S1), the 11 motivation factors and 4 perception factors included in the study are shown in Table 2.

Motivations to become a teacher: Each motivation item started with the common stem 'I chose to become a teacher because … ' followed by different statements such as 'I have had inspirational teachers' (see Table S7 for full item description). The participants responded to the questions using the 7-point Likert scale from 1 (not at all important) to 7 (extremely important) following the original response options in the scale. The questionnaire consisted of 11 factors, and each factor included 3 items; thus, a total of 33 items measured the student teachers' career entry motivations.

Perceptions of teaching: There were questions about how the participants perceived the teaching profession. The common stem for most items was 'Do you think teaching is … ?' followed by different statements (see Table S8 for full item description). Similar to the motivation items, the 7-point Likert scale with response options ranging from 1 (not at all) to 7 (extremely) was used. The perception questionnaire included three perceptions with three items each and one perception with six items. Thus, a total of 15 items was used to measure science PSTs' perception of teaching.

Analysis

Following the previous FIT-Choice studies examining latent mean differences between cultures (e.g. Goller et al., 2019), a multiple group confirmatory factor

Table 2. The latent mean difference between Finland and Korea.

Categories	Finland Mean (SD)	Korea Mean (SD)	ΔM^{+}	*d*
Motivation				
Ability	**5.26 (1.05)**	4.47 (1.12)	−0.80***	0.73
Intrinsic career value	**6.09 (0.96)**	**5.26 (1.27)**	−0.70***	0.74
Job security	4.80 (1.30)	4.72 (1.22)	−0.07	0.07
Time for family	4.01 (1.98)	4.34 (1.30)	0.31*	0.20
Shape future of children/Adolescents	5.01 (1.43)	4.77 (1.22)	−0.16	0.19
Enhance social equity	4.48 (1.58)	**4.96 (1.29)**	0.39**	0.34
Make social contribution	5.08 (1.42)	4.69 (1.25)	−0.40**	0.30
Work with children/Adolescents	5.05 (1.47)	4.46 (1.35)	−0.44***	0.42
Prior teaching and learning experiences	**5.54 (1.25)**	**5.06 (1.36)**	−0.29**	0.37
Social influences	3.47 (1.58)	3.58 (1.41)	0.15	0.07
Perception				
Expert career	5.54 (1.06)	5.38 (1.11)	−0.31**	0.15
High demand	5.72 (0.93)	5.16 (0.98)	−0.66***	0.59
Social status	4.99 (0.99)	4.54 (0.96)	−0.51***	0.47
Satisfaction with choice	5.67 (1.18)	5.36 (1.19)	−0.47***	0.26

The range of scales is between 1–7. *$p < .05$, **$< .005$, ***< 0.001. ΔM: The Finnish sample was used as the reference group. Thus, a positive or a negative ΔM shows that the Korean sample had higher or lower latent means in comparison to the Finnish sample. **Bold** indicates the top three motivation factors of the two countries. Cohen's *d*: weak effect ($d < .2$), modest effect ($.2 < d < .5$), moderate effect ($.5 < d < 1$), strong effect ($d > 1$). $^{+}$Standardised value.

analysis (MGCFA) was conducted to validate the quality of the psychometric instrument across groups. Then, measurement invariance (MI) was examined across groups before conducting mean different analyses (Tables S2, S3, and S4 present the results of MGCFA and MI). Overall, the validity and reliability of the measurement were satisfactory (please see Supplementary Materials for more detail). A latent mean analysis was conducted to answer our research questions after confirming MI. The Finnish sample was used as a reference group for the latent mean comparison. That is, the mean of the Finnish sample was set as zero and the mean of the Korean sample was freely estimated. Thus, a positive or a negative mean difference showed that the Korean sample had a higher or lower latent mean compared to the Finnish sample, respectively. Additionally, to demonstrate the extent of the differences in latent means (ΔM), Cohen's *d* effect sizes were calculated (Goller et al., 2019). The *d* index was calculated by taking the difference between the means of the two groups and dividing it by the pooled standard deviation across the groups; the results were interpreted based on the following traditional guidelines: weak effect ($d < .2$), modest effect ($.2 < d < .5$), moderate effect ($.5 < d < 1$), and strong effect ($d > 1$). For all these analyses, Mplus 7 was used with the maximum likelihood with robust standard errors and chi-squared (MLR) estimator, and missing data were estimated using full information maximum likelihood estimation (FIML) (Muthén & Muthén, 2012).

Results

RQ1. In what ways, did Finnish and Korean science PSTs possess different motivations for choosing teaching and perceptions of the teaching profession?

