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INFLUENCING FACTORS OF 10TH GRADE STUDENTS' SCIENCE CAREER EXPECTATIONS: A STRUCTURAL EQUATION MODEL

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Abstract. *Science career expectations can be affected by personal science beliefs and social supports. Framed in Expectancy-Value Models, this research studied the influence of science beliefs (science interest belief, self-efficacy belief and value belief) and social supports (parents and teachers) on students' science career expectations by the survey of 798 10th grade students. Based on Structural Equation Model, it was found that: 1) science interest belief, self-efficacy belief, value belief and parents' support can directly predict students' expectations of science careers; 2) the effect of student's perception from parents and teachers support on science choice preferences and career engagement are mediated through the effects on students' interest, self-efficacy and value in science. Therefore, teachers and parents should enhance students' science beliefs and identity for the improvement of their science career expectations.*

Keywords: *influencing factors, science career expectations, Structural Equation Model, 10th grade students.*

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Introduction

Science career expectation is the process of identifying science-related occupations and students constructing self-knowledge during the continuous scientific practices (Tan et al., 2017). Many studies emphasized the role of scientific practice experience in career choice. Through a longitudinal ethnography research, Calabrese et al. (2013) suggested that scientific activities in family, school and society can affect non-mainstream students' science identity, and only those students who can obtain recognition, encouragement and help of science identity and the opportunity to participate in scientific activities finally found self-identity in the future science-related choices. Aschbacher et al. (2010) found that practice experience can change students' perceptions of science learning, career choice and success expectations, and constantly reframe their science identities and pursuits. BØE et al. (2011) believed that the choice of science career was the process of initiative self-construction, and identity is no longer given by others but more exists as self-selection and development. Success expectation belief and task value belief in the Eccles (2009) Expectancy-Value Models could explain the influence of science beliefs on the choice of a science career. These beliefs reflected the results of individual's re-modeling and self-confirmation in the process of socialized science practice, and embodied their sense of belonging, meaning and identity. Therefore, the development of science career expectations is the process of reconstructing science belief, and realization of self-identity through scientific activities in family, school and social fields. Self-identity is individual's understanding of his own experience. This research showed that science career expectation was the tendency to engage in science-related occupations in the future, and also reflected the internal process of individual's constructing science identity and remodeling self-belief and expectation. It is potentially affected by family, society, school and other external factors, and has the characteristics of accumulation, continuity and development.

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Literature Review

Previous studies have generally shown that gender, family economic status, scientific capital, ethnic class and other personal background factors can significantly affect students' science career expectations (Archer et al., 2012; Dewitt et al., 2013;). Further studies have revealed that the change of science career tendency is more predicted by personal science beliefs and social supports, other than class or gender factors (BØE, 2012). Therefore, this research focused on the influence of science beliefs and social supports on science career expectations.

First, science beliefs refer to the cognition and perception of science or science-related occupations that an individual perceives and acquires during science learning or practice, including students' interests in science, recognition of science values, and judgment of self-ability on science. Scholars generally believed that science beliefs have a significant predictive effect on students' science career expectations. Palmer et al. (2017) found that students' science interests, abilities, learning values and future career values were ranked the top four among many factors. Students' science beliefs (interest belief, self-efficacy belief, and value belief) may largely predict students' expectations of science careers, which reflected the process of students' recognition, construction and strategy implementation of science identity, and could effectively shape and explain students' views on science identity (Vincent-Ruz & Schunn, 2018). Holmegaard (2015) believed that the reason why students gave up STEM higher education programs were largely due to their difficulty in establishing an ideal self-identity in STEM-related subjects. Most studies believed that science beliefs can significantly affect science career expectations. However, different scholars have reached controversial conclusions on the impact of different science beliefs on career expectations, the process of motivation and the applicable groups. Mujtaba et al. (2018) found that science interests, value beliefs and their afterschool activities could positively predict science career expectations, but the effect of self-efficacy belief was small. Sheldrake (2016) proposed that science self-efficacy belief of students with high self-confidence significantly affected their expectations of science career, but for those with low self-confidence, the prediction was not obvious. Gottlieb (2018) further suggested that science interest and value belief could significantly predict white males' expectations of science careers. Thus, the effect of science beliefs on science career expectations may vary to ethnic groups and cultural backgrounds.

