International Journal of Latest Research in Humanities and Social Science (IJLRHSS)
Volume 05 - Issue 12, 2022
www.ijlrhss.com || PP. 39-48

The influence of science capital on science achievement of Vietnamese students using the PISA 2015 data

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Abstract: This study examines the link between the aspects of science capital and the science achievement of Vietnamese students. Based on Vietnam's 2015 Program for International Student Assessment (PISA) data, the study analyzes the influence of science capital on students' Science achievement through hierarchical linear modeling (HLM) at two levels, the student level and the school level. The research results show that based on the theoretical framework of social capital and science capital, a number of variables related to science capital in PISA cycle 2015 were identified, including Impact of Environmental Awareness, Enjoyment of science, Instrumental motivation to learn science, Self-efficacy in science, and Epistemological Beliefs.The results of the analysis of the models show that, except for the Instrumental motivation in learning science, the remaining factors all have a statistically significant influence. Out of a total of 60% of the school-level variance and 40% of the student-level variance in the Unconditional model, in the final model, a total of 25.4% of the variance was explained by the students' science capital characteristics, in which the within-field variance is 9.54%, the inter-field variance is 48.9%. Research results provide useful information for improving science capital and science achievement of Vietnamese students.

Keywords: PISA, PISA Vietnam, science capital, social capital, hierarchical linear models, HLM, Science achievement.

1. Introduction

Numerous studies have shown that achieving higher achievement in Science at the high school level predicts a greater likelihood of future success (Millar, 2007). Science is rooted in the strong belief that science understanding is of great importance and should be a feature of an individual's education (You et al., 2021). Science is considered one of the main focuses of education systems, and determining factors related to student achievement levels in the field of Science has always been a topic of interest to many researchers. Although there has not been much study done on the subject, there are now a number of studies that emphasize on the notion of "science capital" and how it relates to students' performance in science. Studies have revealed that high achievers in science are likely to possess high types of capital in the science field (Archer et al., 2015; Aschbacher et al., 2010; DeWitt et al., 2013). However, this role of science capital is not the same in some countries, and varied circumstances should be taken into account when determining its significance and worth.(Wong, B., 2019). Moreover, it is essential to investigate what kinds of science capital promote science activities and whether or not there is any difference in those effects in different countries(Zhang, Y. (2021). Vietnam's science results differ from those of some of the other countries participating in the 2015 PISA cycle. It is certain that Vietnam also has a different history and cultural characteristics compared to other countries. Even in Vietnam, the diversity of student groups is also different, but currently, in Vietnam, the connection between science capital and students' achievement in science has not been studied. Hence, this study analyzed a number of factors in the science capital and science achievement of Vietnamese students through data from the 2015 Program for International Student Assessment (PISA) cycle.

2. Research overview

2.1. Program for International Student Assessment (PISA)

PISA is a program that assesses the level of achievement of certain knowledge, skills and abilities of 15-year-old students after completing the compulsory education program in OECD and partner countries. PISA is conducted every 3 years with three main assessment areas (Math, Science, and Reading), in which the area of focus will be rotated so that detailed data is continuously updated cyclically for each area, and compared in depth every 9 years.

For more than 20 years of operation, PISA has been considered a useful assessment tool for the effectiveness of education systems through the collection of data on students, teachers, and schools. In order to analyze and provide insights into education policy and practice, these data are linked to PISA sector performance data. This allows policymakers around the world to evaluate the knowledge and skills of students in their home countries to students in other countries, set policy goals based on quantifiable objectives from the outcomes of other education systems, learn from policies and practices used elsewhere, and track trends in students' acquisition of these skills (OECD, 2009).