The career entry motivations of both Finnish and Korean samples are summarised in Table 2. It was noted that Finnish science PSTs indicated higher motivations than Korean science PSTs in general, except for two factors: *Time for family* and *Enhance social equity* factors. Although the Korean PSTs rated the personal utility value *Time for family* higher ($M = 4.34$) than the Finnish PSTs ($M = 4.01$), it was one among the lower rated motivation factors for both cohorts. The factor *Social influences* was the lowest motivation for both countries without any statistically significant differences, indicating that their decision to become science teachers was not strongly influenced or encouraged by their family or friends.

Interestingly, the differences in *Ability* and *Intrinsic career values* were significantly higher for the Finnish cohort than for the Korean cohort ($\Delta M = -0.80$ and $\Delta M = -0.70$ respectively) and the effects sizes were moderate ($d = 0.73$ and $d = 0.74$, respectively). While for the Korean participants, *Ability* ($M = 4.47$) was one of the lower rated motivation factors, the factors *Interest in teaching* ($M = 5.26$) and *Prior learning experiences* ($M = 5.06$) were rated higher. However, *Ability*, *Interest*, and *Prior learning experiences* were the top three motivations for the Finnish cohort.

Regarding perceptions of teaching careers, the Finnish cohort rated higher in all the perception factors than their Korean counterparts. The gap was the widest in terms of the perceived *High demands* of teaching.

RQ2. How did female and male science PSTs differ in their career entry motivations and teaching perceptions?

There were no gender specific differences observed in career entry motivations among the Finnish sample (see Table 3). However, the effect of gender differences was evident among the Korean sample with female participants rating *Ability* (ΔM = −0.20) and *Intrinsic career values* (ΔM = −0.15), lower than male participants, although the effect sizes were weak ($d = 0.18$ and $d = 0.14$, respectively). While gender differences were reflected in PSTs' perceptions of job demands in both contexts with females rating teaching as emotionally and physically more demanding (ΔM = 0.74, $d = 0.56$, moderate effect), and teaching science as an *Expert career* requiring higher levels of specialised knowledge (ΔM = 0.19, $d = 0.17$, weak effect) compared with males, a statistically significant difference was observed only in the Korean sample. This was an interesting observation, because the Korean male participants rated themselves higher in *Ability* and *Interest*, compared with the females who perceived teaching careers as more difficult and requiring expertise.

Comparing both contexts, Finnish females and males indicated higher motivational values than Korean females and males, except for the *Enhancing social equity* factor (Table 3). The difference was not significant among the female participants across the two contexts, although there was a significantly high difference between the males, with Korean participants rating higher on *Enhancing social equity* (ΔM = 0.61, $d =$

Table 3. Gender differences within and between countries.

	Finland			Korea			Finland vs. Korea	
	Female	Male	ΔM	Female	Male	ΔM	Female	Male
Motivation								
Ability	5.25 (1.01)	5.26 (1.11)	−0.04	4.37 (1.05)	4.57 (1.18)	−0.20*	−0.98***	−0.64***
Intrinsic career value	6.21 (0.88)	5.92 (1.05)	0.38	5.18 (1.28)	5.36 (1.26)	−0.15*	−0.86***	−0.51***
Job security	4.69 (1.35)	4.97 (1.23)	−0.21	4.78 (1.14)	4.66 (1.31)	0.13	0.07	−0.24
Time for family	3.91 (2.02)	4.16 (1.92)	−0.13	4.29 (1.27)	4.39 (1.33)	−0.09	0.38	0.24
Shape future of children/ Adolescents	5.19 (1.28)	4.77 (1.60)	0.33	4.77 (1.13)	4.76 (1.32)	0.05	−0.36*	0.03
Enhance social equity	4.68 (1.48)	4.20 (1.68)	0.34	5.02 (1.21)	4.90 (1.37)	0.11	0.24	0.61**
Make social contribution	5.03 (1.35)	5.16 (1.51)	−0.07	4.66 (1.15)	4.72 (1.35)	−0.05	−0.44**	−0.35*
Work with children/ Adolescents	5.25 (1.44)	4.77 (1.47)	0.35	4.49 (1.32)	4.43 (1.37)	0.04	−0.61***	−0.23
Prior teaching and learning experiences	5.47 (1.34)	5.65 (1.11)	−0.18	5.09 (1.29)	5.03 (1.42)	0.04	−0.20	−0.42***
Social influences	3.51 (1.52)	3.42 (1.68)	0.03	3.64 (1.37)	3.51 (1.46)	0.09	0.13	0.18
Perception								
Expert career	5.60 (0.93)	5.46 (1.22)	0.26	5.47 (1.02)	5.28 (1.19)	0.19*	−0.36*	−0.25
High demand	5.92 (0.87)	5.44 (0.94)	0.53*	5.41 (0.88)	4.88 (1.02)	0.74***	−0.70***	−0.60**
Social status	4.94 (0.96)	5.07 (1.03)	−0.13	4.55 (0.91)	4.53 (1.02)	0.054	−0.44**	−0.60***
Satisfaction with choice	5.70 (1.20)	5.63 (1.16)	−0.06	5.33 (1.14)	5.39 (1.24)	−0.106	−0.56***	−0.41**

