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The purpose of the study was to examine whether gender differences exist in the mean levels of and relations between adolescents' home environments (parents' view of science, socio-economic status (SES)), motivations (intrinsic and instrumental motivations, self-beliefs), and pursuit of science careers. For the purpose, the Programmed for International Student Assessment 2006 data of Korean 15-year-old students were analysed. The results of the study showed that girls had lower levels of science intrinsic and instrumental motivations, self-beliefs, and science-career pursuit (SCP) as well as their parents' values in science less than boys. Gender similarities, rather than gender differences, existed in patterns of causal relationship among home environments, motivations, and SCP. The results showed positive effects for parents' higher value in science and SES on motivations, SCP, and for intrinsic and instrumental motivations on SCP for girls and boys. These results provide implications for educational interventions to decrease gender differences in science motivations and SCP, and to decrease adolescents' gender stereotypes.

Keywords: *Science-career pursuit; Motivation; Psychosocial learning environment; Gender*

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Introduction

Over the last two decades, the gender gap has greatly narrowed in most professional and educational areas such as higher education, the workplace, and in politics. Although much progress has been made, females are still widely underrepresented in the field of sciences (Campbell, Hombo, & Mazzeo, 2000; National Science Foundation, 2013). This trend is most noticeably evident in Eastern Asian countries, such as China and South Korea, where Confucian beliefs and traditions emphasize a distinction of gender roles that still affect adolescents' self-identity and career orientations today (Watson, Quatman, & Edler, 2002a). South Korea is especially noteworthy because the gender gap is essentially non-existent in science achievements in schools, but is overwhelmingly prevalent in science professions. Specifically, Organisation for Economic Co-operation and Development (OECD, 2007) reported that 15-year-old Korean female students performed comparably to their male counterparts in science achievement. However, female students planned to pursue science-related careers far less than male students with a gender gap of 18.8%, calculated by (number of boys – number of girls)/(number of boys), which was the second largest gender gap reported among OECD countries (OECD, 2007). Moreover, even though Korea had the smallest gender gap among OECD countries in academic achievement in science with less than 10%, Korea's gender gap for degrees awarded in mathematics and computer science was still considered very high with the gender gap of 56% (OECD, 2011).

Thus, we expected that it would be meaningful to examine a unique country like South Korea that presents such a significantly large gender gap in science professions but a near non-existent one in academic achievements.

Much effort has been put into explaining the different relations between social–environmental factors and career development by gender. Bandura's (1986) social cognitive theory (SCT) has been the most influential theory to explain career development and career-related behaviours (Isaacson & Brown, 2000). SCT hypothesizes that three variables, person, environment, and behaviour, affect one another through reciprocal linkages (Bandura, 1986). Based on Bandura's (1986) theory, social cognitive career theory (SCCT) (Lent, Brown, & Hackett, 1994) defines career development of adolescents as the emphasis of cognitive-person variables (self-efficacy, outcome expectations, and goals), and how these variables interact with personal background characteristics (e.g. gender), as well as environmental or social variables (e.g. encouragement from significant others, family socio-economic status (SES)). SCCT proposes that career-related behaviours result from influences that interact among the three variables. Based on these research studies, we have assumed that it was the underlying social–environmental factors (i.e. psychosocial and SES of family) that led to the gender gap in adolescents' motivation and science-career pursuit (SCP). To specify this research hypothesis, we first identified gender differences in home environments, individuals' motivations, and SCPs of Korean adolescents. We then examined how the relationships between home environments, individuals' motivations, and SCP differed according to gender.

Gender and SCP

Gender is a unique variable that plays an important role in explaining adolescents' career choices. Compared to males, fewer females pursue science and mathematics majors in colleges. Moreover, a smaller number of females are employed in science and engineering occupations (Fouad et al., 2010), paid less than males, and passed over on promotions more than men (Goldin, 2014). However, research has reported that the smaller female-to-male ratio in Science, Technology, Engineering, and Mathematics (STEM) majors and professions is due not to ability or achievement, but gender differences in motivation (Rodrigues, Jindal-Snape, & Snape, 2011) across many cultures. For example, when controlling for ability and prior achievements in science, girls tend to show less positive attitudes towards science and feel less competent in science than boys (Heilbronner, 2008), and thus keep girls from taking advanced science courses (Miller, Blessing, & Schwartz, 2006).

Gender differences in science motivation are affected by various socialization processes and learning environments that imply that science is a 'masculine' subject, which could detract females from engaging in science (Eisenberg et al., 1996). Furthermore, as adolescents mature, their concept of gender roles becomes clearer, affecting their interest levels in different subjects. For instance, girls tend to show higher levels of interest than boys in language, but lower levels of intrinsic motivation in STEM subjects (Fouad et al., 2010; MacCallum & Kim, 2000; Meece, Glienke, & Burg, 2006). Other cultures have also reported these phenomena including Germany (Marsh, Trautwein, Ludtke, Koller, & Baumert, 2005), Australia (Watt et al., 2012), and South Korea (Lee & Kim, 2014). In Asian cultures, greater differences in gender-dominant subjects can be found due to the distinct gender role emphasis of Confucianism (Watson, Quatman, & Edler, 2002b).

When examining Korea's unique modern culture, multiple social factors must be taken into account to better understand the dynamics of how modernism and individualism have modified and become integrated with complex traditions of Confucianism and collectivism. Over the last few decades, an industrial revolution occurred transforming the country from strictly an agricultural to an industrial one. Since then, no other country in the world has advanced as quickly in economics, infrastructure, technology and social awareness as Korea has achieved. Unlike in the past, when higher education was more available to the wealthy and affluent, economic growth of the nation meant that more families had increased resources, which resulted in an inflow of modern ideals of equality in Korea. Parents could finally provide equal educational opportunities to their children regardless of sex, which led to small gender differences in academic achievement. In many ways, Koreans are now more socially aware of gender equality, social rights, and equal opportunities than ever, but the undercurrents of certain core traditional Confucian beliefs limit progress of social equality. For example, Confucianism emphasizes a patriarchal society that is still widely accepted in Korea, especially in rural and older generations, which still influences the intricacies of how Confucianism views complicate the dynamics of gender equality and roles. Still, Koreans today must find the balance between the two main responsibilities of ensuring job security, which represents both social status and economic security, and a good marriage, which represents family and social stability. Consequently, young females face traditional family pressures, gender role stereotypes, and the societal conflict to either pursue a professional career or to get married and commit to a life dedicated to marriage and family (Kim & Lowry, 2005; Tak, 1995). Thus, the internal 'tug-of-war' can result in Korean females' low motivation, low self-beliefs, and the underrepresentation of females in male-dominant fields like sciences (Card, Steel, & Abeles, 1980; Kim & Kim, 2003).