Second, social supports such as expectations, encouragements and academic help from teachers and parents may also have an impact on students' expectations of science careers. Rueger et al. (2010) conceptualized the social supports as the emotional and behavioral feedback that students obtained from the outside world. A large number of studies have explored the interaction between social support and science career expectations. Perry et al. (2010) found that support from teachers and parents can significantly affect students' future career choice and preparation. Vedder-Weiss and Fortus (2013) also revealed that students' science goals and participation were affected by their parents, peers, teachers and schools and other external expectations, and the influence of parents and teachers was the most one. Lee et al. (2020) further proposed that parents' science value beliefs can significantly affect boys' future willingness to work in science imposed or indirectly conveyed by parents. Social support may positively explain and predict students' expectations of science careers. However, controversial conclusions have been reached in some studies. Mujtaba et al. (2018) found that teaching methods, science expectations and encouragements from teachers and parents had less explanatory power to students' science career expectations. There may be students in different cultural contexts have different perceptions on social support. For example, the Asian family culture may promote students to identify, or obey their parents' advice on careers. Therefore, this research focused on the influence of social support such as parents and teachers on Chinese students' expectations of science careers.

Third, science belief and social support may have direct effect on science career expectations. Sjaastad (2012) believed that parental encouragement and dialogue could help students recognize and understand the STEM identity. Wong (2012) found that family culture and parents' expectations could influence students' cognition of science-related education to reframe their science value beliefs. Those students who can get encouragements and academic guidance from their parents may be more inclined to recognize the science values, set higher academic goals and take part more seriously in science learning process. In addition to the direct role of parents' support and science beliefs, some studies have further explored the interaction among science beliefs, parents' support and career expectations. Neuenschwander et al. (2007) suggested that parents' expectations can not only directly influence students' academic achievement, but also play an indirect role through self-efficacy beliefs. Sha et al. (2016) also found that family support can not only directly predict science participation, but also indirectly play a role by influencing science interests and self-efficacy. Teachers' guidance and emotional support could

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significantly affect students' academic achievement (Song et al., 2015). Tas et al. (2019) also proposed that teachers' support can positively predict students' science value beliefs and self-efficacy beliefs. Osborne et al. (2003) further confirmed that teaching quality, emotional support and characteristics of teacher-student interaction can not only influence students' attitudes towards science, but also their faith in science learning. Teachers' emotional support and academic help could effectively reduce students' fear of difficulties and anxiety in learning and help them to get a positive science learning experience. Besides, some studies have further explored the intermediary role of teachers' support, science beliefs and expectations. Burns (2019) found that teachers' feedback not only directly predicted students' science value and interest beliefs, but also indirectly affected academic performance through science value and interest. Mohtar et al. (2019) confirmed that STEM interest and self-efficacy beliefs both played an important intermediary role between environment and STEM career expectations.

Research Hypothesis

Science career expectation is the process of an individual to construct science identity and re-model self-belief and expectation. Science beliefs generally have a very important and direct impact on one's future science choices, and Expectation-Value Theory (EVT) has been widely used in the research of science selection and career expectation (Vedder-Weiss & Fortus, 2013). EVT is a comprehensive evidence model which holds that the choices, persistence and performance related to achievement depend on individual's success expectation and task value belief (Eccles & Wigfield, 2002). The former is one's expectations of success and judgment of whether he/she can succeed, and belongs to Bandura's self-efficacy, known as self-efficacy belief. The latter is the subjective value of task that an individual perceives when pursuing a specific activity, mainly including the interest value, importance value and usefulness value.

Therefore, based on social psychology, EVT lays emphasis on the interaction between personal motivation beliefs and external environment, which can explain the complexity, dynamics and developmental characteristics of one's career decisions. By examining students' success expectation and task value, the characteristic of science education and career expectation can be effectively explained over time (BØE et al., 2011). This research analyzed the influence of social support (parents and teachers), self-efficacy belief, interest belief and value belief (importance and usefulness value) on the science career expectations, and further confirmed the mechanism of the above factors. Therefore, this research proposed the following hypotheses:

H_1: The science self-efficacy belief can directly and positively affect students' science career expectations.

H_2: The science interest belief can directly and positively affect students' science career expectations.

H_3: The science value belief can directly and positively affect students' science career expectations.

