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The University of Southern Mississippi

THE EFFECT OF ASIAN ORIGIN, CULTURE AND LEARNING BELIEFS ON HIGH
SCHOOL STUDENTS' PHYSICAL SCIENCE LEARNING BELIEFS

by

Xiaolan Li

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

August 2013

ABSTRACT

THE EFFECT OF ASIAN ORIGIN, CULTURE AND LEARNING BELIEFS ON HIGH SCHOOL STUDENTS' PHYSICAL SCIENCE LEARNING BELIEFS

by Xiaolan Li

August 2013

Asian Americans have been recognized as the *model minority* in the United States since the 1960s. Students from Asian countries are winning in international competitions, especially in science and mathematics. Modern Western scholars working within the constructivist learning theory advocate malleable intelligence and effort, which actually corresponds to Asian learning beliefs and learning behaviors. This research is designed to test if American high school students and Chinese students from the mainland of China who are motivated to attend American universities are different in their learning beliefs of physical science and what accounts for the difference if there is any.

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XIAOLAN LI

2013

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Approved:

Director

Dean of the Graduate School

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CHAPTER I

INTRODUCTION

Statement of the Problem

Generations of psychologists, educators, and cognitive scientists have been working on educating democratic Americans. The understanding regarding the process of learning, per se, is a result of human civilization through which knowledge is accumulated and shared.

Associationism

In Aristotle's era, the amount of knowledge people needed to function in society and nature was not as much as people nowadays need to secure a position. Thus, repetitions aimed at forming memorization could be the key learning method thousands of years ago, but probably not now. Aristotle asserted four learning laws generalized by Olson and Hergenhahn (2009): Law of Similarity, Law of Contrast, Law of Contiguity, and Law of Frequency. Those laws are the core of associationism with the purpose of building connections between objects, and they laid the foundation for the development of later behaviorism. Besides those laws, Aristotle's ideals about learning also include his beliefs regarding learning process, concept representation and organization, learning readiness, and more, which paved the road for the later cognitive psychologists when the time for reasoning, constructing, and modeling knowing rather than mechanic memorization came (Weibell, 2011).

Connectionism

Aristotle's associationism theory of learning is largely inherited by Edward L. Thorndike in his connectionism theory of learning. Thorndike is recognized as the

founder of “learning theory” for almost half a century in America in the last century. In this era of the history, between the late 19th and early 20th centuries, objective experimentation on the behaviors of animals were popular in the fields of psychology and physiology. The learning processes of animals were studied through building associations between the stimulus and response, and principles about learning of animals were generalized with the hope to apply them on human beings. After years of study on the animals’ learning curves, Thorndike asserted three learning laws: Law of Readiness, Law of Exercise, and Law of Effect (Thorndike, 1914). Later on in his career, through experiments on human subjects in the 1920s, Thorndike made two adjustments to the three laws on connectionism. One is that mere repetition would not necessarily bring improvement unless immediate feedback was given. The other one is that the power of the reward and punishment to strengthen or weaken a connection is not necessarily equal in amplitude (Thorndike, 1931).

Progressivism

While Thorndike was leading the mainstream educational research in the early 20th century era, almost parallel or a little earlier, is the research led by John Dewey. According to Lagemann (1989), Dewey, as a progressivism leader, advocated experimentation within a naturalistic setting, which is contrary to the objective experimentation and measurement adopted by Thorndike. The ultimate purpose of Dewey’s research was not to condense learning principles from the experiments and then to implement on humans but to transform the social relationship into a harmony state and to achieve democracy by the way of education. Although Thorndike’s objective experimentation approach was favored over Dewey’s naturalistic observation, Dewey’s

contribution to education and to the social reform is profound and adds significantly to the plural worlds of educational research (Lagemann, 1989).

Behaviorism

Though being successful in leading the mainstream of educational research, the learning principles developed by Thorndike might not always perform as well as expected because learning is not always through building direct connections between the objects and the concepts, especially when learning is becoming less concrete and more abstract. For example, people can sing if they are able read the music score, not only by listening to others singing. Here the music score is the conditioned stimulus, the singing is the unconditioned response. The fact that people can sing is by the association built between the conditional stimulus, music score, and the unconditioned response, singing, through the repeated practice of following the music score with corresponding sounds. This process of association construction is called classical conditioning, originally identified by Ivan Petrovich Pavlov (Weibell, 2011). A significant amount of work had been devoted to understanding how such associations were formed, sustained, terminated, amplified, or weakened. But basically, as a physiologist, Pavlov's interests specifically in psychology were limited and his contribution to psychological research was actually identified by John B. Watson, the founder of behaviorism. According to Watson (1930), behaviorism is the science to explain, predict, and control human behavior, using the principles mainly generated from studies of animals. But his contribution to behavioral learning is not as widespread as another behaviorist, Burrhus Fredric Skinner. As a follower of Pavlov, Skinner identified another type of conditioning, operant conditioning, which is different from classical conditioning termed by Pavlov. His success to develop

the behavioral learning theory is to the extent that the behavior-based principles of learning persisted for almost a century in the American classroom (Weibell, 2011).

Cognitive Learning Theory and Constructivism

Nowadays, behavioral learning principles are still strong forces directing the design of curriculum and instruction. Nevertheless, its influence has been attenuated since the 1950s when people were faced with problems to achieve long-term proficiency when learning other languages (Chomsky, 1967). The learning of other languages was thought to be through persistent repetition and mimicry, thus, behavioral learning principles should work well on language learning. But the truth is language learning is far more complicated than the speculation from the behavioral perspective. Also, during this era, computers came into view and learning was becoming more and more abstract; behavioral learning principles were too limited in facilitating learning at this period of time. Where are the new principles for this new technology and information world? Here comes the new era for a cognitive approach to learning and its descendant, constructivism. Cognitive psychology was not really a new invention because both Aristotle and Thorndike had identified factors precursory to the modern cognitive psychological principles (Bower & Hilgard, 1981; Weibell, 2011). Only recently, however, has cognitive psychology gained significant attention due to the complexity of learning complicated and abstract subjects. Compared with behavioral learning principles, cognitive learning theory concerns knowing instead of responding, focuses on knowledge organization instead of repetition, and views individual learners as active participants who are engaged in the learning process instead of passive recipients of stimulus (Howard, 1983). The full scope of cognitive psychological research is overreaching

while the core of cognitive theories is that knowledge is constructed by the learner within their previous knowledge structure, and this is also the key point of constructivism.

Constructivism, a young paradigm in educational research, is relatively more focused in forming learning theories and in guiding instruction.

Cognitive Constructivism

Jean Piaget (1952) articulated the learning process as a constructive activity where knowledge is built through people's experience with the outside world through assimilation or accommodation. He advocated that the acquisition of knowledge should be actively constructed by cognizing children and the development of the cognition of children depends more on the quality of the thinking from the children than on pure accumulation of knowledge. As a biologist, he discovered that the process of cognition is oriented adaptively towards viability and what has been learned is the knowledge which organizes the experiential world (Glaserfeld, 1989, p. 162). Children are not viewed as repositories for adults' knowledge but as those who are constantly trying to make sense of their own experience. Therefore, the teachers' role would not be to infuse "*truth*" into their minds but to provide the opportunities and incentives for the students to explore the world. Teachers would facilitate students in the active thinking process in order to build the conceptual organization of their own experience (Fosnot, 2005; Glaserfeld, 1983).

Social Constructivism

As a social constructivist, Vygotsky investigated child development and figured out how this development was mediated by the role of culture (Moll, 1990). A child learns the habits of mind of the culture in which the child lives through daily interactions with adults in the culture, including oral and written language, and other symbolic

representations. From these interactions, the child derives meaning, and this kind of understanding affects a child's construction of knowledge regarding the culture and the specific knowledge of the culture. This process is known as internalization. Vygotsky also developed the Zone of Proximal Development, which can be described as the distance between the actual developmental level and the level of potential development. He claimed that the educator's role is to help children to gain experiences that are within their Zone of Proximal Development, in order to encourage their individual learning. At the same time he promoted cooperative learning between the students and the educators (Moll, 1990). He claimed that "The most effective learning occurs when the adult draws the child out to the jointly constructed 'potential' level of performance" (Bickmore-Brand & Gawned, 1993, p. 49).

Sequential Constructivism

In the research on the development of children, Bruner (1966) proposed three modes of representation: enactive representation (action-based), iconic representation (image-based), and symbolic representation (language-based). These three modes of representation are not segregated as those stages described by Piaget, and they are integrated and are only loosely sequential because they can easily *translate* into each other. Thus, Bruner's work suggests that even a young learner is capable of learning any material as long as the instruction is organized appropriately, in sharp contrast to the beliefs of Piaget. Bruner's (1966) theory suggests that learning is effective when one is faced with new material to follow a progression from enactive to iconic to symbolic representation, and this holds true even for adult learners. In accordance with this understanding of learning, Bruner (1968) proposed the spiral curriculum, which means

the same topic is revisited at different time intervals and at different depths from shallow to deep. Bruner emphasized the significant impact of the environment over intelligence, and teachers in the school are actually in control of this environment for growth of intelligence (Rowland, 1970). Bruner (1986) advocated scaffolding in preparing children for their developmental growth by giving proper guidance before the children are self-sufficient.

Asian Scholars' Interpretation of Western Educational Endeavor

The spirit of those learning theories described regarding the learning process and the role of the educators and teachers corresponds to what Li has generalized as the *mind oriented* Western learning beliefs, which hold a neutral feeling towards learning (Li, 2003b). To learn is to acquire outside knowledge, to develop skills, and to realize personal goals. Since the 1800s, educators from Europe have been advocating child-centered education. The Euro-American model of learning is an elaborated system on the mind, thinking, and inquiry (Li, 2003b). Although there is so much effort from generations of educators, psychologists, and cognitive scientists, the international competitions, particularly in mathematics and science, show that American students are not fulfilling their country's anticipation to think much more logically and scientifically on average than students from other countries, especially those from Asia. Asia is the largest and most complex continent, which has about 50 countries and over four billion people. The portion of Asia that is the central focus of this study is the Confucian Asian countries, which are unique societal clusters of countries, according to House, Hanges, Javidan, Dorfman, and Gupta (2004). Confucian Asian countries refer to a specific geographic region with common Confucian teaching, which parallels the Catholic

teaching in Europe (Inglehart & Carballo, 1997). Those Confucian Asian countries include China, Korea, Japan, and Vietnam where Confucianism has been the basic principle for thousands of years (Yum, 1988). Consequently, people of those Confucian Asian countries are called Confucian Asians and are assumed to hold similar values and beliefs. One of the core values Confucian Asians share in education is that they all hold high regard for learning and put great emphasis on effort to achieve academically (Stankov, 2010).

Asian Countries' Achievements in International Assessments

The Trends in International Mathematics and Science Study (TIMSS) has been implemented since 1995 by the International Association for the Evaluation of Educational Achievement (IEA) to measure the mathematics and science knowledge and skills of fourth and eighth grade students. It has been held every four years: 1995, 1999, 2003, 2007, and 2011. TIMSS is designed to align the mathematics and science curricula within those competing countries so that the performance of students from the United States can be presented to their international peers even within different educational contexts. The results of the academic comparison from different educational contexts could potentially provide some suggestions for improvement in education (Gonzales et al., 2009). In the 2007 TIMSS, the average mathematics score of fourth grade United States students was higher than 23 of 35 countries. There was no significant difference with four other countries, and the U. S. average was lower than eight countries. These countries are Hong Kong, Singapore, Chinese Taipei, Japan, Kazakhstan, Russian Federation, England, and Latvia. The average science score of fourth grade United States students was higher than 25 of 35 countries. There was no significant difference with six

other countries, and the U. S. average was lower than four countries. These countries are Singapore, Chinese Taipei, Hong Kong, and Japan. The average science score of eighth grade United States students was higher than 35 of 47 countries. There was no significant difference with three other countries and the U. S. average was lower than nine countries. These countries are Singapore, Chinese Taipei, Japan, Korea, England, Hungary, Czech Republic, Slovenia, Hong Kong, and Russian Federation. The average mathematics score of eighth grade United States students was higher than 37 of 47 countries. There was no significant difference with five other countries, and the U. S. average was lower than five countries. These countries are Chinese Taipei, Korea, Singapore, Hong Kong, and Japan. (Gonzales et al., 2009).

Similar results are generated from the Programme for International Student Assessment (PISA), which is dedicated to measuring the academic performance of 15 year old pupils worldwide. According to the 2009 PISA results, Shanghai (China) ranked number one at all the three subjects: mathematics, science, and reading. There were also a significant number of Confucian Asian countries ranked in the top ten in all three subjects. There were six Confucian Asian countries in the top ten in mathematics achievement and five Confucian Asian countries in the top ten in science and reading achievement (U.S. Department of Education, 2011).

It is my hypothesis that Confucian Asian countries rank top at the academic performance in these international competitions because of Confucianism. Confucianism advocates the malleability of human beings per se, and thus promotes the beliefs in malleable intelligence. Confucianism attributes success to effort and emphasizes moral

self-perfection through lifelong learning, which, in turn, is regarded as the ultimate purpose of life (Lee, 1996; Li, 2003a).

