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The effect of inquiry-based learning experiences on adolescents' science-related career aspiration in the Finnish context

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ABSTRACT

Much research has been conducted to investigate the effects of inquiry-based learning on students' attitude towards science and future involvement in the science field, but few of them conducted in-depth studies including young learners' socio-cognitive background to explore mechanisms which explain how inquiry experiences influence on career choices. Hence, the aim of this study was to investigate in what ways and to what extent the inquiry learning experiences in school science affect students' future career orientation in the context of socio-cognitive mechanisms based on socio-cognitive career theory(SCCT). For the purpose, Programme for International Student Assessment (PISA) 2015 data were used focusing on science literacy, and the sample of Finnish 15-year-old students ($N = 5782$) was analysed by structural equation modelling with the hypothesised Inquiry-SCCT model. The results of the study showed that inquiry learning experiences were indicated as a positive predictor for the students' career aspiration, and most of its effects were mediated by outcome expectations. Indeed, although self-efficacy and interest in learning science indicated positive correlations with future aspiration, outcome expectation presented the highest correlation with the science-related career. Gender differences were found in the model, but girls indicated higher outcome expectation and career aspiration than boys in Finland.

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Inquiry-based learning; career choice; socio-cognitive career theory

Introduction

The twenty-first century is known as the era of the science since it has made great progression and in-depth impact on our lives. Many nations, thus, focus on science education to attain competitive superiority in technology and economy for the future. However, unlike their continuous efforts to promote scientific literacy on adolescents, especially in Western countries, much research has indicated decreasing interest and lack of readiness of students to pursue science-related professions (Osborne & Dillon, 2008). Accordingly, science education community attempts various movements in order to prompt young learners to engage in scientific activities and to continue their career in science,

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technology, engineering, and mathematics (STEM) fields by promoting their interest in school science.

Inquiry-based learning (IBL) is one of the remarkable attempts in increasing students' positive attitude towards science and science career by introducing authentic scientists' work into school science (Martin-Hansen, 2002). Through this learning process, students can experience how scientific knowledge has been constructed and what it would be like if they work in the field of science (Lee & Butler, 2003). Interestingly, undergraduate students involved in the hands-on independent research showed positive attitudes towards STEM career aspiration regardless of their majors (Lopatto, 2010; Russell, Hancock, & McCullough, 2007). The result can be explained in accordance with Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994) that students' learning experiences undoubtedly affect their vocational interests which, in turn, subsequently influence occupational choice through socio-cognitive mechanisms such as self-efficacy beliefs and outcome expectations. However, although the important effects of adolescents' learning experiences influenced career path orientation (Schoon, 2001; Tai, Liu, Maltese, & Fan, 2006) and plausible effects of inquiry-based science education on students' STEM career trajectories, few studies have been conducted to delineate the effect of IBL towards young learners' career choices.

Hence, the aim of the study was to investigate the extent to which students' experience in IBL has effects on students' expectation to pursue a science-related career based on secondary data analysis with Programme for International Student Assessment (PISA) 2015 (OECD, 2016). This study was conducted with the lens on the SCCT framework which includes complex social contexts correlating with students' career pursuit. With regard to multiple regressions, structural equation modelling (SEM) was adopted to measure the fit of the model and the effects of IBL on the career choices.

IBL as students' learning experiences

As previously mentioned, IBL which stimulates and reflects scientists' authentic work among students (Zion & Mendelovici, 2012) becomes the keystone of science education for last decades. It is less teacher-directed step-by-step instruction, rather, a more ' own experiences (Anderson, 2002). This approach fosters students' understanding of what is included in scientific knowledge and how it is produced (National Research Council [NRC], 2000). As presented in Table 1, IBL is accounted in various ways by the amount of given autonomy to learners in designing the investigation (Koksal & Berberoglu, 2014). For instance, an open inquiry is a way to give the most autonomy to students in conducting an inquiry so that they can lead to ask research questions, design their own experiments, and draw a conclusion based on the observed result by themselves. On the

Table 1. Comparison of levels of inquiry in different studies.

Zion et al. (2007)	Bell et al. (2005) (Lederman, 2009)	Question	Method	Solution
Open	Open	S	S	S
Guided	Guided	T	S	S
	Structured (Direct)	T	T	S
Structured	Confirmation (Exploration)	T	T	T

Note: Involvement of S: student, T: teacher.

other hand, a teacher leads most of the inquiry process instead of students in confirmation inquiry practice. However, the terms of levels of inquiry are defined in different ways as shown in Table 1 in different studies. For instance, a concept of guided inquiry from Zion, Cohen, and Amir (2007) includes both concepts of guided and structured inquiry of Bell, Smetana, and Binns (2005) or the concepts of guided and direct inquiry of Lederman (2009), and the term structured from Zion is similar to the term confirmation of Bell or exploration of Lederman. In this research, we followed and used the definitions from Zion and his colleagues because of its simplicity and suitability for this study.

Zion et al. (2007) sectionalise inquiry into three forms as teacher-directed structured and guided inquiry and student-directed open inquiry. However, despite structured inquiry's fundamental role in learning science for familiarising with a basic inquiry skill, since it does not reflect the real nature of science, it is not often deemed as IBL (PRIMAS, 2011). Thus, much research focuses more on students' learning experiences in guided and open inquiry and their effects on students' achievements and attitudes (e.g. Arnold, Kremer, & Mayer, 2014; Koksal & Berberoglu, 2014; Sadeh & Zion, 2012).

In accordance with Zion and Mendelovici (2012), guided inquiry requires students to investigate and follow what a teacher presents to them. The teacher decreases the uncertainty of inquiry process by giving students supports with inquiry questions and procedures, but the teacher never provides the answer to the questions nor steps of inquiry. Moreover, unlike structured inquiry, 'students are involved in decision-making from the data collection stage, and may come up with unforeseen yet well-conceived conclusions' (p. 384). Hence, students involved in guided inquiry believed that they spent less time for designing inquiry process, but more time for writing and reporting conclusion (Sadeh & Zion, 2012). In addition, if there exist complex phenomena that students have to learn about, but, cannot be tested in the school, 'a teacher (or students) can provide applicable scientific data from a variety of sources to use in the investigation' (Martin-Hansen, 2002, p. 35) and can explain how it can be applied to diverse phenomena. For these reasons, guided inquiry is deemed as a transition between structured and open inquiry (Koksal & Berberoglu, 2014).