2.2. Theoretical framework of social capital and science capital

2.2.1. Social capital

The idea of social capital is thought to have been initially introduced in 1916 by Lyda Judson Hanifan (Lohmann, 2013). He used the term "social capital" to refer to connections between people or groups of people, including friendship and mutual sympathy. By the 1980s, the concept of social capital was included in the social science dictionary (Fukuyama, 2002) and really became an important science concept in Bourdieu's "Forms of Capital" (Bourdieu, 1986). Many different concepts of social capital have emerged over a long period of formation, development, and contribution to the development of many areas of life. Some typical definitions of social capital are presented as follows: Putnam (1995) defined social capital as a set of social organization traits, such as norms, networks, and trusts, that promote cooperation and coordination for the common good. Furthermore, Coleman (1988) defines social capital as comprising facets of social structure, obligations and expectations, channels of communication, and a set of norms and effects that limit and/or promote a variety of behaviors. According to Nahapiet and Goshal (1998), central to social capital theory is a network of relationships that form valuable resources in organizations. Bhandari and Yasunobu (2009) further describe social capital as a multifaceted component that entails a variety of social norms, values, beliefs, trusts, obligations, connections, networks, friends, membership, human engagement, information flow, and organizations that encourage cooperation and collective action for mutual gain and contribution to economic and social progress. Social capital, which includes the network along with shared standards, beliefs, and understandings, according to the OECD (2002), promotes collaboration within or between groups. PISA applies Social capital theory to build a framework to measure students' happiness. The OECD approach to the assessment of resources focuses on the broader natural, economic, human, and social systems, where social relationships are an aspect of measurement. For example, social capital is one of the OECD theories that explains the important role parents play in their relationship with schools to create a positive, supportive environment for students. Dika and Singh (2002) state that social capital theory has many important roles in life and in research. It is positively related to educational and psychosocial outcomes. Coleman (1988) focuses on the necessity of social capital for the development of a child's human capital because the child cannot benefit from parental resources without social capital.

2.2.2. Science capital

On Bourdieu's research, the term of "scientific capital" is built. According to Archer et al. (2014), science capital is a conceptual tool to indicate various kinds of economic, social, and cultural capital specifically that are related to science, especially those with the potential to create, use, or exchange value for individuals or groups to support and enhance their attainment, engage in mentoring, and/or engage in science. Some studies criticize the concept of science capital and claim that it is not a particular capital. It refers to the benefit and resource of knowledge that can facilitate studying, involvement, or engagement in science (Wong, 2016). Science capital is a science-specific subset of the broader social and cultural capitals (Archer et al., 2015).

Because examining science capital as a subset of social capital, which refers to the scientifically relevant forms of social and cultural capital, Archer et al. (2015)'s definition of science capital and the OECD's approach to the definition of social capital are both used in this analysis. These definitions capture important elements of social capital, which are reflected in the toolkits PISA uses, such as networks and common norms. Additionally, the inclusion of the keyword "within or between groups" reflects the view that social capital works on multiple levels and includes bridging potential. This is consistent with the multistage regression model I implemented during data analysis for the study.

2.3. Overview of the impact of factors of science capital and science achievement of students

2.3.1. Effect of ESCS

Education research has always given a great deal of consideration to how the economic, social, and cultural status of the student's family (ESCS) influences their ability to learn. In educational research, the effect of family socioeconomic background on student achievement has been found as one of the consistent findings (Schulz, 2005). This is considered to be the most important influencing factor at the student level (Perry, 2010). The strength of this relationship is so widely accepted that many educators take it for granted (White, 1982). Data from PISA also shows that most nations have a substantial correlation between ESCS and science student achievement. (Assessment & Co-Operation, 2004). Sirin (2005) confirms that student-level ESCS is one of the greatest indicators of academic success after conducting a meta-analysis of 74 papers on the topic..However, despite the fact that several studies have found an actual connection between ESCS and student accomplishment, the degree of this connection differs significantly between nations (Dika & Singh, 2002).

2.3.2. Effect of learning motivation

Motivation is a psychological construct that influences student achievement and provides the psychological strength needed to perform an activity for humans (Schunk, Meece, &Pintrich, 2012). Learning motivation includes *Enjoyment of science* (JOYSCIE) and *Instrumental motivation to learn science* (INSTSCIE). The majority of studies on the relationship between learning motivation and student learning outcomes confirm a significant relationship between science enjoyment and instrumental motivation. Areepattamannil et al. (2011) suggest that students who lack motivation to study science, especially at both the high school and university levels, are likely to have lower achievements. Many studies, such as Kartal and Kutlu (2017), Grabau and Ma (2017), or OECD (2007), show a statistically significant influence of Enjoyment of science and Instrumental motivation to learn science on PISA's science results. Specifically, Enjoyment of science has a stronger relationship with learning outcomes than Instrumental motivation. However, some studies did not record the effect of the statistical significance of Instrumental motivation on student learning outcomes in some countries (Diep Be, 2015).