Lee (1996) asserted that

There is an extraordinary emphasis on effort, willpower or concentration of the mind in the Confucian tradition. Because there is a strong belief in attainability by all, there is also a strong belief that one's failure is not due to one's internal make-up or ability, but one's effort and willpower. (p. 39)

Asian Americans' History in America

The high achievement in education of Asians is not restricted within those Confucian Asian countries. Since the 1960s, Asian Americans have been acknowledged as the "*model minority*" by the American society because of their achieved social status through education and hard work. College students in general-the white, African American, Asian, Hispanic, and Native American college students-all perceive Asian American college students to be more prepared, motivated, and more likely to have greater career success than whites (Wong, Lai, Nagasawa, & Lin, 1998). According to the 2000 census special report on Asian Americans, Asian Americans have a higher percentage of attending prestigious universities and getting college degrees, and a higher rate of working professional jobs and earning more money than the average American (Reeves & Bennett, 2004). But the history of Asian Americans is not long enough to assert that being Asian will insure that they will have a higher chance to be successful academically or professionally.

Asian American history began in the 1850s when more than 30,000 Chinese men made the transoceanic journey to work in the California gold mines and on the

transcontinental railroads. A smaller number of Chinese went to work in the Hawai'i sugar plantations. Eventually, half of these men went back to their home country (Tamura, 2003). In the deep south of the Mississippi Delta, Chinese immigrants were initially brought in to work on the cotton farms to replace the black labor lost in the late 19th century. Gradually they left the farms and became grocery store owners doing business in black neighborhoods. This Chinese community had women as the center of the family. Thanks to their increasing economic status and connections with the white church, they were more and more becoming assimilated into the white community. However, at the same time, their children were not always allowed in the white schools. Only after 1953 could Chinese children in Mississippi legally go to the white schools (Sanchez, 2003). After World War II, the American government passed the Immigration Act of 1965 which opened the door for millions of Asians to enter the U. S., resulting in family reunification (Tamura, 2003). That is the time when Asian Americans were recognized as the model minority. This was half a century ago.

The Disparity of Different Generations of Asian American Students

Research has already shown that the younger generations of Asian Americans tend to have lower achievement in education than the earlier generations of Asian Americans (Grant & Rong 1999; Kao & Tienda, 1995; Kaufman, Chavez, Lauren, & Carroll, 1998; Rong & Grant, 1992; Zhang, 2001). According to Grant and Rong (1999) and Rong and Grant (1992), the children of immigrants attained the highest achievement in education and the second generation students outperformed the other generations generally. Kao and Tienda (1995) found out that the first and second generations of Asian Americans had greater aspirations to graduate from college than the third generations and

that there was no significant difference between the first and the second generations. In the study conducted by Kaufman et al., (1998), they observed a significant difference in the proficiency level in mathematics between the second and third generations of Asian American students. The second generations outperformed the third generations. Zhang (2001) conducted research on the consistency and variability of the impact in different subject areas across different grade levels from the National Education Longitudinal Study of 1998 and found out that the first and second generations outperformed the later generations at each grade and had faster academic growth. Science and mathematics were the two subject areas that distinguished the first and second generations from the later generations.

From previous studies, it is obvious to see that there is something special in those Asian countries that motivate or facilitate students' learning, which Western countries can learn from. Western students tend to depend on the teachers to arouse their interests, to conduct effective instructions for their understanding, and also be able to organize different activities, while Chinese students want the teachers to have deep content knowledge in order to answer questions regarding the content and to be a good role model (Li, 2003b). The process of learning influenced by Confucianism is a self-perfection process with the utilitarian benefits being part of the motivation towards education. Therefore, Chinese have more adaptive learning beliefs and more affect toward learning compared to their Western peers. The Chinese culture cultivates the desire to have lifelong learning, to remain humble, to be diligent, and to emphasize endurance of hardship, perseverance, and concentration (Li, 2003b). The affect or interest the students hold for learning comprises one of the three main aspects of motivation, the

intrinsic values (Pintrich & Schunk, 2002). Most of the research done by Western researchers is focused on how to teach and how to help students to construct their knowledge, but little has been directed into how to raise the children to grow up to love learning, to be responsible for their own learning, to have more adaptive learning beliefs, and to have a more diligent learning behavior; however, researchers have agreed that intelligence could be cultivated through education and effort is necessary for success. No matter how hard-working those Asians are, looking back in history, especially the history since industrialization, it is Europeans who have made the most significant breakthroughs in both natural science and social science. East Asians are believed to have the highest Intelligence Quotient (IQ) according to Lynn (2006) who has done 25 years of research on race IQ difference, and East Asia also has the most population compared to other races. Why has this populous race, which is reported to have the highest IQ and which also holds the diligent learning beliefs, not made as many breakthroughs as Europeans? Lack of curiosity and creativity are generally pointed out as being the two main reasons in mainland China for the lack of great breakthroughs.

This research is dedicated to investigating the physical science learning beliefs of students from different ethnical, cultural, and social backgrounds. A student survey was developed by the researcher, which is composed of three parts: the five demographic items, the personal interests and confidence items, and the Epistemological Beliefs Assessment for Physical Science (EBAPS) Axis 5: Sources of Ability to Learn. Students from both mainland China and America were surveyed. The students in America were surveyed online via Survey Monkey, and the students from the mainland of China who are motivated to attend the American universities were paper-surveyed in an international

high school of mainland China. One- way ANOVA (analysis of variance), two-way ANOVA, and multiple regression (MR) were used in this research, where the total scores of the answers to the Epistemological Beliefs Assessment for Physical Science (EBAPS) Axis 5: Sources of Ability to Learn on the student survey were the dependent variables, while the location of the participants, -mainland China or America-, the five demographic items, and the personal interests and confidence items were the independent variables. The results of the survey were analyzed to see if students of different social environments and demographic backgrounds with different personal interests and confidence will have different epistemological beliefs in learning physical science, besides how much the social environment, the five demographic factors and personal interests and confidence variables together could account for the variance of students' epistemological beliefs in physical science learning and their individual contributions for the explanation of the variance. Further research could be done to investigate the relationship between the students' social environments and their personal interests and confidence in physical science learning.

Purpose of the Study

The purpose of this quasi-experimental study is to investigate the physical science learning beliefs of American high school students and their counterparts from the mainland of China who are motivated to attend American universities.

The Student Survey is composed of five demographic questions, two personal interests and confidence in physical science learning questions, and five items from the Epistemological Beliefs Assessment for Physical Science (EBAPS) Axis 5: Sources of Ability to Learn, which will be used to test all the student participants' learning beliefs

regarding fixed ability or effort in physical science. EBAPS was originally developed by Andrew Elby, John Frederiksen, Christina Schwarz, and Barbara White at the University of California, Berkeley to test students' learning beliefs about the nature of knowledge and the learning process in the physical sciences setting. EBAPS has five axes: structure of scientific knowledge, nature of knowing and learning, real-life applicability, evolving knowledge, and the source of ability to learn. These axes correspond to the multi-dimensions of epistemological beliefs (Cano, 2005; Philips, 2001; Qian & Alverman, 1995; Schommer, 1990, 1993). In this study, the researcher will use the Axis 5: Source of Ability to Learn to probe the students' learning beliefs about the source of the ability to learn. The researcher will add five biographic questions and two personal interests and confidence items before the EBAPS Axis 5: Source of Ability to Learn to gain the students' demographic background and personal interests and confidence in learning physical science.

One-way ANOVA will be done for all the eight independent variables, including the participants' current country of residence, the five demographic items, and two personal interests and confident items, to identify the variable which will significantly influence the students' epistemological beliefs in fixed ability and effort in learning physical science. Multiple regression will be applied where all the eight independent variables will be put into the model to explain for the variance of the total scores of the five questions from EBAPS Axis 5: Source of Ability to Learn. The result of ANOVA and the multiple regressions will indicate if students of different ethnic, social, and cultural backgrounds, different religious influence, academic interests and confidence will have different total score in EBAPS Axis 5, thus different learning beliefs regarding

fixed ability or effort in learning physical science and how much the model together could account for the variance of the total score on EBAPS Axis 5 and the individual independent variable's contribution. One-way ANOVA will be applied to test if participants from mainland China and the U.S. will have different levels of personal interests and confidence in learning physical science. Two-way ANOVA will be further conducted to explore if the participants' current living country and their personal interests and confidence in physical science learning will interact to influence the students' total score on EBAPS Axis 5.

Research Questions and Hypothesis

This research is to investigate if American high school students have different learning beliefs in learning physical sciences regarding fixed ability and effort compared to their counterparts from the mainland of China who are motivated to attend American universities after high school. The researcher wants to find out if Asian cultural and social environments influence students' learning beliefs in physical science learning and to what level is the influence. Also this research explores if other factors, such as family religious orientation, ethnicity, the students' personal academic interests, and confidence, would influence students' learning beliefs in physical science learning.

The research will be done in two countries, in America and in the mainland of China. In America, the Student Survey will be put on Survey Monkey in order for the student participants in America to finish. In the mainland of China, the researcher will spread out the survey to the students who are taking physical science, physics, or chemistry in the international high school where she is teaching International Baccalaureate (IB) chemistry. The school setting is an international high school where

all the students are Chinese, and all of them are motivated to attend American universities after high school.

The researcher will use one-way ANOVA and multiple regression where the fact that the participants are from the mainland of China or America, the five demographic questions, the two personal interests and confidence in learning physical science items will be the independent variables, while the total scores of the five questions from EBAPS Axis 5: Source of Ability to Learn will be used as the dependent variables. The researcher assumes that the more students are influenced by Asian cultural and social environment, which encourages effort and life-long self-perfection, the more favorable attitude they will have towards effort in learning physical science, the higher chance they will hold beliefs in malleable intelligence and, hence, the higher the total scores they will have on EBAPS Axis 5: Sources of Ability to Learn. Thus, Chinese students from the mainland of China, are assumed have higher EBAPS scores than the American students. Religion would possibly influence students' EBAPS scores, especially those students whose families believe Confucianism, since Confucianism advocates hard work and life-long self-perfection. In the meantime, the students' academic interests and confidence in learning physical science will also be regressed against their EBAPS scores, to investigate if those personal feelings and characteristics will have a stronger or weaker influence on students' physical science learning beliefs regarding fixed ability and effort than the social, cultural, religious, and biological factors.

The research questions to be investigated are:

1. Are the learning beliefs which are tested from the EBAPS, Axis 5: Source of Ability to learn significantly different between students from the two different social

contexts, mainland of China and America, between students from different ethnic, religious, and biological backgrounds with different personal academic interests and confidence in physical science learning?

2. How much variance of the total score on EBAPS, Axis 5 could be explained by all the variables in the model and what are their specific contributions to the variance?

3. Are the learning beliefs in physical science influenced more significantly by the social, cultural, religious, and biological factors or by the individual interests and confidence in physical science learning?

4. Do students from America and mainland China differ significantly in their interests and confidence in learning physical science?

5. Is the influence of personal interests and confidence on the students' total scores on EBAPS, Axis 5 different for students living in mainland of China and the U.S.?

CHAPTER II

REVIEW OF RELATED LITERATURE

In the same education system, Asian American students have achieved higher academic success than their Western peers (Chen & Stevenson, 1995; Kao, 1995; Sue & Okazaki, 1990). Many studies have been done to investigate the myth of model minority. My research is dedicated to investigating if those high achieving Asian students have more mature epistemological beliefs about the sources of ability to learn in physical science learning compared to their American counterparts. Sophisticated epistemological beliefs facilitate learning in general (Buehl & Alexander, 2005; Hofer, 2000) and in physical science learning (Stathopoulou & Vosniadou, 2007).

Epistemological Beliefs

Beliefs are not as ideal as faith but they are more than opinions and people are committed to beliefs (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Personal epistemology is a belief system which is composed of several somewhat independent but perhaps interrelated dimensions (Hofer, 2000; Schommer, 1990). According to Schommer (1990), personal epistemological beliefs are multifaceted, which means they have at least five dimensions: the structure, certainty and source of knowledge, and the control and speed with which to gain the knowledge. While Hofer (2000) assigned two main areas to allocate the dimensions of personal epistemological beliefs: the nature of knowledge and the process of knowing. Under the nature of knowledge, there are two dimensions: certainty of knowledge and simplicity of knowledge, which combine to explain what knowledge is. Under the process of knowing, there are two dimensions:

source of knowledge and justification of knowledge, which together describe the means by which people come to know.

The reason for epistemological beliefs to be gaining increasing interest from educators and psychologists is because they are part of the cognition process of knowing and critical thinking (Hofer & Pintrich, 1997). Epistemological beliefs have been researched to influence students' processing of information (Stathopoulou & Vosniadou, 2007), comprehension, study strategies, and academic performance (Garrett-Ingram, 1997; Schommer, 1990). The cognitive process, which involves contemplation, evaluation, and judgments regarding relevant theories, requires people to reflect on their own thinking. This metacognitive ability is not evident in people before early adolescence when they hold very simple and naïve epistemological beliefs about knowledge and the process of knowing (Kuhn, Amsel, & O'Laughlin, 1988). Based on two longitudinal studies on college students, Perry (1970) proposed that students' transition from simple dualistic conception of knowledge to a more complicated, sophisticated view of knowing. Building on Perry's work, King and Kitchener (1994) initiated 15 years of interview studies with participants who grew from high school students into their thirties. This elaborate work has led to the refined seven stage developmental model which is dedicated to describing the process of knowing and knowledge reconstruction. Again, the seven stage developmental model confirmed that a higher level of reasoning is more evident over time in the participants' life span, and those who demonstrated to be in Stages 6 and 7 consistently appeared to be advanced graduate students (King & Kitchener, 1994). Thus, it is not surprising to conclude that epistemological beliefs are important in cognitive processes of knowing, thinking, and

reasoning and, reciprocally, with the increase of knowledge and experience, people are more prone to have sophisticated epistemological beliefs.