Open inquiry is known as the most complex level of IBL that 'teachers define the knowledge framework in which the inquiry will be conducted, but allow the students to select a wide variety of inquiry questions and approaches (student-designed or selected)' (Zion & Mendelovici, 2012, p. 384) as what scientists do in their work. For its complexity and uncertainty, teachers' ability to guide students into the proper stage of questioning is the key to successful experimental work in the open inquiry (Zion et al., 2007). However, on account of its closeness to scientific inquiry, the teacher who lacks scientific research experiences has difficulty in adopting the open inquiry practice (Roth, McGinn, & Bowen, 1998). On the other hand, the students involved in open inquiry learning report positive attitudes towards science and science learning as well as their perception of the experiment (Berg, Bergendahl, Lundberg, & Tibell, 2003). In addition, they believed that they felt a greater sense of cooperation with other pupils and more involvement in the project through open inquiry learning experiences (Sadeh & Zion, 2012).

Regarding a relationship between inquiry experiences and career choice, Russell et al. (2007) reported that 68% of participants in hands-on research indicated increased interest in STEM career and 29% of them indicated increased anticipation to obtain Ph.D. in STEM fields irrespective of their majors in the university. Moreover, their longitudinal research reported that 30% of students who experienced 12 months of research experience expected to pursue Ph.D., while 13% of students with 1–3 months of research experience and 8% with no research experience expected to continue their study on Ph.D. Thus, it indicates that more inquiry experiences can lead students into more STEM career trajectories. However, as Wild (2015) noticed, despite latent capacities of the learning experience in career choices, their relationship has not been explored in depth to date, especially learning experience in IBL.

Social cognitive career theory (SCCT)

Lent et al. (1994) introduced a Social Cognitive Career Theory (SCCT) related to learning experiences based on Bandura's (1986) Social Cognitive Theory (SCT). According to Bandura, self-efficacy and outcome expectations play an important role in future goal setting. In science education, self-efficacy, the belief in one's capability to master the task, is well studied that indicates a positive relationship between students' performance (Britner & Pajares, 2006; Lavonen & Laaksonen, 2009) and their selection of science-related activities (Britner & Pajares, 2001). Also, outcome expectancy is indicated as an important variable to predict students' career intentions in science (Fouad & Smith, 1996; Holmegaard, Madsen, & Ulriksen, 2014). Lent et al. (1994), then, connect Bandura's theory with contextual factors and personal inputs so as to explain how individuals' career decision-makings occur. Contextual supports and barriers linked with person inputs are external factors that moderate goals or actions marked with dashed lines in Figure 1. Therefore, through SCCT model, researchers can predict students' academic or career choices which interplay with personal backgrounds, self-efficacy, outcome expectations, and interests.

As shown in Figure 1, students' learning experiences play a pivotal role as a mediator between personal backgrounds and socio-cognitive mechanisms in SCCT model. However, despite the influential role of the learning experience, only a few vocational developmental studies to date have been conducted to examine the role of learning experiences in the model. Gainor and Lent (1998) examined the effect of four math-related learning experiences on self-efficacy and outcome expectation, and they reported that all those learning experiences were significantly related to socio-cognitive mechanisms.

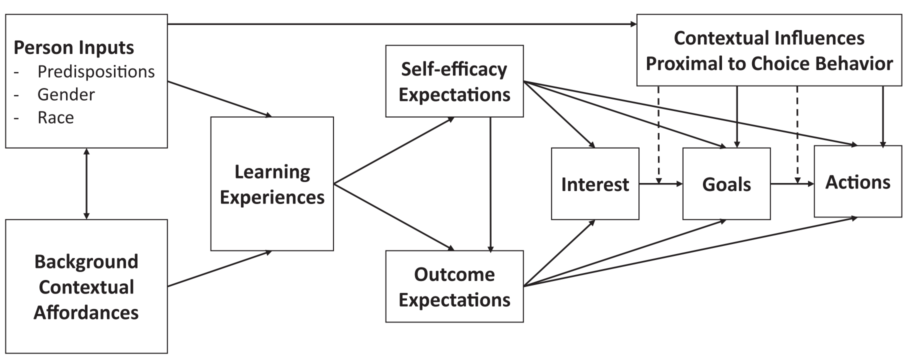

Figure 1. Socio-cognitive career theory (SCCT, Lent et al., 1994). Reprinted from Lent et al. (1994, p. 93) with permission from Elsevier.

Schaub and Tokar (2005) tested the effect of personality on interest through learning experience across Holland's (1997) RIASEC (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional) themes, and the result strongly supported that learning experiences related positively with self-efficacy beliefs and outcome expectations. Schaub and Tokar also indicated that learning experiences affected outcome expectations largely through students' self-efficacy indirectly, so it proved the prediction of SCCT model of Lent et al.'s (1994). In science education, Taskinen, Schütte, and Prenzel (2013) focused on how the amount of additional science activities influenced students' career choices through interest, and self-concept. Based on multi-level analyses, the result showed that students' additional learning experiences indirectly affected students' future-oriented motivation through students' interest and self-concept. Wang (2013) conducted a longitudinal study with recent high school graduates attending universities to extend the understanding of the entrance into STEM majors based on SCCT framework. According to the result, intent to major in STEM, which was affected by students' exposure in science courses, indicated high correlation with students' STEM major choices. Thus, we hypothesised that the IBL as a science learning experience affects students' future career choice through science self-efficacy and science outcome expectations as depicted in the SCCT model.

Science-related career orientation

Students' early career expectations in science field indicate as a key variable to predict their future career longitudinally. Schoon (2001) reported that the most important predictor of U.K. students engaging in science careers at the age of 33 was their educational interest at the age of 16. Similarly, Tai et al. (2006) found that the 8th graders' expectation to work in the science field at the age of 30 were 1.9 times higher to get a bachelor's in biological science and 3.4 times higher to get physical science degree compared to students who did not have any expectation in science careers.

Accordingly, the factors that influenced on students' aspiration towards STEM-related career have been studied in many facets. As Taskinen et al. (2013) argued, however, most of them focused more on individual motivational factors such as students' interest, self-related perception, or other backgrounds. Indeed, students' interest in science is revealed as a keystone to getting more students participate in a science career (Fouad et al., 2010; Simon & Osborne, 2010). Also, students' self-efficacy which describes the subjective belief in one's ability in specific domain is revealed as a significant predictor of undertaking STEM study and contemplating career choices (Zeldin, Britner, & Pajares, 2008) as well as self-concept (Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2013; Simpkins, Davis-Kean, & Eccles, 2006). While self-efficacy focuses on individual science tasks, self-concept focuses on competence in an academic discipline (Bong & Skaalvik, 2003). Marsh and Yeung (1997) reported that based on these self-related perceptions, students distinguished careers that are suited for them to succeed and careers that are unlikely to be successful. Given that career choices are driven by students' personal preferences based on their interest and perception, we also considered them as meaningful psychological variables in our study.