2.3.3. Effect of self-efficacy in science

Bandura (1977) defines self-efficacy as a self-assessment of the skills required to accomplish specific goals. Individuals consider themselves competent when they believe they can successfully complete tasks (Zimmerman, 2000).

Studies on the link between self-efficacy and academic achievement have revealed a favorable association between them. All nations taking part in PISA 2006 demonstrate a correlation between students' self-efficacy and science achievement. If one point increases in self-perception of self-efficacy, the score increases by one point. The average generating number increased by 20 points based on the science performance of 49 of the 57 participating countries (OECD, 2007).

2.3.4. Effect of Environmental Awareness

Environmental awareness is a component of the PISA student questionnaire; they are related concepts and can be considered the main source of explanation for one's understanding of the environment. Although there are many different propositions, it is generally accepted that refers to the capacity to use scientific information, identify issues, and reach conclusions based on data in order to comprehend and take action about the natural world and the modifications brought about by human activities (OECD, 2007). In addition, some other studies also suggest that the important components of science knowledge are resource usage and environmental quality (Roth & Lee, 2016). Environmental awareness and protective behaviors are considered important outcomes of science education in many countries (Alves et al., 2009). Environmental awareness is a complex combination of environmental knowledge, values, attitudes, and even emotions, as well as environmental factors such as personality traits or significant personal background that are important for environmental behavior (Kollmus and Agyeman, 2002). Thus, environmental awareness is found to be significantly related to scientific knowledge (Föste-Eggers et al, 2018).

2.3.5. Effect of Epistemological Beliefs

Bandura (1997) describes epistemological beliefs as individuals' evaluation of what they can do and their beliefs about their ability to successfully complete a particular task or exhibit a completed behavior. Related to these descriptions, epistemological beliefs are individuals' own assessments of how well they can perform specific tasks needed to find solutions to problems in science. Students' epistemological beliefs are related to their strategies and results in learning (Hofer & Pintrich, 1997). Numerous studies reveal that students tend to enhance their science achievement if they have more epistemological beliefs about the nature of scientific knowledge, such as the belief that scientific knowledge is always evolving, the conviction that one's scientific abilities may develop, and so on (Chen and Pajares, 2010).

3. Research Methods

3.1. Samples and data

The study used PISA cycle 2015 data published on the OECD website. Data from Vietnam is extracted for research purposes. A total of 188 schools and 5826 students aged 15 were sampled across the country. The sampling method implemented is stratified sampling in two stages: The first step is to sample students; the second step is to select a sample of the field (OECD, 2016).

3.2. Instruments

Instruments are variables collected from student questionnaires and student science achievement. All variables included in the study are presented with the indicators and definitions detailed below.

3.2.1. Dependent variable

The science competence of Vietnamese students participating in the 2015 PISA cycle is defined as science competence. Knowledge of science as a form of human knowledge and research, awareness of how science and technology shape the physical, intellectual, and cultural environments, and a willingness to engage in scientific inquiry are all components of science competence. Science competence is defined as an individual's scientific knowledge and the use of that knowledge to identify questions, continue to acquire new knowledge, interpret science phenomena, and draw evidence-based conclusions about scientific problems. The capacity to interact with scientific-related challenges, which is a student's unique science-related reaction that necessitates knowledge and depends on their interest in the topic, is a more condensed definition of science competency (OECD, 2016).

The science competency variable for Vietnamese students uses achievement variables calculated from 10 reasonable values (PV) in the 2015 period PISA data set provided by the OECD. Since PVs have an equivalent distribution, we chose PV1 as the dependent variable in our study.