Most work on epistemological beliefs has assumed that they are domain general and can transcend different domains. Until recently, researchers have come to realize that the epistemological beliefs are also domain specific. In King and Kitchener's (1994) 15 years of research, they found that the social science graduate students scored higher than the mathematical science graduate students in the seven stage developmental model for epistemic reasoning. According to Hofer (2000), the first year college students are more likely to see scientific knowledge as static and certain than psychological knowledge, less prone to making justification of knowing in science based on their personal knowledge and experience than in psychology, and more possible to believe in experts and authority as the source of knowledge in science than in psychology.

Despite the domain specificity, researchers have proved that in the physical science domain, the more sophisticated epistemological beliefs, the more possible the students will have a deep understanding of the subjects. Songer and Linn (1991) found that those students who view science as dynamic and appreciate interpretation and integration as the appropriate learning strategies had more chance to understand thermodynamics than those who treat science as pure accumulation of truth and facts and adopt memorization as the learning strategy. Further research advocates this assertion that sophisticated and mature epistemological beliefs in physical science are necessary for physical science learning, and those students who believed simple and static knowledge would be less likely to make necessary conceptual change in physics learning (Qian & Alvermann, 1995; Stathopoulou & Vosniadou, 2007).

In order to improve learning, curriculum and instruction have been developed to explicitly address mature and sophisticated epistemological beliefs in physics (Elby, 2001; Otero & Gray, 2008). The purpose of the research is achieved and favorable learning results and deeper understanding is generated through the implementation of the curriculum with explicit epistemological beliefs. A possible explanation for this phenomenon could be due to increased personal interest and belief in personal efficacy, which facilitates the generation of positive learning effect (Otero & Gray, 2008).

Currently, although concerns have been given to the social-cultural contexts to shape personal epistemological beliefs, research is rarely done to investigate across different ethnic groups and countries.

Attribution Theory

Stevenson and Stigler (1992) explained the achievement gap between Asians and Americans through their observation in Asian schools and in Asian families. They concluded that Asian parents are more involved in their children's education, Asian schools are better organized for learning, and Asians place more emphasis on effort instead of on ability in academic success. Japanese mothers are reported to attribute effort as the cause of success in school much more often than American mothers (Holloway, 1988). Attribution theory has been explored for decades. According to the attribution theory, the causal explanations individuals give for success and failure are significantly related to their subsequent motivations and behaviors (Weiner 1979). Western children tend to attribute success to their ability but failure to their lack of effort, so that effort is not viewed as a stable cause of success in Westerners (Weiner, 1986). Conversely, Chinese students in Hong Kong attribute both success and failure to effort, so effort is the

stable cause of success (Hau & Salili, 1990, 1991). Those children who are taught to attribute performance to the lack of effort show much more motivation to persist in doing the subsequent tasks and the attribution retaining as a valuable classroom technique has been suggested to teachers to motivate their students (Cecil & Medway, 1986; Dweck, 1975; Schunk, 1982). Also, the students who attribute failure to uncontrollable factors, for example, luck, are more resentful and angry when facing failure, while students who attribute failure to lack of effort become shameful or embarrassed when they fail (Holloway, 1988). This finding corresponds to Li's (2004) research that American children show more resentment toward their high performance peers, while Chinese students show more respect, and American high-achieving students have concerns from their peers to be high-achieving students.

Intelligence as the Output of Education

Hernstein and Murray (1994) attributed Asian American students' high academic achievement to their higher Intelligence Quotient (IQ) scores compared to the general population. According to Flynn's (1989) analysis of a variety of IQ tests done at various locations at different periods, the average IQ of the Chinese American children were found to be below 100. Later on, however, their educational achievement and career success is equivalent to those European Americans with an IQ of 120 (Flynn, 1991). What counts for this discrepancy between the initial IQ and the later achievement implies that the IQ alone is not enough to predict performance. Early in 1982, Lynn observed that the IQ disparity between Japan and America was increasing, and this phenomena later gave birth to the famous Flynn Effect, which means the IQ in history has grown, especially since industrialization around the world (Flynn, 1998). Industrialization has

brought with it the need for an educated workforce, the subsequent mass education, the growing interests of the people to pursue higher education, and the improvement of the child-raising facility, such as the improvement of schooling, education television, and education technology. But according to Flynn (1998), the general people's real world cognitive ability associated with the IQ has not been seen to increase rapidly. This might imply that people are not becoming smarter even though they now have a higher IQ, they are just better equipped with more strategies and have more access to education.

According to Lynn (2006), who has done more than a quarter of a century's work on the race difference in IQ, concluded that East Asians have the highest IQ of 105, but according to the history of human civilization, most of the spectacular academic findings are not done by those Asians with the highest IQ, but done by Europeans who are more prone to explore the universe and to create new things. IQ is important, but for the academic performance, it is not always the only determinant. Genetics are already set while the environment is always changing. According to Rushton and Jensen (2005), genetics and the environment both account for 50% of the IQ, which means people can control half of their intelligence potential.

Asian children have more adaptive learning beliefs regarding ability or intelligence compared to their western peers, and they believe in effort to increase their intelligence or they think intelligence is malleable (Dweck, 1999; Li, 2003b). Research on the effect of beliefs regarding the malleability of intelligence has shown that those students who are taught to believe the nature of intelligence is malleable endorse stronger learning goals, have a higher motivation and hold more positive beliefs about effort and they generally outperform those who are not taught to believe in the malleability of

intelligence (Blackwell, Trzensniewski, & Dweck, 2007). Research was done on some African American college students. The experimental group was introduced to the concept of malleability of intelligence and they expressed higher level of enjoyment, engagement in education and achieved higher compared to the control groups (Arosen, Fried, & Good, 2002).

Heritance does play a role in shaping intelligence, but the acquisition of intelligence depends profoundly on experience to gain those competencies. The cultivation of intelligence depends on the quality of experience, which means intelligence could be nurtured through education (Martinez, 2000). Neuroscience research has confirmed this assumption since persisted corrective actions are less evident within those students who perceive intelligence to be a fixed entity, less sustained error correction memory-related activity will happen within their brain. Those students generally have less desirable learning results compared to students who view intelligence as incremental (Mangels, Butterfield, Lamb, Good, & Dweck, 2005). Intelligence should not be seen just as an input to education, but should be an output, or a conclusion of all the educational experience (Snow & Yalow, 1982). Lohman (1993) articulated that, intelligence tests, similar as achievement tests, only measure developed abilities, not potential or innate capacity. This malleable view toward intelligence and the attribution theory toward success and failure is coincided with traditional Chinese beliefs that the inborn intelligence is not contributory much to a person's potential in learning, whereas determination and effort decides the ultimate success (Li, 2001).

Cultural and Social Determinants

Cultural value system has been used to explain Asian American students' high academic performance. Cultural learning beliefs have played an important role in shaping individuals' learning beliefs and learning behaviors. Children's understanding of learning has been influenced by those cultural learning beliefs and this corresponds to Vygotsky's theory about cultural internalization (Li, 2005; Moll, 1990). The traditional Confucian understanding of learning implies that knowledge is not only the externally existing body but also is social and moral knowing. The process of learning is a "self-perfection" process so that Chinese have more affect toward learning compared to Westerners. Chinese students believed that learning is a gradual process that requires tremendous dedication and methodical steps. They want to achieve mastery of the material in order to contribute to society. They develop the virtues of resolve, diligence, endurance of hardship, perseverance, and concentration that are more essential than actual learning activities and which they believe are applicable to all learning activities and processes (Li, 2005). This corresponds to Ames and Archer's (1988) research result that the students who perceived mastery goals in their learning adopt more effective strategies, preferred more challenging tasks, had more positive attitudes toward education in class and put more effort in learning. Glasersfeld (1983) mentioned that more reflective activity would be needed from the learners when the concepts and operations are abstract in mathematics. The understanding of those concepts and operations requires a series of abstraction, thus a succession of reflective effort. Any succession of reflection effort would only come from strong motivation. This explains the reason for Asian Americans to have high performance in mathematics in particular, because mathematics requires

successive of reflections which demands effort and great motivation from the students perse.

Although cultural influences may play an important role in shaping people's beliefs in learning, the social environment where the children are brought up should not be ignored. Research done by Kaufmann (2004) has shown that Nonimmigrant Chinese students share the same beliefs with their immigrant peers regarding effort in learning, but they demonstrate significantly different behaviors than their immigrant peers. They generally desire more entertaining while at the same time require more of the teachers or the school to teach, whereas the immigrant students place more emphasis on their own effort. Research has shown that the later generations of Asian American students tend to have lower academic performance and a slower academic growth rate than the earlier generations, especially in subjects like mathematics and science (Grant & Rong, 1999; Kao & Tienda, 1995; Kaufman et al., 1998; Rong & Grant, 1992; Zhang, 2001). The difference in academic achievement between the early two generations and the later generations in the American educational system implies that the earlier generations are taking the advantages of both of the two different cultures and the later generations are losing their Asian cultural values and assimilating into the mainstream of American culture or just giving their Asian culture a face respect (Kaufman, 2004). This does not mean that one culture or educational system is better than the other. Also, this finding again reinforces that the assumed IQ difference in races might not be the reason to explain Asian Americans' high academic performance. The early two generations bring with them the good part of the Asian educational system and flourish in the American educational system.

Generations of educators puts a lot of effort to find out the best way to teach the students and the best way to develop a group of teachers who learn how to teach for deep understanding, to motivate the students by interesting and relevant subjects, but have not put much effort into investing the personal agency of the individual students to find their own way of learning and to hold themselves responsible for themselves to put effort to fulfill their own potential. By observing classrooms from Asia, American and Europe, Stevenson and Stigler found that in Asia, the activities in the classroom are arranged primarily for learning the content, the interaction is from students to the content, but in America, the classroom activities are more socially oriented and not very content oriented, which means the interactions are mainly between people and the interactions from students to content is missing (Stevenson & Stigler, 1992). The purpose of this research is to investigate if the students of different ethnicity, cultural and social environment will have different learning beliefs in physical science. The researcher wants to find out how much Asian origin, culture and beliefs influence students' learning beliefs and what else would influence students learning beliefs in physical science learning and to what level is the influence.

CHAPTER III

METHODOLOGY

Preliminary Procedures

Participants

The research will be conducted in both America and China. In America, the high school students are typical American students of different ethnical background taking physical science classes, physics or chemistry. Links of the Student Survey on the Survey Monkey will be spread to the high school students by their physical science teachers. Their responses will be collected through the Survey Monkey.

In China, the researcher works as an International Baccalaureate (IB) chemistry teacher in an international high school. All the students in the international high school are native Chinese students who are born and grew up in China. All the students attending this high school are motivated to attend American universities after high school. Although these students want to go to study in American universities, they are typical Chinese students for three reasons: first, they grow up in typical Chinese families and their parents are typical upper-middle class Chinese; second, all the students in the high school are Chinese students and all these students are also from Chinese middle schools and primary schools; third, the social environment they live in is China. From these three levels of familiar, cultural, social environmental analysis, it is not difficult to conclude that those students are typical Chinese students whose beliefs can represent Chinese students' learning beliefs. The student participants will be those students enrolled in the high school's physics and chemistry classes.

Procedures

In order to conduct the research in America, the researcher will contact her advisor of USM if she would like to assist in the research and send a recruitment letter (Appendix B) to the physical science teachers she knows. After permission is given, the researcher will send her advisor the recruitment letter (Appendix B) and her advisor will email the recruitment letter (Appendix B) to the physical science teachers. The physical science teachers who agree to participate in the research will recruit their students to finish the Student Survey on-line through Survey Monkey and spread out the link of the Student Survey on the Survey Monkey to the students. The student participants will finish the Student Survey on line from the link. The researcher will collect the American students' responses from Survey Monkey.

In China, the researcher will contact the administrator of the international high school if she could conduct the research in the high school with all the students taking physical science, physics or chemistry. Once upon permission is given, the researcher will contact all the physical science teachers and ask their permission to do the research in their classroom. Once permission is given, the research will give the survey (Appendix A) to the physical science teachers of the international high school and the physical science teachers will pass the survey to the participant students so that they can finish these survey. The physical science teachers will collect the survey and give them back to the researcher.

The researcher will use one-way ANOVA to test if any of the eight independent variables, which includes the participants' current living country, the five biographic items, and personal interests and confidence in learning physical science items, will

significantly influence the dependent variable: the students' total scores on EBAPS Axis 5: Source of Ability to Learn. Categorical variables with more than three different categories, birth place, ethnicity and religion orientation from family, will be recoded into dummy variables. Multiple regression will be applied to explore how much the model together would explain for the variance of the total score on EBAPS Axis 5 and the individual contribution of the independent variables. American students and Chinese students will be further compared with their personal interests and confidence in learning physical science using one-way ANOVA. Two-way ANOVA will be utilized to see if students from different countries with different levels of interests and confidence in learning physical science will have different epistemological beliefs regarding fixed ability and effort.

Operational Procedures

Paper survey of the participants in mainland China was organized and input into the SPSS software manually, and the survey from the Survey Monkey for the American participants was downloaded and transformed into the SPSS electronically.

Descriptive was run on the participants' gender and current living country. Out of a total of 156 high school students participants, aged from 14 to above 18, there were 93 participants from the mainland of China and 63 participants from US. There were 66 males, 88 females and 2 missing values.

The participants' total score on EBAPS Axis 5 was explored and the normality of distribution of the data was tested. Then the sample was split into two groups: the participants from mainland China and the participants from US. Pie graphs were drawn for the two groups of participants' birth place, ethnicity, religious orientation, personal

interests and confidence in physical science learning separately. Then the two groups were combined for later analysis. One-way ANOVA was run for all the variables, including the students' current living country, age, gender, birth place, ethnicity, religion orientation from the family, personal interests and confidence in physical science learning on the effect of the total EBAPS Axis 5 score.