Furthermore, as those interest and perceptions in science are generally aroused from and influenced by learning experiences at school (Taskinen et al., 2013), it is, thus, worth investigating how the scientific learning experiences at school have an effect through socio-cognitive mechanisms on students' career choice as SCCT model suggests. We assumed that IBL experiences at school, in turn, lead students to familiarise with scientific work, to improve positive attitudes, and, eventually, to pursue a more STEM-related career.

Research context and purpose of the study: IBL in Finnish context

Finnish science education has drawn much attention due to their successful achievements from large-scale international studies such as PISA or TIMSS (Trends in International Mathematics and Science Study) . It is commonly agreed that the successful implementation of the national-level core curriculum and teacher professionalism have made big contributions in Finnish students' top performance (Lavonen & Juuti, 2016). Regarding the Finnish curriculum, although they introduced a reformed curriculum in 2016, since we used the sample from PISA 2015 and students participating PISA 2015 were taught based on the previous curriculum of 2004, we focus on describing the Finnish National Core Curriculum for Basic Education published in 2004 (Finnish National Board of Education [FNBE], 2004) in the following section.

According to the FNBE (2004), students in grades 1–4 learned an integrated natural science, 'Environmental and Natural Studies', comprising the fields of biology, geography, physics, chemistry, and health education including the perspective of sustainable development. Students in fifth and sixth grades studied two integrated subjects – Biology & Geography and Physics & Chemistry. Then, seventh to ninth graders learned finally five science subjects separately – Biology, Geography, Physics, Chemistry, and Health Education. The FNBE emphasised on IBL in science education even from the first grade. According to the curriculum, students in the first to fourth grades were asked to observe, investigate, perform scientific experiments with a teacher's guidance, and present the information they have achieved. In addition, it was clearly written that 'Biology instruction must be inquiry-based learning' (p. 176) for grades 5 to 6 and 'Biology instruction must be inquiry-based learning, and it is to develop the pupil's thinking in the natural sciences' (p. 179) for grades 7–9. Also, as final assessment criteria of biology study for a grade of 8, students were asked to achieve a skill to 'carry out small-scale investigations independently' (p. 181). Not only biology, but also other instructions of chemistry, physics, and geography kept focusing on IBL by emphasising on carrying out scientific investigation, interpreting the results, drawing conclusions, and applying the acquired knowledge in different, practical life situations with a teacher's guidance and support. Indeed, in Finnish context, a teacher has played a pivotal role in leading and conducting an inquiry in school science. In 2014, the FNBE published a reformed national core curriculum (FNBE, 2014) to be implemented at the school since 2016. The new curriculum introduced an integrated science for first to sixth grades called Environmental studies and five traditional science subjects for seventh to ninth grades. However, an IBL or approach still has been placed in the centre of teaching and learning science.

Regarding the level of inquiry practice in Finland, Lavonen and Laaksonen (2009) analysed PISA 2006 data and reported that teachers in Finland implemented more *traditional inquiry* activities such as doing practical experiment in the laboratory or asking students to draw conclusions of the investigation, and, thus, students were required less to conduct *science inquiry* than average OECD (Organization for Economic Co-operation and Development)countries such as designing their own experiment or testing their own ideas. However, practical work in Finnish context is not structured inquiry but more close to guided inquiry (Lavonen & Juuti, 2016) based on the criteria of Sadeh and Zion (2012). Therefore, Lavonen and Juuti concluded that students' inquiry practice with a teacher's guidance could enhance important inquiry competencies such as explaining scientific phenomena or drawing evidence-based conclusions so that Finnish students have achieved higher score from international assessments such as PISA which emphasised and measures inquiry knowledge as a core competency. With the same PISA data, Kang and Keinonen (2017) analysed the effect of inquiry experiences on Finnish students' interest and achievement. Based on factor analyses and previous literature, they obtained two inquiry-related factors – Guided and Open inquiry which are similar to the *traditional* and *science inquiry* of Lavonen and Laaksonen (2009) respectively – and concluded that students' guided inquiry experience was correlated positively with interest and achievement, but the open inquiry practice indicated negative correlation with achievement and had no significant relationship with students' interest. Since Finnish students were revealed as they almost never allowed to practise open inquiry, that negative correlation was likely due to the low frequency of conducting an open inquiry which can cause poor quality of open inquiry implementation in Finland.

Given previous literature and research, in this study, inquiry in Finnish context is defined as guided inquiry for that perception of inquiry is predominant in the curriculum and mostly implemented by teachers in Finland. However, in the reformed Finnish curriculum (FNBE, 2014), more open-ended inquiry skills are emphasised than before. For instance, according to the assessment criteria for physics in grades 7–9, 'the assessment of experimental work may progress hierarchically from basic working, observation, and measurement skills to instructed research assignments and, finally, to open-ended research' (FNBE, 2014, p. 421), and the same principle is applied to all other science subjects. Therefore, it is expected to be observed more open inquiry implementation in Finland from 2016.

Despite Finnish students' continuing top performance in science, however, a challenge still remains, since they have reported a lack of interest in science and science-related careers. Moreover, Finnish students' interest was one of the lowest among PISA-participating countries in 2006, and it has decreased more in 2015 (OECD, 2016). In addition, they still have less considered science-related careers for their future. Therefore, examining Finnish sample and understanding how IBL experiences affect their career trajectory would provide the basis for comparative studies across other Western countries where students indicate lower or decreasing interest in science and the curriculum values in acquiring scientific inquiry skill as a core competency to become a scientifically literate citizen.

In sum, the primary aim of the study was to extend the research on SCCT by examining how IBL as a learning experience has effects directly and indirectly on students' science-related career choices through self-efficacy, outcome expectations and interest as shown in Figure 2.

Hypothesised indirect paths from IBL to Career Goals are:

H1. IBL experiences → a → f → Career Goals.
H2. IBL experiences → b → g → Career Goals.