3.2.2. Independent variables

According to Archer et al. (2015), science capital includes "attitude towards science," "participation in science activity relationships," "self-concept in science," and "the influence of parents and teachers of science and lessons." Although the social capital factor in the PISA scales does not reflect the components as originally stated (Archer et al., 2015), the variables of science-relatedness in PISA cycle 2015 provide a valuable and replaceable data set to further explore the concept of science capital (Wong, 2019). Therefore, in this study, we use the following variables: economic, social, and cultural status, Instrumental motivation to learn science, enjoyment of science, self-efficacy in science, epistemological beliefs, and environmental awareness are some of the factors that show students' science capital, and these factors are specifically described as follows:

(a) Economic, social, and cultural status (ESCS)

According to the OECD (2016), the ESCS is a composite index that collects information about the economic, social, and cultural aspects of a student's family and includes three basic factors: the highest educational attainment of both parents, expressed in the minimum number of school years to get there in each country (PARED); the highest employment status of both parents (HISEI), as shown on the international scale ISCO (International Standard Occupational Classification); and another index called HOMPOS, which is made up of 25 variables about what the student's family has in the home.

(b) Instrumental motivation to learn science (INSTSCIE).

With a degree of agreement (1: Totally disagree, 2: Disagree, 3: Agree, 4: Totally agree) on the questions posed, students' perceptions of how to use science in school for their academics and future career goals were used to build the index. Studying science is worthwhile since it will assist me in the career I want to pursue in the future; What I learn in scientific classes is crucial since I will need it for a future career; Studying the sciences is beneficial as it will improve your employment possibilities; A large portion of what I study in scientific classes can aid in my desired career path.

(c) Enjoyment of science (JOYSCIE)

The index is designed based on how students respond to questions about their perspectives, how they utilize science in the classroom to learn, and their future career goals. On the following statements, please choose one (1 = totally disagree, 2 = disagree, 3 = agree, and 4 = totally agree): The work I intend to conduct in the future will benefit from my attempts to learn about science subjects; Because I will need it for the work I intend to do in the future, what I learn in science is crucial; Studying the sciences is advantageous since it will improve my professional opportunities; Science classes have taught me a lot of things that will aid in my career search.

(d) self-efficacy in science (SCIEEFF)

The following 4-level Likert scale is used to assess students' cognitive capacity to use scientific knowledge in practical contexts (e.g., comprehend and evaluate news reports or take part in debates about science topics). I can describe things in one of four ways: 1: I have never heard of this, 2: I have heard about this but I don't know how to explain it, 3: I know about this and can explain it; 4: I know this well and can explain it in detail. The scale includes the following items: increased atmospheric concentrations of greenhouse gases, nuclear waste, the use of genetically modified organisms (GMOs), the effects of removing trees for other purposes, extinction of plants, air pollution, and lack of water.

(e) Environmental Awareness (ENVAWARE)

This index measures students' knowledge of environmental issues, such as the following: the use of genetically modified organisms (GMOs), nuclear waste, the effects of deforestation to make way for other uses of land; an increase in the amount of gases contributing to the greenhouse effect in the atmosphere; lack of water, loss of plant and animal species, and air pollution. These items are rated on a 4-level Likert scale, including: 1: I have never heard of this; 2: I have heard about this, but I would not be able to explain what it really is about. 3: I know something about this and could explain the general issue. 4: I am familiar with this and would be able to explain it well.

(f) Epistemological Beliefs (EPIST)

This component compiles students' perceptions of their knowledge and comprehension of the scientific method, comprising the following elements: Conducting an experiment is a useful technique to determine whether something is true. Ideas in extended science change from time to time; Good responses are supported by data from a number of experiments; to be certain of the findings, it is preferable to do more than one experiment. The concepts in scientific books occasionally change, even though experts in the extended sciences occasionally alter their thoughts about what is true in science. These items are rated on a 4-level Likert scale, including: 1: Strongly disagree, 2: Disagree, 3: Agree, Strongly agree.

