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Note to Contributors

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We accept manuscripts on every aspects of education. We only accept four types of manuscript: Editorial, Short Communication, Article, and Review. Editorial is an invited perspective written by our editors. Review is solicited and welcomed from the experts in corresponding research fields. All manuscripts should be submitted online. In addition, the following suggestions may serve as a general guide.

Authors should note that they are writing for an international audience. National colloquialisms and idiomatic use of language should be avoided to the extent possible. Word choices and sentence constructions that might imply bias against persons on the basis of gender, racial or ethnic group membership, disability, sexual orientation, or age should be avoided.

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Judicious selection of references is an important function of the authors. Cited references should be listed alphabetically according to author, and the author's last name and publication year should be used in the text. The full title of each paper should be given. Each citation should be checked with the original publication to avoid embarrassing errors. The system used in the Chemical Abstracts for abbreviations of journal names should be followed.

The length of a paper is no measure of its quality, and it is only the latter that determines acceptability for publication. However, practical considerations make if desirable to set a provisional limit of 10,000 words of the main text that does not include tables, figures, and references; and at least 1,000 words for each accepted paper should have for the main text. The acceptability of a manuscript cannot, of course, be finally decided until the finished product has been examined. The acceptance is contingent upon the advice of the Editor-in-Chief of the *SIEF*.

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Authorized Organization for Manuscript Collection in China Mainland

(中国大陆地区授权组稿单位)

China Tao Xingzhi Research Association –
Wisdom Education Institute

中国陶行知研究会智慧教育研究院

EDITORIAL

Inaugural Preface of *Science Insights Education Frontiers*

WITH continuing globalization, education in today's world is changing every year. Whether it is a researcher who studies theory, or an instructor engaged in the practical work of education and teaching, educational professionals are constantly thinking about various problems in education, pursuing excellence and actively exploring at the forefront of theory and practice. In order to disseminate the results of educational theorists and practitioners in a timely manner, and to enable the world's educational community to keep abreast of the most cutting-edge theoretical research and practical exploration results, we edited and published the journal *Science Insights Education Frontiers.*

Science Insights Education Frontiers is a global professional journal of education. It is aimed at educational professionals from all over the world, including researchers engaging in studies related to education, psychology, and physical education, teachers and principals working in primary and secondary schools, college students studying pedagogy, postgraduate and doctoral students doing research in various educational research organizations, as well as those enthusiastic about education reform and development.

Our journal focuses on the realities of education in the world, pays attention to cutting-edge educational theory research and the latest achievements in educational reform and experimentation, tracks hot topics in educational practice around the world, and promotes advanced education and teaching experience to a diverse and global audience.

Based on this, we will set the main sections as follows: frontiers of educational theory research, frontiers of educational practice, educational empirical and experimental research, school education and teaching reform cases, professional development, curricula and teaching, moral education, academic conference review, education Pen talks, cutting-edge newsletters, and so on.

We hope that through our efforts, we not only aid the dissemination of educational theoretical research and practical exploration, but also provide a platform for educators to communicate. Through the process of discussing and sharing the frontier issues of education, we can jointly promote the reform and development of education and contribute our strength to the realization of a beautiful educational ideal.

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EDITORIAL

Education in the New Era

WHAT does it mean to be educated in this new era? With the emergence of technology and technological solutions, education is not as it used to be. While many have argued that technology has done more harm than good to education, there has been major development to the face of education, especially in this new era. Before you can understand this concept, you need to understand what education looked like before this era.

The earliest formal school was in Egypt, but it was only available to royal offspring and sons of the rich, physicians, scribes and temple administrators. Here, their education was restricted to the duties that they performed. Also girls were not allowed education, as they stayed home with their mothers learning cooking and household duties. But as school became more widespread in China, France, India, and other empires and provinces, more population became literate, including women. Different empires and provinces had different styles of formal education, but one thing was common to all of them; education was restricted to enabling moral enlightenment. Also, the percentage of people who had formal education was few, as it was restricted to a few privileged people.

During the early middle ages, the monasteries of the Catholic Church were the hub of formal education. As such, the first schools in this time were monastic schools, where the teachers were the monks and priests. Students were proud of their masters and unlike education in the early times, it was mostly free. This was because the church mandated that every priest and monk educated their flock. The curriculum was also restricted to the liberal arts such as music, poetry, dancing, writing and speaking.

Coming down to the fifteenth century, schools derived their origins from the monastic schools of the middle ages and as such had religious bases and free education for the poor was mandated by the church. However in the seventeenth century, a new form of education was adopted, which moved from the liberal arts curriculum to a more universal one. Rather than specializing in one or more of the arts, subjects were broad, although mostly science related.

Increasing interest in education from the authorities caused an analysis into teaching methods and in 1884, there was an education conference in London, which attracted education experts from all over the world and caused a shift in the educational systems.

Since then, education has undergone major developments, especially with the proliferation of technology, showing major difference between education of the old era and the new era. In the new era, schools are secular and

publicly owned, although there are still private schools owned by religious organizations.

In most countries, education in the new era is compulsory up to the age of 16. In fact, there have been major strides in increasing the dropout age to 18. Also, more women hold degrees of higher education, as compared to education in the old era which restricted women from getting educated.

Because technology influences the types of job people can have, making conventional jobs obsolete, educational systems are changing to accommodate these new trends. This is seen in the proliferation of new courses of study. According to Tony Wagner, in 'Creating Innovators: The Making of Young People who would Change the World.' thriving in this new era would require real competence rather than good grades. As a result of this trend, schools are no longer focused on conventional subjects, but on building educated persons who are creative and can think critically. This they achieve through internships, community service, personal school projects, etc.

In the new era, students can opt for laptops, smart phones and tablets, instead of books, which can be destroyed and cause loss of information. Also, education is no longer restricted by distance, because students can have access to education from the comfort of their bedrooms, through distance learning portals. Access to learning materials is unprecedented in the new era, as podcast, videos, audios and even books can be downloaded from the internet. Teachers also have ease of teaching, as they are not the primary source of information. The role of teachers is gradually shifting to guides, as students take more responsibility for their learning. Technology has also aided them in creating instructional materials and also in enhancing their teaching materials.

Furthermore, student learning experience is enriched as they can collaborate with other students from farther places using technology. They can even learn from the results of research carried out by other students, made possible by the internet. They can collaborate on projects through the use of Google docs, and other available applications.

Since the early age when education developed in Egypt, education has gone through developmental phases, showing remarkable changes in the new era. Technology has been a major determinant in this development, because it has changed the way people get educated. Education in the new era is still a work in progress as more changes will be observed in the near future.

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META-ANALYSIS

A Meta-Analysis on the Effects of STEM Education on Students' Abilities

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Abstract. Does STEM education improve students' higher-level thinking and cognitive abilities? So far, empirical research has not yielded consistent conclusions. As such, this study applied the method of meta-analysis to synthesize quantitatively existing research to better understand STEM and its effects on students' abilities associated with learning. The study found that STEM education is conducive to improving students' higher-order thinking and cognitive ability levels with an effect size of (d = 0.798). The results indicate that teaching methods and student experiences in STEM education have a positive effect on student learning.

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***Keywords**: STEM education; Higher-order thinking; Higher-order cognitive abilities; Student learning*

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***Conflict of Interests**: None.*

SINCE the 1980's, when the National Research Council (NRC) advocated strengthening undergraduate sciences, mathematics, engineering, and technology education, STEM education was implemented in the United States. It has been gradually expanded from higher education to K-12 education. During this transition, various departments of the federal government issued large numbers of policies and reports to increase STEM education and putting in place financial inputs to ensure implementation. One of the most prominent reasons for doing so was to maintain the United States prominent roles in world politics and economics (Thomasian, 2007; CoSTEM, 2013; Honey et al., 2014). The realization of the strategic significance of STEM education had a number of other countries around the world also begin experimenting with STEM education (Marginson et al., 2013). These actions have led researchers, primarily in education, to analyze whether STEM education is conducive to improving students' learning abilities.

To this point, STEM education evaluation has mainly focused on the outcomes of students. As far as the content of the evaluation is concerned, it includes not only the students' academic achievements, but also, measurements of their abilities and tendencies towards subject learning and employment. For instance, a general assessment system built by the STEM Education Association in Portland, Oregon, required the measuring of students' use of knowledge, higher-level cognitive abilities, academic acceptance, and motivational resilience (Saxton et al., 2014). The National Research Council also reported that it was not sufficient to only be concerned with students' test scores when evaluating STEM education, but to also consider the impact on students' interests, creativity and behavior. However, there is no agreement on whether and how much STEM education affects students' abilities to learn. Yildirim (2016) systematically analyzed the improvements of students' innovative abilities through STEM education; but, failed to specify to what extent are its affects. Sarac (2018) posited that STEM education can improve students' scientific process skills (d = 0.820); yet, did not answer whether STEM education can help to improve the skills required by STEM professionals in the broader context. In contrast to the relatively optimistic findings of the aforementioned, Jang (2016) pointed out that STEM education did not assist the 18 important abilities of STEM professionals, and therefore, a more cautious approach to the effectiveness of STEM education needed to be taken.

Literature Review and Theoretical Framework

STEM Education

Research has not yet formed a unified understanding of STEM education. Carmichael (2017) analyzed the policy texts of various states in the United States and found that the states, for the most part, had different understandings of STEM education and how it was to be implemented. Hence, defining the operations of STEM education became a primary objective.

The STEM Education Act of 2015, defined STEM education as "education in science, technology, engineering, mathematics and other fields, including education in computer science" (US Congress, 2015). The stringent focus on subject areas failed to make a comprehensive summary of the rich connotation of STEM education (Sanders, 2009.

We believe that a more reasonable and comprehensive definition of STEM education is needed to better reflect the developmental process and full characteristics of the program. In its early stages, STEM education focused on the knowledge of subjects and ignored the links (Atkinson & Mayo, 2010), which to some degree weakened students' interest in STEM subjects and lowered their academic performance (Kelley & Knowles, 2016). For this reason, the United States has proposed further reforms, including the implementation of STEM integrated education, thus to enhance students' interest and ultimately improving their learning achievements (Honey, et al., 2014). This integration of the disciplines expanded the effectiveness by way of integrating them to real-world situations and problems, using problem-based, inquiry-based, and project-based learning.

From the perspective of STEM education, we consider that STEM education has two outstanding characteristics: first, it emphasizes the integration of science, technology, engineering and mathematics; and, secondly transforms traditional teaching models to a student-center model. As defined by the National Association of High Schools, STEM education is one that breaks the boundaries of traditional subjects and integrates teaching and learning of science, technology, engineering and mathematics as a guide that encourages students to solve problems using their newly learned knowledge. All in all, we defined STEM education as: an education approach which based on authentic environment and integrate science, technology, engineering and mathematics or more other subjects by students-centered learning model, such as project-based learning, design-based learning, inquiry-based learning and so on, to cultivate students' ability and improve their achievement.

Higher-order Thinking and Higher-order Cognitive Abilities

Bloom et al. (1956), classified educational goals as to being: knowledge, comprehension, application, analysis, synthesis and evaluation. Many scholars regard knowledge as low-order thinking and of low cognitive ability; whereas, the other remaining skills from Bloom's Taxonomy as being higher-order thinking and of higher cognitive abilities (Miri, 2007). Wood (2007) divided higher-level cognitive abilities into three dimensions: problem-solving, evidence-based discussion, and metacognitive. Considering the prominent purpose of education to develop skills more than knowledge, scholars have explored the influence of different teaching methods. Hemlo & Ferrari (1997) examined how to cultivate students' higher-order thinking based on problem-based learning. Hopson (2001) found that the application of educational technology in classroom teaching can also improve students' higher thinking abilities. Lastly, Zohar and Dori (2003) dis-

covered that after attending training projects using of high-order thinking abilities, poor performing students had a larger net increase compared to higher performing students.

The Relationship between STEM Education and Students' Abilities

In existing empirical literature, results on the relationship between STEM education and students' abilities are inconsistent. Some studies indicate that STEM education can significantly improve students' abilities levels and there is a large effect size. For example, Fan and Yu (2017) found that engineering-based technology education showed large improvement ($\eta^2 = 0.18$) in high school students' higher-order thinking. Li et al (2016) discovered that when comparing with non-STEM education, STEM education significantly improved students' problem-solving abilities (d = 0.526). However, other studies had noticed STEM education, though beneficial to students', was much less effective. Cakir et al (2016) found that STEM education had improved the level of students' reflective thinking abilities, but at a rate of (d = 0. 1319). Psycharis & Kallia (2017) study on computer programming-based learning saw only a small influence on students' critical thinking (d = 0.229). Then, there were studies that observed no effects on students' abilities levels, such as, Choi and Hong (2015) (creative problem-solving) and Anwari (2015) (metacognition).