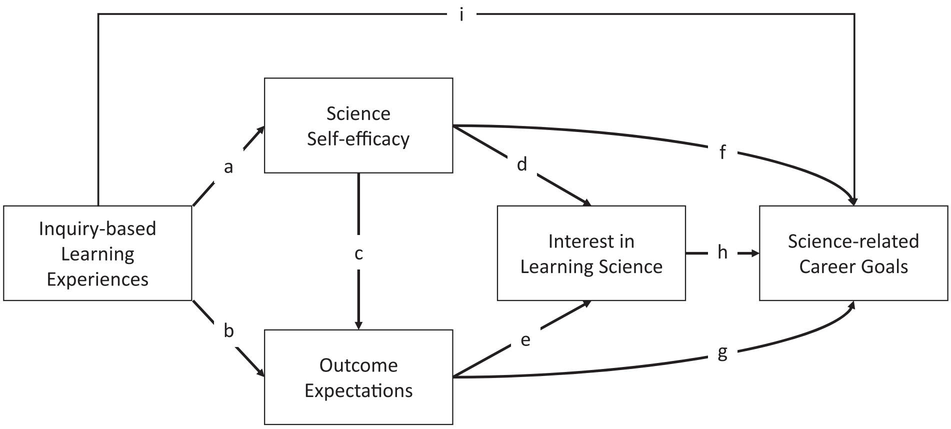

Figure 2. Hypothesised path model depicting Inquiry-SCCT.

H3. IBL experiences → a → c → g → Career Goals.
H4. IBL experiences → a → d → h → Career Goals.
H5. IBL experiences → b → e → h → Career Goals.
H6. IBL experiences → a → c → e → h → Career Goals.

Method

Participants

For the sake of the study, data collected from the PISA 2015 focusing on science achievement were chosen and analysed. Our sample consisted of $N = 5782$ Finnish students (48.8% female and 51.2% male) from 168 schools, and most of them were 9th graders (9th: 87%, 8th: 13%).

The PISA is one of the comprehensive international assessments to measure students' capabilities. They measure not only their content knowledge of the subjects but also the use of knowledge to meet and solve the real-life challenges. In addition to the measurements, students' contextual background, such as gender, socio-economic status, or immigrant status, was surveyed to navigate the relationship between students' achievement and their environments (OECD, 2016). One subject among reading, mathematics, and science literacy, is focused triennially from randomly selected groups in 15-year-old students mainly in industrialised countries. Followed by PISA 2006, PISA 2015 provided a variety of information related to science education including students' interest, self-efficacy, outcome expectation, and science-related career orientation in science as well as a learning experience in IBL.

Variables

All variables were derived from student questionnaire in PISA 2015 (OECD, 2016). Answers with a four-point Likert scale with the response among one to four were coded or recoded so that positive scores of students' perception or attitude could indicate higher levels of agreement with asked concepts. Questions related to core variables of this study are listed in Table 2.

Future career goal

The main dependent variable, students' future career goal related to science, was a dichotomously coded variable based on the PISA survey item. In PISA 2015, students were asked to answer the open-ended question, 'what kind of job do you expect to have when you are about 30 years old'. As followed by the analysis of PISA 2015, we classified students' answers including four groups of science-related jobs – Science and engineering professionals, Health professionals, ICT professionals, and Science technicians and associate professionals (see PISA 2015 report (OECD, 2016, pp. 282–283)). Subsequently, science-related jobs were coded as 1, and all the other jobs as 0 as a binary variable (1 = 17%, 0 = 83%).

IBL experiences

Students' learning experiences in IBL were derived from students' responses for ST098 'When learning <school science> topics at school, how often do the following activities occur?'. In this set of questions, students were asked to choose how often inquiry activities occur in learning school science (OECD, 2016). Among nine questions, we selected five

Table 2. List of core variables in the study.

Variable name	PISA 2015 label	Description
IBL experiences	ST098Q01	Students are given opportunities to explain their ideas
	ST098Q02	Students spend time in the laboratory doing practical experiments
	ST098Q05	Students are asked to draw conclusions from an experiment they have conducted
	ST098Q06	The teacher explains how a <school science> idea can be applied to a number of different phenomena (e.g. the movement of objects, substances with similar properties)
	ST098Q09	The teacher clearly explains the relevance of <broad science> concepts to our lives
Interest in learning science (ILS)	ST094Q01NA	I generally have fun when I am learning <broad science> topics
	ST094Q02NA	I like reading about <broad science>
	ST094Q03NA	I am happy working on <broad science> topics
	ST094Q04NA	I enjoy acquiring new knowledge in <broad science>
	ST094Q05NA	I am interested in learning about <broad science>
Self-efficacy (SE)	ST129Q01TA	Recognise the science question that underlies a newspaper report on a health issue
	ST129Q02TA	Explain why earthquakes occur more frequently in some areas than in others
	ST129Q03TA	Describe the role of antibiotics in the treatment of disease
	ST129Q04TA	Identify the science question associated with the disposal of garbage
	ST129Q05TA	Predict how changes to an environment will affect the survival of certain species
	ST129Q06TA	Interpret the scientific information provided on the labelling of food items
	ST129Q07TA	Discuss how new evidence can lead you to change your understanding about the possibility of life on Mars
	ST129Q08TA	Identify the better of two explanations for the formation of acid rain
Outcome Expectation (OE)	ST113Q01TA	Making an effort in my <school science> subject(s) is worth it because this will help me in the work I want to do later on
	ST113Q02TA	What I learn in my <school science> subject(s) is important for me because I need this for what I want to do later on
	ST113Q03TA	Studying my <school science> subject(s) is worthwhile for me because what I learn will improve my career prospects
	ST113Q04TA	Many things I learn in my <school science> subject(s) will help me to get a job

items which represent inquiry practice in Finnish context, and these items are similar with variables representing guided inquiry from the studies of Kang and Keinonen (2017) and Lavonen and Laaksonen (2009). In addition, we conducted factor analyses with varimax rotation with eigenvalues greater than one, and found that these five variables were gathered in one factor. Therefore, we decided to use these five items as a proxy of students' inquiry experiences in Finland.

Interest in learning science

Given that the SCCT is an approach to understanding educational and occupational interest, a construct of students' interest in doing science activities is proper for this study. In PISA 2015, students' participation in science-related activities out of school was surveyed such as watching science-related TV programmes or visiting websites about science topics. However, OECD (2016) reported that most of the participating students seldom engaged with these out-of-school activities, and, especially, Finnish students were among the lowest levels of engagement with those out-of-school science activities. Indeed, students' participation in out-of-school activities may be affected by not only their interest but also various factors such as socio-economic status, educational systems, or parental involvements. Therefore, we concluded that this out-of-school activities participation could not be a proper representative of students' interest in science activities. Thus, instead of a construct of doing science, we used variables which represented students' motivation in learning science since 'motivation can be regardedas a driving force behind engagement, learning and choice of occupation in all fields' (OECD, 2016, p. 121). In PISA 2015, students were asked how much enjoyment they have in learning science with five statements. For instance, students were asked how much they agree or disagree with statements like 'I am interested in learning about <broad science>' or 'I enjoy acquiring new knowledge in <broad science>' and they answered with a four-point Likert scale (Cronbach's $\alpha = 0.95$).