In the above scales, to obtain the normalized indicators, the principal component analysis (PCA) method is used. All OECD and partner nations and economies are concurrently assessed using this approach for the 2015 cycle. As a result, all nations and economies equally contribute to the estimated index scores, which are transformed using a mean of 0 and a standard deviation of 1 for the mean of pupils in OECD nations. A higher index value indicates a higher level of economic, cultural, and social status for each student's family or for each country or economic region, as calculated by the overall average of each indicator across the different regions. students in each of those countries or economic regions (OECD 2016). These indicators are used in the study not only for the purpose of analyzing and evaluating the general characteristics of each scale but also for comparing each scale with the average of OECD countries or territories.

4. Result

4.1. Descriptive statistics outcomes

Table 1 demonstrates general descriptive statistics of the factors that represent the science capital of Vietnamese students.

Table 1. General descriptive statistical results of the factors showing the science capital of Vietnamese students

Factor	Mean	Median	Std. Deviation	Minimum	Maximum
Index of economic, social and cultural status	-1.82	-1.98	1.08	-5.66	1.95
Enjoyment of science	0.64	0.51	0.8	-2.12	2.16
Instrumental motivation	0.48	0.37	0.71	-1.93	1.74
Science self-efficacy	-0.27	-0.35	0.9	-3.76	3.28
Epistemological beliefs	-0.14	-0.19	0.72	-2.79	2.16
Environmental Awareness	0.06	-0.02	0.73	-3.38	3.28

As mentioned above, the scales of economic, cultural, and social status of students' families, Enjoyment of science, Instrumental motivation in learning science, Science self-efficacy, Epistemological beliefs, and Environmental Awareness are normalized to mean zero, standard deviation 1, for OECD countries/territories participating in PISA cycle 2015. The higher value of each indicator shows the more dominant characteristics of that scale. Therefore, according to Table 1, the two factors of Instrumental motivation and Enjoyment of science are higher than the average of OECD countries/territories participating in the PISA 2015 cycle. That means Vietnamese students are more motivated and more interested in Science. The environmental awareness index is at the same level as that of OECD countries/territories. Two indicators of Self-efficacy and Epistemological beliefs are lower than the overall average of OECD countries/territories (the two scales have standardized indexes of -0.48 and -0.27, respectively). Particularly, the index of economic, cultural, and social status of Vietnamese families is much lower than the average of OECD countries/territories (nearly 2 times lower than the standard deviation).

The above findings reflect the actual characteristics of both the current and previously published studies. Vietnam's GDP per capita has been the lowest among all countries and regions participating in PISA since the first cycle (2012).Vietnam's ESCS index in the 2012 and 2015 cycles was always the lowest. Low self-efficacy in science and low methodological beliefs are also consistent with Asian students' characteristics of modesty and high expectations of themselves (Ho, 2009). Furthermore, the instrumental motivation and interest in high science are consistent with the tradition of studiousness, with Vietnamese students always making efforts and investments in their learning. Thus, the first preliminary analysis shows that the science-related capital of Vietnamese students has disadvantages but also has outstanding characteristics related to the cultural characteristics of the country.

4.2. The results of multilevel regression model analysis
4.2.1. The model's analysis of variance findings

Analyzing the variance of the dependent variable at various stages is suggested as the first step in multilevel regression analysis. Within-school variance and inter-school variance will be used to analyze the variance in students' academic performance in science in this study. Both multilevel regression and a mixed model ANOVA (analysis of variance) can be used to determine these two variance components. This is the equation for multilevel regression:

$$Y_{ij} = \beta_{0j} + \varepsilon_{ij}$$
$$\beta_{0j} = \gamma_{00} + U_{0j}$$

where Yj represents the achievement of student i in school j, β0j is the intercept for school j, Ɛ ij is the residual at the student level, γ00 is the overall intercept. The formula for the estimate of the inter-school and within-school variance and the intra-school correlation is calculated using the formula:

$$\rho = \frac{\sigma^2_{between\text{-}school}}{\sigma^2_{between\text{-}school} + \sigma^2_{within\text{-}school}} = \frac{\tau^2_0}{\tau^2_0 + \sigma^2}$$

with $\sigma^2_{between\text{-}school}$ or τ^2_0 the between-school variance and $\sigma^2_{within\text{-}school}$ or σ^2 the within-school variance.