*$p < .05$, **< .005, ***< 0.001. ΔM: The Finnish and male samples were used as the reference group, and thus, a positive or a negative ΔM shows that the Korean teachers (or females) have higher or lower latent means in comparison to their Finnish (or male) counterparts.

0.55, moderate effect). The Finnish females and males also rated teaching perceptions higher than the Korean female and male participants.

RQ3. How did the different teaching subjects in science education affect the PSTs' career entry motivations and teaching perceptions?

Acknowledging the differences in the structure of science teacher education programmes in the two contexts, the analysis was conducted by classifying the Finnish sample into two groups: Biology & Geography group and Physics & Chemistry group; while the Korean sample was divided into four groups; Physics, Chemistry, Biology, and Earth Science. Table 4 shows that the Biology & Geography group in Finland indicated higher motivations in the altruistic motivation factors such as *Shaping future of children* and *Making social contributions* than the Physics & Chemistry group. In a similar way, the Korean data showed that the Biology group generally had higher motivations than the other three groups. However, no significant gender differences were identified between the different science subject groups in either context. However, the trend was different in terms of teaching perceptions. There was no statistically significant difference between the teaching subject groups in the Finnish context, although the Biology & Geography group indicated slightly higher average values than the Physics & Chemistry group. However, the Biology group indicated higher average values in most of the perception-related factors than the other science PST groups in Korea. Analysing the

Table 4. Differences between majors and gender.

	Finland			Korea				
	Major	Gender		Major	Gender			
	PC-BG	PC	BG	*P* vs. C vs. B vs. G	*P*	C	B	E
Motivation								
Ability	None	None	NA	B > *P***,C**,G***/ *P* > G*/ C > G*	None	M > F**	None	None
Intrinsic career value	None	None	NA	B > C*,G***/ *P* > G**	None	None	None	None
Job security	None	None	NA	B > *P**,C*	None	None	None	None
Time for family	None	None	NA	None	None	None	None	None
Shape future of children/ Adolescents	BG > PC*	None	NA	B > *P***,C*,G**	None	None	None	None
Enhance social equity	BG > PC*	F > M*	NA	B > *P***,G**	None	None	F > M*	None
Make social contribution	BG > PC*	None	NA	B > *P****,C*,G***	None	None	None	None
Work with children/ Adolescents	None	F > M*	NA	B > G**/ C > G**	None	None	None	None
Prior teaching and learning experiences	None	None	NA	B > *P**,G**	None	None	None	None
Social influences	None	None	NA	None	None	None	None	None
Perception								
Expert career	None	None	NA	B > C**	None	F > M*	None	None
High demand	None	None	NA	None	F > M*	F > M***	F > M***	F > M**
Social status	None	None	NA	B > C*,G**	None	None	None	None
Satisfaction with choice	None	None	NA	B > *P**,G** / C > *P**, G*/ G > *P***	None	None	None	None

P: Physics, C: Chemistry, B: Biology, G: Geography, E: Earth Science, NA: not applicable. Due to the low sample size, the calculation concerning gender differences could not be completed for the Finnish BG group. **p* < .05, **< .005, ***< 0.001.

gender differences within the different teaching subject groups, Korean female PSTs seemed to be more inclined to view teaching as a highly demanding career than males, while no such differences were observed among the Finnish participants. However, gender differences could not be calculated due to the low sample size of the Finnish sample for the Biology & Geography group (Female = 31, Male = 9). For reference, the observed mean values were as presented in tables S5 and S6.