Alternatively, careers in humanities (i.e. education, business, social studies, and literature) offer ideal working conditions for young females who desire a balance of pursuing a career while managing their matriarchal duties of the home (Hakim, 2006). Correspondingly, these ideal positions of teachers or public servants typically do not require science-related majors. In other words, girls are encouraged to pursue professional careers with the caveat of also fulfilling the responsibilities within the home (Turner, 2002). Either via explicit demands or implicit messages in homes, schools, or society, Korean females are pressured to believe that there are more attractive alternatives than pursuing the sciences as fields of study and careers (Choi & Kim, 2009).

Effects of Psychosocial and Socio-economic Home Environments on Motivation and SCP

Adolescents' motivation and self-beliefs are developed by a socializing process. Students become more aware of their abilities and interests in various areas, as well as be realistic and specific in their career choices through the use of feedback of significant others (Hirschi & Lage, 2007). Especially, the interaction with significant others, such as friends and parents, occurs in informal learning settings; and these informal learning sources are reported as stronger predictors for academic achievement and career choices in science (Feder, Shouse, Lewenstein, & Bell, 2009; Gerber, Cavallo, & Marek, 2001). First, during adolescence, adolescents are affected more by their friends' opinions compared to other age groups (Fuligni & Eccles, 1993). For instance, social support from friends contribute directly to men's and women's ability to envision themselves in a future science career, which predicted their interest in and motivation for a science career (Buday, Stake, & Peterson, 2012; Lyons & Quinn, 2010). Gender differences exist in peer relation that girls value friendships and the approval and support from friends more than boys (Adler, Rosenfeld, & Towne, 2004; Parker & Asher, 1993; Rubin et al., 2004). Therefore, girls are more affected by friends' opinions than boys in choosing a career.

However, among the informal learning sources, parents are the most influential informational sources, affecting learning motivations and career choices (Lindner, Murphy, & Briers, 2001). In general, parental support for autonomy is considered as a facilitator for the enhancement of adolescents' motivation and self-efficacy (Gottfried, Fleming, & Gottfried, 1998; Pomerantz, Wang, Ng, & Robert, 2005). Another way that parents influence their children is through their shared beliefs and opinions in the home environment, delivering messages to children to value certain careers more than others (Kohn, 1977; Metheny & McWhirter, 2013). Previous researches have reported that if parents have a positive attitude towards sciences and provide affirmative science-related activities to their children, students' science learning motivations and achievements increase (Bleeker & Jacobs, 2004; Fleer & Rillero, 1999). A recent study found that parents' beliefs, including their perception of importance in specific subjects (math, reading, sports), and the child's ability positively predicted adolescents' self-concepts of abilities and values (Simpkins, Fredricks, & Eccles, 2012; Watt et al., 2012).

Likewise, although parents' beliefs and values in the home affect students' academic motivation and career aspirations, students can also be affected by their parents' SES related to educational resources and parenting types. Researchers have reported that family SES, parents' income level, education, and career, are significant predictors of cognitive achievement (Bloom, 1964), socio-emotional outcomes (Bradley & Corwyn, 2002), and occupational opportunity and career aspirations (Turner & Lapan, 2003). These effects of family SES on adolescents' development are explained by the mediation of parents' interaction with children and educational supports. For example, parents with higher SES tend to expect more from their children to succeed in school, value autonomy and academic activities more highly, and provide affluent educational resources compared to parents with low SES (Macionis, 2006).

Notably, these influences of psychosocial and socio-economic home environments on students' career choices could be stronger in Confucian cultures, such as Korea, where society emphasizes the affection between parents and children, and children's obedience to their parents (Lent et al., 2001; Markus & Kitayama, 1991).

Individuals' Motivations and Science-Career Orientation

Individuals' motivations, such as intrinsic and instrumental motivations and self-beliefs, significantly influence SCP (Farmer, 1987). These motivation constructs could be explained best by Ryan and Deci's (2006) self-determination theory (SDT). According to SDT, there are three types of motivational (i.e. amotivation, extrinsic motivation, and intrinsic motivation) or regulatory styles that are conceptualized as a continuum that is divided into six levels from no motivation to varying degrees of controlled regulation to autonomy, or self-governance (Deci & Ryan, 1985; Ryan & Deci, 2000; Schunk, Pintrich, & Meece, 2008). SDT defines the first motivational style (level 1 of continuum) as amotivation, the state absent of any regulation. Next, extrinsic motivation is the motivation to engage in activities where the activities are the means to the goal. This style consists of four behaviour types (levels 2–6): (a) fully externally motivated behaviours (external regulation); (b) behaviours motivated by a sense of duty or guilt that are initiated from an internal source (introjection); (c) pursuing a goal for the instrumental value of the task (identification); and (d) pursuit of goal for its importance to the sense of self, which is integrated by various internal and external sources of information but not motivated intrinsically (integration). The last motivational type (level 6), intrinsic regulation, is defined as engaging in the activity for its own sake such as intrinsic interest and enjoyment. In addition, this motivational development from amotivation through extrinsic motivation to intrinsic motivation is characterized by the development of perceptions of competence and control that are closely related to self-beliefs in their ability to do specific activities as well as general academic abilities.

A large body of research have reported that intrinsic motivation, such as interest and enjoyment, plays an important role in learning (Barrett, Barile, Malm, & Weaver, 2012; Eccles & Wigfield, 1995; Gottfried, 1985; Windschitl & Andre, 1998), science achievement, and pursuing science careers. For example, intrinsically motivated students choose more advanced science classes and show higher achievement than students who have low intrinsic motivation (Andre & Windschitl, 2003; Lapan, Shaughnessy, & Boggs, 1996). Positive effects of intrinsic motivation are very similar across the various cultures in Western and Asian countries (Shin, Lee, & Kim, 2009). However, cultural contexts is an important factor in understanding intrinsic motivation. For example, motivation research has generally suggested that higher intrinsic motivation correlates with higher achievement (Schiefele, Krapp, & Winteler, 1992; Schunk et al., 2008). However, Asian students appear to have significantly lower levels of intrinsic motivation than students from Western countries despite showing high academic achievements in international academic assessments such as Programmed for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (Mullis, Martin, & Foy, 2012; OECD, 2007).