The expectancy-value beliefs (science beliefs including self-efficacy beliefs, interest beliefs and value beliefs) in EVT can significantly predict students' science career expectations, the expectations, encouragement and help from parents, teachers and other social support may also have directly predictive influence on science career expectations. Students' science career expectation was significantly influenced by their parents' attitudes towards science (Dewitt et al., 2013), family capital and parents' habits could significantly explain kids' science career expectations (Archer et al., 2012). Similarly, external expectations from parents and teachers would positively predict students' science goals and participation (Vedder-Weissand & Fortus, 2014). Therefore, this research proposed the following hypotheses:

H_4: Parents supports can directly and positively affect students' science career expectations.

H_5: Teachers supports can directly and positively affect students' science career expectations.

In addition, external support has a significant influence on science beliefs. For example, help and care from parents and teachers could positively influence science self-efficacy belief and interest belief (Rice et al., 2013). Some scholars further explored the interaction between science beliefs, social supports and career expectation (Sha et al., 2016), and they found that parents' support not only directly predicts students' science participation and selection, but also indirectly influences science interest and self-efficacy. Caspi et al. (2019) proposed that students' STEM efficacy beliefs and interest beliefs could play a positive intermediary role between environment and career expectations. Therefore, this research assumed that science beliefs played an intermediary role between social support and science career expectations, and the hypotheses were as follows:

H_6: The science interest belief plays a positive intermediary role between parents' support and science career expectations.

H_7: The science self-efficacy belief plays a positive intermediary role between parents' support and science career expectations.

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H_8: The science value belief plays a positive intermediary role between parents' support and science career expectations.

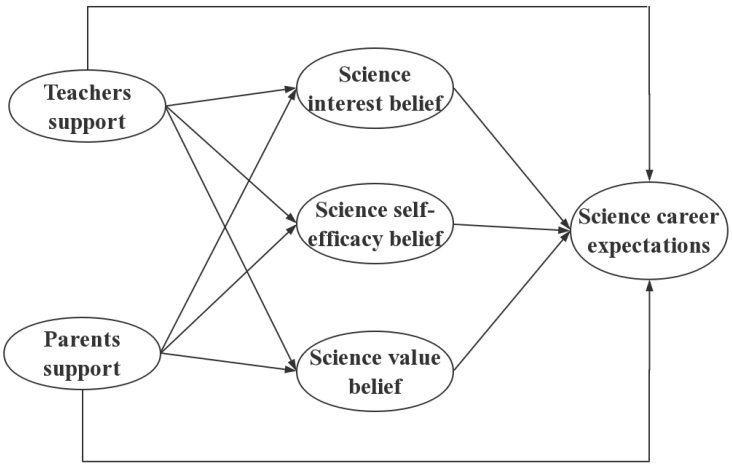
H_9: The science interest belief plays a positive intermediary role between teachers' support and science career expectations.

H_{10}: The science self-efficacy belief plays a positive intermediary role between teachers' support and science career expectations.

H_{11}: The science value belief plays a positive intermediary role between teachers' support and science career expectations.

This research had 11 hypotheses and constructed a model of influencing factors related to science career expectations in Figure 1 using Structural Equation Modeling to examine: 1) Whether science interest belief, self-efficacy belief, value belief and social support can influence students' science career expectations? 2) Whether students' science beliefs can play an important intermediary role between social support and science career expectations?

Figure 1
The structural model of influencing factors of science career expectations



Research Methodology

General Background

EVT provides an important framework for analyzing science career expectations, that is, when students believe they can do science-related tasks well and recognize the value of these tasks, they may have the motivation to complete science tasks to reflect science learning persistence and the willingness to engage in science-related careers in the future. Besides, the theory also emphasized the high correlation between expectations of success and perception of task value. Nagengast et al. (2011), by reviewing PISA data (n=398750) of 57 countries, found that the interaction of science self-efficacy, interest belief and expectations have a significant impact on students' participation in science activities and their science career expectations. The building of individuals' expectancy-value beliefs is potentially influenced by cultural background, gender, parents, teachers and other external support factors. Eccles et al. (1993) summarized important research from past 10 to 15 years and proposed that positive family and school environments could significantly change and enhance students' expectancy-value beliefs and their learning achievements.