Further studies realized that the effectiveness of STEM education can be influenced by external factors. Inman (2011) discovered that STEM education can improve students' scientific inquiry abilities; yet, the degree of effectiveness was influenced by socio-economic factors. Taylor (2016) research showed that students' experience in STEM education would affect the improvement of problem-solving ability, and the effect of STEM education is better for novice students.

Based on the above review, this study will focus on answering the following three questions through meta-analysis:

1) Is STEM education conducive to improving students' abilities?
2) To what extent does STEM education affect students' abilities?
3) During the process of STEM education, what factors will be influenced?

Research Method

The method used for the study was meta-analysis which is a quantitative synthesis method to review literature. Initially, this method was applied to synthetically evaluate results of clinical psychology research. Compared with traditional methods, which often relied on subjective judgments, meta-analysis is objective, systematic, and evidence-based. Thus, gaining acceptance in the fields makes up the social sciences (Lipsey & Wilson, 2011).

On the whole, the main steps of meta-analysis are: 1) enacting inclusion criteria; 2) searching and filtering documents; 3) coding documents and extracting data; 4) assessing the quality of the included documents; 5) calculating the mean effect size; 6)

analyzing heterogeneity; and, 7) testing publication bias and sensitivity. These steps were followed to answer the research questions posed in this study.

Inclusion Criteria

We collected and screened selected literature according to the following inclusion criteria:

(a) The literature enrolled was published in English between 1996 and 2018 and the type of literatures was not limited. After all, English is an internationally accepted academic language and most of the research on the effects of STEM education is published in this language.

(b) The content focuses on STEM education and students' abilities in elementary education. As well, the impact of STEM education on the abilities of students' in elementary education, excluding special education, vocational education, and after school programs.

(c) Literature that included comparisons between STEM education and non-STEM education using effect size. Evaluations were made using the criteria of Cheung and Slavin (2013a) – large differences in pretest were excluded (ES > 0.5) and randomized trials without pre-test are included.

(d) At least two teachers were teaching the experimental group and the control group had to be separated to minimize the impact of teacher factors. This was done because if the two groups were taught by only one teacher, the independence of the intervention could not be guaranteed.

(e) To avoid possible deviation of experimental results, students were not alerted of the reason for doing specific functions.

(f) The sample size of the experimental group and control group were similar. This was done to avoid bias.

(g) The statistical information needed to be sufficient, so that, effect size could be calculated.

Searching and Scaffolding Documents

The key terms used during Google Scholar and ERIC searches included: STEM education, higher-order cognitive skills, higher-order thinking, creative skills, innovation capacity, creativity, problem-solving skills, problem-solving ability, ability, skill. In all, 28012 studies were found and designated for this study. A further breakdown is shown in **Figure 1**.

Coding and Data Extraction

In heterogeneity analysis, the literature should be grouped according to research design and sample characteristics. Therefore, coding was done accordingly:

(a) Gender (Ge): female code-0, male code-1. Samples containing male and female was reported as 2 and unreported samples as null.

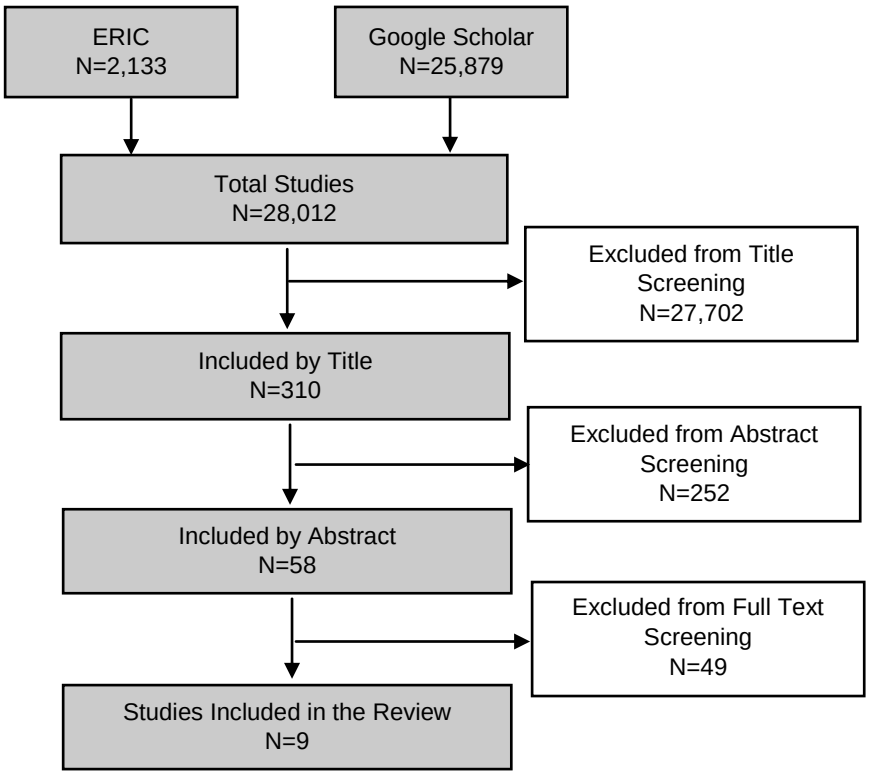

Figure1. Search and Screening Process.

(b) Family socioeconomic background (SES), Low SES coded-l, medium SES coded-m, high SES coded-h. A sample containing low, medium and high SES was coded-mix, and unreported samples coded-null.

(c) Race (E), White coded-w, Afro-American coded-b, Asian coded-a, Hispanic coded-h, and others code-o. A sample contains multiple ethnic groups code-mix, and for non-reported code-null.

(d) Grade (Gr): K-5 code-P, grade 6-8 code-m, grade 9-12 code-h.

(e) Ability type (AT)

(f) Area (Lo)

(g) STEM Teaching Method (TA), Project-based Learning coded-PBL, Problem-based Learning (PBL) coded-pbl, Inquiry-based Learning coded-IBL, Design-based Learning coded-DBL, and other STEM educational measures were coded-other.

(h) Research design (Rd), the quasi experimental design coded-QE, and the random experimental design was coded-re.

(i) Duration of intervention (D), According to the length of the experiment, it was divided into four levels: 0-2 months, 2-4 months, 4-6 months, 6 months+.

(j) Sample size (Ss), using the guidelines set out by Cheung & Slavin (2013b), studies with a sample size greater than 250 were designated as large sample studies, and studies with a sample size less than 250 were assigned as small studies. Accordingly, we coded the large sample studies as l and the small sample studies as s. (**Table 1**)

Table 1. Details of Included Research.

Study	Ge	SES	E	Gr	TA	D	AT	Lo	Ss
Childress, 1996	Null	Null	Null	M	Other	0-2 mo	Problem-solving skills	USA	Small
Eseryel, 2011	2	Null	Null	M	Other	2-4 mo	Problem-solving skills	USA	Large
Lartson, 2013	2	Mix	Mix	H	DBL	2-4 mo	Problem-solving skills	USA	Small
Kibett, & Kathuri, 2015	Null	Null	Null	M	PBL	2-4 mo	Higher-order cognitive skills*	Kenya	Small
Rehmat, 2015	2	Null	Mix	P	Pbl	4-6 mo	Critical thinking	USA	Small
Robinson, et al., 2014a	Null	Null	Null	P	IBL	6 mo+	Science process skills	USA	Small
Robinson, et al., 2014b	Null	Null	Null	P	IBL	6 mo+	Science process skills	USA	Small
Cotabish, et al., 2013	2	Null	Null	P	IBL	6 mo+	Science process skills	USA	Large
Psycharis, & Kallia, 2017a	2	Null	Null	H	Other	0-2 mo	Critical thinking	USA	Small
Psycharis, & Kallia, 2017b	2	Null	Null	H	Other	0-2 mo	Reasoning skills	USA	Small
Hashem, 2015a	2	Mix	Mix	M	Other	2-4 mo	Critical thinking	USA	Small
Hashem, 2015b	2	Mix	Mix	M	Other	2-4 mo	Critical thinking	USA	Small

*: The author does not specify which ability is tested in the higher-order cognitive ability dimension, but is generally referred to as "higher-order cognitive skills".

Quality Assessment of Studies

Considering that meta-analysis is a method of quantitative synthesis of existing research, the quality of the included literature will affect the quality of the final results. Referring to Valentine & Cooper's (2003) method for evaluating the quality of literature, this study assessed the quality from five aspects: whether the literature clearly described the interventions, research design, sample characteristics, testing tools and measurement processes (unclear-1, somewhat clear-2 and clear-3). As **Table 2** shows, the quality of the literature included was high enough to meet the needs of this study.

Table 2. Document Grades.

Study	Intervention	Research Design	Sample Characteristics	Test Tool	Measure Process	Total
Childress, 1996	2	2	1	1	2	8
Eseryel, 2011	2	2	1	2	2	9
Lartson, 2013	3	3	3	2	2	13
Kibett, & Kathuri, 2015	2	2	1	2	2	9
Rehmat, 2015	3	2	2	2	2	11
Robinson, et al., 2014a	3	2	1	2	3	11
Robinson, et al., 2014b	3	2	1	2	3	11
Cotabish, et al., 2013	2	2	2	2	2	10
Psycharis, & Kallia, 2017a	2	2	1	2	1	8
Psycharis, & Kallia, 2017b	2	2	1	2	1	8
Hashem, 2015a	3	2	3	2	3	13
Hashem, 2015b	3	2	3	2	3	13

Analysis of Result and Discussion

Combining Effects

This study used Comprehensive Meta-Analysis Vision 2 software to calculate the effects. From the selected samples, it cannot be assumed that the reported effects of all documents were consistent and the results of the heterogeneity reported a significance of ($Q = 58.950$, $p < 0.0001$). Therefore, a random-effect model (Michael Borenstein et al., 2009, p83) was used for further analysis. Used was the "one study removed" method to exclude possible outliers. The principle behind this method was to enable calculation of the average effect of the documents. If the deviation between the calculated average effect and the original value was too large, the documents were deemed as abnormal values and were not included in the final effect analysis (Young, et al., 2017. As shown in **Table 3**, the effects of the studies were distributed between 0.229 and 1.647. Eight of the effects were statistically significant and the remaining three were not significant. The combined effect $d = 0.798$ ($p < 0.0001$) in the random effect model was calculated, which was a moderate effect according to Cohen's (1988) criteria. To a certain extent, this result can answer questions 1 and 2, STEM education is conducive to improving students' higher-order cognitive abilities and higher-order thinking abilities. It also shows that STEM education can cultivate students' ability to meet the needs of the STEM labor market.

Table 3. Effect and Combined Effect Volume.

Study	Ability	Statistics for Each Study						
		Cohens'd	SE	Variance	Lower limit	Upper limit	Z-value	p-value
Childress, 1996	Problem-solving skills	0.551	0.355	0.126	-0.145	1.246	1.552	0.121
Eseryel, 2011	Problem-solving skills	0.303	0.131	0.017	0.047	0.559	2.316	0.021
Lartson, 2013	Problem-solving skills	1.015	0.248	0.062	0.528	1.502	4.088	<0.0001
Kibett, & Kathuri, 2015	Higher-order cognitive skills	1.647	0.186	0.035	1.283	2.011	8.865	<0.0001
Robinson, et al., 2014a	Science process skills	1.437	0.276	0.076	0.897	1.978	5.211	<0.0001
Robinson, et al., 2014b	Science process skills	0.585	0.191	0.037	0.209	0.960	3.054	0.002
Cotabish, et al., 2013	Science process skills	0.497	0.077	0.006	0.346	0.649	6.430	<0.0001
Psycharis, & Kallia, 2017a	Critical thinking	0.229	0.254	0.064	-0.268	0.726	0.902	0.367
Psycharis, & Kallia, 2017b	Reasoning skills	0.502	0.260	0.067	-0.007	1.011	1.933	0.053
Hashem, 2015a	Critical thinking	0.800	0.235	0.055	0.340	1.260	3.408	0.001
Hashem, 2015b	Critical thinking	1.408	0.331	0.109	0.759	2.056	4.255	<0.0001
Mean ES		0.798	0.143	0.021	0.517	1.079	5.568	<0.0001

Analysis of Heterogeneity

We used moderator analysis (Yong et al., 2017) to explore the source of heterogeneity. Due to the insufficient sample characteristics reported in the literature, this study was unable to treat gender, SES and ethnic variables as moderators and, at the same time, Kibett & Kathuri (2005) study did not report the items under higher-order cognitive skills, so ability type was excluded. Consequently, grade level, STEM education approaches, experi mental duration and sample size were chosen as moderators to test heterogeneity. Test results (see **Table 4**) showed STEM education approaches as the leading factor of heterogeneity ($Q_B = 39.101$, $p < 0.0001$), meaning different STEM education approaches had different effects on students' abilities. Teaching approaches and project-based learning had the best effects, while problem-based learning had no effect on the improvement of students' abilities. There was only one study dealing with

Table 4. Analysis of Moderators Effect Size.