These cultural differences could be attributed to how certain Asian cultures overvalue academic achievement scores for college entrance exams. These scores dictate and limit students' university and career paths depending on how low or high students perform on these tests. Therefore, students face immense pressures at home and in the fiercely competitive educational environments they are subjected to from primary levels (Hyun, Lee, & Lee, 2000; Rohlen, 1983; Stevenson & Baker, 1992). Asian students are constantly faced with extrinsic pressures and reasons for studying and achieving in schools for future successes (Tauer & Harackiewicz, 1999; Tyler, Boykin, & Walton, 2006), which ultimately lowers their intrinsic motivation (Schunk et al., 2008). More research is needed to better understand the unique dynamics of Asian students' motivations and achievements.

On the other hand, students may also study science for reasons of instrumental value such as preparing for future jobs and entering college along with their intrinsic motivation, which corresponds to levels 4 and 5 of SDT, identification and integration, respectively. For instance, when a task is perceived to be important or useful for a future goal, students are more motivated to engage in the task instrumentally (Nieswandt & Shanahan, 2008; Wigfield & Eccles, 1992). In South Korea, academic achievement is perceived as the primary requirement for getting better jobs after graduation (Hyun et al., 2000). These career-based motivations force students to strive for academic recognition especially in science and math, the two main subjects that are closely related to the success of college entrance examinations and future jobs.

Self-beliefs as well as intrinsic and instrumental motivations are closely related to Korean students' career orientation. According to SDT, competence beliefs are essential for motivation (Schunk & Zimmerman, 2006). Competence beliefs refer to the students' expectancies about their personal capacities, such as with respect to ability, efforts, and means, to perform certain actions, which are related to self-efficacy and self-concepts (Bandura, 1997). Self-efficacy refers to individuals' perceived capabilities for performing actions in specific area at a designated level, and self-concept is individual general beliefs about themselves in terms of their academic capabilities. As students have higher self-concepts of their science academic abilities and self-efficacies for performing specific science tasks successfully, they are more likely to consider pursuing science and engineering majors (Lent, Brown, & Larkin, 1984; Zeldin, Britner, & Pajares, 2008). Recent research using Korean subjects have reported that students' career maturity and life goal pursuit are closely related to academic self-concept and achievements (Kim & Kim, 2008; Lee, Kwon, & Shin, 2013). This tendency is more significant for girls than boys because Korean girls who are interested in career fields that are male dominated, such as science, experience a psychological conflict between their academic self-concept and social expectations of gender roles (Lee et al., 2013). Accordingly, it is important to consider students' gender when examining the effects of motivation of Korean students' career.

Overview of the Current Research

Despite the emphasis on narrowing the gender gap in science-career choices, empirical research examining the interactive relations between learning environments, academic motivation, and career pursuit is lacking (Dik & Duffy, 2009; Lent et al., 1994).

Thus, our primary goal was to explore whether linkages really exist between home environments, individuals' motivations, and SCP and identify what these linkages are by examining how these different variables are interrelated and how they contribute uniquely to adolescents' SCP with a focus on the gender differences. For this purpose, we proposed two research questions. First, whether gender differences exist in the home environments, motivations, and SCP. Second, whether gender differences or similarities, regardless of gender, exist in regard to the overall model of the relations between home and school environments, motivations, and SCP. Figure 1 displays a theoretical model depicting anticipated relations between variables among home environments, motivations and SCP. Specifically, we hypothesized that SES (composed of income, highest educational, and occupational levels of parents) affects the psychosocial home environment (composed of parents' perceived importance, general value, and personal value of science), which affects students' intrinsic motivation (composed of enjoyment and interest), instrumental motivation, self-belief in science (composed of self-efficacy and self-concepts in science), and SCP. In addition, we hypothesized that the psychosocial home environment affects SCP through its effect on students' motivation to learn science including intrinsic motivation, instrumental motivation, and self-belief in science.

Our goals through this current investigation were to advance our understanding of gender differences in adolescents' SCP by analysing a large national-representative

