THE IMPLEMENTATION OF CONSTRUCTIVISM IN CHEMISTRY IN REMOTE AREAS OF CHINA

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Education (Chemistry)

School of Education
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AUGUST 2021

DEDICATION

This thesis is dedicated to my parents and relatives, who gave all kinds of help for me to complete my studies, whether it was spiritual or material support. They encourage me to be optimistic, overcome difficulties and grit, so that I have enough confidence to persist until the last moment.

ACKNOWLEDGEMENT

Before the preparation of the thesis began, I would like to appreciate my subject lecturers such as Assoc. Prof. Dr. Baharin bin Abu, Dr. Chuzairy bin Hanri, Dr. Nor Hasniza binti Ibrahim, Dr. Corrienna binti Abdul Talib and Assoc. Prof. Dr. Johari bin Surif for giving me wonderful lectures. Since my undergraduate background is not from education, their teaching on constructivism theory has been very rewarding for me, and it is also the reason why I decided to adopt this theory as the foundation of the thesis.

I am particularly grateful to my supervisor Dr. Chuzairy bin Hanri. He put forward many meaningful suggestions for revision to me in the early, middle, and late stages of the thesis. After completing each chapter, he took the trouble to help me revise and adjust. If it were not for his guidance and support, my thesis could not be completed smoothly and was finally recognized.

In addition, I would like to thank the lecturers from UNIVERSITI TEKNOLOGI MALAYSIA (UTM) and the School of Education for setting up workshops for our paper submissions and Turnitin.

I would also like to appreciate my graduate students. In this special period of COVID 19 pandemic, because my absence on campus will cause delays in obtaining information, they have provided me with timely and effective information.

I would also like to appreciate all the Chinese teachers who participated in the questionnaire survey of my thesis for their help to make my thesis smooth.

Finally, I still want to appreciate my parents and friends for giving me the most precious spiritual support.

ABSTRACT

Constructivism pays attention to the subject status of students, students' active discovery in the teaching process, and the construction of the meaning of knowledge, which coincides with the concepts of chemistry new curriculum reform of middle schools and science education in the beginning of the 21st century in China. Through a review of the literature in the past two decades, it is found that the theoretical development of constructivism in China is still lacking, which lead to some teachers are unable to carry out the new curriculum standards smoothly because of their lack of understanding of constructivism, especially in remote areas, there are very few related researches, and it is impossible to understand the situation of curriculum reform without a comprehensive understanding of the implementation of constructivism in China. Therefore, this study aims to understand the implementation level of constructivism in the chemistry curriculum reform in remote areas of China from three aspects that consist of teachers' knowledge level, attitudes and current teaching environment. This study used a quantitative approach to conduct a questionnaire survey of 42 middle school chemistry teachers in Shihezi City, a remote area of China. According to the pilot test, the questionnaire has high validity and reliability, with a reliability of 0.978. The data obtained have used SPSS for descriptive statistics, including median, frequency and percentage. The research results show that the constructivist knowledge of teachers in this area is at a moderate level, and their attitudes towards constructivist theories are highly recognized, while the current constructivist teaching environment is approximately at a medium level. This research is conducive to understanding and promoting the professional development of constructivism in remote areas of China, and is conducive to discovering problems that hinder the implementation of constructivism and proposing targeted solutions.

ABSTRAK

Konstruktivisme mementingkan status subjek pelajar, penemuan aktif pelajar dalam proses pengajaran, dan pembinaan makna pengetahuan, yang bertepatan dengan konsep kimia pembaharuan kurikulum baru sekolah menengah dan pendidikan sains pada awal abad ke-21 di China. Melalui tinjauan literatur dalam dua dekad yang lalu, didapati bahawa perkembangan teori konstruktivisme di China masih kurang. Sebilangan guru tidak dapat melaksanakan standard kurikulum baru dengan lancar kerana kurangnya pemahaman tentang konstruktivisme, terutama di daerah terpencil, terdapat sedikit penyelidikan yang berkaitan, dan mustahil untuk memahami situasi pembaharuan kurikulum tanpa pemahaman yang komprehensif mengenai pelaksanaan konstruktivisme di China. Oleh itu, kajian ini bertujuan untuk memahami tahap pelaksanaan konstruktivisme dalam pembaharuan kurikulum kimia di kawasan terpencil di China dari tiga aspek yang terdiri daripada tahap pengetahuan guru, sikap dan persekitaran pengajaran semasa. Kajian ini menggunakan pendekatan kuantitatif untuk melakukan tinjauan soal selidik terhadap 42 guru kimia sekolah menengah di Bandar Shihezi, sebuah kawasan terpencil di China. Menurut ujian rintis, kebolehpercayaan dan kesahan soal selidik adalah hebat, dengan kebolehpercayaan 0.978. Data yang diperoleh akan menggunakan SPSS untuk statistik deskriptif, termasuk median, frekuensi dan peratusan. Hasil penyelidikan menunjukkan bahawa pengetahuan konstruktivis guru di daerah ini berada pada tahap yang sederhana, dan sikap mereka terhadap teori konstruktivis sangat diakui, sementara persekitaran pengajaran konstruktivis saat ini lebih kurang pada tahap sederhana. Penyelidikan ini kondusif untuk memahami dan mempromosikan perkembangan profesional konstruktivisme di kawasan terpencil di China, dan kondusif untuk menemui masalah yang menghalangi pelaksanaan konstruktivisme dan mencadangkan penyelesaian yang disasarkan.

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INTRODUCTION

1.1 Overview

Increasingly advanced technology and innovative development have not only brought about earth-shaking changes in the manufacturing industry, but also put forward higher-level requirements on the labor force and education and training industries. In the 21st century, the new round of industrial revolution (fouth industry revolution) indicates human capital is no longer just regarded as the carrier of supply and demand, the creator of goods and services, but also as the core of modern digital economy and knowledge reform, as well at the critical moment of the transformation to the industrial revolution 4.0 (IR 4.0), the core transformation of digitalization and intelligentization requires the education circle to focus on how to cultivate more new-type and compound labor force to meet the demand of high-tech talent market (Zashchitina & Pavlov, 2019).

The demand for talents in today's global labor market is different from the previous three eras of the industrial revolution. The labor force with conventional knowledge, cognition, and operational capabilities cannot meet the future development needs of society. IR 4.0 emphasize workforce with soft skills such as communication, cooperation, planning, management, creation, problem solving, and critical thinking (Short & Keller-Bell, 2021).

To meet the demand of Industrial Revolution types of workforce, education is also undergoing a process of transformation. From the initial teacher with absolute authority in the classroom education 1.0, to the examination-focused and result-oriented education 2.0, to the gradual transformation to student-centered education 3.0, the roles of students and teachers are no longer antagonistic and unequal. Until now, the education 4.0 that we are experiencing now reflects the cooperation and innovation between students and teachers (Makrides, 2019).

It can be said that the innovation embodied in education 4.0 reflects the transformation of the traditional "education dissemination model", which has allowed scholars and educators to start thinking about new philosophy of education (Nola & Irzik, 2006). Constructivism learning theory is such a theory that has a great impetus to educational reform and development, and has a great impact on the learning process of learners and the teaching methods of instructors. Constructivism focuses more on students learning than on teachers teaching that emphasizes on ownership of the learning process by learners, experiential learning and a problem-solving approach to learning (Julia, G., 2018). The constructivist view of learning believes that knowledge is not acquired through teacher teaching, but learners use the help of others (such as teachers) in a certain context, use necessary learning materials, and acquire it through meaning construction, people are active explorers and builders of knowledge in the constructivist learning, and the construction of knowledge is carried out through the interaction between people and the environment (Jia, Q., 2010). In the process of teaching, learners are no longer passive receivers of knowledge, but active participants in knowledge, processing subjects of information, and active builders of meaning. Thus, "context", "collaboration", "conversation" and "meaning construction" are the four elements considered to be the constructivist learning environment (Dagar V&Yadav A., 2016).

At present, various fields around the world are advocating new talents with transferable skills in the 21st century to conform to the development trend of the IR 4.0, hence, when national talent training institutions at all levels build an innovative talent training system, in addition to having traditional cognition and operational capabilities, they should focus on soft power aspects such as thinking skills, communication skill and management skill (Short & Keller-Bell, 2021). The training of thinking skills must be student-oriented, taking into account their age characteristics and ways of thinking, stimulate their interest in learning, tap their creative potential, and achieve the transfer of skills and knowledge (Short & Keller-Bell, 2021). Constructivism is a kind of guiding ideology that advocates "student-centered", which encourages students to actively construct meaning of knowledge, and supplement and perfect the meaning of knowledge in practice. In the process of constructing meaning, students' innovation, analysis, and critical thinking skills have been greatly improved, and their problem-solving skills, planning and management skills have also been improved, in addition, through communication and collaboration with others, the soft skills that are particularly important in the workplace-communication and cooperation have also mastered (Chen, D, L. 2009). Therefore, taking constructivism as the guiding ideology of talent training in the 21st century is an important decision to conform to the development of IR 4.0.

Educational institutions around the world have been engaged in the study and application of constructivism. In order to adapt to the trend of industrial Revolution 4.0, modern science education is also constantly exploring and groping in the reform, with great changes in teaching methods and teaching contents. This transformation is exactly the hotbed for development of constructivism (Hao, Y, J. 2013).

The European Union began a new round of scientific education reform at the turn of the century, the EU takes lifelong learning as the starting point of education, attaches great importance to the construction of students' scientific

knowledge and improvement of scientific quality, encourages teachers to improve their professional standards in a constructivist teaching environment, and provides students with an equal and open educational environment (Wang, X, L., 2011). The representative of developed countries - the United States, whose government successively promulgated a series of policy since the 1990s to guarantee implementation of a student-centered, self-directed learning philosophy. Faced with the demand for new talents, Singapore's Ministry of Education (MoES) has introduced several important new initiatives in recent years, including the Technology Improvement Program, the thinking training program and the National Education Program which pay more attention to adaptability and diversity of teaching methods(Guo, Y, M., 2012).