Sample Selection

This research took Chinese 10th grade students as the participants under the background of college entrance examination in January 2020, and the study group was selected based on the following two considerations. One is that 10th grade students who chose their subjects of examination may evaluate the interests of their own and the influence of parents, teachers and peers, so as to truly reflect expectations of science careers in the future. On the other hand, because the 10th grade students have relatively stable self-knowledge and social cognition, they

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can make relatively independent judgments on career expectations. Although the study of career expectation attached much to the students from grade 7 to 12, ethical factors were also taken into account in the selection of students. Chinese students from grade 11 and 12 have relatively heavy academic burden, and grade 10 happens to be the first stage after the end of compulsory education. This research finally selected 10th grade students in Shandong province, China, and collected 920 online questionnaires. After carefully sorting out and deleting the invalid questionnaires, 798 were effective. Among them, 306 were boys and 492 were girls. There were 362 in the schools at the provincial level, 340 at the municipal level, and 96 at the district level. Other ethical aspects were also ensured by anonymous method to protect the privacy of students in the survey.

Table 1
The status of participants

	Total questionnaire	Valid questionnaire	The percent	Male	Female
	920	798	86.74	306	492
Provincial School	407	362	88.94	131	231
Municipal School	390	340	87.79	137	203
District School	123	96	75.61	38	58

Instrument and Quality

To determine the interaction among six potential variables in the hypothesis model, the research developed a questionnaire, items of which were measured by 5-point Likert scale. 25 items were developed at first and 2 items with unknown directions were moved by consulting experts, then language correction was done to ensure the content validity. After the preliminary data survey on the newly developed questionnaire, the research carried out the reliability and validity test and factor loadings analysis through SPSS 22.0 and Amos 24.0 to form a complete questionnaire with 22 items after deleting 1 item whose factor load was not obvious (Table 2). The reliability and validity of the data were also tested to ensure the quality of measurement scale. First of all, the reliability test showed that the total reliability coefficient α of the scale was .940, and the reliability coefficients on the subscales of parents'/teachers' support, interest, self-efficacy belief, value belief and career expectations were .842, .825, .896, .897, .870, .891. It can be found that this scale has high internal consistency. Secondly, the validity test was carried out by means of confirmatory factor analysis (CFA). The results of confirmatory factor analysis of the scale were χ^2/df=2.576 (<3, indicating a good fit) and RSMEA=0.044 (<3, indicating a good fit), and the goodness of fit index were all greater than 0.9 (GFI=.944, AGFI=.927, NFI=.957, TLI=.968, CFI=.973). This scale is reasonably divided, and then, the AVE test was used to test the convergent validity and discriminant validity of the scale. The results showed that the factor load of each item in the scale is between .712 and .923, the average variance extraction (AVE) is between .577 and .7534, and the combined reliability (CR) is between .8275 and .9014. All the six subscales have reached the ideal aggregate validity.

Table 2
Dimension the questionnaire

Dimensions	Indicators
Demographic variables	Gender, age, grade, school type
Parents support	Career expectation, academic help, activity support
Teachers support	Teacher encouragement, learning guidance and academic care
Science self- efficacy	Expectation of scientific success and judgment of scientific self- ability
Science interest	Scientific attitude, course elective, scientific experiment
Science value	Science importance value and science usefulness value
Science career expectations	Science career expectation and science learning intention

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Data Analysis

This research used Structural Equation Modeling on the sample data to investigate the impact of science beliefs and social supports on students' science career expectations, and to reveal the intrinsic mechanism of the influencing factors. Firstly, according to the standardized path coefficient (*B*) in the Structural Equation Model, the study analyzes the direct effect of science interest belief, value belief, self-efficacy belief, parents' and teachers' support on science career expectation. Secondly, with the help of Bootstrap intermediary test, the study also tests the intermediary effect of science beliefs on parents'/teachers' support and science career expectation, then confirms the intermediary effect of different influence paths in the model through the scope of 95% confidence interval. The convergent validity can explain the consistency relationship between each dimension and the corresponding potential variables, the discriminant validity can also explain the structural validity of the scale from the relationship among different potential traits. Therefore, this study further tested the discriminant validity of the scale. The criterion for determining the discriminant validity among dimensions is whether the arithmetic square root of AVE of the dimension is greater than the correlation coefficient with other dimensions. Table 3 shows that the square root of AVE in each dimension is greater than the standardized correlation coefficient, and the dimensions of the scale have good discriminant validity.