Science self-efficacy

As we described about self-efficacy previously, it deals with students' confidence in the individual, specific science tasks such as 'describe the role of antibiotics in the treatment of disease' or 'predict how changes to an environment will affect the survival of certain species'. In PISA 2015, students were asked, 'How easy do you think it would be for you to perform the following tasks on your own?' with eight items measuring student's self-concept in science (Cronbach's $\alpha = 0.89$).

Outcome expectation

Students' outcome expectation variables focused on 'the importance of learning STEM subjects to prepare for college, a career, and to get a job' (Nugent et al., 2015, p. 1075) such as 'Many things I learn in my <school science> subject(s) will help me to get a job' or 'Studying my <school science> subject(s) is worthwhile for me because what I learn will improve my career prospects'. Four items measured students' instrumental motivation to learn science at school (Cronbach's $\alpha = 0.93$).

Students' backgrounds as control variables

Students' gender, immigrant status, and socio-economic status were included in the model as control variables. The PISA Index of ESCS (economic, social, and cultural status) was formed with home possessions, books in the home, the higher parental occupation, and the higher parental education similar to previous PISA studies (OECD, 2016). For immigrant status, dummy variables were generated to distinguish students among native, first generation, and second generation of immigrants. Gender was coded as male = 1 and female = 0.

Data analysis

MPlus Version 7.3 (Muthén & Muthén, 2012) was used in conducting measurement and structural models in this study. Given that the main outcome variable was dichotomous, a probit regression model was conducted with the weighted least square with adjustment in mean and variance (WLSMV) estimator, to assess the fit of the model and indirect effects of IBL on students' career trajectories as presented in Figure 2. Although SEM assumes multivariate normality, 'as data normality assumption barely holds in social science studies, it is always safer to use robust estimators for model estimation' (Wang & Wang, 2012, p. 61). Mplus offers WLSMV, or robust WLS, that 'is specifically designed for categorical observed data (e.g. binary or ordinal) in which neither the normality assumption nor the continuity property is considered plausible' (Li, 2016, p. 937).

Since this study aimed at estimating direct and indirect effects of inquiry learning experiences for students' career choices, two parts, CFA (confirmatory factor analysis) and path analysis, of SEM were carried out. Kaplan (2000) depicted the CFA and the path analysis as '(a) the measurement models, which link the observed variables to the latent variables and (b) the structural part, which links the latent variables to each other using systems of simultaneous equations' (p. 2). CFA is used on the occasion of the theoretical background, or empirical findings already exist with the variables (Wang & Wang, 2012), thus, before testing CFA, 'factors are theoretically defined, and how specific indicators or measurement items are loaded onto which factors are hypothesized' (p. 29).

In addition to CFA, a path analysis was carried out to measure diverse indirect effects in the model with students' demographic variables including gender, socio-economic status, and immigrant status. For SEM measures how a specific factor predicts other factors or is influenced by those factors (Wang & Wang, 2012), this method can be used to test mediated effects among factors in the model(Kelloway, 2015).

In order to assess the goodness of model fit, traditional cut-off values were applied: RMSEA (The Root Mean Square Error of Approximation) below 0.05 or 0.08, SRMR (Standardized Root Mean Square Residual) below 0.08, and CFI (Comparative Fit Index) and TLI (Tucker Lewis Index) above 0.95 (Wang & Wang, 2012). In addition, because of the high complexity of the model and the large sample size, the 1% level of statistical significance was considered.

We used students' final weightsoffered by PISA to correct for selection bias (Asparouhov, 2005)' participation are likely to result in sampling error. In addition, in order to handle missing data, pairwise deletion was applied as a default of the estimator.

Results

Descriptive statistics

Descriptive statistics in comparison to inquiry practice between Finland and OECD are presented in Table 3 including the value of Cohen's *d* measuring different effect sizes between two groups (Cohen, 1992). First five variables are related to inquiry practice in Finnish context close to guided inquiry such as students do practical experiments in the laboratory, or they draw conclusion from the investigation they have done, and the next four variables are related to open inquiry practice such as students designing their own experiments, or they are allowed to test their own ideas. As shown in Table 3, we found very small or no differences in implementing guided inquiry practice between Finland and OECD. However, open inquiry practices are clearly less practised in Finland than the average of OECD countries.

Given that first five items represents inquiry practice in Finnish context, we checked percentiles of the items in detail as shown in Figure 3. According to the responses, among several inquiry practices, Finnish students are given many opportunities to explain their thoughts in science lessons followed by teachers' explanation of application and relevance of science in the different or practical situation. On the other hand, they did not conduct practical experiments often in learning science at school, and 30.3% of students responded that they never conduct experiments at school in Finland.

As shown in Figure 4, as well as the means of five inquiry-related variables in Table 3, Finnish students' response patterns in frequency of inquiry practices are also similar with the other OECD countries. Again, in overall OECD countries, 30.9% of students had no chance of conducting a practical experiment in science classes at school.

Descriptive statistics for four core constructs of this study were summarised in Tables 4 and 5. The reliability values of each latent variable satisfied all traditional cut-off ($\alpha > 0.7$), and the correlations between latent variables were all significant ($p < .01$) and positive. Since the mean values were ranged between 1 and 4, the score close to one meant most students marked at 'Never happened' (for learning experience variables) or 'Strongly disagree' (for attitude variables). Compared to OECD countries, Finnish students marked lower in inquiry experience, interest in science, outcome expectation, and self-efficacy, although the effect sizes are small. However, correlations between inquiry and other attitude variables are higher in the Finnish sample than OECD average. That is, despite

Table 3. Descriptive statistics of inquiry practice: comparison of Finland and OECD.

		Finland		OECD		
	Range	Mean	S.D.	Mean	S.D.	*d*
(1) Ss explain ideas	1–4	2.97	0.87	2.96	0.94	0.01
(2) Ss do practical experiments	1–4	1.94	0.78	1.93	0.86	0.01
(3) Ss draw conclusions	1–4	2.23	0.85	2.38	0.96	−0.16
(4) T explains application	1–4	2.58	0.85	2.75	0.94	−0.18
(5) T explains relevance	1–4	2.47	0.89	2.64	0.99	−0.19
(6) Ss argues about questions	1–4	1.68	0.81	2.18	0.96	−0.55
(7) Ss design experiments	1–4	1.28	0.63	1.77	0.95	−0.61
(8) Ss debate about investigation	1–4	1.59	0.78	2.01	0.97	−0.48
(9) Ss test their own idea	1–4	1.58	0.78	2.11	0.98	−0.61

Notes: Cohen's *d*: no effect ($d < 0.2$). Small effect ($0.2 < d < 0.5$), moderate effect ($0.5 < d < 0.8$).