Similarly, China, which carried out comprehensive education reforms in the early 21st century, was also one of the members affected by the wave of constructivism (Hao, Y, J., 2013). Then, how about the implementation of constructivism in quality education of basic science in China, especially in chemistry education? This research will review the implementation of constructivism in the context of the chemistry curriculum reform in China from 2003, and focus on the implementation of constructivism in remote areas.

1.2 The necessity of applying constructivism in the chemistry new curriculum

The basic education curriculum reform carried out in China at the end of the 20th century was based on the context of the global curriculum reform, and the international constructivist trend of thought must also be reflected in it. With the advancement of society and technology, China’s traditional teaching methods can no longer meet the requirements of modern education. Students can freely plan their own

learning under the guidance of teachers; schools and teachers focus more on delivering teaching strategies to students instead of knowledge (Wei, B, B., 2015). The idea of only focus on spreading knowledge, accumulating knowledge without paying attention to the collection and processing of information, and focusing only on the results of education rather than the educational process is no longer suitable for the reality of social development with rapidly increasing information. At the same time, constructivism born in the 1980s in the United States that attaches importance to the subject status of students, students′ active discovery in the teaching process, and the construction of the meaning of knowledge, which coincides with the concepts of new curriculum standards and quality education (Hao, Y, J., 2013). The prevalence of constructivism in China is being applied and promoted in this context.

The new curriculum standards are based on the concept of promoting students' all-round development and cultivating students' scientific literacy, and major adjustments have been made in curriculum settings, teaching goals and knowledge systems. The main goal of education is adjusted to enable students to achieve a unified and harmonious development in the three dimensions of knowledge and skills, process and methods, emotional attitudes and values. The basic curriculum concept of "Compulsory Education Curriculum Standard (2011 Edition)" clearly states: “Enable every student to learn vivid and interesting subject knowledge with a happy mood... Provide every student with equal learning opportunities... Starting from the students' existing experience...Let students have more opportunities to actively experience the process of scientific inquiry... Provide a variety of learning evaluation methods for each student′s development...”.

Under the guidance of constructivist teaching theory, a teaching model that is compatible with constructivist theory is gradually formed in the context of new curriculum reform, that is, “student-centered, and the teacher plays the role of organizer, instructor, helper and facilitator throughout the teaching process. Use

context, collaboration, conversation and other learning environment elements to give full play to the initiative, enthusiasm, and initiative of students, and ultimately achieve the goal of enabling students to effectively realize the meaning construction of the current knowledge." (Wei, W, X., 2018).

Comparing the core concepts of the new curriculum standard and the key elements of constructivist teaching theory, it is not difficult to find that the student self-directed learning advocated by constructivism is exactly the "inquiry" emphasized in the new curriculum standard. In addition, constructivism believes that learning is promoted by social interaction, which is in line with the new curriculum standard that requires students to cultivate their own spirit of cooperation and social responsibility in the process of learning. Moreover, constructivism believes that knowledge should be constructed by learners based on their own understanding, this is also the new curriculum standard that teachers should help students learn knowledge and skills rather than directly impart it. Ultimately, the ultimate objective of constructivism is for learners to master learning strategies and thinking skills so as to freely respond to various challenges in the future, this is also the ultimate goal proposed by the new curriculum standards for students to learn.

According to the national "Science (Grade 7-9) Curriculum Standard Trial Draft" and "Chemistry (Grade 9) Curriculum Standard Trial Draft", junior high school science chemistry courses are all science introductory courses aimed at cultivating students' scientific literacy, of which basic idea is to face all students, based on student development, embody the essence of science, highlight scientific inquiry, reflect contemporary scientific achievements, and design ideas that highlight the two characteristics of "integration" and "inquiry". The compulsory education chemistry course aims to improve students’ scientific literacy, stimulate students’ interest in chemistry, and help students understand the basic processes and methods of scientific inquiry, develop scientific inquiry ability and acquire basic chemical knowledge and

basic skills required for further study and development; Guide students to understand the important role of chemistry in promoting social development and improving the quality of human life, and cultivate students' cooperative spirit and sense of social responsibility through chemistry learning, cultivate students' national self-esteem, self-confidence and pride; guide students to learn to learn, learn to survive, and better adapt to modern life (Ministry of Education , 2011).

Obviously, chemistry is an important course in basic education. In the new curriculum reform of chemistry, the thought of constructivism is especially salient. (Guo, J, H., 2020). In terms of specific teaching methods, constructivism advocates discovery learning, inquiry learning, discussion, cooperative learning, individualized teaching, and the use of modern information technology for teaching, the embodiment of constructivism in the new chemistry curriculum standard mainly from the following three aspects to explore:

1. The outstanding manifestation of constructivism in the chemistry curriculum standard is the emphasis on scientific inquiry.

Constructivism advocates the construction of knowledge, and one of the main forms for students to construct knowledge is inquiry. The so-called inquiry is the use of facts and observations to answer questions and solve problems. Synthesizing the opinions of different scholars, the inquiry mainly includes the following steps: (1) discovering and identifying problems; (2) forming hypotheses to explain events or solving problems; (3) collecting data to test hypotheses; (4) drawing conclusions from data ; (5) Reflect on the initial problem and the thinking process of solving the problem or summarize on the basis of the conclusion. The chemistry curriculum standard points out that scientific inquiry is an important practical activity for students to actively acquire chemical knowledge, understand and solve chemical problems. It involves raising questions, conjectures and assumptions, making plans, conducting experiments, collecting evidence, explaining and concluding, reflecting and

evaluating, expressing and communicating, and so on. These elements basically correspond to several steps of constructivist inquiry

2. Emphasis of context also is the manifestation of constructivism in the chemistry curriculum standards

In the teaching recommendations of the chemistry course standard, it is clearly pointed out that the creation of learning context can enhance the pertinence of learning, which is conducive to exerting the role of emotion in teaching, inspiring students' interest, and making learning more effective. In the suggestions of textbook compilation , it is also required to draw materials from the students' life experience and the reality of social development, which can not only draw the content of chemistry learning from practical problems, but also allow students to start learning in actual context, and can also apply chemistry knowledge in the actual context. These claims are consistent with the ideas of constructivism. It can be said that the standard emphasizes the role of learning context from multiple aspects and perspectives.

3. Constructivism is reflected by emphasizing that students construct knowledge through social cooperation in the chemistry curriculum standards

Scientific inquiry is the main way for students to construct knowledge. For more comprehensive activities and inquiring experiments, the standard advocates organizing students to collaborate in small groups to cultivate students' team spirit and ability to work together. The chemistry curriculum standard also points out that students have different knowledge backgrounds, and their ways of thinking about problems may also be different. They also have different perspectives and levels of understanding of the same problem. In the inquiry teaching, teachers should organize students to communicate and discuss with each other purposefully. These requirements are in fact a reflection of the social interaction advocated by constructivism that can promote learning.

Curriculum implementation is a key link that affects curriculum reform. As one of the systematic teaching theories, constructivism teaching theory can provide greater support and help for changing the teaching methods of teachers and students (Wang, X., 2015). If constructivist theories and related concepts can be better penetrated and reflected in the front-line teaching practice, it will provide important ideas, ways and supplements for teaching reform. Therefore, this study intended to study the implementation of constructivism through new chemistry curriculum in China.

1.3 Low implementation of constructivism in China

Since the start of the new round of basic education curriculum reform, the daily teaching of classrooms, teachers and students has undergone unexpected changes, and it has also posed severe challenges to the entire education system. Through literature review, successful cases of curriculum reform almost appeared in developed cities, a large amount of paper affirmed the teachers' understanding and the attitude towards implementation of constructivism.

According to Fan & Zhao's (2015) study, chemistry teaching mode based on Constructivism Teaching Concept - "Three Stages Two Levels" classroom teaching model successfully implemented in Wuhan city which is first-tier city of China. "Three stages and two levels" is a comprehensive manifestation of meaning construction and inquiry constructivism. The so-called "three stages" is to divide a class into three stages in time for students to learn by themselves, teachers to teach and guide, and students to practice and consolidate. The so-called "two-level" refers to the two levels of knowledge and ability that students acquire through self-study, listening and practicing.

The model can be summarized as follows:

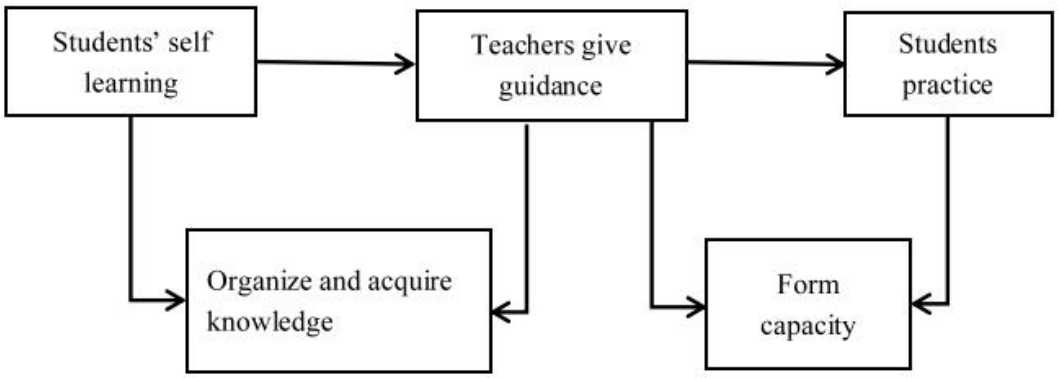

Figure 1.1 "Three Stages Two Levels" classroom teaching model

The reform of this teaching model formed under the guidance of constructivism theory overcomes the shortcomings of the traditional single teaching mode, promote the implementation of new curriculum reform. It can not only cultivate students' interest in learning, activate students' thinking, but also enable students to master systematic and solid basic knowledge, and can be used flexibly in connection with reality, which is conducive to the development of students' abilities while acquiring knowledge, is conducive to enhancing the artistry and appeal of teaching, and is conducive to allowing students to learn in situational and cooperative environment, turning the classroom into a learning paradise full of vitality.