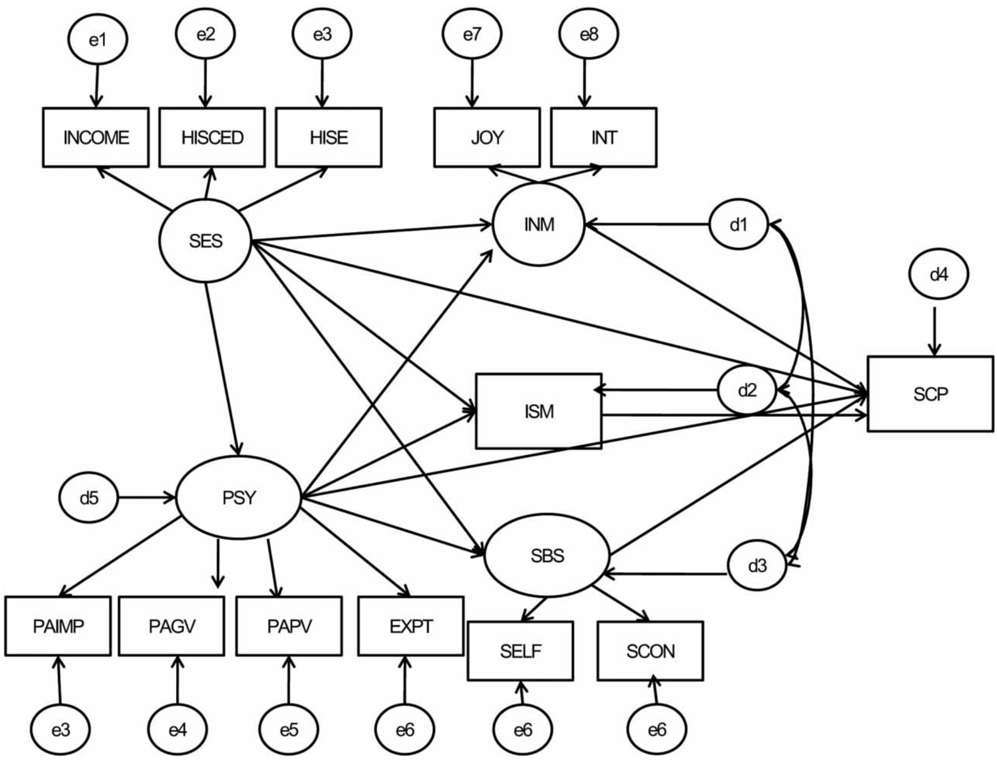

Figure 1. The hypothesized model tested across the groups. Note: SES: socio-economic status, PSY: psychosocial environment, INCOME: household annual income, HISCED: highest educational level of parents, HISEI: highest occupational status of parents, INM: intrinsic motivation, ISM: instrumental motivation, SBS: self-beliefs in science, SCP: science-career pursuit, PVS: parents' view of science, PAIMP: parents' perceived importance of science, PAGV: parents' perceived general value of science, PAPV: parents' perceived personal value of science, EXPT: expectation for children, ENJ: enjoyment of science, INS: interest in science, mint: interest in experiment, SCPN: self-concept in science, SEFF: science self-efficacy, d1: deviance of INM, d2: deviance of ISM, d3: deviance of SBS

sampling data of South Korea. In addition, we expected that the study would provide explanations for why a larger gender gap in science career still exists in Asian cultures, and define useful suggestions for educational interventions to narrow the gender gaps in science.

Method

Sample

For the purposes of the study, data collected from the 2006 PISA were selected and analysed. PISA organized the collected data by stratifying the samples into two stages, where individual schools and 15-year-old students were selected. In stage one, individual schools, where 15-year-old students could be enrolled, were systematically sampled with probabilities proportionate to size, where size represented the estimated number of eligible students that were enrolled. In stage two, 15-year-old students were sampled within the sampled schools. Thirty-five students were selected with equal probability from the selected schools.

The sample used in the study included 5,176 15-year-old Korean students (2,563 girls, 49.5% and 2,613 boys, 50.5%) from 155 schools and their parents (3,736 mothers, 72.2%; 1,317 fathers, 25.4%; or 123 guardians, 2.4%). The sample represented 284,279 girls and 292,370 boys of the 15-year-old Korean adolescent population. The PISA survey weight was employed for all further analysis.

Measures

The home environment variable included psychosocial and socio-economic factors. In regard to individual motivations, self-beliefs and both intrinsic and instrumental motivations were considered. The outcome variable was SCP. All measures were answered on a four-point Likert scale (1 for strongly agree and 4 for strongly disagree), where all item scores were reversed except for the item, parents' expectations for their children to have science career (0 for no, 1 for yes). All items can be found in PISA report (OECD, 2009).

Psychosocial home environment. Psychosocial home environment was composed of four sub-factors of parental opinions/beliefs/perceptions/view of the following: importance of science, the general value of science, personal value of science, and expectation for children's science career. Parents' view of importance of science was measured by four items such as 'It is important to have good scientific knowledge and skills in order to get any good job in today's world.' Reliability of this scale showed a coefficient value of .76.

Five items measured parents' perceptions of the general value of science, which included 'Advances in <broad science and technology> usually improve people's living conditions.' Its reliability was adequate by showing a value of .83 (Cronbach's α).

In contrast to parents' perceptions of the general value of science, parents' perceptions of personal value of science was measured by four items that asked how science was related to or affected parents personally, which included 'Some concepts in <broad science> help me to see how I relate to other people.' The reliability of this scale (Cronbach's α) was .77.

Expectation for children's science career was measured by two items that included 'Do you expect your child to go into a <Science-related career>?' and 'Do you expect your child to study science after completing secondary school?' The reliability of this scale (Cronbach's α) was .83.

Socio-economic home environments. The socio-economic home environment variable was composed of household annual income, highest educational level of parents and highest occupational status of parents. Household annual income was assessed by the question of 'What is your annual household income' by five scales of national currency.

The highest educational level of parents (HISCED) corresponded to the higher ISCED level of either parent. PISA (OECD, 1999) classified parental education using indices on parental education (ISCED) that were constructed by recoding educational qualifications into seven categories from 0 for none to 6 for theoretically oriented tertiary and post-graduate.

The highest occupational status of parents (HISEI), assuming both parents have incomes from jobs, corresponds to the higher International Socio-Economic Index of the two occupational status levels of the parents (Ganzeboom, De Graaf, & Treiman, 1992). As the scores of all three indices (HISCED, income, and HISEI) increased, the levels of annual income, education, and occupational status were found to have increased as well.

Intrinsic motivation to learn science. We composed a latent variable of intrinsic motivation with enjoyment of science and interest in science subjects. First, enjoyment of science was assessed with five items that included 'I enjoy acquiring new knowledge.' It had a strong reliability coefficient with Cronbach's α of .91.

The measurement for interest in learning science consisted of a set of eight questions that inquired about the participants' level of interest in different science subjects. An example question was 'How much interest do you have in learning about the following <broad science> topics?' The reliability coefficient of Cronbach's α was .81.

Instrumental motivation to learn science. In PISA 2006, students' instrumental motivation to learn science was measured by five questions that inquired about students' feelings towards the idea that learning science was important for their future studies and jobs. The example questions included 'I study science because I know it is useful for me.' The scale had a strong reliability coefficient (Cronbach's α) of .93.

Self-beliefs in science. As part of the PISA 2006 survey, items were developed to identify how students believe that they can succeed in science. These beliefs were defined by two ways, self-efficacy and self-concept. Science self-efficacy was measured by asking 'How easy do you think it would be for you to perform the following tasks on your own?' The tasks included eight tasks such as 'Explain why earthquakes occur more frequently in some areas than in others.' The reliability coefficient of Cronbach's α was .83.

Whereas science self-efficacy measures students' confidence in performing specific science tasks, science self-concept measures the general level of students' belief in their academic abilities in science. Science self-concept was measured by how much they agreed to six statements that included 'I can usually give good answers to test questions on school science topics.' The scale had a strong reliability coefficient (Cronbach's α) of. 92.

Science-career pursuit. Students' SCP was assessed by four questions that asked of their intentions with regard to future study or work in science. The example items included 'I would like to work in a career involving science.' The reliability coefficient (Cronbach's α) scale was .92.

Results

Descriptive Statistics and Correlations

The descriptive statistics and correlations between variables for each gender are presented in Table 1. The means of all the variables were lower for girls than for boys. Strong Pearson correlations were present between sub-variables of intrinsic motivation, instrumental motivation, self-beliefs in science and students' SCP, which ranged from .22 to .79.