Categorical variables, birthplace, ethnicity and religion orientation from family, were recoded into dummy variables. Standard multiple regression was run as a pilot with all the independent variables or their corresponding dummy variables put simultaneously to explain the variance of the participants' total score on EBAPS Axis 5. The model was tested for its normality, linearity, homoscedasticity, independence of residuals and the correlation within the independent variables was checked for further analysis.

Then a hierarchical multiple regression was run in which the participants' current living country, age and gender were put into the 1st block, and the participants' interests and confidence in physical science learning were put into the 2nd block to account for the variance of the total EBAPS score on Axis 5.

Further exploration was run to test if students' currently living in different countries, U.S. or mainland China would have different personal interests and confidence in learning physical science through one-way ANOVA. Two-way ANOVA had been utilized to explore if the influence of personal interests and confidence on the students' total score on EBAPS Axis 5 was different for students living in different countries?

CHAPTER IV
ANALYSIS OF DATA
Reliability Measures

Combined from both America and mainland China, there were a total of 156 high school students participants, 66 males, 88 females and 2 missing values, aged from 14 to above 18. Of them 93 participants were from the mainland of China and 63 participants were from U.S. The participants' total score on EBAPS Axis 5: Source of ability to learn was analyzed (see Figure 1).

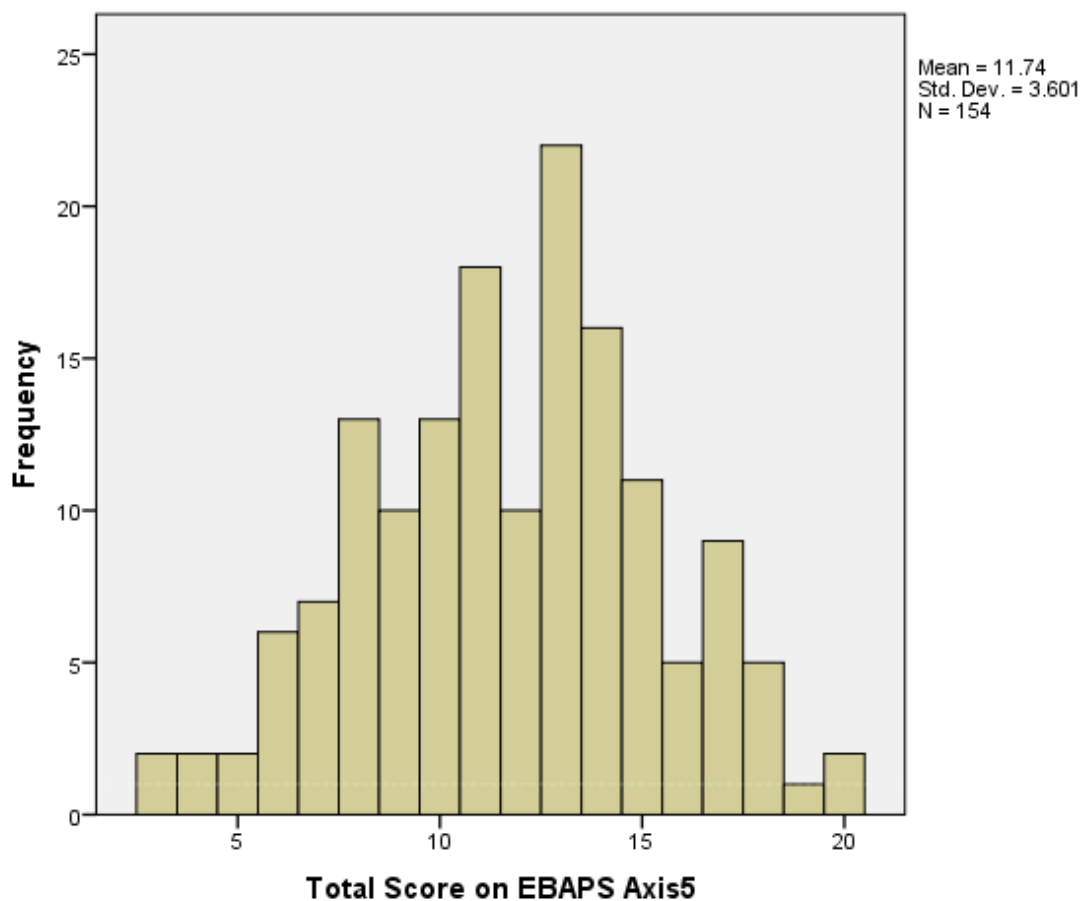


Figure 1. The participants' total Score on EBAPS Axis 5: Source of ability to learn.

According to the Kolmogorov-Smirnov statistic, a non-significant result, 0.098, indicated the normal distribution of the participants' total Score on EBAPS Axis 5.

All of the 93 participants from the mainland of China were born in Asia, and out of the 63 participants from U.S., 61 were born in North America, 1 was born in Asia and 1 was born in Africa (see Figure 2).

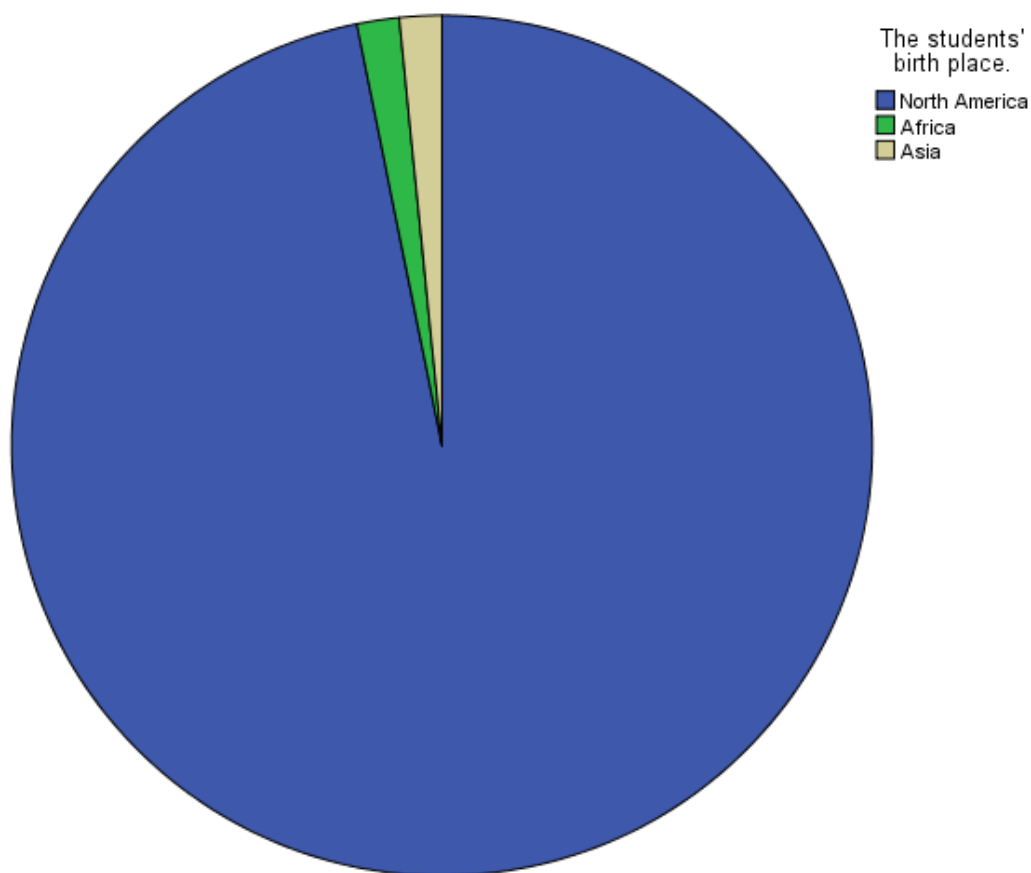


Figure 2. The American participants' birth place.

All of the 93 participants from the mainland of China were Asians, while the 63 participants from U.S. had a diverse ethnicity. About 62% of the total participants were Caucasian (see Figure 3).

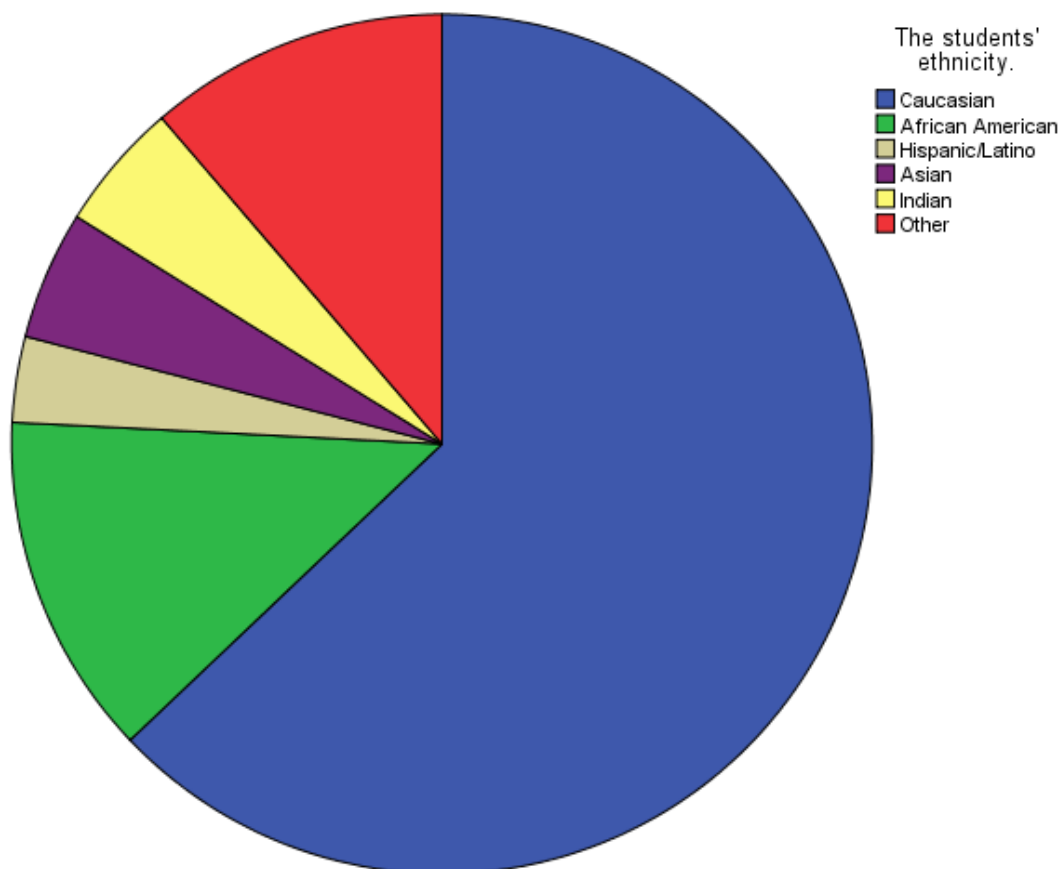


Figure 3. The American participants' ethnicity.

Among the 93 participants from the mainland of China, 77 had no religious orientation from their family, 9 had Buddhist orientation, 5 had Christian orientation, and 2 had other orientation, no student had Confucianism as the religious orientation from family (see Figure 4).

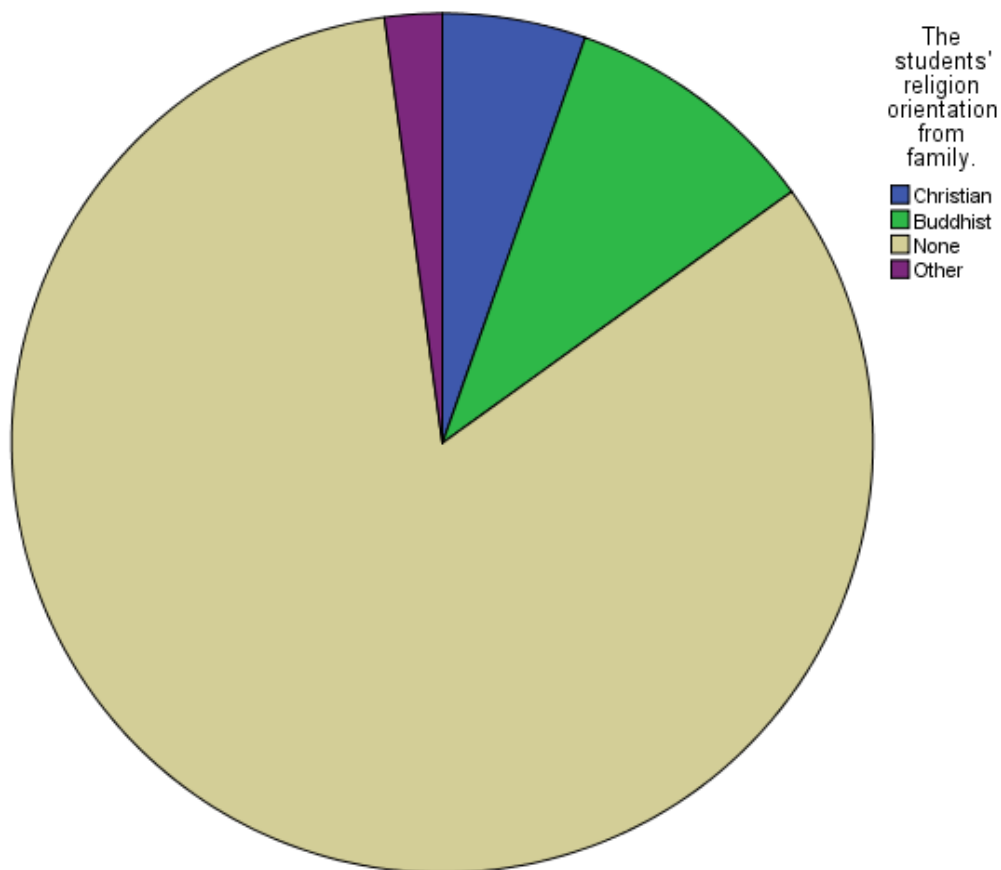


Figure 4. The main land of China participants' religion orientation from family.