In addition, Hao, Y, J. (2013) pointed out in his research based on survey that 350 middle school chemistry teachers from first-tier regions such as Beijing, Tianjin, Xiamen, Kunming and other places have a more comprehensive and deeper grasp of the basic knowledge of constructivism (93%); in the practical teaching design, constructivist contextual teaching will also be applied by 97% teachers, all of teachers focus on students' inquiry stage in the learning process, and half of teachers support and agree with cooperative learning. However, in terms of experimental teaching, limited by the lack of teaching equipment, only 30% of teachers will organize

students to conduct pre-experiment drug preparation and group experiments and write experimental reports.

Similarly, reported in the same study of Hao, Y, J. (2013), the remaining 350 middle school chemistry teachers from Hohhot, a developing city in Inner Mongolia, lacked the basic knowledge of constructivism, and even 6% of the teachers said they had no knowledge of constructivism at all; less than 50% of teachers agree with constructivist contextual teaching, 29% of teachers choose to apply it in actual teaching design. In the design of inquiry teaching, teachers' choice of heuristic questions is only 40%, which is far less than 80% of first-tier teachers. However, in terms of the design of knowledge application, the proportion of teachers in the second-tier city is comparable to that of teachers in first-tier cities. In terms of cooperative learning, only 17% of teachers strongly agree with it, and even 52% of teachers believe that students do not have the ability to learn independently.

In terms of experimental teaching, developing cities are even more limited by the lack of teaching equipment. Only 9% of teachers will organize students to conduct pre-experiment drug preparation and group experiments and organize experimental reports.

It can be found that there are some common problems in implementation of constructivism in chemistry new curriculum. For remote areas, which are inherently scarce in education resources than the first-tier or developing areas, they will inevitably encounter more difficulties and problems when implementing a series of policies for the new curriculum reform and new theory of pedagogy, such as constructivism, which not only constrict the implementation of the new curriculum reform, but also restrict the promotion of constructivism in the whole country (Sang, Y, J., 2016).

Also based on the 2030 Agenda for Sustainable Development Goal 4 issued by United Nations General Assembly in 2015 (UNESCO, 2016), emphasized education challenges of lifelong learning, equity and curriculum content to OECD countries, equity will be measured in a series of dimensions (such as gender, socio-economic status and location) (OECD, 2019). This means that education in remote areas and developed areas should gradually narrow the gap, and under the guidance of this policy, the barriers to teaching reform caused by the uneven distribution of educational resources should be reduced. The premise of improvement is to accurately grasp the problem, thus research on education in remote areas is essential, especially for a country like China with extremely unbalanced development in all aspects, the education level of developed regions does not represent the overall level of the country, and the focus of education development should fall on developing regions and remote areas.

Therefore, this study will focus on the practice of constructivism, a new educational theory in remote areas, and make specific recommendations based on the actual implementation.

1.4 Important roles of teacher in implementing constructivism

Many previous research reports (Mendro, 1998; Strong & Tucker, 2000; Anderson & Helms, 2001; Powell &Anderson, 2002) have pointed out that teachers are the key to the successful implementation of teaching plans and teaching reforms. Simply put, the importance of teachers in the education process is no less than the intention to reform the curriculum. In the process of new curriculum reform, junior middle school chemistry teachers working in the front line of teaching are also constantly exploring and reforming in their own work practice (Wu, L, N., 2016).

Constructivism from its origins to swept various disciplines in global education, the most impact is undoubtedly the teachers in the front line of teaching. This is a kind of teaching theory that emphasizes the transformation of learners into a dominant position, and requires learners to reflect on their own experience during the learning process, reconstruct their own knowledge system and understanding of problems to improve their higher-order thinking skills and master various abilities in real life (Gangwar, 2017).

In this context, the teacher is no longer the leader of the classroom, and the classroom is no longer simply teaching knowledge directly from the teacher to the students, especially in chemical science education, abstract knowledge has increased the difficulty for students to learn. After changing the teacher-oriented teaching method, how to combine constructivism with the requirements of the new curriculum reform and use it in teaching activities reasonably, which poses a huge challenge to knowledge of teaching theory for teachers (Plourde & Alawiye, 2003).

According to Patil and Kudte's (2017) research, teachers' implementation of constructivist teaching in chemistry courses cannot be separated from the confinement of traditional teaching models because they lack the knowledge base of constructivist theory. Similarly, applying constructivism in chemistry requires the assistance of many teaching models, however, teachers who lack theoretical knowledge are often unable to properly apply these teaching models to classroom teaching. This leads to a vicious circle.

If the education system is not equipped with teachers with good understanding and sufficient knowledge reserves towards contructivism theory, no matter how good a teaching plan or reform implementation is, it will become empty talk. As an important link between national education reform and students, teachers must have a sufficient understanding and preparation for constructivism of teaching reforms. If

teachers' knowledge is not enough to apply teaching theories, the delivery of curriculum reforms will be cut off (Toh, Ho, Chew & Riley, 2003).

Furthermore, although the expectations of middle school chemistry curriculum standards for chemistry education are changes throughout the chemistry teaching system, the important task of implementing reforms is still almost concentrated on teachers. However, through a literature review of global science education, it is found that teachers' attitudes towards major changes in teaching methods such as constructivism in the reform are the another key factor to the success of the reform (Liang & Gabel, 2005).

Whether teachers implement constructivism in the classroom has a great relationship with teachers' beliefs and attitudes, because teachers' attitudes will affect their views on constructivism and doubts about its effectiveness. In addition, the problems in the current reform also need to be discovered and pointed out by teachers. If teachers are skeptical of the constructivist teaching methods required in the reform, they will not be able to smoothly adopt and actively use them, and they will not be able to discover the problems in the reform in the teaching process (Beck, Czerniak & Lumpe, 2000)

In the earliest report on the implementation of constructivism in school curricula, Connelly and Ben-Peretz (1980) argued that teachers must have full trust in the prepared curriculum reforms before the reforms can be implemented correctly and effectively. In other words, if a school wants teachers to use constructivism as a teaching theory to carry out curriculum reforms in the teaching process, the most critical preparation is to understand teachers' attitudes, through training and other methods, teachers can have a correct attitude and maximum trust in constructivism, so that curriculum reform can proceed smoothly.

At present, in the process of implementing constructivism, teachers' beliefs and attitudes are considered to be one of the key factors for the success of the implementation. If teachers hold wrong beliefs or opposing attitudes, all their teaching implementations are based on these beliefs above, teaching results are inevitably separated from the concept of constructivism; on the contrary, if the teacher's belief in constructivism is correct and strong, the teacher will be committed to leading students in the classroom in a reasonable and efficient constructivist environment that they have constructed, inspiring students' interest in new content and constructivist teaching (Savasci-Acikalin, 2009). The engagement of students will strengthen teachers' belief in constructivism, and will be more confident (Peker & Ulu, 2018).

In addition, the teacher's attitude will also influence the teacher's behavior and decision-making in the actual teaching process. According to the results of Kaymakamoglu's (2018) research report, some teachers adopt an attitude of identification with constructivism and actively practice this theory in their teaching practice. They believe that they are conducting teaching activities according to the requirements of the new curriculum reform, because the core principles of the new curriculum standard adopt the student-centered constructivist teaching theory. Although some teachers also are in favor of the application of constructivism in the new curriculum reform, they do not have experience in applying this new teaching concept or the lack of knowledge of constructivist theory leads to classrooms that only reflect traditional teaching methods in actual teaching.

Based on the review of the problems of teachers in the above two parts of global science education, it is not difficult to find that this is not an isolated phenomenon. Therefore, the Chinese education system, which has followed the respect for teachers and respected education for thousands of years, and the traditional teaching model is deeply rooted, cannot avoid the same problems in curriculum reform.

In addition, the focus of this research is the remote areas of China. In addition to the problems of the teaching staff, the relatively backward teaching environment in remote areas is also an important factor hindering the implementation of constructivism in the new chemistry curriculum reform.

1.5 Lack of conducive environment to implement constructivism in remote area

Constructivism can basically be defined as a learning method that defends students' subjective construction, interpretation, and reorganization of their knowledge (Windschitl, 1999). This kind of learning environment requires students to be responsible for themselves, and teachers help students make meaningful constructions through the use of questioning, problem solving and inquiry in the classroom (Marlowe & Page, 2005).

Some researchers emphasize that the constructivist classroom has a positive impact on individuals' metacognitive skills, creativity, critical thinking skills, and problem-solving skills (Jager, Jansen, & Reezigt, 2005; Lam, 2011; James, Gerard, & Vagt-Traore, 2010; Tezci & Gürol, 2003; Maypole & Davies, 2001; Bay, Bagceci, & Cetin, 2012; Wilson, 2010). Therefore, evaluating the advantages and disadvantages of the constructivist learning environment have important reference significance for cultivating the above-mentioned types of talents.

To sum up, constructivist classroom upholds a student-centered learning environment and redefines the roles and relationships between teachers and students. An ideal constructivist teaching environment should foster creativity, independence,

problem solving and lifelong learning. This kind of teaching environment is exactly what China's new curriculum reform emphasizes.

In the previous part, we discussed the implementation of constructivism in remote areas. On the one hand, teachers' constructivist teaching design and implementation are restricted by their mastery and attitude towards constructivism; on the other hand, the literature review of the implementation of the standard found that the teaching technology support in remote areas is also restricted by the level of economic development.

Therefore, this study will select China's most remote Shihezi city in Xinjiang as the research object to determine the environmental factors that hinder the implementation of constructivism in remote areas.

1.6 Problem statement

China's chemistry curriculum reform has also referred to a certain extent from the direction of education 4.0 for the training of learners. Therefore, the development and implementation of constructivism in the context of China's curriculum reform has become very important. However, through the foregoing perspectives on the implementation of constructivism in China, the role of teachers in the implementation of constructivism, and the teaching environment for the implementation of constructivism theory, the application and popularization of constructivism in the process of China's teaching reform have not yet reached a satisfactory level, especially in remote areas where the economic and educational development are relatively backward. Reform are difficult to implement and lack the support of objective conditions, which leads to the application of constructivism in most

classrooms is still on the surface and does not truly reflect the connotation of constructivism.