Accordingly, the results of model analysis Unconditional model show the results presented in Table 3:

Table 3. Unconditional model analysis results

Level	Fix effect	Estimate
School	Intercept, γ_{00}	518.53
	Random effect	Variance
Student	R	3506.9
School	U_0	2368.8
	ICC (Intra-class correlation coefficient)	0.40

Intra-class correlation coefficient (ICC) = Level 2 Variance (L2V)/(Residual Variance (RV) + L2V) = 2368.8/(2368.8+3506.9) = 0.40. Thus, the school-level variance and the residual (student-level variance) are both statistically significant (sig < 0.01) in the unconditioned model, showing that 40% of the variance in achievement in science relates to schools in Vietnam. If we consider the variation in students' science achievement around the mean as 100%, the difference in results between students in the same school contributes 60%, and the difference in mean results between schools contributes 40%.

The empty model was used for subsequent analyses with student-level variables (variables of science capital). Using the progressive elimination procedure, the unreliable student-level variable with the greatest p-value is initially removed. Once every inconsistent student-level variable had been eliminated from the analysis and a Level 1 explanatory model had been created, the analysis was repeated. The ESCS index was the only method used in this study to estimate the school average. We incorporated a multistage regression model to investigate the variations by student gender because the student gender variable (ST004D01) is a demographic-specific variable included in the analysis. The following equations reflect the final model at levels 1 and 2:

Level-1 Model:
Y = P0 + P1(ST004D01) + P2*(ENVAWARE) + P3*(JOYSCIE) + P4*(SCIEEFF) + P5*(EPIST) + P6*() + E*

Level-2 Model:

P0 = B00 + B01(M_ESCS) + R0*
P1 = B10
P2 = B20
P3 = B30
P4 = B40
P5 = B50
P6 = B60

Table 4. Results Table Estimated Final Effects

STT	Science achievement	Level-1 Model			Final model		
		Coefficient	SE	P-value	Coefficient	SE	P-value
	INTRCPT2, B00	526.14	3.43	0.00	*525.81*	*2.85*	*0.000*
	School level						
1.	*M_ESCS, B01*				39.46	4.95	0.00
	Student level						
1.	ST004D01, B10	-13.02	1.57	0.00	-13.20	1.58	0.00
2.	ENVAWARE, B20	6.75	1.34	0.00	6.79	1.33	0.00
3.	JOYSCIE, B30	4.27	1.09	0.00	4.37	1.09	0.00
4.	SCIEEFF, B40	8.05	1.09	0.00	7.98	1.09	0.00
5.	EPIST, B50	13.23	1.25	0.00	13.05	1.25	0.00
6.	ESCS, B60	6.24	0.92	0.00	5.07	0.91	0.00

Table 4 shows that 5/6 student-level variables, namely student gender, Environmental Awareness, enjoyment of science, Science self-efficacy, and epistemological beliefs , have a statistically significant influence on science competence. The factor of Instrumental motivation did not have a statistically significant effect. The above four factors remained significant after including the field-level variables (M_ESCS: Mean ESCS Index of the School) in the final model.

More specifically, female students have lower performance than male students (the difference is -13.2 points). Following this is the Economic, Social, and Cultural Index, where after adjusting for all other factors, a rise in ESCS standard deviation is linked to an increase in Science achievement of roughly 5.07 points. Meanwhile, the standard deviation of the Environmental Awareness factor increased. Science self-efficacy and enjoyment of science are linked to a 4-6 point increase in students' science achievement. As for the factor of Epistemological beliefs, the change of one standard deviation of this index leads to an increase in science competency by about 13 points. At the school level, a gain of roughly 39 points in Science was seen for every one standard deviation higher in the average ESCS at the school.