Moderator		K	Q_B	ES	95% CI		p-value
Grade level	Primary school	3	4.026 (p=0.134)	0.568	0.432	0.705	<0.0001
	Middle school	5		0.793	0.616	0.970	<0.0001
	High school	3		0.589	0.302	0.877	<0.0001
STEM education approach	DBL	1	39.101 (p<0.0001)	1.015	0.528	1.502	<0.0001
	IBL	3		0.568	0.432	0.705	<0.0001
	Other	4		0.342	0.143	0.541	0.001
	PBL	3		1.335	1.074	1.596	<0.0001
Duration	0-2 mo	3	8.024 (p=0.017)	0.401	0.085	0.718	0.013
	2-4 mo	5		0.835	0.663	1.006	<0.0001
	6 mo+	3		0.568	0.432	0.705	<0.0001
Sample size	Large	2	21.774 (p<0.0001)	0.447	0.317	0.578	<0.0001
	Small	9		0.938	0.778	1.097	<0.0001

problem-based learning and the result was that it had no effect on improving students' abilities (this area needs further study). Moderator's experimental duration and sample size indicated influence on the mean effect size ($Q_B = 8.024$, $p = 0.017$). As for experimental duration, STEM education is more efficient during 2-4 months, longer or shorter intervals had suboptimal results. Robinson and his colleagues (2014) found students during the first year of STEM education perform well in the science process skill tests but not as well in the second year. Taylor (2016), meanwhile, found that effects of STEM education can be influenced by students' learning experiences. Novice learners gained more learning than those students considered higher achievers. It appears as the STEM program goes on, the impact of STEM education on student abilities gradually declines. Grade level was the only factor that had no significant influence on the mean effect size, which means that STEM education is suitable for all K-12 students.

In regard to research question 3 of this study: it was found that STEM education approaches and students' learning experiences are the moderator variables on students' abilities. The results, though, could not identify whether the demographic factors and ability types had any impact on the mean effect size of STEM education.

Publication Biases and Sensitivity Testing

In the meta-analysis process, a funnel plot is commonly used to test for publication bias. If there is publication bias, it will lead to skewed final result and the calculated mean effect size would need to be treated with caution. The publication bias test for this study

is shown in **Figure 2**; results show a funnel plot that is basically symmetrical, meaning that there is no publication bias.

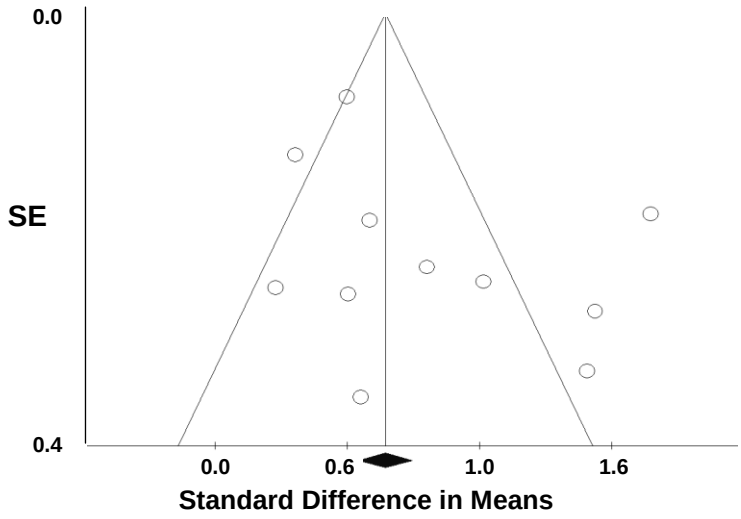

Figure 2. Publication Bias Test (funnel figure).

In order to judge the robustness of the analysis results, a classic fail-safe N test was used. This test was employed to calculate the minimum number of unpublished studies that could reverse the final results, in particular, in the area of robustness. A larger N means that the difference between the included studies and excluded studies would affect results more so; hence, the results of the meta-analysis would be more robust (Rosenthal, 1979). This study's fail-safe N was 449 ($p < 0.0001$), which means we needed to include an additional 449 studies to attain robustness.

Limitation of Research

There are two limitations in this meta-analysis. First, the number of included studies is slightly insufficient. The main reason for this deficiency is that there are few empirical studies on the relationship between STEM education and students' abilities, especially in the Asian region. Secondly, when studies were included, we limited the research design to two experimental design groups. Though, the process of exploring for causal relationships between variables are the standard, this criterion would have declined the sample size of this study's meta-analysis.

Findings and Conclusions

The meta-analysis used to synthesize existing empirical research on the relationship between STEM education and K-12 students' higher-order thinking and cognitive abilities found that STEM education is conducive to improving students' ability levels. The mean effect size ($d = 0.798$, $p < 0.0001$) is large enough to support this conclusion using Cohen (1988) principle. The results for heterogeneity analysis indicated that both STEM education processes and students' learning experiences can influence the effects of STEM education. Lastly, there was no significant difference in STEM education effect among students for different grades, indicating that STEM education is an effective model for all K-12 students' development of higher-order abilities.

Based on the research of this paper, it is concluded that there are still many gaps, yet, to be filled. First, researchers have supported the hypothesis that STEM education has more effect on students' achievement than non-STEM education (Becker & Park, 2011； Sarac, 2018), but it lacks enough studies to fully explain which STEM education practices would best fit for specific subjects and learning environments. Secondly, more research is needed to identify which factors influence the effects of STEM education in the area of human capital accumulation. For instance, groups such as women, African-Americans, Hispanics, and Asians are disproportionately underrepresented in current STEM education research (Beede et al., 2011; Koch et al., 2011; US Department of Education, 2016).

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ORIGINAL ARTICLE

Evolution of China's National Policies for Higher Vocational Education Since the New Millennium

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Abstract. This paper explores the evolution of China's national policies issued by the Ministry of Education for its higher vocational education (HVE) across different stages over the two decades in 21st century. In the bigger context of market economy that demands HVE to play its role in promoting human capital, the intents of HVE policies issued at each of the three important stages are analyzed in detail. Then primary major progresses of the sector are charted out, and challenges and prospects are discussed. The paper identifies important strategies through which national HVE policies intend to improve the sector's overall quality to generate human power, including expanding size for the whole HVE sector, transferring responsibility to provincial and local governments to improve efficiency, enhancing teacher quality, increasing program coverage, increasing praxis elements, completing assessment scheme, selecting model institutes to create impetus for growth, adopting the strategy of group schooling to mobilize more resources to the sector, promoting international cooperation, instituting a credit system and so on. The primary progresses of HVE due to the series of policies are mainly manifest in size growth, structure completion, and raising social recognition. Challenges and concerns, however, remain to be resolved in terms of the sector's ability to generate sufficient qualified manpower.

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IN China's governmental discourse and academic domain, Mr. Deng Xiaoping's talk on socialism in 1992 has been viewed as a turning point for the nation's reform and opening up in history. Deng, as the most powerful former leader who remained practically influential even after his retirement in the ruling Chinese Communist Party, remarked when he investigated the newly-established special economic zone in the southern city of Shenzhen that 'the essence of socialism is to liberate and develop productivity force, eradicate exploitation, eliminate polarization, and eventually achieve the goal of common wealth' (Deng, 1993). The talk has been viewed by many with greater significance inasmuch as for the first time a Chinese leader tended to bring in and promote the concept of market economy for the country's continued reform and opening up course that had begun since 1978. Long before 1992, almost every sector of the economy was planned, and although there had emerged debate about planning and market in the late 1980s, nobody would dare to take bold actions in doing business without supportive policies allowing so. Deng's remarks set the tone and encouraged the nation to take bolder actions by stating that 'a planned economy or market economy is not what distinguishes socialism from capitalism.' To 'further liberate the productivity' (Deng, 1993) was emphasized much as the ultimate goal in his talk for the nation's economic development.

Against such backdrops, several years after this important talk on China's future, market economy was popularized in many sectors of the economy and increasing competitiveness to secure the market instead of simply waiting for governmental subsidy was viewed as a key to survival and success. A post-secondary education that could meet the demand for skilled talents for various industries was thus unprecedentedly needed, and the role of higher vocational education (HVE) in the late half of the 1990s was emphasized with louder voices by the government for future economic boost.

Distinctive from general higher education provided by comprehensive universities, Higher Vocational Education (HVE) in Chinese education system refers to the post-secondary level skilled manpower-oriented and employment-oriented education whose direct purpose is to serve local economic development (Luo & Fang, 2011, pp. 225). A critical time point – the year of 1996 – has to be mentioned, when the Vocational Education Law of People's Republic of China was established and Higher Vocational Education (HVE) was legitimized with two other levels of vocational education: junior vocational education and secondary vocational education, resulting from numerous debates about the position and function of vocational education in the society. In 1998, the passage of another significant law – Higher Education Law formally includes HVE as a true and important part of tertiary education, thus HVE secured its position in legal terms for the first time since the founding of People's Republic of China. Since the early 21st century, against China's two important backdrops – higher degree of economic

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marketization following entry into the WTO and expansion of the higher education sector, the demand for more skillful graduates provided by the HVE sector has been even higher, and these two backgrounds lay the foundation for HVE's development in the later nearly two decades to come.

One influence that marketization in the economic sector and the whole reform agenda exerts on the vocational education sector is represented by the national governments' granting rights to the establishment and management of HVE institutions to provincial-level governments, as we will continue to explore in the rest of the paper. The national government, however, mostly represented by the Ministry of Education, remains powerful in putting forward policies of guidance for all subordinated level HVE stakeholders to follow. Thus, the exploration of national policies on HVE development does assist insights into the direction and string of thoughts as to China's HVE's development as a whole sector. In the 21st century, following the formalization of Vocational Education Law and the legalization of HVE sector as an indispensable part of tertiary education, the Chinese Ministry of Education has put forward a series of policies touching a variety of aspects for HVE's advancement.

Figures 1 and **2** display the position of HVE in the overall Chinese education system at large. In terms of vocational education, the earliest stage is the junior secondary vocational education, followed by three types of senior secondary vocational education, and then postsecondary vocational education. One point worth mentioning is that currently junior secondary education, though extremely rare in rural areas, still exists mostly in rural areas where there is much less developed economy (Guo & Lamb, 2010, pp 19), indicating that there is indeed early education stratification in some less developed areas of China. Another point to mention is pertaining to the subtle change in the name of the sector. In Fig 1, the postsecondary level Higher Technical Vocational Education (HTVE) which literally means "*高等技术职业教育*" in Chinese language has been replaced by "*高等职业教育*" literally translated as "Higher Vocational Education" by the academic domain and the government discourse since 1996 when the Vocational Education Law was passed. Therefore, to be loyal to original Chinese discourse, HVE instead of HTVE is used in this paper as we investigate this sector in China.

As shown in Fig 2, HVE is involved in a three-level administrative structure: national level, local level and institutional level. At the national level, while Ministry of Human Resources and Social Security and Other Ministries of Industry and Trade occasionally release policies concerning HVE development or students' employment, the Ministry of Education remains the main ministerial administrative and instructive body to guide HVE development nationwide, even after it passes the rights of approving newly-established HVE institutions to provincial-level governments in 1999.

Against such backdrop, the research questions underpinning this paper's analysis include:

1) What is the trajectory of China's HVE policy evolution in the 21st century when China needs a tremendous amount of human capital to underpin its economic development and transition?