The reason for the research on this subject is that in the preliminary research preparation, nearly a hundred articles on the application of constructivism in the new curriculum reform of junior high school chemistry were collected, one part is about the academic discussion and hypothesis about the characteristics and development of the theory, and the other part is about the practical application and reflection of the theory in the classroom by frontline teachers, but very few introduction to the implementation of remote areas was found.

Based on China’s national conditions, if the development of basic education is to be comprehensively improved, reforms in remote areas are the top priority. If remote areas remain behind or even lagging behind in the new policies, China's basic quality education will not be able to reach the level expected of a major education country.

Therefore, if schools and teachers in remote areas have expectation to implement the practical application of constructivism theory in junior high school chemistry curriculum reform, they must understand the teachers’ attitudes and knowledge of constructivism theory in remote areas first. Only then can they give targeted suggestions to help remote areas improve the implementation of new curriculum reform based on the constructivism theory.

1.7 Objectives of the study

This research aims to study the implementation of constructivism in remote areas of China under the background of the new curriculum reform in junior high schools.

1.7.1 Research Objectives

The research objectives are as follows:

A survey was developed to understand the implementation of constructivism in remote areas.

According to the survey results:

1. To determine chemistry teachers' knowledge of constructivism theory in remote areas
2. To determine chemistry teachers' attitude of constructivism theory in remote areas
3. To determine the implementation level of constructivism theory in remote areas

1.7.2 Research questions

The research questions of this study are as follows:

1. What is the degree of teachers' understanding about constructivism theory in remote areas ?
2. What is the attitude of teachers in remote areas towards the implementation of constructivism in chemistry curriculum reform?
3. What is the implementation level of constructivism theory in remote areas?

1.8 Significance of the study

In the process of research on this subject, the literature had been extensively reviewed on the combination of constructivist learning theory and the new curriculum teaching of middle school chemistry on the Chinese literature platform, such as CNKI, VIP, WANFANG DATA, AIXUESHU, BAIDU SCHOLAR, and found that the existing research results mainly involve two directions.

One direction is the systematic introduction of the characteristics of constructivist learning theory, teaching methods, teaching modes and other macro aspects by professional educational science theoretical researchers, and the researchers according to the teaching practice of various disciplines in China and more in-depth investigation and reflection on the present situation of the application of constructivism learning theory, put forward the theory should be taken to the dialectical attitude, critical to draw lessons from to absorb. The research results in this direction focus on macro-theoretical speculative research, and have a strong academic color. The specific guidance value for frontline teachers' teaching practice remains to be discussed.

The other direction of research results is from the action research of middle school chemistry teachers. They proposed to use constructivist learning theory to innovate chemistry teaching practice, and put forward specific operational suggestions based on the teaching of a certain lesson or a certain topic. The research results in this direction focus on applied research at the practical level, and have a greater guiding value for practice. However, the comprehensiveness of the research topics and the inadequacy of the coverage of the area will reduce the reference value of the theory in teaching practice.

Therefore, this research has the following research significance:

1.8.1 Conducive to promoting the implementation of the new curriculum standard of junior middle school chemistry in remote areas of China

In order to implement the requirements of the new curriculum standard to make a fundamental change in teaching, teachers must first establish a new teaching concept in practice and change the traditional teacher-centered teaching model. However, the teaching model that has been used for decades and hundreds of years is difficult to change in just a dozen years.

It can be seen from the literature that most teachers hope to meet the requirements of the new chemistry curriculum reform to improve their teaching, but they are often overwhelmed and insufficient, and even lost in confusion.

Analyzing the reasons, in addition to lack the in-depth analysis of the new curriculum standards of secondary school chemistry, the lack of appropriate theoretical guidance is also an important factor. Constructivist learning theory is

providing a good idea and a good method for the effective implementation of the new chemistry curriculum concept.

This research analyzes the point of convergence between constructivist learning theory and the new curriculum reform of middle school chemistry, and proposes suggestions for applying constructivist learning theory to guide teaching practice from the aspects of context creation, scientific inquiry, and cooperative learning according to the characteristics of chemistry disciplines, thereby helping chemistry Teachers implement the new chemistry curriculum reform in practice.

1.8.2 Conducive to promoting the professional development of chemistry teachers in remote areas

Teacher professional development is ultimately reflected in the professional development of individual teachers, and its specific content includes the establishment of professional ideals, the expansion of professional knowledge, the development of professional abilities and the formation of professional self (12 normal universities, 2004). The professional ability of a teacher is the most prominent external manifestation of the comprehensive quality of a teacher, and it is also a core factor for evaluating the professionalism of a teacher.

The professional ability of teachers in remote areas often lags behind that in developed areas. The new chemistry curriculum reform has made chemistry teaching a specialized education and teaching activity, making chemistry teaching more professional and technical. How to creatively carry out various teaching activities, improve and explore teaching methods, and apply constructivist learning theory to guide teaching practice in the context of new courses is more important and urgent.

Therefore, whether chemistry teachers in remote areas can meet the challenges of the new curriculum reform, and realize the two-way improvement of teaching thinking and teaching behavior is extremely important. For example, in order to realize the transformation of learning methods advocated by the new chemistry curriculum reform, the prerequisite is to require a qualitative change in the role of teachers. Teachers must become the guide, organizer, and evaluator of student learning.

On the surface, the teaching behavior of teachers in classroom teaching seems to be much less, but in fact, the labor that teachers need to pay has increased. This is because teachers need to devote more energy to lesson preparation, analyze academic conditions, preset key points and difficulties of inquiry, use existing teaching resources to stimulate students' enthusiasm for inquiry, and carry out effective inquiry activities to improve teaching effectiveness. In a word, it is impossible to meet the requirements of the new curriculum reform without mastering certain educational and teaching theories.

It is hoped that through this research, chemistry teachers in remote areas can consciously apply constructivist learning theory to practice new curriculum concepts, improve effective teaching, and become expert teachers and research teachers with a certain value of reference.

Therefore, this research focuses on introducing the application of constructivist theory in middle school chemistry courses and exploring the practical results of this application in remote areas, hope that through a more systematic and comprehensive interpretation of the constructivist learning theory and the investigation and analysis of the cognition and application of the theory by middle school chemistry teachers, to help teachers in remote areas of China to better apply

this theory in their teaching practice to implement the new chemistry curriculum standards and improve teaching effectiveness.

1.9 Conceptual framework

Teachers are the ultimate executors of the new curriculum reform concept. How do middle school chemistry teachers know constructivist learning theory?

What is the attitudes of middle school chemistry teachers apply constructivist learning theory to guide teaching in classroom teaching? What is the level of implementation of this theory? Based on the above objectives, this research is developed on the basis of absorbing the essence of existing research results. The conceptual framework as follow:

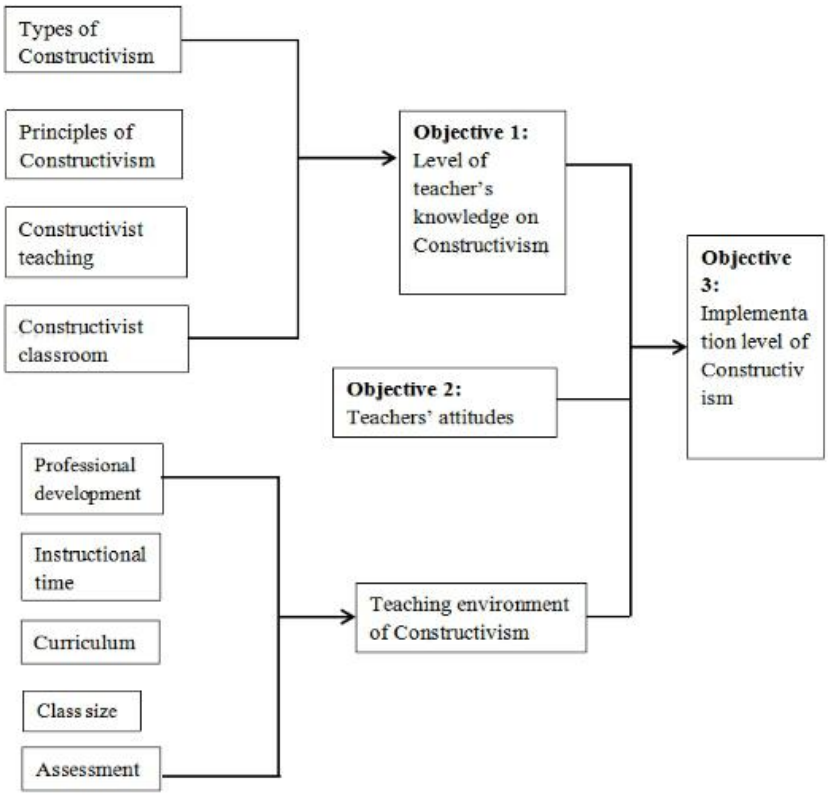

Figure 1.2 Conceptual framework

Through the types, principles, and constructivist teaching behaviors, constructivist classrooms determine the research objective 1:Teachers' level of constructivist knowledge and understand teachers' attitudes toward constructivism to determine the research objective 2. Determine constructivist teaching environment from aspects consist of professional development, instructional time, curriculum, class size, and assessment. Combine knowledge level, attitude and teaching environment to determine the research objective 3: implementation level of constructivism in remote area.

1.10 Definitions of terms

1.10.1 New curriculum reform of secondary school chemistry

New curriculum reform of secondary school chemistry is a curriculum reform movement which is carried out by the Ministry of Education according to the Chinese national conditions. At the same time, the document named Compulsory Education Chemistry Curriculum Standards were issued to provide theoretical guidance for the new reform and put forward new requirements for the chemistry curriculum of Junior middle schools in China.

Compulsory Education Chemistry Curriculum Standards clearly pointed out (Ministry of Education , 2011):

Every student shall be provided with equal learning opportunities so that they can have the necessary chemical knowledge, skills, methods and attitudes to adapt to modern life and future society; Have the necessary scientific literacy to adapt to future survival and development, and at the same time pay attention to enable students of different levels to get good development on the original basis. The basic starting point is to promote student development, that is, student development-oriented.

This kind of educational thought and curriculum concept not only pays attention to the wholeness, comprehensiveness and initiative of student development, but also pays attention to the difference and continuity of development.