Among the 63 participants from the U.S., 55 had Christian orientation from their family, 3 had Hindu orientation, 2 had Muslim orientation, and 1 had other orientation (see Figure 5).

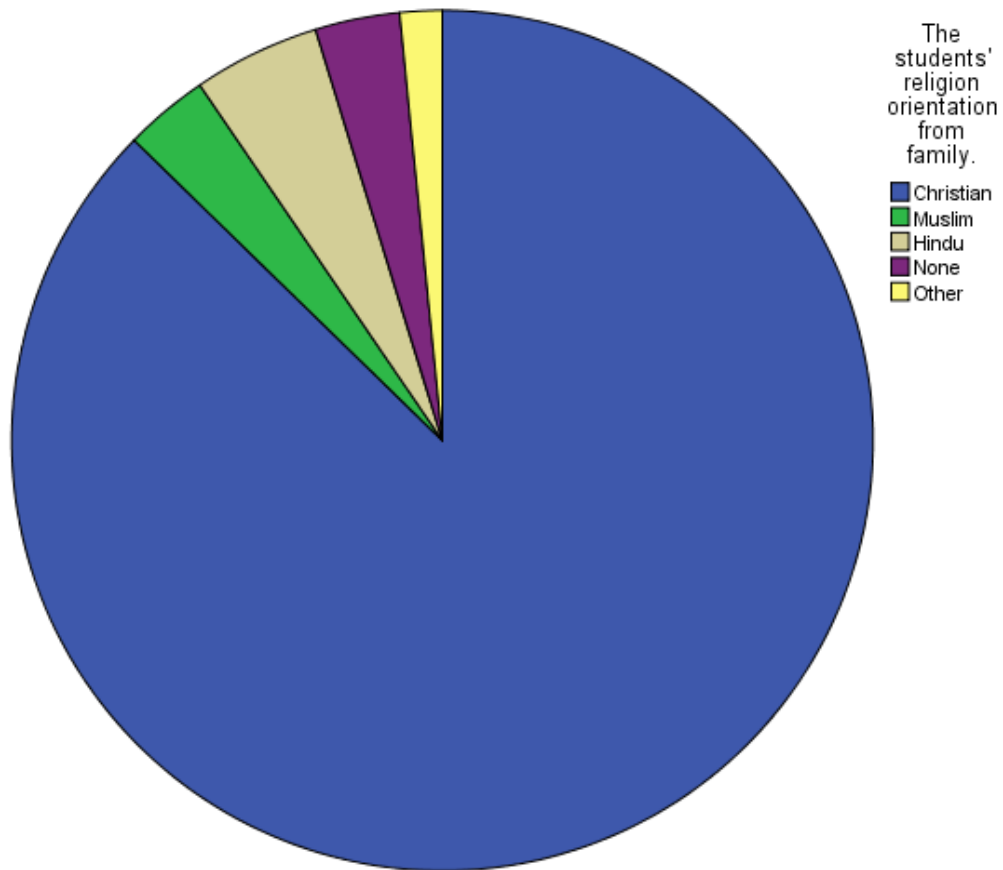


Figure 5. The American participants' religion orientation from family.

Among the 93 participants from mainland China, 18 students had chosen strongly like physical science, 40 had chosen like, 27 had chosen neutral, only 2 students did not like and 6 students strongly did not like physical science (see Figure 6). The majority of students investigated had at least neutral attitudes toward physical science learning.

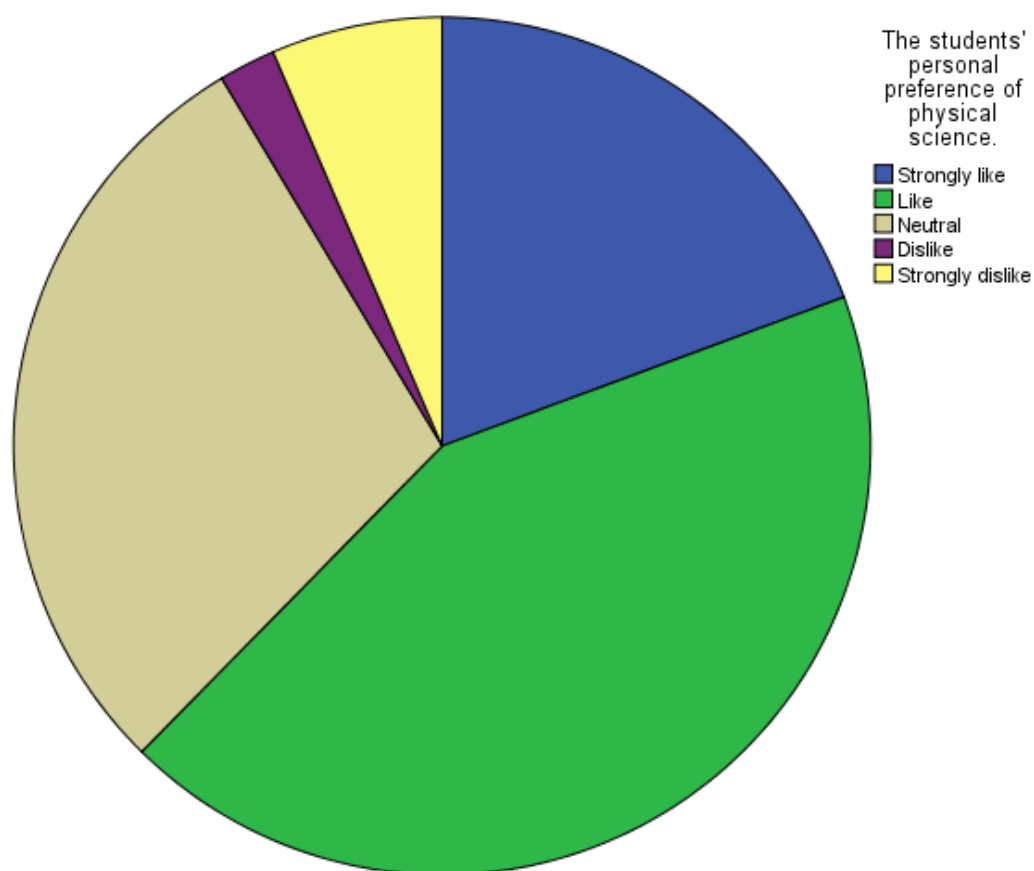


Figure 6. The main land of China participants' personal interests in learning physical science.

Among the 63 American participants, 22 students had chosen strongly like physical science, 23 had chosen like, 12 had chosen neutral, only 2 students did not like and 2 students strongly did not like physical science (see Figure 7). The majority of the students investigated had at least neutral attitudes toward physical science learning.

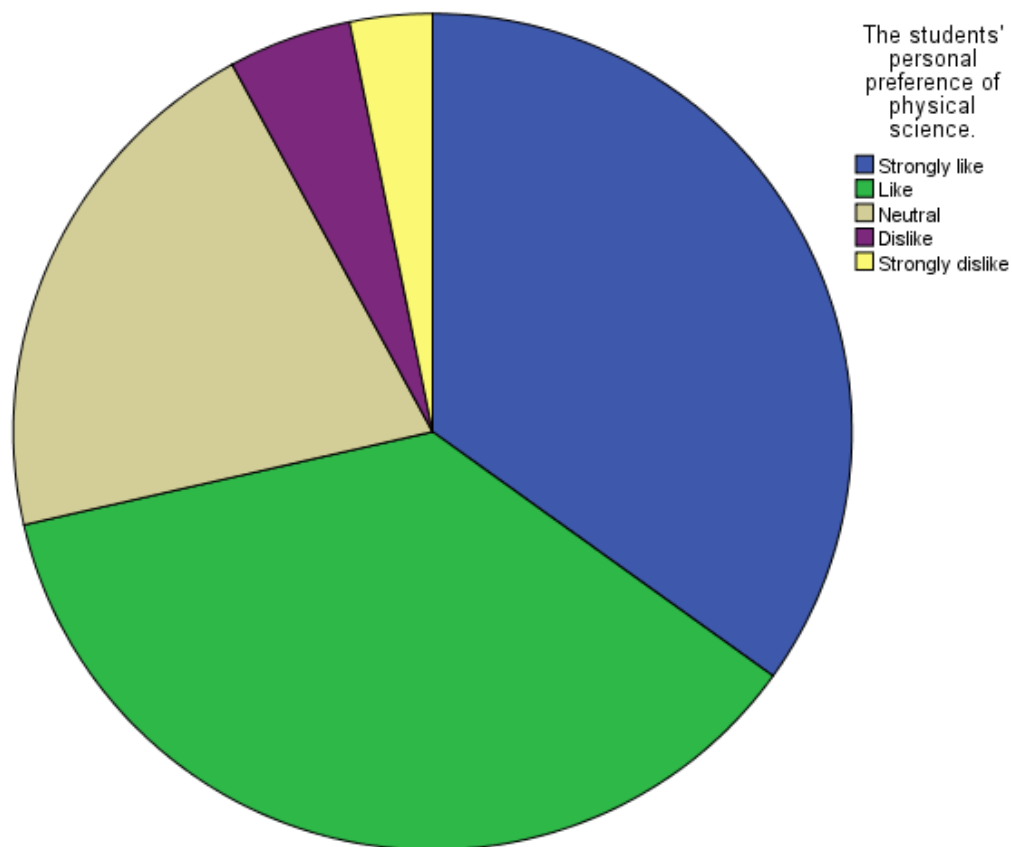


Figure 7. The American participants' personal interests in learning physical science.

Descriptive was summarized in the Table 1. Most students from both mainland of China and United States had at least neutral attitudes in learning interests towards physical science learning (see Table 1).

Table 1

The number and percentage of students having different levels of interests in learning physical science from Mainland China and U.S.

The students' current living country	Mainland of China		United States	
	Number	Percentage	Number	Percentage
Strongly like	18	19.4%	22	36.1%
Like	40	43.0%	23	37.6%
Neutral	27	29.0%	12	19.7%
Dislike	2	2.2%	2	3.3%
Strongly dislike	6	6.4%	2	3.3%
Total	93	100%	61	100%

Among the 93 participants from mainland China, 10 students had chosen strongly agree to have good grades in physical science, 40 had chosen agree, 33 had chosen neutral, only 7 students did not agree to have good grades and 3 student strongly did not agree to do well in physical science (see Figure 8). A total of 53.8% of students had confidence to have good grades in learning physical science.

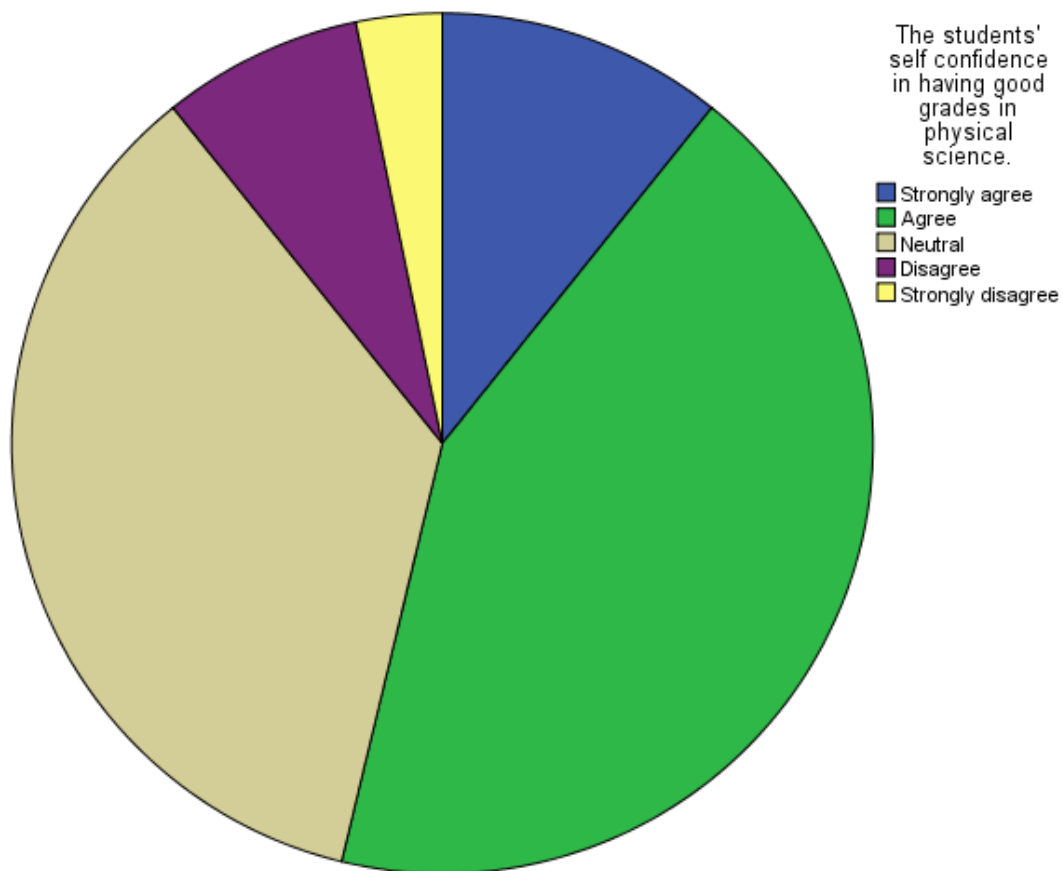


Figure 8. The mainland of China participants' personal confidence in learning physical science.