Table 5. Variances explained in the final model

No.	Composition of variance	Student	School	Total
1.	Null Nodel	3506.9	2368.8	5875.7
2.	Level-1 Model	3174.45	1832.37	
3.	Final model	3172.15	1210.59	
4.	Proportion of variance available initially(%)	60	40	100
5.	Proportion of variance explained by level 1 predictor model(%)	9.48	22.65	14.79
6.	Proportion of variance explained by final model (%)	9.54	48.9	25.4
7.	Proportion of variance unexplained by level 1 predictor model(%)	90.52	77.35	85.21
8.	Proportion of variance unexplained by final model(%)	90.46	51.1	74.6

According to Table 5, the baseline variance rates at the student and school levels were available for study were around 60% and 40%, respectively. This value represents the greatest variation that may be accounted for in later studies at the student and school levels. Table 5 demonstrates that the final model's student- and school-level variables contribute around 25.4% of the variation. There may still be some student-level factors left out of this study, accounting for the remaining 74.6% of the overall variation that the model cannot account for.

5. Conclusion

This study aims to discover, through the analysis of 2015 PISA data, the factors related to science capital that affect the science achievement of students in Vietnam. In addition to the overview of social capital theories, science capital, and the variables of science capital were determined through Vietnam's 2015 PISA cycle data. The study tries to apply the available information from secondary data according to an advanced method (hierarchical linear models) to analyze the data. The research results show that there is a statistically significant influence of 5/6 factors of science capital on the science achievement of Vietnamese students, namely Environmental Awareness , Enjoyment of science , Science self-efficacy , Epistemological Beliefs (except for Instrumental motivation).

The research variables, which are aspects of the students' science capital under consideration, are confirmed in terms of the above-mentioned characteristics for Vietnamese 15-year-old students, and their influence on the academic achievement of the children confirmed in the research is consistent with some studies on social capital in general and science capital in particular. The research results are one of the proofs that propose solutions to improve science capital as well as improve students' science achievements. The solutions proposed in the study are as follows:

For students and their parents, multilevel regression analysis shows the positive correlation of factors such as awareness of science issues, enjoyment of science, epistemological beliefs, science self-efficacy, and the economic, social, and cultural status of students' families with science achievement. As a result, this outcome will first and foremost help to increase parental understanding of the significance of their role in their children's academic performance. Parents should support their children in becoming more self-assured, interested in learning more about science, and suitably motivated to accomplish this goal. Second, families understand the need to improve conditions to provide secondary resources for students' science learning. This is tied to the economic, cultural, and social conditions of the student's family. As the economic, cultural, and social conditions of a student's family improve, students will have the opportunity to access other resources to enhance their science capital in their science studies. Most importantly, students themselves are aware of their own confidence, beliefs, and motivations. When students have confidence and determine the right methodology for approaching scientific problems, they can improve their own science capital as well as their skills.

Recommendations for teachers: Regarding the factors of students' self-perception, the research results have proven that epistemological beliefs, Enjoyment of science, Self-perception about Science issues have a positive impact on students' self-efficacy. Additionally, several findings indicate that students' epistemological beliefs affect how they think, reason, or acquire knowledge and predict how well they will do in science (Hofer, 2001; Mason et al., 2013). As a result, it is indeed imperative to provide students a science curriculum that is more efficient and progressive, with a focus on science knowledge and inquiry-based learning. In turn, this will boost students' interest in science subjects and their own scientific proficiency. These findings suggest that improving students' reading science ability will be more possible if school science classes can increase their intellectual confidence in science, enjoyment of science, and drive to succeed.

Research has proven that students' epistemological beliefs about science have a constructive effect on their science competence. Through a detailed analysis of the observed variables of the scale, we propose a strategy to improve students' epistemological beliefs about science in the teaching process, which clearly emphasizes epistemological beliefs about science. It should be made abundantly clear to students that teaching them about science epistemology will help them develop their scientific knowledge and comprehension of how science works. Students may experience what scientists do, discover how scientific knowledge is developed and evaluated, and build their procedural skills and cognitive ideas about science via the study of science inquiry as well as the history of science.

For educational administrators: Research has demonstrated the benefits of performing analyses to assist in the process of recommending solutions or making policy based on evidence from research findings. The results from the research can help managers develop solutions for making policies related to science teaching and learning. Allocating science-related resources among different families and schools, for example; having strategies to increase student confidence and trust; and having supportive policies in science education for female students.

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