1.10.2 Constructivism learning theory

Constructivism is derived from the theory of children's cognitive development (Fangfang,L.,2013). Due to learning process is closely related to the individual cognitive development, the cognitive laws of human learning process can be better explained by constructivism, in other words, how learning occurs can be better explained, how does meaning constructed, how does concepts formed,and the ideal learning environment include main factors, etc. (Sarita, 2017). In short, a set of new and more effective cognitive learning theories can be formed under the guidance of constructivism, and on this basis,it is possible to realize a more ideal constructivist learning environment.

1.10.3 Remote areas

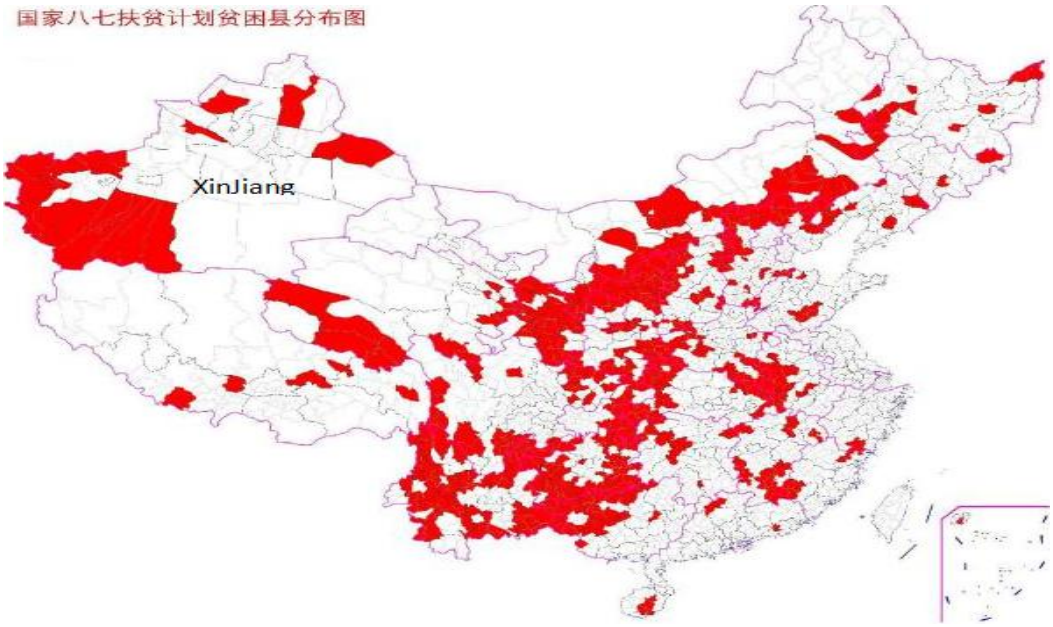

Figure 1.3 Distribution of remote areas in China

According to data released by the National Bureau of Statistics, remote areas are generally defined as areas where GDP lags behind the national average and

education and medical resources lag far behind other regions. Based on the document issued by Ministry of Personnel and Ministry of Finance, there are still 984 counties and cities classified as remote and poor area in China highlighted in the red part of map. In the upper left corner signed in the map above, it is the largest province in China named XinJiang, which is the most remote location in china according to standards of the National Bureau of Statistics, a representative city named ShiHeZi will be selected for this study.

1.11 Summary

This chapter introduces the implementation of constructivism on a global scale and the development status of the introduction of the Chinese curriculum system so far.

At present, most of the literature that can be retrieved on Chinese literature platforms are concentrated in areas with the most developed economy and education, such as Beijing, Shanghai, and Jiangsu, and only a small part of them has investigated and studied the implementation of constructivism in remote areas. The data is still not sufficient and representative, it is impossible to provide feedback on the situation of constructivism since the introduction of the middle school teaching system, let alone understand whether there are a series of obstacles due to geographical reasons in the implementation process. Therefore, this study will select the most remote areas of China to conduct surveys to understand the extent and attitudes of teachers in that region to constructivist knowledge, and to analyze the implementation of constructivism in teaching practice.

REFERENCES

Acat, M. B., Anilan, H., & Anagun, S. S. (2010). The problems encountered in designing constructivist learning environments in science education and practical suggestions. *TOJET: The Turkish Online Journal of Educational Technology*, 9(2).

Aceves, T. C., & Orosco, M. J. (2014). Culturally responsive teaching (Document No. IC-2). Retrieved from University of Florida, Collaboration for Effective Educator, Development, Accountability, and Reform Center website http://ceedar.education.ufl.edu/tools/innovationconfigurations/

Alenezi, A. (2017). Obstacles for teachers to integrate technology with instruction. *Education and Information Technologies*, 22(4), 1797-1816.

Allen, M. (2017). *The sage encyclopedia of communication research methods* (Vols. 1-4). Thousand Oaks, CA: SAGE Publications, Inc doi: 10.4135/9781483381411

Anagün, S. S. (2018). Teachers' Perceptions about the Relationship between 21st Century Skills and Managing Constructivist Learning Environments. *International Journal of Instruction*, 11(4), 825-840.

Anderson, R. D. & Helms, J. V. (2001). The ideal of standards and the reality of schools: Needed research. *Journal of Research in Science Teaching*, 28 (1), 3–16.

Azano, A. P., & Stewart, T. T. (2016). Confronting challenges at the intersection of rurality, place, and teacher preparation: Improving efforts in teacher education to staff rural schools with qualified teachers. *Global Education Review*, 3, 108–128.

Babakus, E., & Mangold, W. G. (1992). Adapting the SERVQUAL scale to hospital services: an empirical investigation. *Health services research*, 26(6), 767.

Bada, S. O., & Olusegun, S. (2015). Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education*, 5(6), 66-70.

Bailey, C., Jensen, L., & Ransom, E. (2014). Rural America in a globalizing world: Problems and prospects for the 2010s. Morgantown: West Virginia University Press.

Barak, M. (2017). Science teacher education in the twenty-first century: A pedagogical framework for technology-integrated social constructivism. *Research in Science Education*, 47(2), 283-303.

Barrett, N., Cowen, J., Toma, E., & Troske, S. (2015). Working with what they have: Professional development as a reform strategy in rural schools. *Journal of Research in Rural Education*, 30(10), 1–18.

Basnet, L.D. (2013), *Gender Discrimination and Children's Right to Education in Nepal. Perspective of Parents and Children*. Master's thesis for the award of master of philosophy (MPhil) in childhood studies.

Basturk, S. (2016). Primary Pre-Service Teachers' Perspectives on Constructivism and Its Implementation in the Schools. *Universal Journal of Educational Research*, 4(4), 904-912.

Bay, E., Bagceci, B., & Çetin, B. (2012). The effects of social constructivist approach on the learners' problem solving and metacognitive levels. *Journal of Social Sciences*, 8(3), 343-349.

Baysen, F., & Baysen, E. (2017). Teacher Candidates' Understandings and Progress of Constructivism in Science Teaching. *International Journal of Educational Sciences*, 19(2-3), 166-180.

Bearden, W. O., Netemeyer, R. G., & Mobley, M. F. (1993). Multi-item measures for marketing and consumer behaviour research. *In Handbook of Marketing Scales*. Sage New York.

Beck, J., Czerniak, C. M., & Lumpe, A. T. (2000). An exploratory study of teachers' beliefs regarding the implementation of constructivism in their classrooms. *Journal of Science Teacher Education*, 11(4), 323-343.

Begg, A. (2015). Constructivism: An overview and some implications. *Centre for Science Maths Technology Education Research*, The University of Waikato.

Bell, L. M., & Aldridge, J. M. (2014). *Student voice, teacher action research and classroom improvement*. Springer..

Bhandary, S. (2017). *Understanding some cultural barriers to women's access to education: a case study in rural Nepal* (Master's thesis).

Biddle, C., & Azano, A. P. (2016). Constructing and reconstructing the “rural school problem” A century of rural education research. *Review of Research in Education*, 40(1), 298-325.

Boettcher, J.V., & Conrad, R. (2010). *The online teaching survival guide: Simple and practical pedagogical tips.* San Francisco, CA: Jossey-Bass.

Bonnano, A. (2014). Agriculture and food in the 2010s. In C. Bailey, L. Jensen, & E.

Boone, H. N., & Boone, D. A. (2012). Analyzing likert data. *Journal of extension*, 50(2), 1-5.

Brooks, J., & Brooks, M. (1993). *In search of understanding: the case for constructivist classrooms*, ASCD. NDT Resource Center database.

Brown, D. L., & Schafft, K. A. (2011). *Rural people & communities in the 21st century: Resilience & transformation*. Malden, MA: Polity Press.

Cai, Z, P. (2019). Thinking and Discussion on the New Curriculum Reform of Middle and High School Chemistry Cohesion. *Reading World (General)*, 18-18. (in Chinese)

Cao, Y. (2017). On the problems and solutions in junior middle school chemistry teaching under the new curriculum reform. *Mathematics, Physics and Chemistry (Education Theory)*, 31. (in Chinese)

Caulfield, J. (2019). *How to do thematic analysis*. Retrieved on July, 7, 2020.

Chen, D,L. (2009). Cultivation of innovative talents under the guidance of constructivist theory. *Science and Technology Information*, 421.doi:CNKI:SUN:KJXX.0.2009-16-337.

Chen, L, L (2008). *Analysis of the People's Education Edition "General High School Curriculum Standard Experimental Textbook: Chemistry" from the perspective of constructivism*. Central China Normal University. (in Chinese)

Chen, Q, Z. (2013). Suggestions for junior middle school chemistry experiment teaching under the new curriculum concept. *Xueyuan*, 151.

Chyi, H. and Zhou, B. (2014), “The effects of tuition reforms on school enrollment in rural China”, *Economics of Education Review*, Vol. 38, pp. 104-123.

Committee on Psychological Testing, I. V. (2015). *Psychological Testing in the Service of Disability Determination*.

Connelly, F.M., & Ben-Peretz, M. (1980). Teachers' roles in the using and doing of research and curriculum development. *Journal of Curriculum Studies*, 12, 95-107.

Cox III, E. P. (1980). The optimal number of response alternatives for a scale: A review. *Journal of marketing research*, 17(4), 407-422.