Among the 63 American participants, 32 students had chosen strongly agree to have good grades in physical science, 20 had chosen agree, 7 had chosen neutral, only 2 students did not agree to have good grades in physical science (see Figure 9). A total of 85.3% of students had confidence to have good grades in learning physical science.

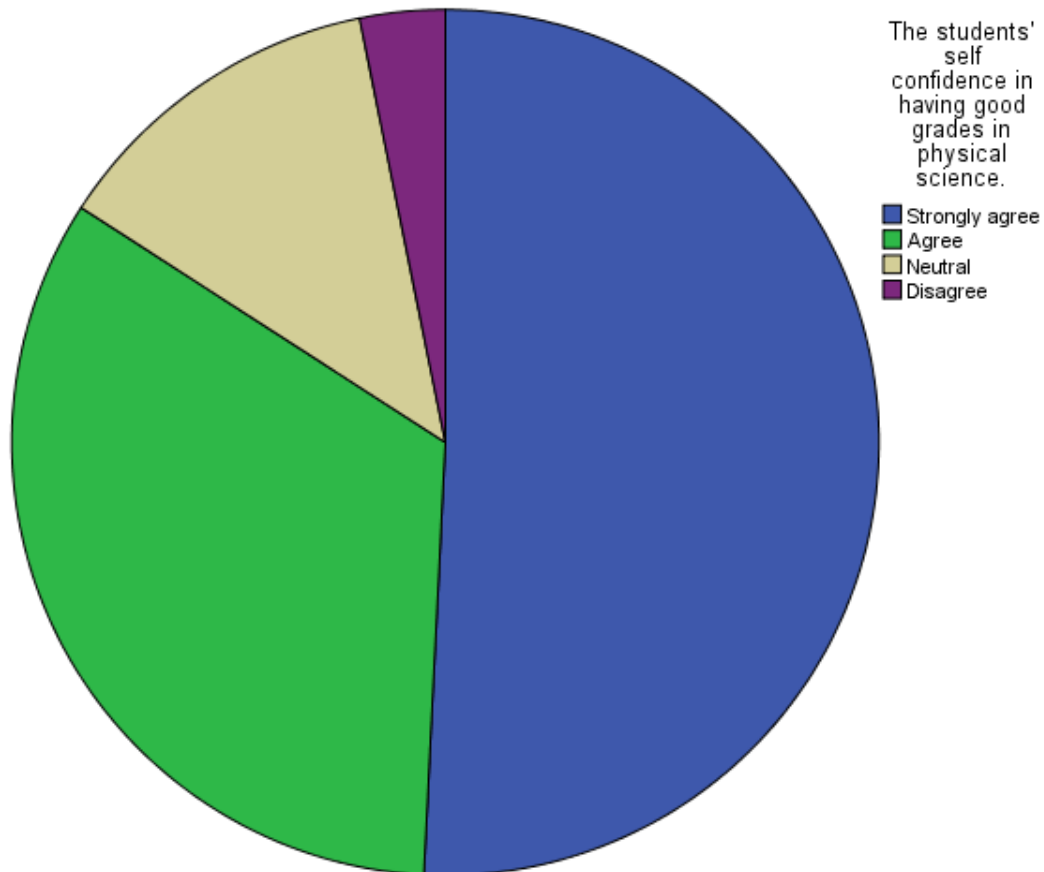


Figure 9. The American participants' personal confidence in learning physical science.

Descriptive was summarized in the Table 2. Most students from both mainland of China and United States had at least neutral attitudes in their confidence to have good grades towards physical science learning. The majority of American students, a total of 83.5% participants agreed to have good grades in physical science compared to 53.8% Chinese participants (see Table 2).

Table 2

The number and percentage of students having different levels of confidence in learning physical science from Mainland China and U.S.

The students' current living country	Mainland of China		United States	
	Number	Percentage	Number	Percentage
Strongly agree	10	10.8%	32	52.5%
Agree	40	43.0%	20	32.8%
Neutral	33	35.5%	7	11.5%
Disagree	7	7.5%	2	3.3%
Strongly disagree	3	3.2%	0	0%
Total	93	100%	61	100%

One-way between-groups analysis of variance (ANOVA) was conducted to explore the impact of the participants' current living country on the total EBAPS score on Axis 5. There was a statistical significance at the $p < 0.05$ level in the total EBAPS score on Axis5 between the American and Chinese participants groups: $F(1, 152) = 5.13, p = 0.025$. The participants from US scored higher on the EBAPS Axis 5 compared to their counterparts from the mainland of China (see Table 3).

Table 3

Descriptive Statistics for total EBAPS score on Axis 5: Source of ability to learn for students from U.S. and mainland of China

Students' current living country	N	Mean	Standard deviation
United States	61	12.54	3.858
Mainland of China	93	11.22	3.339

One-way between-groups analysis of variance was further repeatedly conducted to explore the impact of the participants' age, gender, birth place, ethnicity, religion orientation from the family, personal interests and confidence in physical science learning on the total EBAPS score on Axis 5. And all the statistical results from ANOVA for the eight variables were summarized in the Table 4.

Table 4

ANOVA results for all the eight variables' impact on the total score of EBAPS Axis 5

Variables	df	F	<i>p</i>
Current living country	1	5.130	0.025
Age	5	0.834	0.528
Gender	1	2.994	0.086
Birth place	2	3.112	0.047
Ethnicity	6	2.131	0.053
Religious orientation from family	5	2.786	0.020
Personal interest in physical science	4	1.439	0.224
Personal confidence in physical science	4	1.182	0.321

From Table 4, it is obvious that, beside the current living countries, participants born in different places or of different religious orientation from family differed significantly on their mean total EBAPS Axis 5 score from other groups.

Categorical variables with more than three different categories, birth place, ethnicity and religion orientation from family, were recoded into dummy variables. Standard multiple regression was run as a pilot with all the independent variables or their corresponding dummy variables put simultaneously to explain the variance of the participants' total score on EBAPS Axis 5. From the correlations, the participants' current living country, and the dummy variables of birth place, ethnicity and religion orientation from family were highly related, with correlations of 0.974, 0.701 and 0.826 respectively. Thus, for the following hierarchical multiple regression, the dummy variables of the participants' birth place, ethnicity and religious orientation from family were not included in the analysis.

From the Normal Probability Plot (P-P) of the Regression Standardized Residual (see Figure 10), the points were in a reasonably straight line, thus there was no major deviations from the assumption of normality.

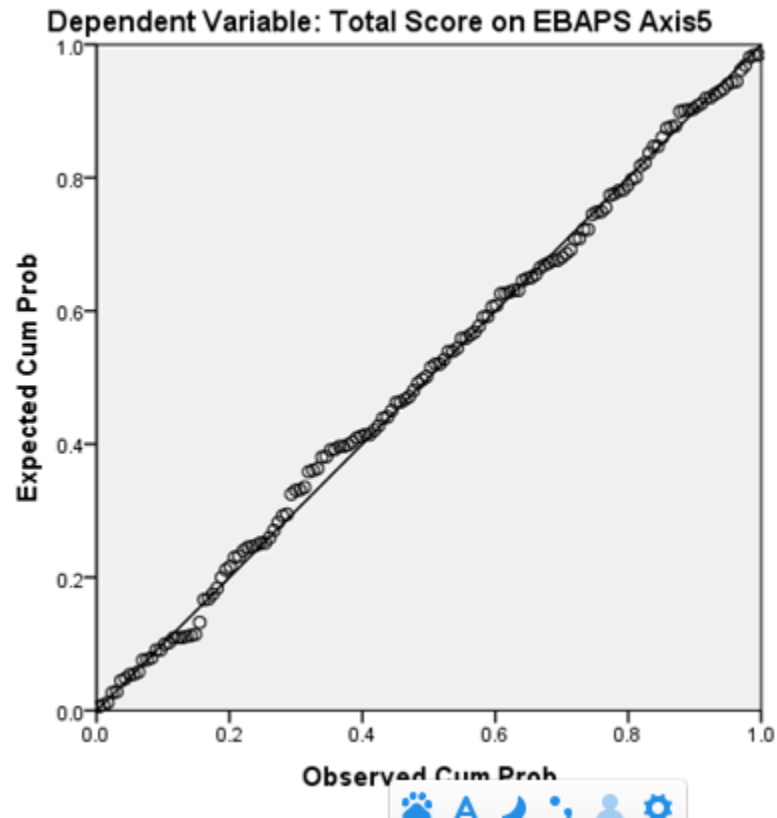


Figure 10. Normal Probability Plot (P-P) of the Regression Standardized Residual.

From the Scatterplot of the standardized residual (see Figure 11), the standardized residuals were roughly rectangular distributed, thus there was no major violations from the assumption of homoscedasticity and independence of residuals.

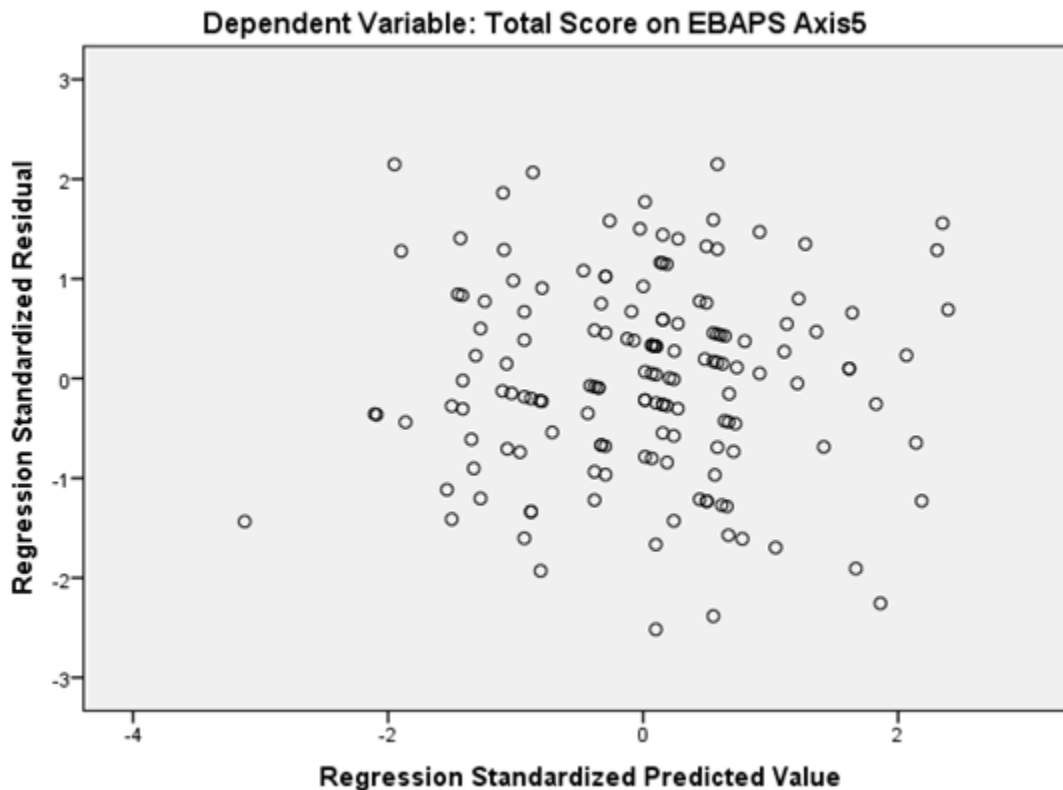


Figure 11. Scatterplot of the standardized residual.

Overall, the model was normally distributed and explained 0.158 of the total variance and did reach statistical significance (Sig=0.0112).

Hierarchical multiple regression was run with the participants' current living country, age and gender in the 1st block, and their interests and confidence in physical science learning in the 2nd block. The 1st block explained 0.074 of the total variance in the total score on EBAPS Axis 5. After entry of the participants' interests and confidence at the 2nd block, the total variance explained by the model as a whole was 0.096, $F(5, 146) = 3.094$, $p=0.011$. The two control measures explained an additional 0.022 of the variance in the total score on EBAPS Axis 5, after controlling for current living country, age and gender, R^2 change = 0.022, F change (2, 146)=1.765, $p=0.175$. The 1st block was statistically significant while the 2nd block per se was not. In the model, only

the participants' current living country and gender were statistically significant, with the gender recording a beta value of 0.254 and the current living country recording a beta value of 0.239 (see Table 5).

Table 5

Hierarchical multiple regression results

Variables		B	Beta	Sig
1st Block	Current living country	1.770	0.239	0.022
R ² =0.074	Age	-0.082	-0.024	0.797
	Gender	1.850	0.254	0.004
2nd Block	Personal interest in physical science	-0.547	-0.155	0.117
Δ R ² =0.022	Personal confidence in physical science	-0.013	-0.003	0.974

Notes: R²=0.096, $p=0.011$

One-way between-groups analysis of variance was conducted to explore the impact of the current living country on the participants' interests in physical science learning. There was no statistical significance at the $p < 0.05$ level in the participants' interests in physical science for the two groups: $F(1, 154) = 2.923, p = 0.089$. The participants from U.S. and the participants from the mainland of China did not have significant difference in their interests towards physical science (see Table 6).