Research Results

Considering the high correlation among different science beliefs (interest, self-efficacy and value belief) and the collinearity interaction among them, the collinearity can be expressed by the residual correlation among different science beliefs (Jeffries et al., 2020). The results showed that χ^2/df=2.576 (<3, indicating a good fit), RMR=.024 (<.08, indicating a good fit), RSMEA= .044 (<0.05, indicating a good fit), and each goodness-of-fit index is greater than 0.9 (GFI=.944, AGFI=.927, NFI=.957, TLI=.968), CFI=.973). The fitting parameters in the model constructed are good and suitable for the further exploration of variable relations, and the standardized path coefficients of influencing factors are obtained in Figure 2. This research conducted a path test on the research hypotheses in the model to clarify the direct effect of each influencing factor on science career expectations.

Figure 2
The standardized path coefficient of influencing factors of science career expectations

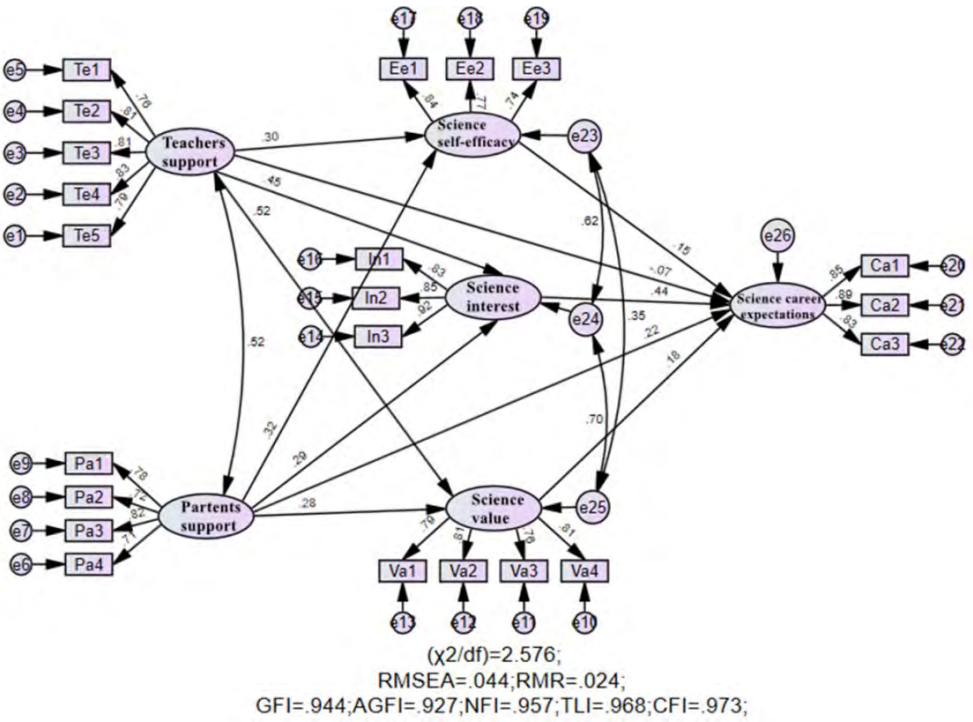

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Table 3 shows the corresponding indicators and their test results. The standardized coefficient (*B*) of each H_1-H_4 hypothesis path in this model is positive (p<.01), reaching the statistical significance, and H_1-H_4 hypotheses are supported by data. The science interest belief, self-efficacy belief, value belief (usefulness and importance value) and parents' support (science activity support, career expectation and science academic help, etc.) can directly predict students' expectations of science careers. Results also show that science interest belief (*B*=.436) > parents' support (*B*=.216) > science value belief (*B*=.182) > science self-efficacy belief (*B*=.15). So, students' expectations of science careers are more reframed and constructed by personal scientific beliefs, which can better reflect students' sense of belonging, meaning and identity compared with the influence of external support factors. Besides, the standardized coefficient of teachers' support (science academic expectation, requirement, encouragement, guidance and teaching strategies, etc.) on the expectations of science careers is -.073 and *p*=.068 (>.05), indicating no significant direct impact on science career expectations. Teachers' support is likely to affect students' science career expectations indirectly by influencing their science beliefs.