Crossman, Ashley. *Understanding Purposive Sampling: An Overview of the Method and Its Applications*. Retrieved from https://www.thoughtco.com/purposive-sampling-3026727 on April 18, 2018

Dagar V, Yadav A (2016) *Constructivism: A Paradigm for Teaching and Learning*. Arts Social Sci J 7: 200.

Devlin, S. J., Dong, H. K., & Brown, M. (1993). Selecting a scale for measuring quality. *Marketing research*, 5(3).

Du, Y. and Sun, Z. (2016), *Research on Compulsory Education Financing in China*, Springer, Berlin.

Edward, et al., 2014. Student transition from primary to lower secondary school in Cambodia: narrative insights into complex systems. *Prospects* 44, 367–380.

Eppley, K. (2015). "Hey, I saw your grandparents at Walmart": Teacher education for rural schools and communities. *The Teacher Educator*, 50(1), 67–86.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance improvement quarterly*, 26(2), 43-71.

Fan, J,F.& Zhao, E,L. (2015). Teaching reform and practice of "Chemical Teaching Method Experiment" guided by constructivist theory. *Chemical Industry Times*, 43-45. doi:CNKI:SUN:HGJS.0.2015-09-011.

Fangfang, L. S. L. (2013). Teaching Transformation of Constructivist Learning Theory. *Education Research Monthly*, 4.

Field, A. (2009). *Discovering statistics using SPSS* (3rd. ed.) Thousand Oaks, CA: SAGE Publications, Inc.

Fraenkel, J. R., & Wallen, N. E. (2006). *How to design and evaluate research in education* (6th ed.). NY: The McGraw-Hill Companies, Inc.

Gable, R.K., & Wolf, J.W. (1993). *Instrument development in the affective domain: Measuring attitudes and values in corporate and school settings*. Boston: Kluwer Academic.

Gagnon, G. W., & Collay, M. (2005). *Constructivist learning design: Key questions for teaching to standards*. Corwin Press.

Gangwar, B. P. (2017). Constructivist approach in teaching learning. *Deliberative Research*, 34(1), 71-74.

Gash, H. (2014). Constructing constructivism. *Constructivist foundations*, 9(3), 302-310.

Gao,S, H. (2017). Junior high school chemistry teaching in the context of the new curriculum reform. *Teaching management and education research*. (in Chinese)

Doi:10.3969/j.issn.2096-224X.2017.06.024.

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference. 11.0 update* (4th ed.). Boston: Allyn & Bacon.

Gilakjani, A. P., Lai-Mei, L., & Ismail, H. N. (2013). Teachers' use of technology and constructivism. *International Journal of Modern Education and Computer Science*, 5(4), 49.

Glasgow, N., & Berry, E. H. (2013). *Rural aging in 21st century America*. Dordrecht, Netherlands: Springer.

Gong, B, F. (2015). A preliminary exploration of junior middle school chemistry classroom teaching under the new curriculum reform. *Examination Weekly*, 154-154. (in Chinese)

Grant, J. S., & Davis, L. L. (1997). Selection and use of content experts for instrument development. *Research in nursing & health*, 20(3), 269-274.

Green, S. B., & Salkind, N. J. (2007). *Using SPSS for Windows and Macintosh: Analyzing and understanding data* (5th ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Guangming Daily, 2015, September 10. *How attractive is the Special Position Teacher Program? Guangming Daily*. Retrieved from http://cpc.people.com.cn/n/2015/0910/c83083-27567125.html (In Chinese).

Gupta, S. (2011). Constructivism as a paradigm for teaching and learning. *International Journal of Physical and Social Sciences*, 1(1), 23-47.

Guo, J, H.(2020). On improving the effectiveness of chemistry teaching with constructivism in junior high school under the new curriculum reform. *Learn weekly*, 70-70. (in Chinese)

Guo, Y, M. (2012). *Research on Chemistry Teaching Design from the Perspective of Constructivism*. Southwest University. (in Chinese)

Hao, Y, J. (2013). *Practical research on constructivist learning theory in the teaching of new chemistry courses in middle schools.* Inner Mongolia Normal University. (in Chinese)

Hằng, N. V. T., Meijer, M. R., Bulte, A. M., & Pilot, A. (2015). The implementation of a social constructivist approach in primary science education in Confucian heritage culture: the case of Vietnam. *Cultural Studies of Science Education*, 10(3), 665-693.

He, W.M. (2013), "82% students of secondary vocational schools from rural areas means what?", *Education and Vocation*, Vol. 34 No. 1, pp. 16-17.

Huang, S, W. (2013). Problems and countermeasures of chemistry teaching in rural junior high schools under the new curriculum reform. *Xueyuan*, 138-138, 155. (in Chinese)

Hutchinson, C. B. (2006). Cultural constructivism: The confluence of cognition, knowledge creation, multiculturalism, and teaching. *Intercultural Education*, 17(3), 301-310.

Jager, B., Jansen, M., & Reezigt, G. (2005). The development of metacognition in primary school learning environments. *School Effectiveness and School Improvement*, 16(2), 179-196.

James, V., Gerard, R. L., & Vagt-Traore, B. (2010). Enhancing creativity in the classroom. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. Retrieved from http://www.textbookequity.org/oct/Textbooks/Orey_Emergin_Perspectives_Learning.pdf

Jamieson, S. (2004). Likert scales: how to (ab) use them. *Medical Education*, 38(12), 1217-1218.

Jančič, P. (2016). *ZASTOPANOST KONSTRUKTIVISTIČNEGA PRISTOPA PRI POUKU DRUŽBE* (Doctoral dissertation, Univerza v Mariboru, Pedagoška fakulteta).

Jia, Q. (2010). A brief study on the implication of constructivism teaching theory on classroom teaching reform in basic education. *International Education Studies*, 3(2), 197-199.

Jointly compiled by 12 key normal universities in China (2004).Fundamentals of Pedagogy. Beijing: *Education Science Press*, 112. (in Chinese)

Johns, R. (2010). Likert items and scales. *Survey question bank: Methods fact sheet*, 1(1), 11.

Johnson, S.M., 2012. Having it both ways: building the capacity of individual teachers and their schools. *Harv. Educ. Rev*. 82 (1), 107–122.

Julia, G. (2018). The integration of technology in problem-based learning. *Technology and the curriculum*. https://techandcurriculum.pressbooks.com/chapter/tech_pbl/

Kaymakamoglu, S. E. (2018). Teachers' Beliefs, Perceived Practice and Actual Classroom Practice in Relation to Traditional (Teacher-Centered) and Constructivist (Learner-Centered) Teaching (Note 1). *Journal of Education and Learning*, 7(1), 29-37.

Jonassen, D. H. (1999). Designing constructivist learning environments. In C. M. Reigeluth (Ed.), *Instructionaldesign theories and models, a new paradigm of instructional theory* (pp. 215 - 239). New Jersey: Lawrence Erlbaum Associates.

Keng, C.S., 2003. Why do girls drop out of primary schools? An evidence from rural Cambodia. *J.f Cambodian Stud*. 1 (1), 3–15.

Khelifi, K. (2013). *Learner and teacher readiness for constructivism in the Algerian EFL classroom: The case of 3rd year literary classrooms in Colonel Abd Elhadi Secondary School (Sidi Bel-Abbes)* (Doctoral dissertation).

Kosnik, C., Menna, L., Dharamshi, P., & Beck, C. (2018). Constructivism as a framework for literacy teacher education courses: the cases of six literacy teacher educators. *European Journal of Teacher Education*, 41(1), 105-119.

Krahenbuhl, K. S. (2016). Student-centered education and constructivism: Challenges, concerns, and clarity for teachers. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 89(3), 97-105.

Kruea-In, N., & Thongperm, O. (2014). Teaching of science process skills in Thai contexts: Status, supports and obstacles. *Procedia-Social and Behavioral Sciences*, 141, 1324-1329.

Lamanauskas, V. (2010). Integrated science education in the context of the constructivism theory: Some important issues. *Problems of Education in the 21st Century*, 25, 5.

Lam, F. (2011). *The socratic method as an approach to learning and its benefits* (Senior Honors Dissertation). Retrieved from http://repository.cmu.edu/cgi/viewcontent.cgi?article=1126vecontext=hsshonors

Lamichhane, P., Puri, M., Tamang, J., & Dulal, B. (2011). Women's Status and Violence against Young Married Women in Rural Nepal. *BioMed Central (BMC) Public Health Volume 11, Issue* (19).

Lavrakas, P. (2008). *Encyclopedia of Survey Research Methods 1st Edition*. SAGE Publications. Laerd Dissertation, Lund Research Ltd. Total Population Sampling. Retrieved from http://dissertation.laerd.com/total-population-sampling.php on April 18, 2018

Lee, C. (2017). *Research on chemistry teaching design under constructivist learning theory*. Yan'an University. (in Chinese)

Lee, Y, F. (2015). Suggestions for junior middle school chemistry experiment teaching under the new curriculum concept. *"Future Talent"*, 151-151. (in Chinese)

Leon, A. C., Davis, L. L., & Kraemer, H. C. (2011). The role and interpretation of pilot studies in clinical research. *Journal of psychiatric research*, 45(5), 626-629.

Li, F.L., Zhou, M.Y., Fan, B.L., 2014. Can distance education increase educational Equality?ddEvidence from the expansion of chinese higher education. *Stud. High. Educ*. 39 (10), 1811e1822.

Li, H., Loyalka, P., Rozelle, S. and Wu, B. (2017), "Human capital and China's future growth",*The Journal of Economic Perspectives*, Vol. 31 No. 1, pp. 25-47.

Li, L., Liu, H.M., 2014. Primary school availability and middle school education in rural China. *Labour Econ*. 28 (c), 24-40.

Li, M., Yang, R., 2013. Interrogating institutionalized establishments: urban-rural inequalities in China's higher education. *Asia Pac. Educ. Rev.* 14 (3), 315e323.

Liang, G., and M. Akiba. 2015. Teacher evaluation, performance-related pay, and constructivist instruction. *Educational Policy* 29 (2): 375–401.