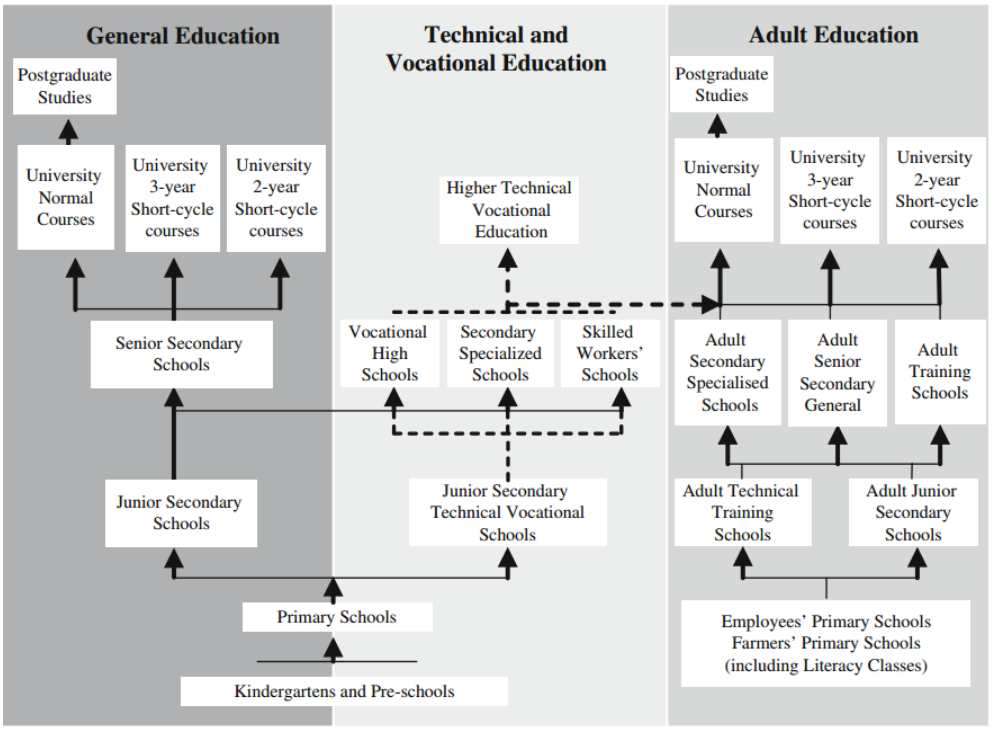

Figure 1. The Overall Structure of China's Education System.
Source: Guo and Lamb (2010, pp 19)

2) What are the ideas behind the different policies issued at various stages in terms of HVE's contributions to the development of human capital?

Methodologically, official policy documents issued by the Ministry of Education constitute the main source of data for my analysis. The paper employs a historical approach to review these official policy documents by extracting and summarizing their main purposes and major influences. As the focus of this paper is on policy intent rather than policy implementation, my analysis is concentrated on how China's educational decision-making departments led by the Ministry of Education aim to advance its postsecondary vocational education rather than the formulation and implementation of one or some single policies.

The rest of the paper is organized into three major sections. In 'Policy Evolution', I chart out specific important policies officially released at various stages over the past two decades. For each of the stage, policy intents and characteristics are the focus of analysis. In the section 'Primary Progress', I analyze several important changes that took place after each stage's policy came into effect. Last, in 'Challenges and Pro-

spects', the barriers to overcome and the five key aspects of problems in the HVE sector to be addressed in years to come are illustrated.

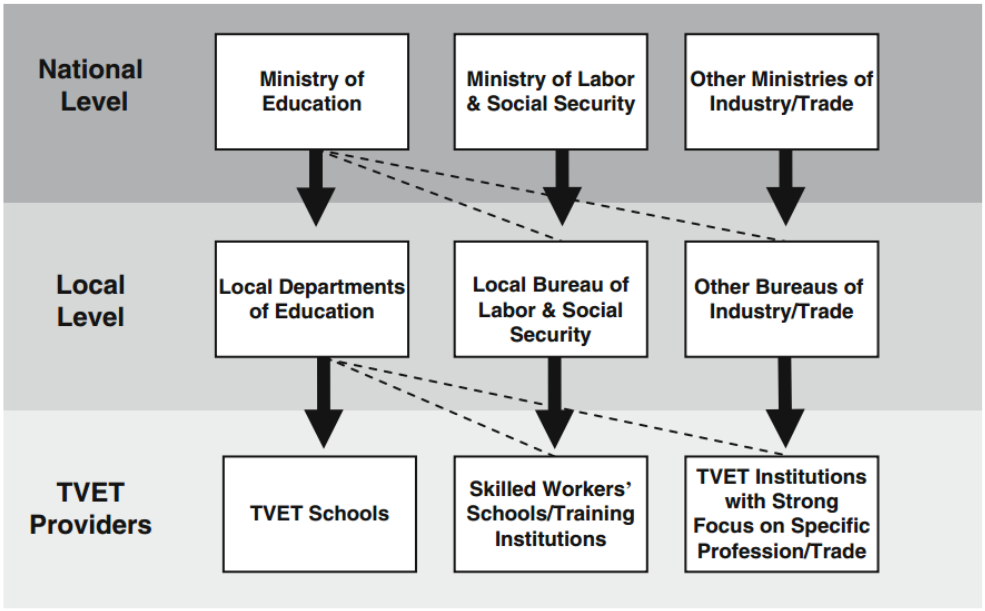

Figure 2. The Administration of Vocational Education in China.
Source: Guo and Lamb(2010, pp 26)

Policy Evolution

A series of HVE policies have been issued over the past two decades to address sector problems at various stages. This paper's analysis starts from the year of 1999 marked by Ministry of Education's first policy action after the Vocational Education Law came into effect in 1996. Considering the changes taking place in the HVE sector, I divide China's almost 20 years' HVE development into three major stages --- from scratch to existence, from simpleness to maturity, and the most recent stage with a new initiative for sector innovation.

1) 1999-2005: From Scratch to Existence

Right after the legitimization of HVE sector, the Ministry of Education issued 21st Century-Oriented Education Development Initiative in 1999, in which several strings of thoughts became clear consensus: 1) expanding HVE sector to enroll more students to

enlarge the basis for producing more human capital; 2) allowing multiple types of institutions such as HVE colleges, particular schools in general universities, adult education institutions as HVE providers to draw on strengths of various social and academic forces for developing HVE; 3) gradually granting the responsibility for HVE development to provincial-level governments to enable HVE to better cater to needs of locality. However, the national educational body – Ministry of Education remains instructional by issuing policies to guide the practices of provincial and local governments, and HVE providers in terms of the direction of the country's HVE development; 4) the keywords of the goal of HVE set on 'application' to provide front-line applicable graduates in service, production and management (MOE, 1998). In 2000, the State Council (2000) released a policy document to formally grant the rights to ratifying the establishment of HVE institutions to provincial governments. Meanwhile, this document transferred the responsibility of funding HVE into provincial governments as well. But it reserved the rights of formatting standards for HVE institutions and the quality assessment standards for the national Ministry of Education. Entering the 21st century, with respect to how to further improve the quality of HVE, Ministry of Education started to write two important concepts into the documents it issued in 2000: 'Double-qualified Teachers' and 'Institution-Industry Connection'. While the latter sounds easier to understand, the former concept is more filled with Chinese characteristics semantically referring to a teacher both qualified in teaching students at institutions and qualified in industry work at the same time. This is to emphasize the government's realization of the necessity to strengthen both theory and application for HVE students, and it was this realization that the Ministry of Education further issued three guiding documents to improve the quality of teaching plan, faculty, management, and two other documents on establishing the quality assessment standards in the same year.

A total of 30 policies were issued between 2000 and 2005 to address various aspects of HVE development, including some special motivating initiatives such as the decision to build national model HVE institutions. Statistically, in 1999, there were a total of 474 HVE institutions in China, while this number almost tripled by 2005. In a similar trend, the students registered at HVE institutions increased by 7 folds from 1,112,497 in 1999 to 7,129,579 in 2005 (Luo & Fang, 2011, pp.246). The HVE expansion during these years out-speeded that of general higher education, and HVE contributed a great deal to the overall tertiary education expansion by accepting multitudes of students. In 2003, the proportion of registered students in all types of HVE institutions accounted for 42.3% of all tertiary education's registered students, and in Chinese context it was metaphorized as 'occupying the half of the whole sector' (MOE, 2015c).

For this period, HVE's legal position in China was firstly secured from none to existence, and a large number of related policies and measures were established from scratch. The boost of HVE took its form mainly in establishing many more institutions than ever before and in enrolling an unprecedented number of students with an accelerating speed one year after another. Apart from the quantity development, marketization of HVE institutions' operation was adopted, with HVE institutions having high degree of autonomous rights to running the institutions.

These strings of thoughts demonstrate the government's urgent need of applied talents for the upcoming 21st century economy, and the decision of distributing authority over HVE into provincial and local governments embodies a willingness to spark innovation in HVE management for such a centralized nation as China.

As a newly legitimatized type of tertiary education, some barriers along with the HVE's fast development emerged at this stage. Many policies were put forward in a way that 'crossed the river by feeling the stones' (Deng, 1993), and their effects were not resistant enough to withstand the test of time yet. One outcome was called "Three Nots and One High" (*三不一高*), which is actually a paradox. "Three Nots" refers to that the nation would not issue the uniformed graduation certificate; students' employment would not be automatically guaranteed as in the planned economy period; and the uniformed national college students' employment registration card would not apply to HVE graduates. "One High" refers to the new fact that the high tuition for HVE must be paid by students mostly, and the 'high' here means HVE tuition is much higher than ever before and also higher than general universities.

The fact that HVE students had to seek jobs themselves after graduation and the downgrade of HVE institutions level from national to provincial level to an extent degraded the attractiveness of higher vocational education compared with general higher education in universities, but in line with the trend of the expansion of higher education sector, including higher vocational education as well as certain clarified policy intents, many more HVE institutions started to spring up across the whole country. In addition, in the whole 1990s, the tertiary education graduate rates of China was relatively low, and the willingness of many families to send their children to HVE institutions to receive tertiary education, if they were not able to be accepted into universities, maintained high despite the fact that the cost of HVE became much higher and it had to be mostly born by families themselves.

The severely insufficient funding support by provincial and local governments forced many newly established institutions to charge students high fees, which was the fundamental reason why the aforementioned "One High" appeared, but the lack of money to a large extent limited their capacity to absorb excellent faculty and other teaching resources as well as upgrading the hardware of the institutions. While almost every institution was going great lengths to raise funds from multiple sources, this was far no match compared with the fiscal need due to the rapid expansion of student numbers.

The new sector in line with the trend of the expansion of the tertiary education at large did enroll more students, but this sector seemed in a rush and not fully prepared when it came to how to achieve sound and long-term development by building distinctive benchmarks and ensuring the quality of education.

Another point worth noting is the assessment of HVE quality. It was visible that Ministry of Education realized the importance of evaluation of how well HVE institutions performed and it established special commissions to research into formatting assessment schemes in 2003 and eventually issued the separated standards of quality assessment for HVE. The assessment did not formally kick off until the end of 2004(Luo

& Fang, 2011:252), which means from 1999 to 2004, the whole HVE sector developed without an authoritative yardstick to measure itself. As an old Chinese saying, however, goes that 'Everything is hard at the beginning', despite the incompleteness of relevant mechanism in the whole HVE sector, the first step it went, however, paved the way for its later development from 'from simpleness to maturity' in the following few years.

2) 2006-2014: From Simpleness to Maturity

After the initial expansion from 1999 to 2005, the government realized the accompanying consequences including quality issues, employment issues as well as the pattern issues for cultivating desired talents and graduates. Therefore, the policies issued since 2006 was mainly aimed at "consolidating the previous achievements and improving the internal development" (Luo & Fang, 2011). The phrase "internal development" (in Chinese: *内涵建设*) refers to the core issues concerning the quality and soft power of a certain project or entity in Chinese context, and it is paralleled with another concept 'external development' referring mostly to quantity, size and hardware. For a university or an HVE institute, 'internal development' refers to the quality of teaching, education patterns and all other issues pertaining to students' growth and development.