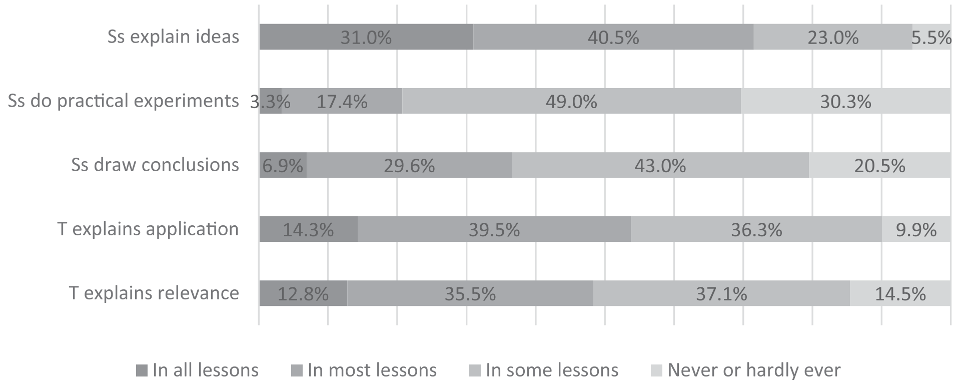

Figure 3. Finnish students' response on frequency of IBL.

Finnish students' lower frequency in experiencing inquiry, their experiences were more related to their positive attitude towards science than other OECD countries.

Confirmatory factor analysis

The CFA was performed with four latent constructs: IBL, interest in learning science, outcome expectation, and self-concept. The measurement model reached an adequate level of model fit (RMSEA = 0.038 (90% C.I. 0.037 and 0.040), SRMR = 0.025, CFI = 0.969, TLI = 0.965). In addition to the model fit, we checked reliability and validity of the model based on Fornell and Larcker's (1981) criterion. According to their report, a composite reliability (CR), which assesses the internal consistency of a measure, value of 0.7 or higher indicates sufficient reliability of the model; to ensure convergent validity measuring that the constructs that should be theoretically related are actually related, average variance extracted (AVE) value should be 0.5 or higher; to assess discriminant validity measuring the constructs that are expected not to be related are in fact not related, a squared root value of AVE for each latent construct should be higher than each latent constructs' highest correlation. As shown in Table 6, the CRs of each latent variable were all higher than 0.7, and the AVEs were higher than 0.5, and one is only marginally lower

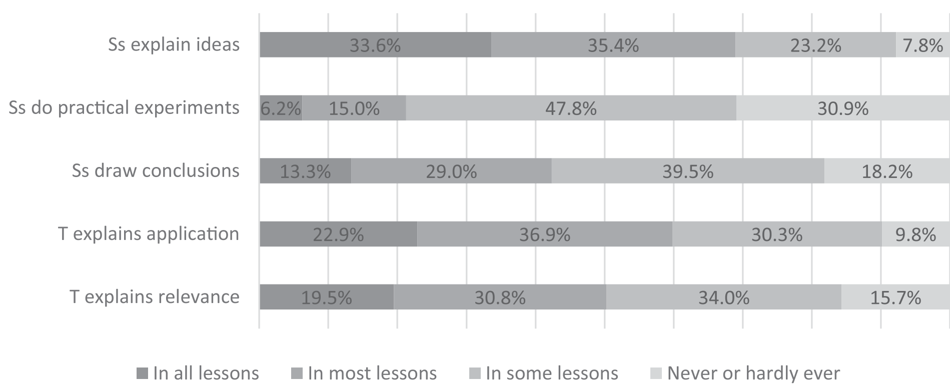

Figure 4. Average of OECD students' response on frequency of IBL.

Table 4. Descriptive statistics of four variables.

	Range	Finland			OECD			
		Mean	S.D.	α	Mean	S.D.	α	*d*
IBL	1–4	2.44	0.60	0.76	2.53	0.67	0.76	0.14
Interest in learning science	1–4	2.57	0.73	0.95	2.73	0.78	0.93	0.21
Outcome expectation	1–4	2.79	0.75	0.93	2.90	0.79	0.92	0.14
Self-efficacy	1–4	2.71	0.65	0.89	2.76	0.67	0.88	0.08

Notes: Cohen's *d*: no effect ($d < 0.2$). Small effect ($0.2 < d < 0.5$).

(0.48). Thus, it met Fornell and Larcker's criterion. Moreover, showing that the each squared root value (bolded on Table 6) was higher than the highest correlation of each correlation between latent variables, this model demonstrated satisfactory reliability and validity.

Path analysis

Finally, we tested the fit of ' career pursuit as depicted in Figure 5. Given that PISA has offered the clustered data, that is, some students in the same school share similar environmental backgrounds, which may cause biased results (Geiser, 2013), we first checked an Intra-class Correlation Coefficient (ICC) measuring 'the proportionof the total variance in the outcome variable that is explained by differences between groups '(Bowen & Guo, 2011, p. 67). However, we found that the ICC was 1%, which means most of all observations are independent; that is, the analysis of clustered data is needless; therefore, we did not consider multi-level

Unstandardised path coefficients are demonstrated in Figure 5 and the numbers in parentheses refer to standardised coefficients (all paths $p < .01$). Overall model fit indices (CFI = 0.91, TLI = 0.89, RMSEA = 0.038 (90% C.I. = 0.036, 0.039)) indicated good fit according to the recommendations (Kaplan, 2000; Kelloway, 2015; Wang & Wang, 2012).

Regarding the effects of IBL experiences on other variables, it indicated positive relations with self-efficacy (SE, 0.44, $p < .01$) and outcome expectation (OE, 0.41, $p < .01$) in science while it presented negative direct correlation with science-related career trajectory (FUT, −0.18, $p < .01$) (see Figure 5). However, all indirect paths between IBL and FUT through other constructs indicated positive correlations (see Table 7), and, thus, their overall correlation became positive (see Table 8). This positive relationship between IBL and FUT was mainly attributed to the mediation effect of students' outcome expectation (OE) between IBL and FUT, since OE has strong positive correlations with both IBL (0.41, $p < .01$) and FUT (0.57, $p < .01$). Hence, as shown in Table 7 H2, the large portion of the indirect effect of inquiry learning experiences worked through outcome expectation (0.23, $p < .001$).