Table 6

Descriptive Statistics for the students' interests in physical science learning for students from U.S. and mainland China

Students' current living country	N	Mean	Standard deviation
United States	61	2.05	1.025
Mainland of China	93	2.33	1.023

A two-way between-groups analysis of variance (two-way ANOVA) was conducted to explore the impact of the participants' current living country and interests in physical science learning on their beliefs about effort and natural ability, as measured by the EBAPS Axis 5. The Sig=0.583 was manifested from the Levene's Test of Equality of Error Variances, thus the students' total score on EBAPS Axis 5 had equal variance across the groups. The interaction effect between the participants' current living country and their interests in physical science learning was not statistically significant, $F(4,144)=0.189$. See the Figure 12 for impact of the participants' current living country and interests in physical science learning on their total score on EBAPS Axis 5.

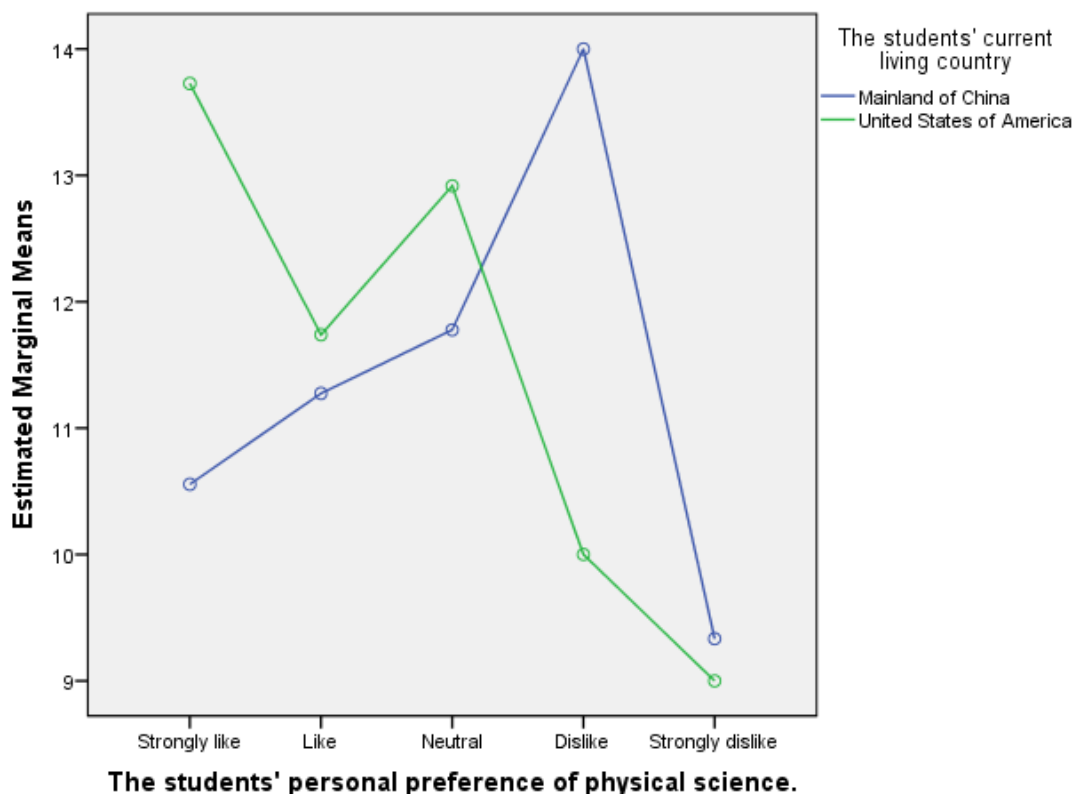


Figure 12. The impact of the participants' current living country and interests in physical science learning on their total score on EBAPS Axis 5.

One-way between-groups analysis of variance was conducted to explore the impact of the current living country on the participants' confidence in physical science learning. There was a statistical significance at the $p < 0.05$ level in the participants' confidence in physical science learning for the two groups: $F(1, 154) = 32.6630, p = 0.000$. The participants from U.S. were significantly more confident than the participants from the mainland of China in having good grade in physical science (see Table 7).

Table 7

Descriptive Statistics for the students' confidence in physical science learning for students from U.S. and mainland China

Students' current living country	N	Mean	Standard deviation
United States	61	1.68	0.820
Mainland of China	93	2.49	0.904

A two-way between-groups analysis of variance (two-way ANOVA) was conducted to explore the impact of the participants' current living country and confidence in physical science learning on their beliefs about effort and natural ability, as measured by the EBAPS Axis 5. The Sig=0.458 was manifested from the Levene's Test of Equality of Error Variances, thus the students' total score on EBAPS Axis 5 had equal variance across the groups. The interaction effect between the participants' current living country and their confidence in physical science learning was not statistically significant, $F(3,145)=0.193$. See Figure 13 for the impact of the participants' current living country and confidence in physical science learning on their total score on EBAPS Axis 5.



Figure 13. The impact of the participants' current living country and confidence in physical science learning on their total score on EBAPS Axis 5.

Discussion of Results

The American participants' mean total score on EBAPS Axis 5: Source of ability to learn was significantly higher than the Chinese participants' mean total score. This is exactly opposite to what had been hypothesized. Students grown up from a Confucian culture which respects hardworking, persistence and perseverance, scored lower than the students grown up in western culture. Although no student from mainland of China reported to have Confucianism as the religious orientation from family, it should not be a proof that Confucianism is no longer the dominant spiritual guidance in China right now. The reason for the students not to choose it as the religious orientation

probably is only because the students see Confucianism as a philosophy instead of a religion (Sun, 2013).

According to the mark scheme of the EBAPS survey, the higher the score the students got for the EBAPS Axis 5, the more mature the epistemological beliefs the students should have regarding the source of ability to learn, and the more the students should believe in effort to improve personal capacity rather than the innate ability. Does the result from the research necessarily lead to the conclusion that American students hold more mature epistemological beliefs in the dimension of source of ability to learn than the Chinese students?

The answer to this question needs more consideration than expected. The Chinese students in the sample were all enrolled in the International Baccalaureate (IB) programme which is one of the toughest precollege programs. Conley and Ward (2009) analyzed the alignment of the IB Diploma Programme standards and the Knowledge and Skills for University Success (KSUS) college-ready standards, and found out that these two standards were highly aligned with each other. The key cognitive strategies emphasized by the IB Diploma program, critical thinking, intellectual curiosity and logical interpretation, were fully aligned with university faculty's expectations in all subject areas. In chemistry, the 47 IB standards aligned completely with the standards of KSUS. From the standards alignment, it is obvious that the IB diploma programme had high requirements, equivalent to that of the university, for its students during high school period in all the subjects. Research was done in the United States by the International Baccalaureate Global Policy and Research (2010), which demonstrated that students enrolled in the IB programme were more engaged academically, behaviorally and

emotionally compared to regular students. The IB diploma programme provided its students with more challenging and also more supportive learning environment, and consequently its graduates compared to the non-IB graduates, were more academically independent and mature, had a higher chance to attend a selective university and finish college according to Coca et al., (2012). In terms of critical thinking, time management, communication and motivation, IB students were viewed to be better prepared than A-level students (Jenkins, 2003).

Before these Chinese students were enrolled in the IB program, most of them were studying in typical Chinese schools where rote memorization was the main learning strategy and effort was mostly simple repetition. But IB program is completely different from the traditional Chinese education. The physical science taught in the IB program was at least equivalent to the sophomore level physical science in America according to the researcher's experience. Being an IB chemistry teacher for almost a year, the researcher gradually understands that the IB physical science is not only very intensive in this content, but also requires the students to think deeply and critically by themselves to deduce meaning and make judgment, and at the same time, to see knowledge as evolving. Old theories are constantly replaced by new theories and the students in the researcher's class constantly expressed uncertainty about what they had learned and felt incapable of learning all the overwhelming contents. Taking physical science class equivalent to college physical science classes, according to Schommer (1990), the students' epistemological beliefs regarding certainty of knowledge should be more mature, and they were more tend to be believe in the evolving nature of science. Effort was no longer equivalent to rote memorization or simple repetitions because no much practice was

available. Deep understanding and internal construction of knowledge was required for comprehension. As much as the researcher knows, most of these Chinese students were hardworking and were willing to learn. But during their process of learning the hard core physical science in the IB programme, some might have experienced significant struggle by just working hard, or simply through repetition. Thus, it is possible that those students had tried hard to learn physical science and they did progress in their knowledge base, but their hardworking was not rewarded correspondingly as much as they had expected and they subsequently believed that innate ability might be more important than effort in learning physical science. In research done by Kienhues, Bromme, and Stahl (2007), results had shown that gaining in knowledge did not promise gaining in epistemological beliefs, actually, the more knowledge the students gained, the less advanced epistemological beliefs they adapted. Specifically for physics, research done by Redish, Saul, and Steinberg (1998) indicated that gaining more knowledge in physics lead the students to deteriorate in epistemological beliefs. Thus, it is not really rare for those Chinese high school students learning college level physical science contents to retain naive epistemological beliefs regarding inborn ability and effort. On the other hand, the American students in this study were regular students not enrolled in IB programme and their physical science learning might not be as intensive and demanding as these Chinese students had experienced in the IB programme, thus, American students in this study would have a more positive attitudes toward their ability to control learning in physical science.

According to Eren (2007), the first year Turkey college students compared with the second year college students, showed a statistically significant tendency to believe

that learning depends on effort rather than inborn ability while the later had a significant tendency to believe in the evolving nature of knowledge. The fact that the sophomores had less sophisticated epistemological beliefs in the source of ability to learn dimension but more mature epistemological beliefs in the uncertainty of knowledge dimension corresponds exactly to this research and indicates that the development of the different dimensions of epistemological beliefs might not be simultaneous. This corresponds to what Phan (2008) had speculated in his research about epistemological beliefs and self-regulated learning that different dimensions of epistemological beliefs might not develop in synchrony. Research had shown that epistemological beliefs, similar as other intellectual development, should progress from a naive/immature state to the more sophisticated/mature state (Katung, Johnstone, & Downie, 1999; King & Kitchener, 1994). Nevertheless, it never implied that epistemological beliefs should proceed without any recessing period. Buehl and Alexander (2005) had asserted in their research that the different dimensions of epistemological beliefs might progress independently which means one could possess a naive standpoint at certainty of knowledge but endorse effort instead of inborn ability in learning at the same time. Thus, it is reasonable to conclude that those Chinese students had endorsed effort but suffered greatly in the IB program physical science learning using only simple repetition effort instead of deep strategy. With the increment of tentative knowledge learning, they were going through a rough transition period to view knowledge as evolving, some of them might have suffered uncertainty and insecurity, realized effort along would not work and resorted to lack of innate ability for excuse. They might be under the way to understand that effort, though

important, still requires other factors, such as effective strategies, strong motivation, time management etc (Dahl, Bals, & Turi, 2005).

The American students' relatively higher total score on the EBAPS Axis 5 might be due to the fact that they were still holding general epistemological beliefs. Research done by Buehl and Alexander (2006) suggested that middle school and early high school level's students' epistemological beliefs were still rudimentary and not domain specific yet. Research on the dimensionality and disciplinary difference in personal epistemology by Hofer (2000) showed that 1st- year college students more often saw knowledge in science as certain and unchanging than in psychology which means they had not suffered the transition state of viewing science knowledge as changing in high school yet thus they might think science could be learned by simple repetition or simple effort along. The fact that the American high school students in this research endorsed effort more than Chinese students might only be because they were holding simple optimistic ideals regarding physical science learning.

From Table 2 ANOVA results, it is obvious that in addition to the students' current living country, birth place and religious orientation from family also impacted the students' total score on EBAPS Axis 5 significantly. But from multiple regression, dummy variables recoded from birth place, ethnicity and religious orientation from family were highly related to the current living country variable, with correlation coefficients of 0.974, 0.701 and 0.826 respectively. All Chinese students were born in China and were Asians and most were non-religious (Figure 4), while almost all American students were born in U.S. (Figure 2), more than half of American students were cautions (Figure 3), and most American students were Christian (Figure 5). Thus,

birth place, ethnicity and religious orientation should not be considered further in the research. However, the other four variables, age, gender, personal interests and confidence in physical science learning, tested by ANOVA, all did not have statistical impact on the total score on EBAPS Axis 5.

Research had shown that individual epistemological beliefs would evolve with age and education (Baxter-Magolda, 1992; Buehl & Alexander, 2006; Schommer, 1990; Schommer, 1993), but high school students were within a relatively small age range and had similar educational experience given other variables controlled, thus, it is not surprising that age did not make statistically significant contribution to EBAPS Axis 5 total score. Research on gender's influence over epistemological beliefs did not align. Some research indicated no difference in males' or females' epistemological beliefs (Chan & Elliott, 2002; Eren, 2007; Phan, 2008) while others revealed gender-related difference in epistemological beliefs, such as, males tended to believe in quick learning compared with females (Neber & Schommer, 2002; Schommer, 1993; Schommer & Dunnell, 1994), male students were more possible to believe in fixed ability compared to the female students (Chen & Pajares, 2010; Schommer & Dunnell, 1994) and female students were less likely to believe in the certainty of knowledge than male students (Bendixen, Schraw, & Dunkle, 1998). In this research, gender along did not make significant difference for the total score on EBAPS Axis 5 which means males and females did not differ in their epistemological beliefs about effort and fixed intelligence.