In 2006, China's Ministry of Education issued an important document (called No.16 document) specifically to emphasize a number of aspects of 'internal development' for HVE. To respond to the prevalent problem of lack of 'vocation' in what students learn and the quality of curricula at HVE institutions, No.16 document highlighted several policy intents at national level to further guide the HVE development nationwide. In the first place, No. 16 document emphasized the adjustment and reform of courses. To quote from the document itself, 'HVE institutions must actively engage in course development participated by industries and enterprises and reform curricula system and teaching contents according to relevant industry standards. When setting curricula standards, the vocational competence must be considered to improve the quality of curricula.' (MOE, 2006) As the instructive body, Ministry of Education then announced that during China's 11th 'Five-year Plan Period', which is from 2006-2010, it would select a total of 1,000 excellent courses from all HVE institutions across the country. Besides, for the curricula reform, it required that HVE institutions must include more 'praxis-oriented courses' in their curricula reform projects. Three aspects of praxis were highlighted in the document: experiment, training, and internship, and there was a measurable requirement that all HVE students must undertake internship in a business for half a year during their study. The highlight of praxis was to challenge the purely theoretical and academic characteristics of HVE courses that had maintained in the fullness of time. It was believed that as higher vocational education must in action differentiated itself from general higher education, and it was a consensus that while theory was needed for students' learning, vocation was more in need.

To be more concrete, in order to practically implement the idea of praxis-oriented learning, the Ministry of Education not simply emphasized the importance of curricula reform, which is important but usually take a long process, but required that HVE insti-

tutions must seek close cooperation with enterprises and build institutions' praxis bases at business, which could be either at the institution or at enterprises. It hoped that through building more praxis bases and cooperative ties with enterprises, the HVE students' internship and praxis could be institutionalized and guaranteed, with or without the institution leaders' willingness and ideas.

The concept of "double-typed teacher" was emphasized with the idea that teachers should in the first place master a profound theoretical knowledge of the subjects they need to teach in the classrooms, and in the meanwhile demonstrate praxis-oriented competence by gaining certain certificates in the industry. To help promote the faculty team of HVE, the Ministry of Education on the one hand required that institutions send their teachers to certain enterprises to gain practical skills and competence in person, and on the other hand required that institutions employ talents from the business to teach full time or part time at the HVE institutions. It's clearly stated that "It needs to form a mechanism that the praxis-oriented courses should be mostly taught by experienced talents from the business and industry" (Luo & Fang, 2007, pp.249).

In addition, completion of the educational assessment mechanism was emphasized as well to further guarantee the quality assurance, and the educational assessment was expected to involve business sectors to participate. Local governments were expected to work out a five-year-cycle assessment system to highlight both process assessment and outcome assessment according to a comprehensive set of indexes such as teachers 'double-typed certificates' rate, institutions' internship bases, students' internship quality, cultivation of students' professional competence, and the structure of faculty team, etc. To speak of, the 'double-typed certificates' rate focuses on how well faculty generally obtain both a teacher certification and a business-related skill certification, and the structure of faculty team probes into how well a faculty team consists of both full-time institutions' teachers and part-time business talents. The tone was that 'vocation' must be once again repositioned as the nature of HVE, and HVE institutions must distinguish themselves from general universities and colleges in terms of educational goals and approaches.

Completion of Assessment Scheme

In line with the calling for the completion of quality assessment scheme, the Ministry of Education formatted HVE Talents Cultivation Assessment Scheme (hereafter called 'New Assessment'), a very instructive document for HVE quality assessment on April 9, 2008, and required that from then on, all local authorities should organize assessment on the quality of education of HVE institutions across the nation according to this document. Before that day, there were two related but not updated schemes (hereafter called 'old documents') in 2004 and 2005 respectively, but the Ministry articulated that the New Assessment issued in 2008 would replace the previous two old ones.

The update of the assessment scheme was a response to the old documents' lack of sufficient investigation into 'vocation' as well as their inflexibility due to 'one yardstick measures all' limits. Many indexes in the old documents were not too quantified with-

out consideration of the uneven economic development of various regions in the country, nor did it take into account the different features of different industries and their different demand for students' different quality.

Compared with the old documents, this 2008 New Assessment scheme has represented a number of changes in such aspects as institution leadership, faculty build-up, curricula development, praxis-oriented teaching, development of special discipline and cooperation with related stakeholders.

With respect to institution leadership, the changes have been mostly reflected in two aspects of the positioning of the HVE institutions. Firstly, in the old assessment document, there was a general statement that teaching must be put as the center of all institutional activities. In contrast, the New Assessment examined more about the prospects and planning of institutional leadership, looking into whether the goal of the institution would truly match the demand of local economies. Secondly, in the old document, the guiding principle set for developing HVE was the combination of industry-Academia-Research, but in the new one, "Academia" was left out from the assessment scheme as there has been a clearer vision of HVE's development and the determination to distinguish HVE from the general universities or colleges.

In terms of faculty build-up, the old assessment contained detailed and quantified indexes such as student-teacher ratio, and the total amount of full time and part time teachers'. In the new assessment, the detailed quantity requirement did not exist anymore, but the emphasis on the quality of part-time and full-time faculty was stronger. Full time teachers who teach general courses are expected to achieve higher level diploma and certificates, and those for professional courses are expected to have more industry experiences. Meanwhile, those who have abundant industry experiences are encouraged to teach as part-time faculty in the HVE institutions.

As for curricula development, the too general statements as to the curricula contents reform, textbooks development and teaching methods reform have been replaced by new statements which put special emphasis on the cooperation with industries. Institutions are expected to develop curricula jointly with industries and to include more praxis-oriented contents into the courses. Teaching methods in the New Documents are expected to be an integration of 'teaching-learning-doing' with more weight put on the practice and vocation. Textbooks of higher quality are needed for the sector, and writing applied teaching materials jointly by institution faculty and industry professionals are highly encouraged in the New Assessment.

Another point worth noting in the new assessment is the development of special discipline. In the old document, the only feature-related concept was a general phrase called 'characteristic innovation'. The original purpose was to offer institutions more flexibility, but it also signified the immaturity of the whole HVE sector's vision of how it could develop to unleash its full potential without a concrete path. In the new assessment, this particular phrase has changed into 'building characteristic disciplines', and this change as a matter of fact pushes the requirement for HVE institutions into a new height in that building a discipline would require a whole set of updates and innovations from goals, input to education patterns and cooperation with the industry and society.

To speak of, in the module of assessment, the old requirement of measuring 'teaching effects' now has become 'social evaluation', which reveals that the new assessment puts more attention on the social feedback of how well HVE actually cultivate their graduates.

The updated assessment scheme has served as a more professional and detailed framework for the nationwide evaluation of HVE quality. It's a mandatory for all HVE institutions which have up to 3 sessions of graduates to participate in the assessment, and to a large extent raises the awareness of institutions themselves to be focused on self-evaluation in that the principle as required in the new assessment scheme is called 'the combination of self-evaluation by institutions and external evaluation by professional experts (*教高*[2008]5). For those institutions that have had 3 sessions of graduates but are not ready yet for receiving external evaluation, they can wait for two more years, but their quota of enrolling fresh students are supposed to be gradually reduced by provincial authorities. Institutions assessed are to be approved "Pass" or "Postpone", with the requirement that institutions assessed "Postpone" have to receive another round of assessment within one year at the cost of reduction of enrollment quota. If an institution fails for the second time to get a "Pass", its qualification of enrolling students will be very likely to be suspended.

Selection of Model and Key HVE Institutions as Impetus of the Sector

On November 3rd, 2006, the Ministry of Education and Ministry of Finance formally kicked off the Initiative of National Model HVE Institutions Selection, aimed at selecting 100 model HVE institutions from 2006 to 2010 within three rounds. The procedure of selection was based on provincial recommendation and then these recommended institutions would receive evaluation by national expert team. The selection criteria mostly represented in 5 aspects: institution leadership, comprehensive competence, education reform, discipline development and social service.

Specifically, institution leadership refers to whether the leadership of an HVE institution would have an advanced strategic mindset on the institution development and the capability needed to mobilize necessary resources, while comprehensive competence is a reference to investigate the overall education quality of HVE institutions as well as their social recognition and industry recognition. Education reform is an index to measure whether an HVE institution has established a long-term mechanism of production and academia with the industry, and discipline development serves as an yardstick to view the core competence of an institution's education capacity. Lastly, social service measures the institution's role in training applied talents for regional economic development.

The goal of building model institutions, as literally revealed, was to spark innovation in educational pattern reform, teaching quality, social service capacity and building up special features. The more concrete goals involved benefiting more than 600 thousand registered students' study and employments, developing approximately 500 quality specialties that cover a wide range of industries, enjoy quality facilities and maintain

close connections with the market and business. Besides, it was also expected that these 100 model HVE institutes would develop around 4000 quality core courses with 1500 categories of textbooks and coursewares. This measure intends to power the core capacity of HVE institutions as education providers: curricula and teaching, which signifies that it has been realized that the transition and upgrade is never to be achieved without the improvement of quality of curricula and teaching.

The 2006, 2007, and 2008 respectively witnessed a total of 100 HVE institutions selected as model institutions as planned, achieving at least that within the HVE sector, there have emerged leading exemplars for other institutions to follow and chase. These three rounds of evaluation from 2006 on to a large extent has enhanced the overall education quality of these institutions as well as the related social recognition.

Following the 100 model institutions, the Ministry of Education issued another document to select 100 Key HVE Institutions, which has been regarded as the second period for model institution project. As stated in the document, 'Over the past four years, model institutions have played a leading and exemplary role in mobilizing educational resources for the development of HVE sector, and for the sake of better serving the needs of the nation's pursuit of a new industrial development path accompanying with economic transition and industry structure update, the Ministry of Education and Finance decide to continue the model institution project and expand the scope of leading HVE institutions so as to push forward the reform and opening up of higher vocational education and further tap the potential role of HVE in cultivating high-quality applied talents and improving employment and people's livelihoods.' (MOE & MOF, 2010)

A timetable for the selection of 100 Key Institutions was put forward in the meantime, scheduling to prioritize the establishment of 40 institutions in 2010, another 30 institutions in 2011 and 30 more institutions in 2012. The time cycle for preferred development is set to be three years and all the 100 key institutions selected, as required, must all receive evaluation by the end of 2015.

Group Schooling and Promotion of International Cooperation

Group schooling is another approach to facilitating resources sharing, cost reduction and draw more non-governmental capital to the HVE sector. It usually involves business participation and HVE institutes merge. The most direct effect of group schooling is to tighten the binds between students and the industry, which is in line with the coherent idea of institution-industry cooperation put forward in very early documents by the Ministry of Education. Taking Shaanxi Electronic Vocational Education Group, located in the northern western region of China--- Shaanxi Province as an example. The HVE institute within the group --- Shaanxi Electronic Industry Institute --- has signed contracts with a number of corporations in a number of fields related to electronics and telecommunications. They believe such an approach has achieved four benefits for the HVE institute and students: 1) internship places for students are guaranteed ; 2) business are invited to participate in the institute's design of training programs; 3) some

production tasks are shifted from business to the institutes; 4) students' employment is mostly directed to these corporations who also provide special and abundant pre-job training for these prospective employees, and corporations can recruit students directly from the institute whose education and program design involve their participation before (Cui, 2012: 182).

Moreover, greater prominence has been given to international cooperation in enhancing HVE's development as with other measures over the past decade. The manifestations of international cooperation are various, including recruiting international students, bringing in international scholars and experts, sign cooperative programs with foreign institutions, organizing international conferences, carrying out faculty exchanges, achieving credit recognition, participating in government-led international cooperative programs, etc. Inspired by the power of openness and cooperation, it is hoped that international cooperation can help HVE institutes gain more understanding of the world, of the trend of the industries, of different education systems and ideas, and bring in quality educational resources.

3) 2015-2018: A New Initiative on Innovation and Development

By the end of 2014, the HVE institutions nationwide amounted to 1,327 with a total of more than 10 million registered students. Quoting an official from the Ministry of Education, 'HVE accounts for half of the whole tertiary education sector' (MOE, 2016). With such enormous capacity, the issue of quality improvement for the whole HVE sector has been urgent than ever before for China's economic transition and sustainable growth. A cluster of prominent national strategies such as Made in China 2025, Internet Plus, Mass Innovation, Targeted Poverty Alleviation and Belt and Road have all posed new demands for talents that are expected to be provided by HVE. Under such backdrop, Ministry of Education at the end of 2014 started to seek advice for a new initiative which can serve as a new guiding principle for the further HVE development in the newest times.