Discussion

Differences in career entry motivations and teaching perceptions between countries

Findings from the current study showed similarities and differences between the career entry motivations as well as teaching perceptions of the Finnish and Korean participants. One of the interesting similarities was that '*having time for family*' was not reported as a key motivator for science PSTs to choose a teaching career in either country. This finding contradicted previous research reporting women choosing teaching careers more than men due to job security and family-flexible work hours (e.g. Tomšik, 2015; Watt et al., 2013). However, it was seen as important to acknowledge the contextual differences. In a welfare state like Finland, which identified as the country that offered the most flexible working environment in Europe (Savage, 2019), it was seen as quite natural for individuals to perceive any career as providing similar opportunities to maintain a healthy work-life balance as a teaching career. In contrast, the finding was interesting in the Korean context where a teaching career had been reported as the one that fitted well with the responsibilities of personal life (OECD, 2019). However, previous studies also indicated that, while the teaching profession was the most preferred career option by Korean secondary school students, they hardly considered the option of having flexible time management while contemplating their future occupations (Seo et al., 2020). Thus, based on our findings and the existing research evidence, it could be concluded that while personal utility values were not completely negated, there were other stronger motives that drove people to choose a science teaching career.

One significant difference in motivations between the PSTs was that the Finnish participants indicated higher confidence in their *teaching ability*, as opposed to their Korean counterparts for whom the *teaching ability* was one of the lowest rated motivations. This difference could stem from the different educational systems for science teaching training. As reviewed, in Korea, the students enter teachers' college right after graduating from secondary education, without spending much time to experience and reflect on their teaching careers. Additionally, there was popularity of the teaching profession which resulted in the high competition for entering teachers' college (Im et al., 2016; MOE, 2021), resulting in some students joining science education purely based on their achievement in the national entrance examination, rather than their interest and confidence in the teaching profession: hence, these students might possess low confidence in teaching science. In contrast, the science PSTs in Finland were required to study science first, and then, only those who were interested and confident in teaching science applied for teacher education. This could be a reason

why the Finnish PSTs demonstrated a higher level of confidence and interest in teaching science, compared to the Korean PSTs. Given that interest and confidence in teaching have been reported as the most important factors predicting teachers' retention in teaching careers (e.g. Yost, 2006), it might be prudent for the international science teacher education community to consider dedicating specific time for PSTs to learn science content during the initial year of the programme and then seek their self-confidence and interest in pursuing careers as science teachers. For instance, the reformation of Korea's current 4-year teachers' college system to a 6-year master's degree programme (4 years for subject studies and 2 years for pedagogy studies) has been under serious consideration as a potential means to improve the teacher education system (KEDI, 2021).

The Finnish sample also showed higher average values in the perception-related factors than the Korean sample, with more Finnish PSTs perceiving teaching science as demanding and requiring high expertise than the Korean PSTs. However, the Finnish participants were more satisfied with their choice to become teachers and viewed teaching science as rewarding. This difference could be attributed to the different training systems in the two countries. For instance, comparing the time for the school practicum, while the Korean PSTs had only four weeks during the four years of their study, the Finnish PSTs usually spend half a year or more at school for the practicum. Thus, the Finnish PSTs might have more opportunities to discuss with in-service teachers and gain more insight into what the roles and responsibilities entailed, potentially providing a more realistic understanding of the demands of the job compared to their Korean counterparts, who only received short-term school experiences during their science education programme. Given the fact that satisfaction in teaching career was a key predictor of teacher burnout (Skaalvik & Skaalvik, 2020), confidence in teaching (Kasalak & Dagyar, 2020), and retention in a teaching career (Ingersoll, 2001), it was seen as important that science PSTs spent sufficient time in school practicums during the training programme to develop a better understanding of the profession's demands and commitments.

Gender differences in career entry motivations and teaching perceptions

The current study found no gender differences in motivations for *having more time for family*, *making a social contribution* or *satisfaction with their choice* of teaching careers in either context, which was contrary to earlier studies reporting female teachers rating personal utility values with family benefits as their motive to choose teaching careers higher than the male teachers (e.g. Tomšik, 2015; Watt et al., 2013). Both females and males in our sample also perceived the teaching profession as an expert career with high demands. The current findings could be attributed to the social status of teaching careers in Finland and Korea. As reviewed, the teaching profession was highly valued and one of the most popular jobs in both countries. So, it could be assumed that this socio-cultural environment had a positive impact on the participants' career entry motivations and teaching perceptions, in general, regardless of their gender.