Liang, L. L., & Gabel, D. L. (2005). Effectiveness of a constructivist approach to science instruction for prospective elementary teachers. *International Journal of Science Education*, 27(10), 1143-1162.

Liu, C. C., & Chen, I. J. (2010). Evolution of constructivism. *Contemporary issues in education research*, 3(4), 63-66.

Liu, Y, N. (2015). A preliminary exploration of junior middle school chemistry teaching under the new curriculum reform. *Future Talent*, 26. (in Chinese)

Lounkaew, K., 2013. Explaining urban–rural differences in educational achievement in Thailand: evidence from PISA literacy data. *Econ. Educ. Rev*. 37, 213–225.

Luo, H. (2020). Problems and solutions in junior middle school chemistry teaching under the background of the new curriculum reform. *East, West, South and North: Education*, 0334-0334. (in Chinese)

Madhura, R. (2011). *Women Education Challenges in India*. Available from http://www.wewomentoday.com/2011/04/30 women- education- challenges in India. (Accessed on 24-05-2017)

Maharjan, R. K., Karki, K. B., Shakya, T. M., & Aryal, B. (2012). *Child marriage in Nepal: Research report*. Kathmandu, Nepal: Plan Nepal, Save the Children Nepal, and World Vision Nepal, Kathmandu.

Makrides, G. (2019). *The Evolution of Education from Education 1.0 to Education 4.0: Is it an evolution or a revolution*. Beer Sheva, Israel.

Maor, D., & Fraser, B. J. (2005). An online questionnaire for evaluating students' and teachers' perceptions of constructivist multimedia learning environments. *Research in Science Education*, 35(2), 221-244.

Marlowe, B. A., & Page, M. L. (2005). *Creating and sustaining the constructivist classroom*. ABD: Corwin Press.

Marton-Williams, J. (1986). Questionnaire design, *in consumer market research Handbook*, Robert Worcester and John Downham.

Maypole J., & Davies T. G. (2001). Students' perceptions of constructivist learning in a community college American history ıı survey course. *Community College Review*, 29(2), 54-69.

McLaughlin, d. K., Shoff, c. M., & Demi, m. A. (2014). Influence of perceptions of current and future community on residential aspirations of rural youth. *Rural sociology*, 79, 453–477.

McLeod, S. A. (2019, july 17). *Constructivism as a theory for teaching and learning. Simply psychology*.

Https://www.simplypsychology.org/constructivism.html

McPhail, G. (2017). Constructivism: Clearing up the confusion between a theory of learning and 'constructing'knowledge. *Journal issue*, (2).

McVee, M. B., & Boyd, f. (2016). *Exploring diversity through multimodality, narrative, and dialogue: A framework for teacher reflection*. New york: Routledge.

Mei, H., Jiang, Q.B., Xiang, Y.Y., Song, X.P., 2015. School consolidation: whither China's rural education? Asian Soc. *Work Policy Rev.* 9 (2), 138e150.

Mendro, R. L. (1998). Student Achievement and school and teacher accountability. *Journal of Personnel Evaluation in Education*, 12 (3), 257–267.

Merriam, S., & Bierema, L. (2014). *The spirit in learning. In Adult Learning Linking Theory and Practice* (pp. 197-206). San Francisco: Jossey-Bass.

Ministry of Education (MoE). (2001b). *The chemistry curriculum standard of compulsory education of full-time system*. Beijing: Beying Normal University Press (in Chinese).

Ministry of Education of (MoE). (2011). *Compulsory Education Chemistry Curriculum Standards*. Beijing: Beijing Normal University Press, 2012 (in Chinese).

Ministry of Personnel, Ministry of Finance. (2006). Provisions concerning the scope and types of remote and difficult areas. *Government document*, No. 61 (2006).

Retrieved July 01, 2006 from http://www.360doc.com/content/11/1226/16/8152352_175115703.shtml (in Chinese).

Mzuza, M.K., Yudong, Y., Kapute, F., 2014. Analysis of factors causing poor passing rates and high dropout rates among primary school girls in Malawi. *World J. Educ.* 4 (1), 48–61.

Nafea, R. M. E. D., & Toplu, E. K. (2020). Future of Education in Industry 4.0: Educational Digitization–A Canadian Case Study. In *Business Management and Communication Perspectives in Industry 4.0* (pp. 267-287). IGI Global.

Nanda et al., (2012). *Study on Gender, Masculinity and Son Preference in Nepal and Vietnam*. New Delhi, International Centre for Research on Women.

Narayan, R., Rodriguez, C., Araujo, J., Shaqlaih, A., & Moss, G. (2013). Constructivism—Constructivist learning theory. In B. J. Irby, G. Brown, R. Lara-Alecio, & S. Jackson (Eds.), *The handbook of educational theories (p. 169–183)*. IAP Information Age Publishing.

Neupane, P. (2017). Barriers to Education and School Attainment--Evidence from Secondary Schools in Rural Nepal. *International Education Studies*, 10(2), 68-83.

No, F., Taniguchi, K., & Hirakawa, Y. (2016). School dropout at the basic education level in rural Cambodia: Identifying its causes through longitudinal survival analysis. *International Journal of Educational Development*, 49, 215-224.

Nola, R., & Irzik, G. (2006). *Philosophy, science, education and culture* (Vol. 28). Springer Science & Business Media.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International journal of qualitative methods*, 16(1), 1609406917733847.

Nurrenbern, S. C. (2001). Piaget's Theory of Intellectual Development Revisited. *Journal of chemical education*, 78(8), 1107.

OECD, 2019. "Why does the Sustainable Development Goal on Education (SDG 4) matter for OECD countries?," *Education Indicators in Focus* 67, OECD Publishing.

Patil, A. M., & Kudte, S. S. (2017). Teaching Learning with Constructivist Approach. *International Journal of Engineering Development and Research*, 5(4), 308-312.

Peker, M., & Ulu, M. (2018). The Effect of Pre-Service Mathematics Teachers' Beliefs about Mathematics Teaching-Learning on Their Mathematics Teaching Anxiety. *International Journal of Instruction*, 11(3), 249-264.

Petrin, R., Schafft, K. A., & Meece, J. (2014). Educational sorting and residential aspirations among rural high school students: What are the contributions of schools and educators to the rural brain drain? *American Educational Research Journal*, 51(2), 294–326.

Plourde, L. A., & Alawiye, O. (2003). Constructivism and elementary preservice science teacher preparation: Knowledge to application. *College Student Journal*, 37(3), 334-342.

Powell, J. C. & Anderson, R. D. (2002). Changing teachers' practice: Curriculum material and science education reform in the USA. *Studies in Science Education*, 37, 107–136.

Qi, Z, M.(2016). Several changes in the reform of middle school chemistry curriculum and issues that should be paid attention to. Reading and writing calculation (teacher edition): *Quality Education Forum*, 22. (in Chinese)

Ramsook, L., & Thomas, M. (2016). Constructivist-linking theory with practice among pre-service teachers at the University of Trinidad and Tobago. International *Journal of Learning, Teaching and Educational Research*, 15(7), 127-137.

Ransom (Eds.), *Rural America in a globalizing world: Problems and prospects for the 2010s* (pp. 3–15). Morgantown: West Virginia University Press.

Rao, J., Meng, X.D., 2012. Rural community development and rural school mapping. China Agric. Univ. J. Soc. Sci. Ed. 60 (4), 53-60 (in Chinese).

Rao, J. N., Hartley, H. O., & Cochran, W. G. (1962). On a simple procedure of unequal probability sampling without replacement. *Journal of the Royal Statistical Society: Series B (Methodological)*, 24(2), 482-491.

Rao, J., & Ye, J. (2016). From a virtuous cycle of rural-urban education to urban-oriented rural basic education in China: An explanation of the failure of China's Rural School Mapping Adjustment policy. *Journal of Rural studies*, 47, 601-611.

Richard O. Ongowo. (2013).Secondary School Teachers' Perceptions of a Biology Constructivist Learning Environment in Gem District, Kenya. *Inter. J. Educat. Res.Technol.*, Vol 4 [2] : 01- 06

Sang, Y, J. (2016). The problems and countermeasures of chemistry teaching in rural junior high schools under the new curriculum reform. *Scientific Consulting (Education and Research)*, 109. (in Chinese)

Doi:CNKI:SUN:KXZK.0.2016-10-091.

Saleh, F., & Ryan, C. (1991). Analysing service quality in the hospitality industry using the SERVQUAL model. *Service Industries Journal*, 11(3), 324-345.

Sarita, P. (2017). Constructivism: A new paradigm in teaching and learning. *International Journal of Academic Research and Development*, 2(4), 183-186.

Sauro, J. (2015). SUPR-Q: A comprehensive measure of the quality of the website user experience. *Journal of usability studies*, 10(2).

Savasci-Acikalin, F. (2009).Teacher beliefs and practice in science education. *Asia-Pacific Forum on Science Learning and Teaching*, 10(1). Art. 12. Available at http://www.ied.edu.hk/apfslt/. Accessed Mai 10, 2012.

Schafft, K. A., Hinrichs, C., & Bloom, D. (2010). Pennsylvania farm-to-school programs and the articulation of localcontext. *Journal of Hunger and Environmental Nutrition*, 5(1), 23–40.

Schafft, K. A. (2016). Rural education as rural development: Understanding the rural school–community well-being linkage in a 21st-century policy context. *Peabody Journal of Education*, 91(2), 137-154.

Schulken, M. (2010, August 10). Rural schools grow leaders to suit needs. *Education Week.* Retrieved fromhttp://www.edweek.org/ew/articles/2010/08/11/37rural-2.h29.html

Serafín, Č., Dostál, J., & Havelka, M. (2015). Inquiry-based instruction in the context of constructivism. *Procedia-Social and Behavioral Sciences*, 186, 592-599.

Shahidul, S.M., 2013. Household decision-making process: it's effect on school dropout behavior for girls in the secondary school level in Bangladesh. *Int. Educ. Stud.* 6 (1), 132–141.

Sharma, M. S., & Bansal, D. (2017). Constructivism as paradigm for teaching and learning. *International Journal of Physical Education, Sports and Health*, 4(5), 209-212.