After some one year, as recently as Oct 21, 2015, the Ministry of Education (MOE) finally issued Higher Vocational Education Innovation and Development Initiative (2015-2018) (hereafter referred to as Initiative) on , with the aim to draw strengths from all walks of life to improve the quality of HVE, and promote it to better serve the demand for professional human capital for the country's economic transition. The Initiative aims to accomplish five critical tasks to guide the HVE's development including increasing high-quality educational resources, enhancing education vitality for institutions, accumulating technological and technical capacity, and completing quality assurance mechanism. Concretely, these five critical tasks have been divided into a total of 65 sub-tasks and 22 major projects assigned to a variety of accountability bearers such as different departments of the Ministry of Education, provincial educational departments, HVE institutions, relative vocational education commissions, industries and business concerned, etc. It is worth noting that according to the list of a total of 87 subtasks and projects, among such many subjects of responsibility, those that need to be led

by provincial government's amount to 71, accounting for around 81.6%, which means provincial governments, will be the major accountability holders for the regional HVE progress.

The Initiative has pointed out 6 directions for HVE's innovation: 1) to offer HVE institutions more decision-making rights in commensurate with their own strengths and weaknesses; 2) shift from quantity expansion to quality improvement; 3) striving for operation of institutions based on more openness; 4)offering more weight to the soft power rather than hardware conditions in the assessment scheme; 5) further emphasizing the significance of enrolling 'double-typed teachers' for HVE institutions; and 6) further strengthening institution-business cooperation by exploring modern apprenticeship mechanisms and establishing more effective internship bases at business.

Another unprecedented aspect for this Initiative is that it has for the first time put forward the exploration of instituting a credit system to record students' school performance as well as a credit banking system to document students' degree studies and non-degree studies. Besides, it also calls for exploring a mutually recognizable credit transfer mechanism between HVE and general higher education.

Primary Progress

With the aforementioned series of policies issued over the past two decades, there has been some primary progress for the HVE sector. The most salient progress is manifest in the growth of the sector size, quantity of HVE institutes and buildup of a more comprehensive vocational education structure. In addition, the calling for the recognition of HVE's important role in producing applied manpower has raised the sector's social recognition than before.

Size and Structure Growth

Since the advent of 21st century, against China's two important backdrops --higher degree of economic marketisation following entry into the WTO and expansion of the higher education sector, China's HVE in line with the trend has experienced rapid development in terms of number of institutes and student registration. There were only a total of 474 providers for HVE in 1999, and this number rocketed to 1,184 in 2008 (Luo & Fang, 2011, pp.246), and further grew to 1,327 in 2014 (China Net, 2015). Correspondingly, students registered at HVE institutions were merely 1,112,497 in 1999, and grew almost by 8 folds to more than 9 million in 2008 (Luo & Fang, 2011:246), and further grew to 10 million plus in the year 2014 (MOE, 2015a). In the foreseeable future, it is expected to develop into a new height with increasing social attention drawn to it and financial resources allocated to it (MOE, 2015b).

Besides, the structure of the HVE system has undergone from scratch to maturity as well. On the one hand, after a decade of market tests and relevant policy guidance, independent higher vocational education institute stands out as the main provider of HVE as a kind of separate tertiary institution (Stewart, 2015) among all the four types

of institutions that entail HVE provision: 1) independent higher vocational education institutes; 2) adult higher colleges; 3) vocational education programs in universities; and 4) other types of non-formal vocational training. HVE students are mostly enrolled from three sources at secondary-level technical schools: vocational high school, secondary specialized schools and skilled workers' schools as shown in Graph One above, and among these three, vocational high schools remain the major source. This trend to a large extent has indicated the normalization and professionalization of the whole HVE sector.

On the other hand, the fields and specialties that HVE cover currently have become much broader than before in accordance with the real needs of the industry and economy. According to the Catalogue of Specialty (2015 version) released by China's Ministry of Education, there are altogether 19 big categories of specialty including 1) agriculture and fishery; 2) resource, environment and security; 3) energy, power, and materials; 4) civil constructions; 5) hydrology and water resources; 6) equipment manufacturing; 7) biological and chemical science; 8) light and textile; 9) food and medical drug; 10) communication and transportation; 11) electronic information; 12) medicine and health; 13) finance and commerce; 14) tourist industry; 15) culture and arts; 16) journalism; 17) education and sporting; 18) public security and judicature; and 19) public administration and service (MOE, 2015c). Under each big category, there are a number of categories which are more concrete than the big category. And under each category, there also exist many concrete specialties (To see **Figure 3**). For example, under big category one: agriculture and fishery, there are 4 categories of specialty which are farming, forestry, grazier and fishery. And under the category of forestry, there are also 13 specific specialties such as forest resources protection, economic forest usage, wild animal resources protection and usage, forest eco-tourism, and so on. The most recent statistics show that there are altogether 19 big categories, 76 categories of specialty, and 589 specific specialties in the official catalogue of specialties for HVE. The relationship of the three is seen in the graph below.

Another progress to be marked is the official recognition of the status of HVE as a sector, mirrored by the unprecedented promotion of its role in providing applied talents and propelling economic development. As in some other countries in the world, HVE's status was traditionally less recognized for a long time than general academic higher education (Xiong, 2011), and Zhao and Lu (2007) attribute the disadvantaged position of HVE to one of the Confucian ideas that 'those who do mental labor rule and those who do manual labor are ruled', echoed by some other scholars who explain such status from the perspective of policies, assessments and actual graduate quality. But as China's economy attempts to achieve a transition from the low-cost and low-skill-based export to a service-based, consumer demand-based and high-tech-based model, ideas on vocational education have gradually changed in the fullness of time. Now, Chinese government has indeed acknowledged four critical roles of HVE in China's economic growth: 1) supporting industrial structure adjustment by outputting millions of skilled manpower; 2) mitigating unemployment in the society, especially among young adults; 3) pushing forward urbanization and development of rural areas; 4) bettering the struc-

ture of the education system and promoting the process of higher education massification. (Liu, 2015)

The growth from none to maturity also applies to national policies and regulations which have been systematized in a step by step manner. Before 1999, the whole sector did not have a clear direction for its development, namely not clear about what type of talents it wanted to produce. In the following several consecutive years after 1999, the Ministry of Education held numerous meetings to discuss the industry-learning-research pattern for the HVE sector, and reiterated that the fundamental task and goal for HVE is to cultivate and produce high-quality technology-applied talents, which clearly articulated the difference in missions between HVE and general higher education, stating that the expected outcome of HVE was not academic talents, but skill-oriented ones. It is for the sake to achieve this ultimate goal that the national policies evolve as we have explored in this paper.

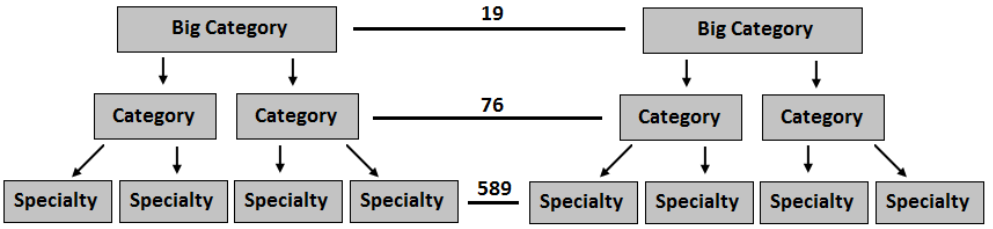

Figure 3. Categories and Specialty Structure for Chinese HVE.
Source: Drawn according to *Catalogue of Specialty* (2015 version) by China's Ministry of Education

Raising Social Recognition

Despite the remaining disadvantaged position of HVE as a whole sector compared with general higher education, the national government has been persistent in exploring new pathways to turn this around and improve the comprehensive quality and position of higher vocational education. At the national level, based upon the existing policies measures including the newly released significant Initiative, in the years to come, the central government's policies of persistent explorations are to be focused on both raising HVE's social recognition and further promoting the implementation of relevant policies on five key areas. With respect to raising social recognition of HVE, the central government naturally links it with a contemporary national strategy – 'China Manufacturing 2025' which aims at upgrading the country's manufacturing power to transit China's economy from the traditional labor-intensive one to a high-tech-supportive one. 10 sectors are to be strongly developed under this strategy including bio-medicine and

high-performance medical apparatus, information technology, energy-saving vehicles, electrical equipment, aerospace and aviation, maritime engineering equipment and high-tech vessel, new materials, high-end numerical control machinery and automation, rail equipment and agricultural equipment.(China Daily, 2015) Thus the demand for exponential high quality vocational talents are urgently needed under such background and the position of HVE has correspondingly been more valued than ever before.

Philosophically, China has once again stressed the concept of 'Craftsman Spirit' nationwide to counteract the traditional bias against craftsman and labor work, as it has been realized that craftsman spirit serves as a core quality to achieve breakthroughs in science and technology that the country needs for its real economic upgrade. As craftsman by its nature has high degree of connection with vocation, as Vice Premier LIU Yandong states that the central government expects to build an environment of 'revering professional skills and competence instead of diploma' nationwide (LIU, 2015). In order to make prevalent social respect to vocational education, the Ministry of Education has taken a series of measures including establishing Annual Vocational Education Week, organizing various kinds of vocational competitions, further building the selected model and key HVE institutions, requiring provinces to submit annual vocational education report, and many other measures to motivate HVE reform and innovation. With all these measures conducted together, HVE is expected to form a social image of openness and vigor to be embedded in people's minds.

Challenges and Prospects

Despite the size expansion and the improvement of the sector's structure as mentioned above, concerns of the sector's quality remain. Compared with general higher education consisting of universities and colleges, the quality of HVE institutes is still faced with many constraints. Mainly targeted at skill development and employment promotion, the quality of HVE and whether its graduates can effectively meet the demand of the market has constituted a concern for all-related debates and discussions in the academic domain regardless of the goodwill of all national policy intents. As Westerheijden, Stensaker, and Rosa (2007, pp.1) stress, quality is the core value in higher education, which should with no doubt include HVE in Chinese context as it accounts for half of the whole tertiary education domain. Some scholars sort of worry that on such special occasions as the recent global economic downturn, the future of Chinese HVE is in doubt (Roggow, 2014), as China's economy updates, a mismatch between employer needs and HVE graduate capabilities seems more salient with the phenomenon that while numerous HVE graduates find it difficult to find a decent job, job seekers also find it hard to employ ideal talents they need to fit the job posts (Kuang, 2006).

Discussing at a micro and effect level, many scholars view the problem from more micro perspectives such as HVE's educational aims, curricula, financial input and other factors. For example, in terms of educational aims, a number of scholars express that HVE ought to further the degree of embodying both "H" (higher) and "V" (vocational), which in their explanations once again implies that HVE bears the responsibility to cul-

tivate high-quality vocation-oriented talents, and the mission of HVE differs from that of the general higher education carried out by universities (Cheng, Li & Liu, 2007). It has been acknowledged that the level should be set high, and the essence of vocation must not be ignored. Some other scholars hold that HVE is supposed to work on improving students' humanity spirit (Tu, 2012), and that serving social and economic development is considered an important mission as well (Wang, 2014). Kuang (2006) based on international comparisons, however, warns that as the enrolled students of HVE institutes are graduates from secondary vocational schools or general schools without any work experience, HVE should not set their goals unrealistically high such as cultivating scientists or world-class engineers. He believes that the goals should be set proceeding from reality and being commensurate with the institutes' real capacity and the external support they can gain, but to cultivate and train applied and skillful talents is in his consent. When it comes to curricula, a large number of scholars consider necessary the need for a shift of emphasis from systematic knowledge teaching to increasing practice-included curricula, and they maintain that skills and competence instead of knowledge should prioritize on HVE institutes' agenda (Ren, 2001; Dai, 2003; Jiang, 2003). With respect to curricula contents, the consensus is that courses should be developed in connection with industry needs, but should avoid making the course as handbooks and discrete skills should be integrated into a certain subject framework backed by relevant theories (Li, 2006; Xu, 2009)

The fundamental challenge for the whole HVE sector is attributed to the lack of sufficient financial support. This not only means the vast gap between HVE institutions and universities in students' average expenditure, but also refers to the uneven financial input between provincial government-led institutions and local government-led institutions. There are well-to-do HVE institutes that have the capacity to purchase advanced experimental equipment and pay teachers well for sure, but the more prevalent situation is that because of the lack of money, a lot of HVE institutes would choose to cut curricula or teachers' salary to make ends meet. Regarding HVE's finance, Du (2007) believes that it is the misconception of HVE as a "level" instead of a "system" that leads to the systematic insufficient finance support to HVE whether it is governmental or non-governmental, and there exists high degree of imbalance across the whole country. Du also believes that the inappropriate positioning of HVE institutes also results in the unreasonable funds for the institutes themselves. Du's views, especially the view of shortage of funds has resonance with Kuang (2006:239) who holds that the overall shortage of governmental input and the scarcity of funds raised from non-governmental bodies directly lead to the lag-behind of facility update and staff attraction for HVE institutes.