That said, gender differences were not completely invisible. Korean females rated higher on job demands, while Korean males expressed higher confidence in their ability to teach science, indicating a pattern that science PSTs with higher confidence

and interest would be more likely to perceive teaching science as less demanding. There were existing findings which substantiate this observation. For example, teachers' efficacy was reported to be significantly related to their job stress, suggesting that increasing the level of confidence in teaching science would eventually reduce the prospective female teachers' stress during and after the teacher training programmes (Lim & Do, 2014). Considering that confidence in teaching was seen as a stable disposition during the teacher training programmes (Eren & Tezel, 2010) and that female science in-service teachers often encountered difficulties in preparing for science teaching and scientific practice in Korea (Lee, 2014), we would like to draw the attention of science teacher educators to recognising this gender difference. It could be recommended to invest in identifying the reasons, and in turn, introduce strategies that would help female science PSTs to build their confidence in teaching science during the training programme. However, such a trend was not noticed in our Finnish sample, where both female and male science PSTs rated their teaching abilities high. This result could be partly attributed to the uniqueness of the Finnish educational system, where students study science for several years before entering the teacher training programme. As higher science content knowledge was seen as leading to higher science teaching self-efficacy (Velthuis et al., 2014), students' science learning experiences prior to the teacher training might have boosted both female and male PSTs' confidence in teaching science in Finland. However, due to our study's limited dataset, further research was seen as desirable to deepen our understanding of this observation.

Teaching subject differences in career entry motivations and teaching perceptions

Our findings also revealed the effect of selected teaching subjects: Biology PSTs reported altruistic motivations and pursued communal goals more than other science major counterparts, while the gender effect was negligible. This was in line with the findings from previous studies which showed that biology majors tended to pursue communal goals more than other science majors, given their stronger connection to human science (Kang et al., 2019). Therefore, as our result showed, different teaching subjects also could affect career entry motivations of science PSTs. Acknowledging that the intrinsic motivations could predict teachers' retention in the teaching profession (Wong & Luft, 2015) and considering the high turnover rate of science teachers (Han & Hur, 2022), especially in Physics and Chemistry (Feder, 2022), more attention and care was recommended for the chemistry and physics teachers such as mentorship programmes and targeted professional development opportunities, because they were likely to possess lower intrinsic motivations than other science teaching groups. In line with previous research (e.g. Kang et al., 2019), our findings could be explained by Physics and Chemistry teachers' preference for things-oriented scientific subjects, which could reduce their altruistic motivations relative to Biology teachers. This reduction in altruism could, in turn, negatively impact their dedication and contribution to teaching. One way to address this issue would be to improve the physics and chemistry teachers' awareness of the connection between science and society and the contribution of science to socio-scientific issues (Sadler et al., 2017).

Conclusion

This study explored how different teacher training programmes, gender, and teaching subjects were related to science PSTs' motivations to become qualified and committed science teachers. The following indicated concluding thoughts and recommendations for the science teacher education community based on our findings. First, Korean PSTs indicated lower confidence in teaching and satisfaction in their career choice than Finnish PSTs, and seemingly these results stemmed from different teacher training programmes within the countries. Second, Korean female PSTs indicated lower confidence in teaching and perceived science teaching as more demanding than their male counterparts, while that difference was invisible in Finland. Based on the findings from the current study, it was recommended that Science PSTs, both males and females, would benefit from studying science content in the initial year at university and pursuing further studies in the science teacher training programme given a personal interest and confidence in teaching science. Third, the study revealed that PSTs' motivations differed by teaching subjects. Thus, physics and chemistry PSTs' altruistic motivations were lower than biology PSTs in both Finland and Korea. Therefore, science teachers' motivations should be carefully monitored, especially for chemistry and physics teachers, because they were likely to have lower altruistic motivations than biology teachers, which might impact their retention in teaching careers in the future.

Limitations and recommendations for future research

First, since this study did not use probability sampling methods, the results were not seen as generalisable. The size of the Finnish sample, especially the biology & geography teaching group, was also small compared to the Korean sample, so we were unable to analyse the gender differences within the biology group. Thus, for future research, we recommend using the probability sampling methods to generalise the findings to a wider population. Second, it is acknowledged that socio-cultural variables other than gender, such as levels of parental income and occupations that might impact PSTs' motivations (Richardson & Watt, 2006) were not included in the current study. Thus, it would be more convincing to include and control those variables in future studies while investigating the effects of gender and teaching subjects on teachers' motivations to teach. Third, as the FIT-Choice scale aimed to collect data embracing all disciplines, any data specific to science PSTs were not collected. However, this study provided a unique insight into how teaching different science subjects could influence PSTs' motivations by comparing PSTs who chose different science teaching subjects. For further research, adding science teacher-specific variables such as interest in specific science subjects or self-efficacy in science subjects (Eick, 2002) to explore motivations and perceptions, was recommended.

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