Table 3
Test results of the research hypotheses

Hypothesis path	The standardized coefficient (B)	*SE*	*CR*	*p*	Supportive/ Not supportive
H_1: Science self-efficacy belief → science career expectations	0.15	0.052	2.979	.003**	Supportive
H_2: Science interest → science career expectations	0.436	0.087	5.536	.000***	Supportive
H_3: Science value → science career expectations	0.182	0.099	2.637	.008**	Supportive
H_4: Parents support → science career expectations	0.216	0.059	5.692	.000***	Supportive
H_5: Teachers' support → science career expectations	-0.073	0.067	-1.82	.069	Not supportive

*Note:*** p<.001; **p<.01; * p<.05*

This research also constructed a structural equation model with science beliefs (science interest belief, value belief and self-efficacy belief) as the intermediary variable, social supports (parents' and teachers' support) as the predictive variable, and students' science career expectations as the outcome variable. Results showed that there are significantly positive correlations among the variables. In this case, it is suitable for the mediation effect test of the above variables. Then, the study used Bootstrap to extract 1000 times repeatedly to construct a 95% unbiased confidence interval and test the significance of the hypothesis path mediation effect based on whether the 95% confidence interval contains 0 or not. The direct effect, the intermediary effect and total effect are shown in Table 4.

Table 4
The intermediary effects test of the model

Path	The direct effect			The intermediary effect					Total effect		
	ES	*SE*	*p*	*ES*	*SE*	Bootstrap 95% CI			*ES*	*SE*	*p*
						Upper limit	Lower limit	*p*			
Te→Ca	-.073	.042	.135								
Te→Ee→Ca				.046	.021	.011	.094	.019 *			
Te→Va→Ca				.095	.046	.017	.201	.015 *			
Te→In→Ca				.196	.05	.09	.291	.003 **			
Indirect total effect				.336	.039	.269	.421	.001 **			
Total effect									.263	.046	.002**

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Path	The direct effect			The intermediary effect					Total effect		
						Bootstrap 95% CI					
	ES	*SE*	*p*	*ES*	*SE*	Upper limit	Lower limit	*p*	*ES*	*SE*	*p*
Pa→Ca	.216	.044	.002**								
Pa→Ee→Ca				.048	.024	.008	.105	.026*			
Pa→Va→Ca				.051	.025	.011	.115	.013*			
Pa→In→Ca				.128	.034	.066	.203	.001 **			
Indirect total effect				.227	.032	.169	.295	.001 **			
Total effect									.443	.041	.002**

Note: Te-teacher factors, Pa-parent factors, Va-science value belief, In-science interest belief, Ee- science self-efficacy belief, Ca-science career expectations; *** p＜.001, ** p＜.01, * p＜.05.

The intermediary effect of science beliefs on teachers' support and science career expectations is mainly realized through 3 parallel intermediary paths: science interest, value belief and self-efficacy belief. The 95% confidence interval of Bootstrap of these three paths does not include 0 (p<.05), which means that they have a significant intermediary effect on parents' support and science career expectations to make H_6-H_8 hypotheses verified. Because teachers' support can't directly and significantly affect the expectations of science career expectations (B=-.073, p=.135>.05), science beliefs hold complete mediation on the teachers' supports and science career expectations. In addition, the intermediary effect of students' science interest belief is most significant (B=.196, p=.003<.01), the intermediary influence of value belief is at the second (B=.095, p=.015<.05), and self-efficacy belief is at the last (B=.095, p=.019<.05). The above inferences further indicate that teachers' expectations, encouragements and academic help may significantly enhance students' science interest and recognition of science values, and then help students to obtain a positive science learning experience. The total effect of students' science beliefs is .227 (p=.001), and the Bootstrap 95% confidence interval is [0.169, 0.295], which does not include 0 (p=.001), indicating that science beliefs have a significant intermediary influence on parents' supports and science career expectations. Because the factors of parents' support can directly and significantly affect science careers expectations (B=.216, p=.002), the intermediary influence of science beliefs between parents' supports and science career expectations is more of a partial intermediary influence. In addition, the intermediary effect of science interest belief is .128 (p=.001<.01), .051 (p=.013<.01) of value belief, and .048 (p=.026<.05) of self-efficacy belief.

Discussion

Framed in expectancy-value models, this research explained the influencing factors and the mechanism of science career expectations from the perspective of science beliefs. First, science interest belief, self-efficacy belief, value belief and parents support could positively predict students' science career expectations, which was consistent with many studies (Mujtabaet al, 2018; Andersen & Ward, 2014; Caspi et al., 2019; Dewitt et al., 2013). Besides, the direct effect of teachers' support on science career expectations was not significant. The reason might be that under the self-selected examination background, teachers' science encouragements, requirements, academic help and care to students did not significantly improve students' learning experience, or even made students mistakenly think that they were not good at learning science, then not be able to promote the development of science career expectations.