Short, M. N., & Keller-Bell, Y. (2021). Essential skills for the 21st century workforce. In *Research Anthology on Developing Critical Thinking Skills in Students* (pp. 97-110). IGI Global.

Shi, L, H. (2019) Study on the Teaching Strategies of Chemistry Experiment in Junior Middle School under the New Curriculum Reform. *China Education Development Strategy Society Education and Teaching Innovation Professional Committee* (1): 2. (in Chinese)

Shi, Rong, (2017). *Education and Nutrition Problems in Rural China* . Dissertations. 3161. https://scholarworks.wmich.edu/dissertations/3161

Strange, M., Johnson, J., Showalter, D., & Klein, R. (2012). *Why rural matters 2011–12: The condition of rural education in the 50 states*. Washington, DC: Rural School and Community Trust.

Strong, J. H. & Tucker, P. D. (2000) *Teacher Evaluation and Student Achievement Washington*, DC: National Education Association.

Sun, L, H. (2013). Problems and suggestions in the teaching of junior middle school chemistry experiment under the new curriculum reform concept. *Reading and Writing (Journal of Education and Teaching)*, 158. (in Chinese)

Doi:CNKI:SUN:DYXT.0.2013-05-133.

Su, Y, X. (2015). *Under the background of the new curriculum reform, an analysis of improving the effective habit of chemistry classroom teaching in remote mountainous junior high schools.* Sichuan Normal University. (in Chinese)

Sylvia, S., Warrinnier, N., Luo, R., Shi, Y., Attanasio, O. and Rozelle, S. (2017), *"From quantity to quality: delivering a home-based parenting intervention through China's family planning workers.*Working paper, Stanford.

Taylor, J. J. (2013). *Confusing stats terms explained: heteroscedasticity. URL: http://www. statsmakemecry.* com/smmctheblog/confusing-stats-terms-explainedheteroscedasticity-heteros ke. html.

Tan, C. (2017). Constructivism and pedagogical reform in China: Issues and challenges. *Globalisation, Societies and Education*, 15(2), 238-247.

Terry, G., &Thapa, N. (2012). *Gender audit of Nepal's school sector reform program*. Cambridge: DFID Human Development Resource Centre.

Tezci, E., & Gürol, A. (2003). Oluşturmacı öğretim tasarımı ve yaratıcılık. *The Turkish Online Journal of Educational Technology-TOJET*, 2(1), 50-55.

Tilden, V., Nelson, C., & May, B. (1990). Use of quali-tative methods to enhance content validity. *NursingResearch, 39*, 172–175.

Toh, K. A., Ho, B. T., Chew, C. M., & Riley, J. P. (2003). Teaching, teacher knowledge and constructivism. *Educational Research for Policy and Practice*, 2(3), 195-204.

Tong, R, L. (2018). Problems and solutions in junior high school chemistry teaching based on the background of the new curriculum reform. *China-Foreign Exchange*, 107. (in Chinese)

Tuncer, C. (2009). Learning and Teaching Language Online: A Constructivist Approach. *Novita's-ROYAL*, 3(1), 60-74.

Tsubaki, M. The Education System in China: Economic and Educational Inequalities between Urban and Rural Areas. *Section 3 Research Reports*, 44.

U.S. Department of Education Office of Educational Technology (2010). *Transforming american education: learning powered by technology:*

National education technology plan 2010. Washington, DC: U.S. Department of Education. Retrieved from: http://www.ed.gov/sites/default/files/netp2010.pdf. Accessed 6 June 2016.

UNESCO (2016), Global Education Monitoring Report 2016: Education for People and Planet: Creating Sustainable Futures for All, *United Nations Educational, Scientific and Cultural Organization*, https://unesdoc.unesco.org/ark:/48223/pf0000245752.

Uzuntiryaki, E., Boz, Y., Kirbulut, D., & Bektas, O. (2010). Do pre-service chemistry teachers reflect their beliefs about constructivism in their teaching practices?. *Research in Science Education*, 40(3), 403-424.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2013). *Elementary and middle school mathematics: Teaching developmentally* (8th ed.). Upper Saddle River, NJ: Pearson.

Valesco, E., 2001. *Why Are Girls Not in School?* Perceptions, Realities, and Contradiction in Cambodia Retrieved on November 26, 2009 from http://www.unescobkk.org/fileadmin/user_upload/appeal/gender/whygirls.pdf .

Wachira, P., & Mburu, J. (2017). Culturally responsive mathematics teaching and constructivism: Preparing teachers for diverse classrooms. *Multicultural Learning and Teaching*, 14(1).

Waltz, C.F., Strickland, O., & Lenz, E. (1991). *Mea-surement in nursing research* (2nd ed.). Philadelphia:F.A. Davis

Wang, ChY., Pan, L., 2012. After"Words-up-moving"-A study on primary boarding schools in three rural areas. *China Agric. Univ. J. Soc. Sci. Ed*. 60 (4), 44e51 (in Chinese).

Wang, D., Gao, M., 2013. Educational equality or social mobility: the value conflict between preservice teachers and the Free Teacher Education Program in China. *Teach. Teach. Educ.* 32 (1), 66–74.

Wang, D., Wang, J., Li, H., & Li, L. (2017). School context and instructional capacity: A comparative study of professional learning communities in rural and urban schools in China. *International Journal of Educational Development*, 52, 1-9.

Wang, L., Zhang, S., Li, M., Sun, Y., Sylvia, S., Yang, E., Ma, G., Zhang, L., Mo, D. and Rozelle, S. (2017),*"Contract teachers and student achievement in Rural China: evidence from class fixed effects"*,REAP working paper, Stanford.

Wang, X,L. (2011). European Union Science Education Reform Analysis. *Comparative Education Research*, 87-88. (in Chinese)

Wang, X. (2015). *Analysis of new and old high school chemistry textbooks based on constructivism*. Yunnan Normal University. (in Chinese)

Wei, B, B. (2015). *Research on junior middle school chemistry teaching practice based on constructivism.* Northwest Normal University. (in Chinese)

Wei, W, X. (2018). Thinking of Middle School Chemistry Teaching from the Perspective of Constructivism. *"Education Circle: Comprehensive Education Research (Part 1)"*, 107-108. (in Chinese)

Whitehead, A. L., Julious, S. A., Cooper, C. L., & Campbell, M. J. (2016). Estimating the sample size for a pilot randomised trial to minimise the overall trial sample size for the external pilot and main trial for a continuous outcome variable. *Statistical methods in medical research*, 25(3), 1057-1073.

Wilson, B. G. (2010). Constructivism in practical and historical context. In B. Reiser & J. Dempsey (Eds.), *Current trends in instructional design and technology* (pp. 1-10). NJ: Pearson Prentice Hall.

Windschitl, M. (1999). The challenges of sustaining a constructivist classroom culture. *Phi Delta Kappan*, 80(10), 751-754.

Woldehanna, T., Hagos, A., 2012. *Shocks and Primary School Drop-out Rates: A Study of 20 Sentinel Sites in Ethiopia*. Working Paper 88. Young Lives.

Wu, L, N. (2016). Problems and countermeasures in the new curriculum reform of junior high school chemistry. *Jiangxi Education: Comprehensive Edition (C)*, 32. (in Chinese)

Wu, Y ,L. (2015). Junior middle school chemistry experiment teaching under the new curriculum concept. *Curriculum Education Research: Study on Learning and Teaching Methods*, 63. (in Chinese)

Wu, Y.X. (2013), "Educational opportunities of Chinese rural and urban residents in 1978-2008: inequality and evolution", *Social Sciences in China*, Vol. 3 No. 1, pp. 4-21, 203.

Xiao, Y., Li, L. and Zhao, L. (2017), “Education on the cheap: the long-run effects of a free compulsory education reform in rural china”, *Journal of Comparative Economics*, Vol. 45 No. 3, pp. 544-562.

Yaghmaie, F. (2003). Content Validity And Its Estimation. *Journal of Medical Education*, 3(1).

YANG, A, G. (2016). Research on the "Diversity" of Junior Middle School Chemistry Classroom Teaching Evaluation. *College Entrance Examination*, 97-, 1 page. (in Chinese)

YANG, M. (2006). *Application of Constructivist Learning Theory in Chemistry Teaching*. Central China Normal University. (in Chinese)

Yang, W.A., Wu, Zh H., 2012. The connotation, historical changes and future development of the vertical relations between China’s urban and rural education. *Lanzhou Acad. J.* 228 (9), 134-138 (in Chinese).

Yue, A., Tang, B., Shi, Y., Tang, J., Shang, G., Medina, A., & Rozelle, S. (2018). Rural education across China’s 40 years of reform: past successes and future challenges. *China Agricultural Economic Review*.

Zashchitina, E. K., & Pavlov, P. V. (2019). Education and business in the Industry 4.0. *Planning and Teaching Engineering Staff for the Industrial and Economic Complex of the Region*, 62-65.

Zeng, J., Pang, X., Zhang, L., Medina, A. and Rozelle, S. (2014), “Gender inequality in education in China:a meta-regression analysis”, *Contemporary Economic Policy*, Vol. 32 No. 2, pp. 474-491.

Zhao, D., Parolin, B., 2014. Merged or unmerged school? school preferences in the context of school mapping restructure in rural China. *Asia-Pacific Educ. Res.* 23(3), 547-563.

Zhang, L, S. (2012). On the teaching of junior middle school chemistry experiment under the new curriculum concept. *Teaching research in elementary and middle schools*, 5. (in Chinese)

Zhang, W, H. (2016). Problems and countermeasures in rural junior middle school chemistry teaching under the new curriculum reform. *Examination Weekly*, 132-132. (in Chinese)

Zhong, D., Chow, S. K. K., & Chen, S. (2018, April). A Model of Mobile Learning Application for Tertiary Education in Rural Area in China: A Preliminary

Study. In *International Conference on E-Learning, E-Education, and Online Training* (pp. 86-94). Springer, Cham.

Zhu, H, X. (2019). Discussion on the problems and countermeasures of junior high school chemistry teaching under the background of the new curriculum reform. *Education: Comprehensive Education Research (Part 1)*, 95-96. (in Chinese)