Table 5. Correlation of four variables.

	Finland			OECD		
	(1)	(2)	(3)	(1)	(2)	(3)
(1) IBL	1			1		
(2) Interest in learning science	0.277*	1		0.220*	1	
(3) Outcome expectation	0.218*	0.410*	1	0.198*	0.389*	1
(4) Self-efficacy	0.235*	0.392*	0.298*	0.202*	0.326*	0.275*

*<.01.

Table 6. Reliability and validity of four constructs.

	CR	AVE	(1)	(2)	(3)	(4)
(1) IBL	0.82	0.48	**0.69**			
(2) Interest in learning science	0.96	0.84	0.59	**0.92**		
(3) Outcome expectation	0.95	0.84	0.31	0.18	**0.91**	
(4) Self-efficacy	0.91	0.57	0.35	0.19	0.53	**0.76**

Regarding future career orientation (FUT), all three latent variables – SE, OE, and ILS – showed positive relations to FUT ($p < .01$), while OE indicated as the most powerful predictor of students' career trajectories directly (0.57, $p < .01$) and totally (0.61, $p < .001$). Therefore, as OE mediates the power of IBL, it also largely mediates the power of SE on FUT, so that the unstandardised coefficient of SE on FUT increased more than twice in Table 8.

Considering that original SCCT model includes students' person input and background as moderators of overall constructs, we put those items as control variables in the model. As shown in Table 9, gender differences were found in all latent variables ($p < .001$) except interest in learning science ($p > .05$). While boys indicated higher self-efficacy than girls, girls indicated higher outcome expectation and career aspiration than boys. Students' socio-economic status affected science self-efficacy, interest, outcome expectations, and future career orientation. Regarding immigration status, first generation immigrant students indicated lower self-efficacy but higher interest in science and the second generation indicated higher outcome expectation in learning science than native. However, these data must be interpreted with caution because, in the Finnish sample, the number of students with an immigrant background was very small (4%).

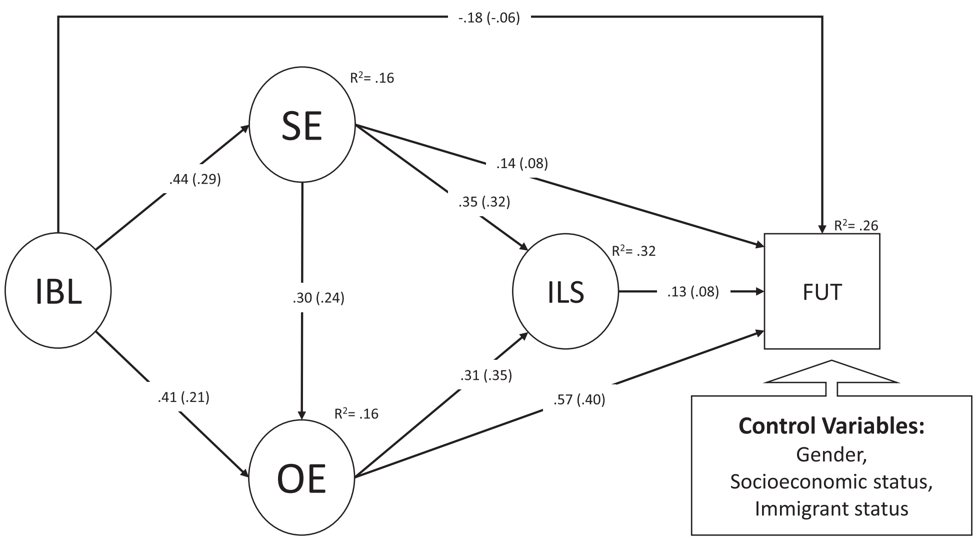

Figure 5. Path analysis of hypothesized Inquiry-SCCT

Note: IBL: inquiry-based learning, SE: self-efficacy, OE: outcome expectations, ILS: interest in learning science, FUT: future career goal, Model fit: Chi-square = 2751.81 (.000), df = 298, CFI = 0.91, TLI = 0.89, RMSEA = 0.038 (90% C.I = 0.036, 0.039).

Table 7. Direct and indirect effects of IBL on future career.

		Unstandardised	SE	Standardised
Total indirect effects		0.41***	0.03	0.15
Effect from each path				
H1	IBL → SC → FUT	0.06**	0.02	0.02
H2	IBL → OE → FUT	0.23***	0.02	0.08
H3	IBL → SC → OE → FUT	0.07***	0.01	0.03
H4	IBL → SC → ILS → FUT	0.02**	0.01	0.01
H5	IBL → OE → ILS → FUT	0.02**	0.01	0.03
H6	IBL → SC → OE → ILS → FUT	0.01**	0.002	0.002
Direct effects		−0.18*	0.07	−0.06

***<.001.
**<.005.
*<.01.

Discussion

The aim of the study was to investigate how inquiry learning experiences in school science affect students' future career orientation in the context of socio-cognitive mechanisms based on SCCT model. According to the result, in Finnish context, IBL experiences clearly indicated as a good predictor for students' career aspiration in science fields. The finding is significant since Finnish students have indicated decreasing interest in science and science occupation continuously in the last decade.

Our research pointed out that future career orientation can be promoted by inquiry learning experience, or guided inquiry practice, in school science for 15-year-old students. More specifically, students clearly were more interested in science career when more guided inquiry activities, such as conducting a practical experiment or drawing a conclusion after the investigations under the teacher's instruction, were offered in the school. This result is in line with previous studies that students who are more exposed to science learning intend to continue more in science majors (Russell et al., 2007; Wang, 2013). Considering direct negative correlation in the model between inquiry and future career, the significant relationship between them resulted from the high positive correlation of inquiry with students' self-efficacy and outcome expectations. In general, on the occasion of job entrance, as people consider their ability and interest (e.g. Eccles, 2005), so do students consider their ability based on self-efficacy belief (Marsh & Yeung, 1997; Parker et al., 2013), especially in science (Fouad et al., 2010; Simon & Osborne, 2010; Simpkins et al., 2006; Taskinen et al., 2013; Wild, 2015; Zeldin et al., 2008). Hence, the result can be interpreted that in the case of students who often get chances to involve in guided inquiry learning, they will have more belief in one's ability and interest in science so that their intent to study or work in science area will be increased. Although students' achievements are not our primary aim of the study, the better achievement of Finnish students was probably derived from their increasing self-efficacy and interest in science by their learning experiences as our model demonstrated

Table 8. Estimated unstandardised coefficients of independent variables on future career orientation.