On the one hand, according to the result of direct effect, students' expectation of science careers is largely influenced by their beliefs of interest, self-efficacy, value and parents' support towards science. This result showed that the factors related to students' personality and family background were the closest factors influencing their science career expectations, and the previous studies, such as Sha et al. (2016), Caspi et al. (2019) and Mohtar et al. (2019), did not distinguish the distance effect of the influencing factors. Sha et al. (2016) found that parents'

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science expectations, activity supports and academic help and science selection expectations were regulated by the science interest belief (B=.149, p<.01) and self-efficacy belief (B=.130, p<.01). Similarly, Harackiewicz et al. (2012) also found that mothers' science recognition and encouragements can significantly affect children's views on the usefulness and importance of science, and finally affect students' choice of science. This research found that science belief plays an intermediary role between parents' support and science career expectations, and the mediation effect of science interest belief is the largest, followed by science value belief and self-efficacy belief. Therefore, parents' science encouragements, supports and feedback can significantly improve students' science ability and value belief, and constantly reconstruct, reframe and develop their science career expectations.

On the other hand, teachers' support only had an indirect effect on students' scientific career expectations, and students' science belief was the intermediary between teachers' support and science career expectations. Although in most studies, such as Hattie (2010) and Burns (2019), teachers played a primary role, few studies also found that teachers have indirect effects. Palmer et al. (2017) suggested that teachers had the least impact on students' choice of science-related subjects, and Ma (2001) also found that teachers' expectations and suggestions may be not able to significantly influence students' mathematics career intention, but parents expectations can positively predict the changes of students' mathematics career expectations. Harmonious teacher-student relationship, creative teaching strategies and rich science activities can not only help students obtain positive science learning experience (Wigfeld, 2009), but also build students' science beliefs and enhance their intention to engage in science-related careers in the future (Tytler & Osborne, 2012). Hattie (2010) proposed that students' academic achievements and motivation are affected by teaching quality, teacher-student relationship and practice activities. Teachers may indirectly promote students' expectations of science careers by stimulating their interest in science and enhancing their cognition of science value. Therefore, the theory and practice of science teacher education may not only focus on the improvement of teachers' competence in teaching skills, but also on how to stimulate students' personality, so as to change passive teaching into active learning. In addition, students' learning experience is also an important factor to stimulate students' science interest and their science enthusiasm (DeWitt & Archer, 2015). Teachers should optimize students' science learning experience by cultivating a good relationship between teachers and students, innovating scientific teaching methods and expanding science activities so as to more effectively stimulate students' science interest and enhance their science value recognition and breakout their stereotype of scientists to build and develop science career expectations.

Conclusions

This research found that students science self-efficacy belief, value belief and interest belief can play a positive intermediary role between parents'/teachers' support and science career expectations, and the intermediary effect of interest belief is significantly better than that of value and self-efficacy belief. The social supports from parents and teachers can be more significant to stimulate students' science interest and enhance their awareness of science value. Different from the dominant factors of teachers in the previous studies, it was clearly found that students' science beliefs can significantly predict their future expectations of science careers, and teachers' and parents' expectations, encouragements, and academic help can indirectly develop students' science career expectations by influencing their science beliefs.

In order to stimulate students' enthusiasm for a science career, families, schools and society should interact with each other to jointly participate in building an environment conducive to the development of students' science career expectations. First of all, schools should provide rich career education environment through the establishment of career education courses, internship activities and other ways to enhance students' knowledge and understanding of science-related careers. Secondly, teachers should adopt various teaching methods such as cooperation, inquiry, argumentation, and interdisciplinary to stimulate students' interest in science and understanding of scientific value, so as to help students acquire positive science beliefs. Finally, parents should also actively participate in students' scientific learning process, not only cognitive and behavioral participation, but also emotional participation.

The gap comparison of this study and existing studies also found that the mechanism of interaction among parents, schools and students is still in the black box. Students with different personal characteristics should adopt a diversified school education model and provide different family education environment. However,

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for students from different countries, regions and families with social and economic backgrounds, there are also many differences in their personality characteristics. Although these studies provide sufficient support for understanding the static distribution of science career expectations of different groups, they pay little attention to the dynamic development and changes of science career expectations. In order to achieve the purpose of science career expectation by stimulating students' personality psychological characteristics, it is needed to develop multi sample and comparative design in the future studies of science career expectation.

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