Gender Differences in Research Variables

In order to examine the gender differences in each variable, multivariate Hotelling's T-Square test was used, which is the multivariate counterpart of Student's *t*. With Hotelling's T-Squared, the combined dependent variables were significantly affected by gender, $T^2 = 25{,}029.516$, $F\,(13, 447{,}064) = 1{,}925.296$, $p < .001$, $\eta^2 = .053$. Therefore, it was revealed that differences by gender existed in psychosocial and socio-economic home environments, motivations, and SCP. The univariate *t* tests were conducted to ascertain which dependent variables accounted for multivariate effects according to gender. Table 2 presents mean values and univariate results.

As seen in Table 2, results indicated that girls' parents reported lower levels of income, education, and occupation status, perceived science to have lower importance, valued science less and had lower expectations of their daughters to secure science-related jobs than boy's parents. More importantly, the effect sizes (Cohen's *d*) indicated that there were relatively greater gender differences in parent's value of importance of science and expectation for children to have science-related jobs than in parents' general and personal values on science.

For motivation variables, girls definitively showed lower interest and enjoyment in science, instrumental science motivation, self-efficacy and self-concept in science than boys. In particular, effect sizes of gender on enjoyment and self-concept in science, and instrumental science motivation were relatively greater than those of interest in science and self-efficacy. Lastly, the SCP variable was found to have the biggest effect size among all variables, where girls pursued science careers significantly less than boys.

However, since there were gender differences in SES, we further tested the gender effect by controlling for effects of SES that could lead to gender differences in

Table 1. Descriptive statistics and correlation for variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	M (girl)	SD (girl)
Income	1	0.457***	0.286***	0.013***	0.186***	0.162***	0.168***	0.191***	0.083***	0.190***	0.198***	0.111***	3.457	1.870
HISCED	0.438***	1	0.348***	−0.030***	0.119***	0.150***	0.146***	0.143***	0.080***	0.152***	0.167***	0.078***	4.470	1.420
HISIE	0.317***	0.397***	1	−0.037***	0.057***	0.092***	0.128***	0.140***	0.036***	0.119***	0.120***	0.068***	50.16	14.379
Importance of science	0.026***	0.024***	0.016***	1	0.443***	0.379***	0.102***	0.101***	0.112***	0.073***	0.083***	0.099***	3.043	0.506
General value of science	0.185***	0.122***	0.105***	0.434***	1	0.553***	0.129***	0.145***	0.096***	0.107***	0.147***	0.095***	3.319	0.452
Personal value of science	0.158***	0.140***	0.068***	0.353***	0.513***	1	0.132***	0.128***	0.123***	0.109***	0.115***	0.109***	2.702	0.533
Enjoyment of science	0.156***	0.091***	0.031***	0.062***	0.095***	0.088***	1	0.705***	0.582***	0.695***	0.41***8	0.647***	2.392	0.710
Interest in subjects	0.151***	0.094***	0.046***	0.084***	0.123***	0.117***	0.701***	1	0.525***	0.596***	0.475***	0.566***	2.283	0.586
Instrumental motivation	0.109***	0.060***	0.028***	0.120***	0.079***	0.097***	0.587***	0.534***	1	0.541***	0.278***	0.672***	2.424	0.722
Self-efficacy in science	0.195***	0.110***	0.065***	0.047***	0.074***	0.096***	0.669***	0.598***	0.559***	1	0.438***	0.590***	1.982	0.602
Science self-concept	0.192***	0.141***	0.071***	0.078***	0.110***	0.119***	0.459***	0.498***	0.305***	0.461***	1	0.327***	2.600	0.526
Science-related job pursuit	0.099***	0.057***	0.007***	0.074***	0.069***	0.081***	0.629***	0.541***	0.649***	0.564***	0.325***	1	1.767	0.704
M (boy)	3.476	4.550	51.08	3.095	3.341	2.745	2.582	2.335	2.541	2.171	2.625	1.992		
SD (boy)	1.887	1.416	14.295	0.494	0.452	0.533	0.744	0.608	0.773	0.673	0.546	0.783		

Note: G: girls, B: boys, correlations for girls are above the diagonal.

***$p < .001$.

Table 2. Means and univariate *t*-test scores for male and female adolescents

Variables	*M* Girl	Boy	*t*	*d*
Income	3.457	3.476	−3.449***	−0.010
HISCED	4.470	4.550	−21.888***	−0.056
HISIE	50.160	51.08	−24.285***	−0.064
Importance of science	3.043	3.095	−39.471***	−0.104
General value of science	3.319	3.341	−17.798***	1.202
Personal value of science	2.702	2.745	−29.723***	−0.078
Enjoyment of science	2.392	2.582	−98.775***	−0.260
Interest in subjects	2.283	2.335	−33.061***	−0.087
Instrumental motivation	2.424	2.541	−59.707***	−0.157
Self-efficacy in science	1.982	2.171	−112.185***	−0.295
Science self-concept	2.600	2.625	−17.772***	−0.046
Science-related job pursuit	1.767	1.992	−115.059***	−0.303

***$p < .001$.

psychosocial home environments, motivations, and SCP. The results showed that gender differences in psychosocial home environments, motivations, and SCP still existed after controlling for the effects of SES: parents' perception about importance of science (F (1, 440,446) = 575.992, $p < .001$), the general value of science (F (1, 440,446) = 413.701, $p < .001$), personal value of science (F (1, 440,446) = 580.406, $p < .001$), and expectation for children's science career (F (1, 440,446) = 10,431.691, $p < .001$); intrinsic motivation with enjoyment of science (F (1, 440,446) = 9,374.883, $p < .001$) and interest in science subject (F (1, 440,446) = 1,193.796, $p < .001$); instrumental motivation (F (1, 440,446) = 4,701.762, $p < .001$); self-efficacy (F (1, 440,446) = 283.459, $p < .001$) and self-concept (F (1, 440,446) = 10,114.136, $p < .001$); SCP (F (1, 440,446) = 12,058.670, $p < .001$).

Testing the Models of Gender Groups

The relations between variables were compared across two gender groups (see Figure 1), where we conducted multi-group structural equation modeling (SEM) analysis that examined group differences in fit of the data, model's parameters, and causal relationships among multiple variables (Byrne, 2001). SEM multi-group analysis was performed with three steps of testing configural equivalence, measurement equivalence, and structural equivalence.