As for the students' personal interests and confidence over epistemological beliefs regarding fixed ability and effort, there was no significant relationship though research had suggested that higher personal interests would engage the students in deep

learning strategies, thus would generate higher academic performance, which would further influence development of epistemological beliefs (Lin, Deng, Chai, & Tsai, 2013). But this relationship was indirect and not statistically proven.

Data from Table 5 demonstrated that the hierarchical multiple regression model overall was statistically significant but could only account for 9.6% of the overall variance of the participants' total score on EBAPS Axis 5. Possibilities could be that the researcher did not include all possible variables which could account for the variance. Early in 1990, Schommer had already suggested that five blocks of students' characteristics could possibly affect personal epistemological beliefs, which included home educational atmosphere and opportunities, parental encouragement and discipline in addition to the variables investigated in this study. Within the hierarchical multiple regression, only the participants' current living country and gender contributed significantly to explain the variance of the total score on EBAPS Axis 5 with relatively large beta values. Block 1 contributed significantly to the variance while Block 2 did not show any significant contribution which implied that the participants' personal interests and confidence in learning physical science were not good predictors of students' epistemological beliefs regarding fixed ability and effort. On the other hand, the social and biological factors, such as the students' current living countries and gender were much better equipped to explain the variance in the students' total score on EBAPS Axis 5 regarding fixed ability and effort.

Another possibility for the limited capability of the model to explain the variance of the total score on EBAPS Axis 5 is that if epistemological beliefs, though conceptualized as a continuum, could be truly represented by adding several continuums

together? When the researcher was manually inputting the data, she realized that the students could have conflicting answers to the EBAPS Axis 5 items. The students could believe in effort in one question but endorse inborn ability in another question.

Furthermore, is it true that the more the students believed in effort, the more mature the students' epistemological beliefs regarding fixed ability and effort?

Result from Table 6 and 7 showed that American students and Chinese had similar interests in learning physical science while American students were more confident in having good grades. This result would again be due to the fact that the Chinese students were enrolled in the hush IB program where they had struggled and lost confidence. Schommer (1990) found that the more higher education the students got, the more possible they would see knowledge as uncertain since advanced knowledge was generally more tentative in nature, and those students who hold immature epistemological beliefs believing in quick learning would be overconfident in test performance. Though still in high school, those Chinese students were actually taking classes aligned with the university standards, and consequently, their epistemological beliefs would evolve to see knowledge as uncertain and changing (Conley & Ward, 2009). Phan (2008) had reported that naive epistemological beliefs regarding fixed ability would much more negatively contribute to the students' self-efficacy beliefs compared with naive beliefs in certain knowledge. This result corresponds to our result that, those Chinese students who probably had experienced the uncertain nature of physical science and endorsed more in fixed ability were less confident in physical science learning compared to their American counterparts enrolled in regular program who believed in effort. Another research done by Lin et al., (2013) had shown that the more students saw scientific knowledge as

uncertain and evolving, the more possible they would be test anxious. Tsai, Ho, Liang, and Lin (2011), had found that those student with more mature epistemological beliefs regarding the certainty of knowledge would be more nervous to provide the correct answer in science tests and be more possible to suffer loss in confidence in learning science. Thus, it is natural that those Chinese students enrolled in the IB diploma programme who had experienced the uncertainty in learning physical science would be more nervous and less confident in having good grades in physical science than their American counterparts who were enrolled in regular class.

CHAPTER V

SUMMARY

The research result was found out to be different from the hypothesis. The Chinese students from mainland of China had lower total score on EBAPS Axis 5 than their American counterparts. Beside the current living country variable, only the birth place and religious orientation from family variables significantly impacted the participants' total EBAPS Axis 5 score. Students of different age, gender, ethnicity, interests and confidence in learning physical science did not differ significantly in their epistemological beliefs regarding effort and fixed ability. Overall, the model per se could explain about 10% of the variance of the total score on EBAPS Axis 5. The learning beliefs in physical science regarding effort and fixed ability were influenced more by the social, cultural, and biological variables than by the individual interests and confidence variables. The students from America and mainland China did not differ significantly in their interests in learning physical science but the American students were more confident in getting good grades in physical science learning. The impact of the participants' current living country and interest or confidence in physical science learning on the their beliefs regarding effort and inborn ability, as measured by the EBAPS Axis 5, was not statistically significant.

The development of epistemological beliefs, which have several different dimensions, does not necessarily grow smoothly from the lowest point to the highest point. Just like any other growth curve, epistemological beliefs could withdraw at certain point when trouble was met. Besides, the different dimensions might not always progress simultaneously. One particular situation could bring in the forward movement of one

dimension but at the same time, could also bring in the backward movement of another dimension. The Chinese students enrolled in the demanding college preparatory IB programme might have tried hard to learn the challenging and evolving physical science content but their effort was not rewarded correspondingly, thus they draw back to endorse inborn ability rather than effort. The American students, on the other hand, were not enrolled in the highly challenging IB programme as those Chinese students did, thus they had not experienced the intensive physical science content learning and the evolving nature of science yet. Their epistemological beliefs might be more general or rudimentary. They were still simply optimistic about their own ability to control their grades in physical science and be more confident in having good grades than Chinese students. The Chinese student had already learned the replacement of old theories by new theories and experienced the uncertainty nature of science, thus their epistemological beliefs regarding certainty of science should be more mature, and consequently, they were more nervous to find the only right answer in the exam, and had lower confidence in having good grades in physical science learning. This explains why the originally regular Chinese students under the influence of Confucianism had more naive epistemological beliefs regarding effort and fixed ability tested by EBAPS Axis 5 total score than their American counterparts, and why they were less confident in having good grades in learning physical science.

Simply from the total score on EBAPS Axis 5 alone, the American students had more mature epistemological beliefs regarding effort and fixed ability than the Chinese students. Nevertheless, it is not appropriate to conclude that American students did have more mature epistemological beliefs in the dimension of source of ability to learn

because they had not arrived the struggling point for the growth of that particular epistemological dimension. At certain sense, the American students could be more naive because they did not realize that physical science learning is demanding and it is also evolving. They might be overconfident in their own ability to control the learning result because of the lack of struggle and failure.

Several limitations could exist in this research. First, the research was designed to be conducted in America through on-line survey monkey and to be paper surveyed in China. In America, a leading professor in science education spread out the links to the science teachers and the science teachers asked their students to participant in the survey. While in China, the researcher as a first year chemistry teacher, asked her other young colleagues to spread out the paper survey. Because of the different status and influence of the professor and the researcher, the attitudes the students taking the survey could be different. The American students could be much more serious taking the survey than the Chinese students did. When recording manually the paper survey data from the Chinese students, the researcher realized that although the Chinese students almost all completed the survey, their answers to the questions might not be through serious contemplation. The researcher observed that the Chinese students' answers to the questions seem to conflict much more often than the American students although no statistical result was generated to support this assumption. Thus, the data generated from the paper survey might not be able to truly represent the Chinese students' epistemological beliefs regarding effort and fixed ability in physical science learning.

Another limitation of the research is that the academic program the American and Chinese students enrolled were not aligned. The American students were regular high

school students enrolled in regular American high schools while the Chinese students were enrolled in the academically highly competitive IB program in an advanced IB certified international school. The difference in their physical science content learning could potentially contribute to the difference in their epistemological beliefs growth, other than the factors the researcher had included in the research. And this influence might be very confounded, since epistemological beliefs generally would develop with content knowledge learning, though with different amplitude for different dimensions.

Thirdly, the researcher originally assumed the Chinese students investigated in this research to be typical Chinese students because they were from regular middle-upper class family, attended regular elementary and middle schools before attending this international high school. But after teaching in this high school for almost one academic year, the researcher found that those students might not be typical Chinese students who could truly represent Chinese students. They were from a very high social economic group, and their home atmosphere and their parents could strongly influence their beliefs in addition to the social and cultural factors. While, on the other side, the American students were typical American students from regular family in the southern states.

The fourth limitation of the research is that the mark scheme defined that the higher total score the students got on EBAPS Axis 5, the more they would believe in effort, and then the more mature the students' epistemological beliefs regarding effort and fixed ability would be. Although the instrument is a well developed survey, it should never be assumed to be perfect. The researcher did a non-published research with eight university professors in mathematics and science, which showed that the professors generally believed that both effort and innate ability were important in learning science

and mathematics. Although at the mean time, they agreed that both knowledge and intelligence could be cultivated through education. Their epistemological beliefs regarding effort and innate ability would be immature if mark scheme was strictly respected to the truth. Thus, it is reasonable to deduce that higher total score on EBAPS Axis 5 did promise more mature epistemological beliefs regarding effort and innate ability. Consequently, the higher mean total score on EBAPS Axis 5 the American students got might not guarantee that they were more mature than their Chinese counterparts.

The last limitation is that although the researcher defined Confucianism as a religion, the students in general, Chinese or American probably would not regard it as a religion, they would rather treat it as a philosophy. The researcher originally assumed the Chinese students to be influenced by Confucianism deep inside their soul, but no matter how much they were influenced by Confucianism, they would not see themselves as religious or see Confucianism as a religion. Being religious, according to the researcher's perception, still is not a norm in China nowadays. Even though they were influenced by Confucianism, the influence might not as profound as the research had expected. China, nowadays, is going through dramatic transformation at all aspects, social, economical, and cultural. Those Chinese students grew up watching American TV and films and they were actually very impacted by western life styles or even values.

Future research could be done to test all the participants' epistemological beliefs regarding the evolving nature of physical science using EBAPS Axis 4, Evolving Knowledge. The result of this future research will testify if the speculation made from this research is correct or not that American students might be more naive in terms of

their epistemological beliefs regarding evolving knowledge and thus were more optimistic about their effort to control their physical science learning. More research should be done to investigate the program the American students were enrolled in and more effort should be needed to search for the difference and similarity between the American and Chinese high school physical science teaching and learning.

One more possible future research is to investigate an equivalent American IB certified high school students' epistemological beliefs regarding fixed ability and effort in learning physical science. The confusing factor of students' academic program will then be eliminated. Thus, the comparison made between American and Chinese students' epistemological beliefs in terms of the sources of ability to learn will be more authentic.

Another possible future research could be done in an international school operated by Americans and where the American educational environment is fostered in Shanghai. In this American owned international school with diverse students sources, IB programme is also provided. Thus, comparison between its students' epistemological beliefs regarding effort and fixed ability with the American students in this research would be more appropriate. More interesting questions could be addressed in this future research because of the diversity of this international school. Cross cultural research and within cultural research could be investigated simultaneously since in this school, when educational environment is controlled, students from west and east might possess different epistemological beliefs from their social, cultural and familial contexts and generate different learning results.

7. Do you make good grades in physics or chemistry?

- a.) Strongly agree.
- b.) Agree
- c.) Neutral
- d) Disagree
- e) Strongly disagree

8. If someone is having trouble in physics or chemistry, studying in a better way can make a big difference.

- (a) Strongly disagree
- (b) Somewhat disagree
- (c) Neutral
- (d) Somewhat agree
- (e) Strongly agree

9. Someone who doesn't have high natural ability can still learn the material well even in a hard chemistry or physics class.

- (a) Strongly disagree
- (b) Somewhat disagree
- (c) Neutral
- (d) Somewhat agree
- (e) Strongly agree

10. Given enough time, almost everybody could learn to think more scientifically, if they really wanted to.

- (a) Strongly disagree
- (b) Somewhat disagree
- (c) Neutral
- (d) Somewhat agree
- (e) Strongly agree

11. To be successful at science...

- (a) Hard work is much more important than inborn natural ability.
- (b) Hard work is a little more important than natural ability.
- (c) Natural ability and hard work are equally important.
- (d) Natural ability is a little more important than hard work.
- (e) Natural ability is much more important than hard work.

12. Read the following conversation between Anna and Emily. Then decide if you agree with one or the other.

Anna: I just read about Kay Kinoshita, the physicist. She sounds naturally brilliant.

Emily: Maybe she is. But when it comes to being good at science, hard work is more important than "natural ability." I bet Dr. Kinoshita does well because she has worked really hard.

Anna: Well, maybe she did. But let's face it; some people are just smarter at science than other people. Without natural ability, hard work won't get you anywhere in science!

- (a) I agree almost entirely with Anna.
- (b) Although I agree more with Anna, I think Emily makes some good points.
- (c) I agree (or disagree) equally with Anna and Emily.
- (d) Although I agree more with Emily, I think Anna makes some good points.
- (e) I agree almost entirely with Emily.

APPENDIX B

RECRUITMENT LETTER TO THE PHYSICAL SCIENCE TEACHERS IN AMERICA

March 21st, 2013,

Xiaolan Li is conducting a research project for her dissertation. The title of the project is, *The Effect of Asian Origin, Culture and Learning Beliefs on High School Students' Physical Science Learning Beliefs*. The purpose of this research is to investigate if the Chinese high school students from the mainland of China who are motivated to come to study in the American universities, the Asian American high school students and American high school students of other groups are different in their learning beliefs in learning physical science. The survey is conducted through Survey Monkey and the link to it is <http://www.surveymonkey.com/s/BBNQT9W>. The risk of the research to your students is minimal or non-existent. Your students' participation is strictly voluntary and their identity will not be revealed. Participating in the study will subject your students to no risks greater than those your students normally encounter in everyday life.

If you are willing to let your students participate, please let me know as soon as you can, hopefully no later than April, 18th, 2013. My email address is xiaolan.li@eagles.usm.edu. Thank you for your time and consideration of this very important matter. With great anticipation, I look forward to working with you and your students to complete this project. I realize that your time is very valuable, and appreciate all your help with this study.

Sincerely yours,

Xiaolan.Li

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