	IBL	SC	OE	ILS
FUT	0.23 (0.09)***	0.37 (0.20)***	0.61 (0.43)***	0.13 (0.08)***

***<.001, the numbers in parentheses refer to standardised coefficients.

Table 9. Correlations between control variables and independent variables.

	SC	ILS	OE	FUT
Gender	0.14 (0.12)***	−0.01 (−0.01)^{ns}	−0.07 (−0.05)***	−0.12 (−0.06)**
ESCS	0.19 (0.24)***	0.05 (0.06)***	0.11 (0.11)***	0.19 (0.14)***
IM1	−0.15 (−0.04)*	0.13 (0.03)*	0.11 (−0.02)^{ns}	0.09 (0.01)^{ns}
IM2	0.01 (0.003) ^{ns}	−0.09 (−0.02)^{ns}	0.26 (0.05)**	0.32 (0.04)^{ns}

***<.001, **<.005, *<.01, ns = non-significant, the numbers in parentheses refer to standardised coefficients.

since these two constructs are highly related to achievements as well. In other words, our result shows that the correlation between inquiry and other constructs is higher than that of the average of OECD countries. That is, Finnish students are likely to experience better inquiry practice in science lessons so that more inquiry practice may result in higher self-efficacy and outcome expectation; it may lead to Finnish students' higher achievement in PISA.

However, this result is not related to another level of inquiry, open inquiry, in Finland since we excluded variables related to the open inquiry. As was revealed in PISA 2006 (Lavonen & Laaksonen, 2009), our result also indicated that Finnish students seldom experienced open inquiry practice at school science in PISA 2015 as well. Nevertheless, since the new curriculum emphasised the role of open inquiry (FNBE, 2014) and it shows a positive relationship with students' cognitive and non-cognitive factors (Berg et al., 2003; Sadeh & Zion, 2012), the teacher should take open inquiry into account in teaching science. Considering that Finnish teachers have successfully implemented the national-level core curriculum so far, we assume that the open inquiry practice will be increased as time goes by in Finland. However, in the sense that it is the most complex level of inquiry (Zion & Mendelovici, 2012), and that teachers have difficulty in adopting this approach without ample experiences of scientific research (Roth et al., 1998), it must be dealt with professional developments for pre-service and in-service teachers. As Lunsford, Melear, Roth, Perkins, and Hickok (2007) reported, by providing pre-service teachers with the basic level to the complex level of inquiry, teachers can progressively develop scientific and critical thinking as well as the production skills of complex inscriptions similar to what scientists actually do.

Surprisingly, according to students' response, more than 30% of 15-year-old students did not get a chance to involve in practical experiments in the laboratory in Finland, and the proportion is much higher than it was nine years ago from the results of PISA 2006 (20%). Although the Finnish educational system allows high autonomy to the teacher in managing class in general (OECD, 2007), their autonomy also is affected by various environmental factors. For instance, according to Kang and Keinonen (2016), Finnish teachers' inquiry implementation was highly correlated with teachers' confidence in teaching science and their collaboration to improve science teaching. In addition, inquiry-related professional development, class size, and school resources were also significantly related to Finnish teachers' inquiry practice. Therefore, it needs a comprehensive approach in order to increase Finnish teachers' inquiry practice so as to increase students' interest.

In addition, specifically in our study, another possibility of experiment absence can be due to students' higher grade in the lower secondary school level as a transition period to the higher secondary school entrance, for, as described, most of the participants were ninth graders who were preparing for the higher secondary school. Thus, teachers may concentrate more on teaching science contents and knowledge rather than on time-consuming experiments. Nevertheless, considering the positive effect of inquiry towards students' attitudes and the longitudinal effects of adolescents' career orientation (Schoon, 2001; Tai et al., 2006), teachers have to always take students' future career into account when they ponder the way to teach in all grades.

Inasmuch as boys show more interest in science and science-related career in general, it was an interesting finding that girls presented higher outcome expectation and career aspiration in Finland. Given the significant effect of outcome expectation on career orientation in our study, female students' higher science-related career aspiration can be attributed to their higher outcome expectation than boys. This result can be explained by unique traits of the Finnish context. According to PISA 2015 (OECD, 2016), Finland is the only country in which girls are more likely to be top performers than boys while other 33 participating countries indicated the large share of top performers among boys than among girls. In addition, they also indicated non-significant gender gap in other non-cognitive components such as interest. However, the result cannot be generalised in other countries with the different cultural background. For instance, Shin et al. (2015) examined similar variables including self-concept, outcome expectation (instrumental motivation), interest in learning (enjoyment of science), and future career pursuit with Korean sample from PISA 2006, and reported the opposite result that girls indicated lower outcome expectation and aspiration in science-related careers than boys. Nevertheless, the result can be explained based on our finding of the high correlation of outcome expectation with career trajectories.

In terms of developing the Inquiry-SCCT questionnaire for measuring the effects of inquiry learning experiences within the socio-cognitive mechanisms, our study found that the given survey questionnaire was well suitable for the hypothesised model showing overall good model fits which closely realised SCCT model with science inquiry experiences. Although it must be validated with other populations of students, we expect that it will be beneficial to researchers, evaluators, and educators in measuring the effect of IBL programmes on students' attitudes and career choices.

However, these findings are not without limitations. In the study, it did not include all participated nations of PISA 2015, which may offer a broad comparison of students' attitude and future career orientation among different cultural backgrounds. However, we provided comparisons of core variables with the overall OECD countries, so it may be possible to assume how it would work in other nations in brief. Also, by reporting Finnish sample from newly published PISA study, research can be extended to other similar educational systems. For further investigation, however, the model needs to be designed more cautiously considering different variables which affect in various ways depending on cultural, economic, and developmental backgrounds.

Another limitation may be the nature of the secondary data analysis. There are many advantages in using large-scale secondary data such as PISA, but it also includes such limitations like survey designs. As we mentioned, it is better to analyse the model with students' interest in doing science rather than learning science according to the SCCT framework. However, in many studies that adopted SCCT, students' interest in learning is also often used since it indicates a positive relation to achievement, course enrolment decisions, and future career interest. Therefore, we suggest a comparison study between the two factors which more appropriately explain students' career intention in science.

In addition, this study is limited by cross-sectional designs, so it would not provide more information about the stability of students' longitudinal decision. Therefore, we suggest conducting a follow-up survey with the PISA 2015 participants, so that it can be revealed how they actually choose their academic and career entrance in future and that we could extend our knowledge about the effect of inquiry in terms of SCCT.

Disclosure statement

No potential conflict of interest was reported by the authors.

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