Before testing the configural equivalence, the hypothesized model was tested separately for the two groups' data and the total sample data. These group-specific models are termed baseline models. Results yielded acceptable model fit indexes for all (Bentler & Bonett, 1980; Kline, 2005): χ^2 (52) = 58,349.457, Comparative Fit Index (CFI) = .955, Normed Fit Index (NFI) = .955, root mean square error of approximation (RMSEA) = .063, standardized root mean residual (SRMR) = 054 for girls; χ^2 (52) = 67,076.754, CFI = .948, NFI = .947, RMSEA = .066, SRMR = .059 for boys; χ^2 (104) = 125,954.192, CFI = .951, NFI = .951, RMSEA = .065, SRMR = .058 for total sample.

When testing for the configural equivalence, the only requirement for the initial step is that across all groups, only the factors and their loading patterns must be the same. The configural model acts as the baseline against which all remaining equivalence tests are compared.

Therefore, configural equivalence is an important prerequisite for tests of measurement and structural invariance to be meaningful (Byrne, Shavelson, & Muthén, 1989). The configural equivalence was confirmed, χ^2 (104) = 125,425.932. CFI, NFI, RMSEA, and SRMR values were .951, .951, .046, and .059, respectively. Since the configural model fits reasonably well, we concluded that the number of factors and the pattern of item loadings were similar across all groups. All factor loadings of the variables were statistically significant ($p < .001$), indicating that all variables used in the study were well represented by the indicators.

Unlike the configural model, the following equivalence tests entail applying equality constraints for 'particular parameters' across groups. In the past, $\Delta\chi^2$ statistic was used for measurement and structural equivalence tests. However, researchers (Cheung & Rensvold, 2002; Little, 1997) have argued that $\Delta\chi^2$ value is an impractical and unrealistic criterion to base the evidence of equivalence. Consequently, comparative models are now being based on the difference between the CFI values (ΔCFI) as a more practical approach in determining the extent to which models are equivalent. Therefore, we used ΔCFI to test the model's equivalence following the criterion that the ΔCFI value does not exceed .01 (Cheung & Rensvold, 2002).

The CFI value of the baseline model was used as a criteria value to decide whether the model fit of the constrained model that placed equality constraints to have the same coefficients for two groups was worse than the model fit of the baseline model (configural model serves as the baseline model).

With the confirmed configural equivalence, the measurement equivalence was tested to identify factor loadings that caused measurement differences (Byrne, 2010). When testing for the equivalence of factor loadings, the factor loading parameters are freely estimated for the first group and the factor loading parameterises for the remaining groups are 'constrained equally' to those of the first group. If the measurement equivalence is confirmed, a confirmed measurement equivalence allows for the assumption that across the groups, the used instruments' items are perceived and interpreted as the same.

Results yielded equivalence for the measurement models (ΔCFI = .000), thereby indicating that the same measurement model could be applied to both groups. The other fit statistics of the measurement equivalence model were very good: $\chi^2(111)$ = 125,425.932, CFI = .951, NFI = .951, RMSEA = .046, SRMR = .060. Therefore, the measurement equivalence was sufficient for further analysis for testing the structural equivalence model (Byrne et al., 1989).

Next, the structural equivalence was tested for the equality of relations among the factors between the two groups. When all the relations between the latent factors were constrained as equal, $\Delta CFI = .001$. The other model fit indices were NFI $= .950$, RMSEA $= .042$, SRMR $= .060$, indicating that the structural model paths could be assumed to be equivalent across the groups. Therefore, relations among home environments, motivations in science, and SCP could be interpreted similarly across both groups.

Path coefficients of the final model are presented in Table 3. The results of the final model showed that the six predictors reliably explained SCP, where the predictors explained 58.1% of the variances of SCP. Specifically, the explained variance was 61.2% for girls and 53.6% for boys.

Relations between variables across groups. All path coefficients were significant. Regarding home environments, socio-economic home environment (SES) positively affected psychosocial home environment (PSY), students' science intrinsic motivation (INM), instrumental motivation (ISM), and self-beliefs in science (SBS). However, even though the effect size was very small, SCP was affected negatively by SES. Psychosocial home environment positively affected intrinsic and instrumental motivations, self-beliefs in science, and SCP.

Regarding the relation between motivations and SCP, intrinsic motivation and instrumental motivations had relatively strong effects on SCP, whereas SBS have a relatively weak effect.

In addition, effect size of each path was compared by using critical ratio (CR), for differences between two parameters in question were calculated by dividing the difference between the parameter estimates by the estimate of standard error of difference. CR was equal to or above ±1.96, indicating that the parameter estimate of one path coefficient was statistically different from the other (Byrne, 2001).

The effect size of socio-economic environment on intrinsic motivation and SBS was larger than the effect of psychosocial environment: SES → INM vs. PSY → INM, CR $= -75.256$, $p < .001$; SES → SBS vs. PSY → SBS, CR $= -53.150$, $p < .001$. On the contrary, the effect size of socio-economic environment on instrumental motivation was smaller (SES → ISM) than psychosocial environment (PSY → ISM) (CR $= -82.540$, $p < .001$). In addition, the effect size of intrinsic motivation on SCP was larger than the effect of instrumental motivation, which was larger than the effect of self-beliefs in science: INM → SCP vs. ISM → SCP, CR $= -19.082$, $p < .01$; ISM → SCP vs. SBS → SCP, CR $= 47.773$, $p < .001$.