This crucial barrier thus leads to a relatively weak connection to industry. During students' study period, they do have some work experiences, but their organized work experiences typically consist of only a few weeks of working at the end of a course, and they do not seem to have connections to multinational corporations that usually incorporate the most advanced industries and international standards (Stewart, 2015). The

incentives for employers to cooperate with HVE institutes are not high either, given the high mobility of HVE graduates, especially in eastern developed regions.

As some international researchers hold that policy implementation follows a far more complex and unpredictable course than most policy makers assume (Osei&Brock, 2006; Kelchtemans, 2007), the above discussions by various scholars reveal the existing gap between national policy intents and their implementation effects, though the focus of this paper is purely on national policy intents. It is certainly noteworthy that it is this gap that propels new national guiding policies to emerge in order to respond to HVE development demand under new circumstances as time progresses.

The Chinese central government represented mostly by the Ministry of Education aims to strengthen HVE development in five major areas according to issued documents. Strengthening discipline development is the first and foremost aspect to be highlighted, with HVE institutions being expected to strengthen their discipline and gradually to establish vocational discipline complex with institutional characteristics and build brands in a step by step manner. The second area to be explored is scheduled to be on the institution of a modern apprenticeship mechanism aimed at tightening the bonds between school discipline and business demand as well as between institutions and industries. Among all other things, modern apprenticeship attempts to resolve the issue of making what students learn inapplicable. The third aspect to be addressed, which embodies a deeper level for the second aspect, is pertaining to the closer cooperation between HVE institutions and business and industries, including more effectively implementing the idea of inviting business and industries to participate in the institutions' core development such as courses design, teaching and internship systems. Fourth, there is scheduled to be more complete regulations and rules on HVE institutions' advancement, including establishing HVE institutions' constitution, board of directors, annual quality report mechanism. Fifth, it is scheduled to further enhance openness and international cooperation in the operation of HVE institutions. On the one hand, China is aimed to bring extraordinary international human resources to improve its HVE quality, and on the other hand, it is expecting through international cooperation and open education that Chinese HVE faculty and students are likely to join more international participation such as working together with other nations to formalize global standards on vocational education, and promoting the mutual recognition of vocational certificates internationally (HTVEC, 2016).

Conclusions

This paper has analyzed China's HVE policy evolution trajectory in the 21st century, charting out policy intents at three major stages in a step by step manner. This trajectory seems to embody an idea of manpower development by 'growth from quantity to quality', with quantity already reaching a desired level while the quality still needs improvement. As an officially recognized important component of the country's education system, the size of the HVE sector has grown from a small base to one that accounts for half of the whole tertiary education sector within just less than 20 years. Considering

the population base of China, such a size of manpower output system is substantially higher than in many other countries in the world. With respect to quality of the human power the sector produces, the desire to improve educational quality through complementary indicators such as forging the sector to be really praxis-oriented, enhancing the overall quality and practical experiences of teachers, completion of assessment mechanism, selecting models to motivate large number of institutes, and mobilizing more resources to the sector by adopting group schooling, to name a few are explicitly reflected in those policy intents, and these intents are driven by the demand of China's economy in the new times. However, due to myriad reasons such as actual resource shortages invested in HVE and the limited time for the society to take HVE as seriously as general higher education, immense challenges and concerns remain when the general public takes a thought of HVE as an educational sector. This leaves a necessity to analyze the gap between policy intents and policy outcomes in future work.

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ORIGINAL ARTICLE

A Study on Cultivating Pre-Service Teacher Empathy

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Abstract. This study investigated empathy of pre-service teachers specializing in primary-school education. It was conducted to determine the factors that affect the empathy levels of students by normal University. The research questions, developed in the countryside context, aimed to determine the roles of gender, normal university or non-normal university, academic education, parental rearing patterns and personality in the empathy levels of pre-teachers. The study group consisted of students (n=287), including 170 normal university students practicing teaching in a rural area. An independent t-test was used to determine whether the empathy of pre-service teachers varied by gender and others factors. The analyses found that the student's average empathy was high and their performance on the concern dimension of empathy varied by gender, normal university or non-normal university. The results also showed that the students' scores on the personal distress dimension of empathy varied by academic education and personality characteristics. There were no significant differences in other dimensions.

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THE English word empathy is derived from the Ancient Greek word *εμπάθεια* (*empatheia*), meaning "physical affection or passion" (Henry George et al., 1940). Although many studies have contributed to the comprehension of empathy, the first name that comes to mind is Carl Rogers. In the past, empathy was commonly defined as the process of understanding and feeling accurately what another individual is experiencing by placing oneself in another's position and letting the other individual know (Rogers, 1975).

Empathy has many definitions that encompass a broad range of emotional states, including caring for other people and having a desire to help them; experiencing emotions that match another person's emotions; discerning what another person is thinking or feeling (Pijnenborg et al., 2012); and making less distinct the differences between the self and the other(Hodges & Klein, 2001). Empathy is also knowing what the other person is thinking or feeling (Davis, 1983). Being empathetic means reading other individuals in an emotional way (Moller, 2000). Liew et al. (2003) defined empathy as an effective reaction caused by fear, anxiety or an expectation about what another individual feels or will feel. In the twenty-first century, empathy is frequently discussed in psychiatry and psychology and is a topic of research in the fields of clinical, social and communication psychology. Empathy is critical in psychotherapy and interpersonal relations (Dinçyürek, 2004). According to Freud, empathy as a practice plays a role in understanding something strange to the self (Ünal, 1972). In addition, empathic skills facilitate effective communication in the social world; it is like an adhesive to help us to help others and deter us from hurting others (Baron-Cohen & Wheelwright, 2004). Baron-Cohen defines empathy as spontaneously and naturally tuning into the other person's thoughts and feelings. However, Badea argues that empathy is a way of understanding the feelings of others, not experiencing them. Empathy helps people to be aware of others' feelings and thoughts (Badea, 2010) and allows us to understand others' intentions, predict their actions and experience feelings triggered by their emotional experiences.

Hoffman (1991) stated that the motivation needed for moral actions depends on empathy. Putting oneself in the other's place, understanding his feelings and his experiences in every condition, is the highest level of empathy (Kirsi, 2003). Empathy includes understanding multiple perspectives on people's actions, historical events and the ability to take an empathic stance (Grant, 2001). Empathy underlines pro-social behavior; in the absence of empathy, individuals display aggressive and acquisitive behaviors while ignoring the rights or suffering of others (Marshall, 2011). Such individuals struggle to identify themselves in imaginative or real life conditions (Dewaele & Wei, 2012). Empathy lends crucial emotional heft to moral actions. For instance, higher empathy scores in nurses with higher well-being (Patricia, 2015). Empathy can also emotionally reinforce kindness, rendering helpers more persistent in aiding others.

Empathy is a conscious, intrinsic capacity that involves two main factors. There are many explanations of the multidimensional nature of empathy; however, recent research has conceptualized empathy as having cognitive and affective aspects. Cognitive empathy, in which one understands others' states of mind with the help of the imagination, can result from intentionally adopting another's psychological perspective. Emo-

tional empathy, defined as one's emotional reaction to another's emotional reaction, can be caused by observing someone's emotional state and briefly experiencing affective resonance. In the literature, affective empathy is referred to as emotional empathy (Lawrence et al., 2004). There are many elements to consider when defining empathy. For example, how do empathy and sympathy differ, if they actually do? Is empathy a cognitive or an effective response to the suffering of others?

School is a place to socialize children in a systematic, disciplined and planned manner, to get them to know each other, and to allow them to acquire empathy in order to produce collectively in society. Through the use of school resources available for the needs of individuals and groups, schools help children develop care and empathy, and learn to be interested in diverse communities with ethnic, cultural and social differences (Gay & Hanley, 1999).

An individual should be sensitive to the feelings of others and should recognize, understand and interpret these feelings to show empathy. Understand another individual's feelings before expressing one's own is the core of empathy. The degrees of teachers' empathy have been estimated to be quite high. Research has shown that all aspects of self were connected to empathy, but the most important predictor of high empathy was favorable self-estimation (Snežana & Stojiljković, 2013).

Teachers' empathy is the most important variable consistently related to positive outcomes and student learning. When students realize their teachers are trying to put themselves in their position and understand what they feel, i.e. when they notice their teachers' empathetic skill, it is likely that they will feel closer to them, trust them and be impressed by them (Kuzgun, 2000). In interpersonal communication, almost all misunderstandings and conflicts are caused by a lack of empathy of at least one party. Conflict between teachers and students were due to less effective communication, especially due to teachers' lack of empathy. The role of empathy in the communication between teachers and students and its application steps is particularly important. The way a teacher interacts with students is significant, influential, and demands meaningful preparation as pre-teachers need better models, practices, and frameworks for teaching, especially if the students represent social classes that are different from the teacher's (Sato & Lensmire, 2009). Pre-teachers must develop not only their teaching skills, but the emotional capacity required to enhance their resilience, survival and ability to innovate. System and planned education in normal university serves to socialize and be socialized, the primary purpose of which is to give students in normal university the opportunity to acquire the capacity for empathy.

Empathy is important for future teachers as it enables them to understand the needs of their pupils and, therefore, offer them adequate and high-quality attention. However, the above literature has focused on the importance of the empathy of in-service teachers, but not the understanding, investigation and training of the empathy of pre-service teachers. Especially in the context of strengthening the abilities of rural teachers, it is imperative to investigate and cultivate the empathy of rural directional normal students. This study aimed to answer the following questions:

(1) How to evaluate empathy levels in pre-service teachers?

(2) Which factors affect the empathy of rural orientation pre-service teachers? For example, are there the differences by gender or other factors?

Methods

Participants

The sample consisted of 300 undergraduate participants enrolled in a public university in China. Surveys were distributed in person to participants, filled out at the participant's convenience, and returned anonymously to the researchers. Of these, 13 were dropped from data analysis because of missing or incomplete data, leaving a total of 287 participants, 66% of the participants were female. Fifty nine percent of the students were from the normal university, and 41% were non-normal undergraduates. Twenty eight percent of students were from the liberal arts, and 72% from sciences. Distribution of the subjects was divided by parenting style, 75% of students were from authoritative parenting, and 25% from permissive parenting. The students of introversion, which measures Eysenck's personality inventory, were 114, and the students of extroversion were 173.

Research Tools

Participants completed the Empathy Quotient Scale. The Interpersonal Reactivity Index (IRI) was first compiled by Davis (1983). Based on previous research on empathy, the Chinese version of the IRI (IRI-C) was revised by Zhan and Wu (1987). The IRI-C scale included 22 statements that measured four dimensions: Personal Distress (PD; 5 questions), which measures self-centered anxiety and discomfort about the plight of others in a stressful interpersonal context; Perspective Taking (PT; 5 questions), which measures individuals' tendencies to adopt others' mental views. Empathic Concern (EC; 6 questions), which measures other-centered empathy and the behavioral tendency to focus on the less fortunate. Fantasy (FS; 6 questions) measures the emotion and behaviors of characters in fictional works such as novels, TV, movies, and plays through imagination. The items were ranked on a 5-point Likert scale (from 0: "does not describe me at all" to 4 "describes me very well"). Negative questions were graded in reverse. Higher total score indicates stronger empathy ability.

The internal consistency coefficient was 0.53-0.78, and retest reliability was 0.56-0.82. Thus, IRI-C has good reliability and validity in application to Chinese people (Fengfeng Zhang, et al., 2010).

Statistical Analysis

Following data collection, the researchers went on to conduct the appropriate statistical analyses in order to examine whether pre-service gender, personality or other factors impact the candidate teachers and quality of teacher education in rural areas.

In all cases, statistical significance was set at $p < 0.05$. The Statistical Package for the Social Sciences (SPSS) software (version17.0) was used for calculating these statistics.

Results

Descriptive Statistical Analysis Results for the Empathy Quotient Scale and Sub-Factors

The participants' mean scores on empathy and four sub-factors (**Table 1**) indicate that pre-service teachers' empathy scores were above average except in the PD category, and they evaluated themselves positively. They made higher self-estimation both of EC (2.47) and PT (2.53). In addition, the lowest sub-factor score was PD and the highest sub-factor score was PT. These high estimations of all dimensions of empathy are understandable because pre-teachers are educated through learning theory in normal university and teaching practice for more than two months in primary school. They are continually involved in pre-service training that contributes to improving their general personal competences.

Analysis of the Difference in Empathy with Several Variables

The first research question investigated whether there was a difference between the scores of males and females on the empathy and sub-factor scales. The results of this comparison are shown in **Table 2,** which reveals that there were significant differences between empathy scores for males and females, as well as in sub-factor scores, except for FS, PD and PT.

The females' empathy EC scores ($M = 2.87$) were significantly higher than males ($M = 2.54$), indicating that the females' emotional ability and reactions were more intense. A significant difference in the empathy concern ($t = 5.01$, $p < 0.001$) was present between females and males, and showed a middle effect size ($d = 0.59$). These results of indicate that the sub-dimensions of empathy allow us to differentiate between men and women, suggesting empathy concern dimensions are more involved in the observed gender differences.

Table 3 shows that there is no significant difference between scores of general undergraduate and normal college students on empathy and sub-factors scores, except for empathy concern ($t = -1.94$, $p < 0.05$). However, in terms of empathy, the scores of normal college students' average scores are higher than undergraduates in non-normal college.

Table 4 shows category differences in empathy scores of pre-service teachers. PD is significantly different between students of the liberal arts and students of sciences. Interestingly, students in the liberal arts EC score are lower than the sciences in personal grief.

Table 1. Descriptive Analysis Results for IRI-C and Four Sub-Factors (n=287).

Variable	Max	Min	Mean	SD
Empathy	4	0	2.17	0.41
Personal Distress	4	0	1.51	0.84
Empathy Concern	4	0	2.47	0.74
Fantasy	4	0	2.07	0.64
Perspective Taking	4	1	2.53	0.63

Table 2. The t-Test Scores of Gender on the Empathy and Its Sub-Factors.

Variables	Gender		t	Cohen's d
	Female (n=189)	Male (n=98)		
Empathy	2.29±0.40	2.16±0.36	2.91**	0.34
Personal Distress	1.58±0. 55	1.51±0.58	1.04	0.13
Empathy Concern	2.87±0.58	2.54±0.53	5.01***	0.59
Fantasy	2.26±0.65	2.15±0.63	1.45	0.17
Perspective Taking	2.42±0.71	2.45±0.52	-0.41	-0.05

*p < 0.05, ** p < 0.01, *** p < 0.001

Table 3. Comparison between Students with Normal and Non-Normal University.

Variables	Non-normal College Students (n=117)	Normal College Students (N=170)	t	Cohen's d
Empathy	2.26±0.47	2.34±0.44	-1.47	-0.18
Personal Distress	1.75±0.89	1.84±0.85	-0.87	-0.10
Empathy Concern	2.58±0.69	2.72±0.51	-1.94*	-0.24
Fantasy	2.89±0.09	2.89±0.73	0.01	0.002
Perspective Taking	2.17±0.79	2.28±0.75	-1.19	-0.14

*p < 0.05

Table 5 shows significant differences in empathy score ($t = 4.00$, $p < 0.001$) and its sub-factors except for PD. At the same time, in each empathy dimension of EC, FS

and PT, scores of authoritative style were higher than permissive style. It is therefore plausible that the pattern of family education and interaction is very important to develop the pre-teacher's empathy ability and skills. Put another way, the empathy ability of child may be modulated by emotional intelligence of their parents via the family's atmosphere feedback.

The researchers then turned to an analysis of empathy between introverted and extroverted student teachers. **Table 6** shows no significant difference between scores of extroverted students and introverted students on empathy and its sub-factors except for PD ($t = -1.74$, $p < 0.05$). However, the average score of introverted pre-service teachers were higher than extroverted students except for PT; the average score of PT for extraversion was higher than for introversion.

Discussion

These findings show that the empathy ability of the pre-service teacher group is generally high, whit average scores higher than two points. Pre-service teachers in normal university are stronger in the dimension of empathy concerns. First of all, they have systematically studied the professional knowledge of education and psychology, and have learned emotional theory and empathy skills. Therefore, their empathy concerns are relatively good, which is related to the fact that pre-service teachers likely have the will to become a teacher, and want to engage in education. Therefore, the pre-service teacher group will have conscious or unconscious daily interactions with people. It shows that teachers are good at listening, good at focusing and good at being empathetic. The results also show that the pre-service teacher performs less well on personal distress. Pre-service teachers are beginning with teaching in school, although they may have some opportunities to reach out to the child, there may be fewer chances for in-depth contact and understanding, and thus less attention to the child's pain, anxiety and discomfort, in this dimension.

Empathy is universal in a public citizen's life, especially within the teaching profession. The high empathy ability of pre-service teachers is likely due to their enthusiasm and less emotional exhaustion, probably due to the fact that trainee teachers are excited about primary school. This results exposed experience of the pre-service teacher, which may be an active empathy or a passive empathy. In-service teachers in the middle school scored the highest on empathy concern and their total empathy scores were higher than those of pre-service teachers. Previous studies have clearly shown that cultivating the empathic ability of pre-service teachers, especially empathic concern, can greatly improve emotional ability and prompt new teachers to adapt to work more quickly.

Many studies have found females to have greater emotional ability than males, or at least be more emotionally expressive (Kring & Gordon, 1998). Consistent with these studies, a study by Barış (2016), revealed that there was significant difference between scores of males and females on the empathy level of the emotional reactivity sub-factor scores. In this study, empathy of females and males were significantly different ($t = 2.91$, $p < 0.01$). In contrast, the in-service teachers in middle school have a similar con-

Table 4. Colleges' Category Analysis of the Empathy.

Variables	Major		t	Cohen's d
	Liberal Arts Students (n=81)	Sciences Students (n=207)		
Empathy	2.19±0.42	2.26±0.40	-1.55	-0.17
Personal Distress	1.36±0.78	1.64±0.70	-3.25**	-0.39
Empathy Concern	2.73±0.58	2.64±0.66	1.26	0.14
Fantasy	2.15±0. 65	2.24±0. 62	-1.22	-0.14
Perspective Taking	2.45±0.69	2.42±0.78	0.45	0.04

** p < 0.01

Table 5. Analysis of Differences Parenting Style.

Variable	Parenting Style		t	Cohen's d
	Authoritative (n=216)	Permissive (n=71)		
Empathy	2.35 ±0.41	2.16±0.39	4.00***	0.47
Personal Distress	1.54±0.80	1.48±0.85	0.67	0.07
Empathy Concern	2.84±0.61	2.60±0.62	3.34**	0.39
Fantasy	2.31±0.69	2.15±0.62	2.11*	0.24
Perspective Taking	2.55±0.70	2.38±0.58	2.13*	0.25

*p < 0.05, ** p < 0.01, *** p < 0.001

Table 6. Analysis of Pre-Service Teacher's Introversion and Extroversion.

Variable	Extroversion (n=173)	Introversion (n=114)	t	Cohen's d
Empathy	2.26±0.36	2.33±0.47	-1.41	-0.17
Personal Distress	1.70±0.89	1.88±0.86	-1.74*	-0.21
Empathy Concern	2.35±0.86	2.50±0.68	-1.63	-0.19
Fantasy	2.64±0.54	2.71±0.78	-0.89	-0.11
Perspective Taking	2.31±0.73	2.24±0.77	0.78	0.09

*p < 0.05

clusion for empathy abilities ($t = 3.65$, $p < 0.001$) in that the female teachers' empathy was higher more than that of male teachers (Guan, 2011). Due to these findings, possible effects of variables other than age and gender on emotional reactivity as a sub-factor of the Empathy Quotient Scale should be investigated (Sharma, 2014).

No difference was observed in empathy ability between countryside-orienting normal university students and normal university students. Because the teacher's education program has been taken seriously by the state, teaching has become an enviable profession. With the popularization of education, the gap between the education levels of normal and non-normal students is less, and opening of the teacher qualification examination has attracted more non-normal students. More importantly, the construction of online courses, such as MOOCs and micro-courses, has led to the rapid development of teacher education. Although the gap between teachers from different backgrounds is becoming smaller, normal students still have unique professional advantages, namely, educational internships. In the real-school situation, pre-service teachers learn to pay close attention to and empathize with the students, so as to truly cultivate their empathy ability. Through the practice of this educational internship, difference in empathy between pre-service teacher and non-teachers is generated.

Analysis of the causes of professional category differences in pre-service teacher' empathy show no difference in the empathy ability of the professional categories of pre-service teacher; the division of liberal arts and science has no effect on empathy ability ($p > 0.05$). However, there is a significant difference in the personal distress dimension ($t = - 3.24$, $p < 0.01$), and the average score of liberal arts students ($M = 1.36$) is lower than that of science students ($M = 1.64$). In the fantasy dimension, the average score of liberal arts students ($M = 2.15$) is lower than that of science students ($M = 2.24$), but not significantly. The average score of liberal arts students is higher than that of science students in dimensions of perspective taking and empathy concern, but not significantly.

Parenting style of authoritative or indulgence has been shown to lead to significant differences in empathy ability. Scores associated with the authoritative style for empathy and the four-dimensions are higher than indulgency style scores. There are significant differences in empathy concern ($t = 3.34$, $p < 0.01$), fantasy ($t = 2.11$, $p < 0.05$), and perspective taking ($t = 2.17$, $p < 0.05$). Indeed, early education and family parenting style has a great influence on people and can one's whole life. These data can be extrapolated, as parents of authoritative parenting styles give appropriate discipline through the process of raising children, and give appropriate care and guidance in terms of emotions. Whether in life or in emotion, children have free space to grow. The children of authoritative child-rearing style are more likely to be emotional, imaginative, sympathetic, concerned about others and be able to adopt others' points of view. Parents who are indulgent pay less attention to discipline in the process of raising children. They want to control their children's lives but at the same time, they neglect to care for their children and provide the correct emotional guidance and education. Such children are more likely to be emotionally selfish, find it difficult to sympathize with others and tend to ignore the opinions of others. According to previous research, the ultimate

mechanisms that drive empathic behaviors evolved in conjunction with parental care to increase survival of close-knit social groups (Trivers, 1971).

Analysis of empathy between introverted and extroverted pre-service teachers showed that all have high scores. Introversion and extroversion are easily associated with emotions. For example, introversion can be understood as emotional inactivity, while extroversion is understood as more active emotions. These results showed that students' average empathy scores with extroverted personality ($M = 2.26$) were lower than those with introversion ($M = 2.33$), and there was a significant difference in the PD sub-dimension ($t = -1.71$, $p < 0.05$). Consistent with previous research, introversion and extroversion have significant regulating effects between empathy and helpfulness (Yan, 2012).

Conclusions and Future Directions

This study demonstrated that empathy of pre-service teachers shows a significant difference by gender and parenting style and found that pre-service teachers' empathy concern is significantly different by gender, the classification of normal university students and parenting style. It also showed that personal distress is affect by personality test of EPQ and Faculty of the liberal arts and sciences.

Empathy is an important foundation for building good relationships between teachers and students. It is very difficult to turn empathy into language, as language is only a part of empathy. A person might believe they are much more empathetic than they really are. This is because someone with poor empathy is often the last person to realize they have poor empathy. More empathy gestures need to be experienced in practice by pre-teachers. With the cultivation of empathy, rural pre-service teachers can deepen their understanding through the activity of positive emotions.

Future research in the emotional ability field of pre-service could benefit from guidelines developed to improve protocols for education and intervention. For instance，a strategy to revitalize the countryside, which includes an extension specifically for emotional and psychological interventions, would be beneficial. Pre-service teachers will carry out social practice activities and enhance empathy through experience. Rural teachers develop an empathic ability to resist pressure. Then, the talented teachers with emotional intelligence love rural education and love rural students, according to local conditions education.

In addition, it would be beneficial to strengthen the training of empathy ability for rural orientation per-service teachers. For example, through imitating dialogue: "I feel you are a bit aggrieved, is it because the teacher just accused you? Was it because you did your homework incorrectly? Are you a bit depressed? Are you worried that the teacher blames you?"

Although research on the effects of emotional education is still in its infancy, our systematic assessment of study suggested that three specific method improvements could be made: (1) Focus on cultivating teachers' ability of empathy, enhancing communication between teachers and students, and promoting a harmonious relationship

between teachers and students; (2) Train teachers to use empathy language and behavior, and express empathy and regulate emotions in a timely and appropriate manner; and finally, (3) Encourage pre-service teachers to express their understanding to students, respect students and communicate with them actively, respect students and achieve the happiness of a teachers' career.

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