Moreover, the total effect was discomposed into direct and indirect effects. Each effect's significance was tested by using bootstrapping and phantom variables (Rindskopf, 1984) that generated 95% confidence intervals for those effects. As shown in Table 4, bootstrapping test indicated that the total indirect effects of socio-economic and psychosocial home environments to SCP, as well as each indirect effect of specific paths, were significant. Regarding total effects of each independent variable on SCP,

Table 3. The estimated standardized path coefficients (final model)

Path	Girls			Boys		
	B	β	SE	B	β	SE
SES → PSY	0.031	.238***	0.001	0.031	.243***	0.001
SES → INM	0.101	.171***	0.001	0.101	.194***	0.001
SES → ISM	0.042	.160***	0.001	0.042	.068***	0.001
SES → SBS	0.113	.271***	0.001	0.113	.267***	0.001
SES → SCP	−0.028	−.048***	0.001	−0.028	−.044***	0.001
PSY → INM	0.686	.195***	0.007	0.686	.167***	0.007
PSY → ISM	0.734	.071***	0.001	0.734	.151***	0.008
PSY → SBS	0.466	.145***	0.006	0.466	.139***	0.006
PSY → SCP	0.039	.009***	0.005	0.039	.008***	0.005
INM → SCP	0.488	.437***	0.008	0.488	.406***	0.008
ISM → SCP	0.324	.333***	0.001	0.324	.320***	0.001
SBS → SCP	0.127	.092***	11.957	0.127	.086***	0.011
SES → HISCED	0.798	.717***	0.003	0.798	.709***	0.003
SES → HISEI	6.383	.592***	0.31	6.383	.587***	0.021
PSY → PIMP	1.763	.557***	0.008	1.763	.556***	0.008
PSY → PAGV	2.195	.699***	0.010	2.195	.755***	0.010
PSY → PAPV	2.320	.778***	0.011	2.320	.675***	0.011
PSY → EXPT	1	.356		1	.339	
INM → ENJ	1	.890		1	.874	
INM → INS	0.742	.801***	0.001	0.742	.793***	0.001
SBS → SEFF	0.570	.551***	0.001	0.570	.552***	0.001
SBS → SCPN	1	.835		1	.797	
d1 ↔ d2	0.295	.662***	0.001	0.295	.642***	0.001
d1 ↔ d3	0.231	.656***	0.001	0.231	.626***	0.001
d2 ↔ d3	0.283	.945***	0.001	0.283	.934***	0.001

Note: SES: socio-economic status, PSY: psychosocial environment, HISCED: highest educational level of parents, HISEI: highest occupational status of parents level of parents, INM: intrinsic motivation, ISM: instrumental motivation, SBS: self-beliefs in science, SCP: science-career pursuit, PVS: parents' view of science, PIMP: parents' perceived importance of science, PAGV: parents' perceived general value of science, PAPV: parents' perceived personal value of science, EXPT: expectation for children, ENJ: enjoyment of science, INS: interest in science, mint: interest in experiment, SCPN: self-concept in science, SEFF: science self-efficacy, d1: deviance of INM, d2: deviance of ISM, d3: deviance of SBS.

$^{***}p < .001$.

the effect of intrinsic motivation was larger than instrumental motivation. Instrumental motivation was followed by SES, psychosocial home environment and self-beliefs. Specifically, the total positive effect of SES on SCP was fully explained by mediation of psychosocial home environment and motivations. In addition, among the total positive effects of psychosocial home environment on SCP, 98.66% was explained by mediation of motivation. In particular, the mediating effect size of intrinsic motivation was larger than that of instrumental motivation ($p < .001$), which was larger than self-belief ($p < .001$).

Table 4. Total, direct, and indirect effects with bootstrapping test

	Unstandardized		Standardized			
			Girls		Boys	
	B	95% CI	*β*	95% CI	*β*	95% CI
SES → SCP						
Total effect	0.071**	.069–.073	.124**	.122–.128	.111**	.109–.114
Total indirect effect	0.099**	.097–.100	.173**	.170–.177	.155**	.152–.157
SES → INM → SCP	0.049**	.047–.000	.087**	.082–.091	.077**	.073–.081
SES → ISM → SCP	0.014**	.013–.000	.024**	.023–.025	.021**	.020–.023
SES → SBS → SCP	0.015**	.012–.000	.026**	.022–.031	.023**	.019–.028
SES → PSY → INM → SCP	0.010**	.010–.011	.020**	.017–.022	.019**	.017–.020
SES → PSY → ISM → SCP	0.007**	.007–.008	.006**	.005–.006	.005**	.005–.006
SES → PSY → SBS → SCP	0.002**	.002–.002	.006**	.005–.007	.006**	.005–.007
Direct effect	−0.028**	−.029–.026	−.049**	−.052–.046	−.044**	−.046–.041
PSY → SCP						
Total effect	0.671**	.657–.686	.153**	.149–.157	.133**	.130–.137
Total indirect effect	0.633**	.621–.644	.144**	.141–.147	.126**	.123–.128
PSY → INM → SCP	0.334**	.319–.346	.076**	.072–.008	.066**	.062–.070
PSY → ISM → SCP	0.238**	.233–.243	.054**	.052–.056	.047**	.046–.049
PSY → SBS → SCP	0.061**	.051–.072	.014**	.011–.017	.012**	.010–.015
Direct effect	0.039**	.028–.050	.009**	.006–.011	.008**	.006–.010

**$p < .01$.

Discussion

This research aimed to understand more clearly gender similarities and differences in terms of mean levels of home environments, motivations, and students' SCP, as well as the relationships between these variables. Although the mean levels were lower for girls for most variables, the relations among the variables were same for both genders.

Girls' Lower Levels in Socio-economic and Psychosocial Home Environments, Motivations, and SCPs

Regarding motivational factors, girls' intrinsic and instrumental motivation and self-belief were found to be lower than that of boys. These results are consistent with previous studies that have consistently shown girls as having relatively low perception of their academic confidence despite having comparably high academic achievement levels (Eccles, 1984; Schunk & Pajares, 2002). In addition, girls were found to have fewer intentions to pursue science careers than boys, similar to previous research studies that have found that girls take less advanced science courses and that fewer girls major in STEM (AAUW, 2000; OECD, 2007). Many researchers reported that girls' lower levels of motivations compared to boys are related to how gender roles are socialized in homes (Gottfried et al., 1998; Pomerantz et al., 2005). In line with these research studies, this study found girls' parents perceived science to be of lower importance for their daughters, valued science less, and expected to have science-related jobs less than boys' parents. These views reflect the disparity of parents' attitudes towards typical male-dominant subjects like science that are dependent on the sex of their children, which are based on their gender-stereotyped beliefs. For instance, when parents of girls were compared to parents of boys, parents of girls believed that science was less interesting and more difficult for their children and believed that their daughters would have lower abilities in math than parents of boys (Frome & Eccles, 1998; Tenenbaum & Leaper, 2003). These gender-stereotyped beliefs are passed from parents to their children. As a result, girls see and internalize their parents' expectations for them that ultimately may have resulted in girls' lower SCP. In other words, unfortunately for girls, their parents' views on STEM negatively affected their motivations in STEM (Campbell & Beaudry, 1998; Simpkins et al., 2012).

In addition, gender differences in socio-economic home environments were found, indicating that boys' parents had higher SES. This result could be explained by the Confucian tradition to prefer sons over daughters, where couples reproduce until a son is born. The number of births and sons usually positively related to SES (Chahnazarian, 1988). Actually, Korea's sex ratio at birth (number of boys to 100 girls) in 1991, when most of the participants of this research were born, was 112.5, whereas the sex ratio at birth for the entire world population was 101 (Statistics Korea, 2014; The Central Intelligence Agency of the United States, 2014).

Gender Similarities Rather than Gender Differences in the Relation Between Variables

Even though there were gender differences in mean levels of socio-economic and psychosocial home environments, motivations, and SCP, the relations between variables were very similar across all gender groups. All path coefficients between variables were not significantly different according to gender.

Regarding home environments, parent's SES positively affected psychosocial home environment by showing that as SES increased, parents perceived science to be more important, valued science more, and expected their children to have science-related careers more. These results are similar to previous research that reported that parents with high SES valued learning, provided more varied learning and cultural experiences, had a higher expectation for their children, and scaffolded children's efforts to learn and reach their expectations (Bradley & Corwyn, 2002).

In addition, SES affected adolescents' intrinsic and instrumental motivation as well as self-belief in science. Access to such materials and experiences provide helpful learning opportunities as well as motivate students to continue learning (Saegert & Winkel, 1990). Therefore, the results of this study imply that SES home environment could affect adolescents' motivations and self-beliefs in science by providing stimulating resources for scientific thinking and interest in science.

However, SES had a direct negative effect on SCP even though the effect size was small. This result, due to the fact that most of SES's total effect on SCP was explained by the mediation of psychosocial home environment and motivations and self-belief, which means that students with higher SES were less likely to have intention of pursuing science careers when statistically controlling the effects of their psychosocial environment and motivations. In addition, the negative effect caused by SES may be due to the general perception in society that jobs in natural sciences and engineering have a 'low return' in terms of financial security and social status. Compared to the time, effort, and finances required in order to prepare for college in sciences and careers, a 'low return' job could dissuade prospective students from pursuing a science career. Moreover, students from higher SES families operate on a higher reference point for career aspiration (Coleman, 1988), and low return jobs like sciences may be more easily disregarded for positions of 'higher value'.

Psychosocial environment including parents' views on science and expectations affected their children's SCP through effects of home environments on intrinsic motivation, instrumental motivation, and self-beliefs for both gender groups. These results are consistent with other research that found parental factors affecting children's career aspiration through motivationally mediated factors (Simpkins et al., 2012).

Regarding motivational factors, intrinsic motivation and instrumental motivation significantly affected students' SCP in all groups. These results are consistent with other research on motivations and career decision as well (Hwang & Lim, 2004). For example, career maturity, which refers to students' rationale for making career decisions that are based on their understanding about themselves and their career pursuits, was positively related to autonomous intrinsic motivation (Hwang & Lim, 2004). Regarding self-belief in science, it had the smallest effect on SCP among the motivational factors, which can be interpreted as Korean students consider their interests and instrumental reasons (i.e. social recognition and financial success) to be more important in their career decisions than self-beliefs.

These gender similarities in the relations between the variables suggest that learning environments and motivations in SCP do operate in very similar ways even though girls perceive low levels of favourable learning environments, science motivation, and SCP. In other words, gender differences exist in the mean levels of perceived environments, motivation, and SCP, but the favourable learning environments of home and school positively affect students' motivations and self-beliefs. As a result, motivations can positively predict the SCP regardless of gender.

Implication for science education and future direction. Based on the results, the implications for educational practices are suggested as follows. Even though gender differences in science achievement have decreased, significant differences still exist in learning environments, science motivations and SCP (Freeman, 2004). The gender differences in science are due to the differences in motivations and attitudes that come from socialization and not from abilities (Tyler-Wood, Ellison, Lim, & Periathiruvadi, 2012). Therefore, it is important to provide educational interventions to decrease students' gender stereotypes and encourage girls to form positive attitudes to science-related jobs. These educational interventions for decreasing gender stereotypes are closely related to socializations and education in both homes and schools, such as parents' everyday interaction with their children and teachers' teaching practices.

First, the confirmative research results showed gender differences in motivations largely due to the socialization process. For example, students are influenced by the same sex of their parents, where girls are more influenced than boys (Simpkins et al., 2012). This means that parents' beliefs about children and their values in science are conveyed to their children, thus intervention should be directed at parent–children interactions.

There are several implications for instructional strategies and classroom involvement to encourage science motivation of girls in schools. For instance, when female students are exposed to feminism and stereotype-defying role models, girls' academic performances, self-beliefs, and job career aspirations increase, stereotypes, inhibitions, and self-doubt decrease (Marx & Roman, 2002; Stout, Dasgupta, Hunsinger, & McManus, 2011). In order to provide exposure of role models, it is necessary to increase the number of female science teachers and provide female students with opportunities to meet female scientists.

These educational interventions would be more effective if provided from an early childhood stage when gender role stereotypes are not yet fixed. According to the American Association of University Women (AAUW, 2000), gender differences in science start to appear in middle school and become more prevalent as students get older. Therefore, it is important to provide early intervention programmes to decrease students' sexist stereotypes and encourage girls to form positive attitudes about science-related jobs. This study has several limitations that can lead to some meaningful future research if addressed successfully. First, participants included in this study were eighth graders, and their career maturity is still in their formative years; thus, further investigation is needed to understand whether the same results could be found in older students. Second, a limited number of parental factors were considered because the data used in this study were not the primary data that were directly collected by the authors to focus on parental factors; rather, it was the secondary data that were collected for PISA. Therefore, it would be meaningful for future research to expand the environmental factors to include parenting styles and home activities. Third, we did not separately investigate the effect of parents on their children by devising fathers' vs. mothers' effect on daughter vs. son. However, when considering research studies that reported different effect size of mothers (education level and parenting style) and fathers on their daughter and son, further investigation seems needed (Baker & Stevenson, 1986; Hsu, Zhang, Kwok, Li, & Ju, 2010; Paa & McWhirter, 2000). Lastly, among various informal learning sources such as family, peers, and outside school learning, we focused on family factors. Thus, further investigation into other informal sources' effect on science-career choice is needed.

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