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ANALYSIS AND COMPARISON OF SCIENTIFIC INQUIRY ACTIVITIES IN EIGHT-GRADE PHYSICS TEXTBOOKS IN CHINA

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Abstract. *In order to analyse whether or not the characteristic of scientific inquiry activities of textbooks in China satisfy the requirements of China's new curriculum reforms, content analysis method was adopted to analyze scientific inquiry activities in junior middle school physical textbooks (grade 8) of five editions authorized by the Chinese Ministry of Education. The results show that the inquiry activities in the five versions of textbooks in China cannot meet the requirements of authentic scientific inquiry regardless of the degree of openness or operationality of cognitive processes and are not conducive to develop students' scientific inquiry skills and scientific reasoning skills. The authors of science textbooks should take note of the latest insights from the world of academia and develop some new authentic scientific inquiry tasks to update textbooks in a prompt manner in order to improve the students' abilities of scientific inquiry. For the textbook reviewers, the present research not only provides them with specific findings, but also provides them with a method to evaluate textbooks.*

Keywords: *physics textbook, textbook evaluation, scientific inquiry activity, content analysis.*

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Introduction

Scientific inquiry has already become a trend in science education throughout the world. Many countries and regions, including the United States, England, Japan, and Taiwan, have made inquiry-based science education and the development of students' scientific literacy the main objective of science education reform (Abd-El-Khalick & Akerson, 2004). In 2001, China implemented a new round of basic education curriculum reform. China's Science (7^{th}–9^{th} grade) course objectives state that "students should understand science knowledge through inquiry, obtain scientific skills, grasp scientific processes and methods, begin to understand the nature of science, form scientific attitudes, emotions, and values, and develop their innovative minds and practical abilities" (The Ministry of Education of the People's Republic of China, 2001). The newly revised curriculum standards for science in 2011 further emphasized the importance of scientific inquiry in science education (The Ministry of Education of the People's Republic of China, 2011). Since science textbooks play a key role in basic education reform (Chiappetta, Fillman, & Sethna, 1991; Chiappetta & Fillman, 2007; Tarr, Reys, Reys, Chavez, Shih, & Osterlind, 2008), they should reflect the trends in education reform. To some extent, textbooks determine students' general perceptions of science (Valverde et al., 2002), and because textbooks serve as the specific manifestations of course objectives, it is the teacher's responsibility to select the best resources for his or her classes. However, studies have shown that textbooks tend to present an overly superficial understanding of science. Therefore, it is pertinent to investigate whether or not the scientific inquiry activities in the eighth-grade physics textbooks in China satisfy the requirements of China's new curriculum reforms in terms of scientific inquiry.

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Due to the important role that science textbooks play in science education, numerous studies have evaluated textbooks from various perspectives. These studies have shown that the inquiry activities of most science textbooks have standard answers, and the purpose of experiments or inquiry activities is to let students memorize knowledge, rather than to explore the unknown (McComas, 1998). Domin (1999) pointed out that such scientific inquiry methods are similar to cooking with recipes; students are asked to carry out experimental operations and data collection according to pre-designed steps rather than being given an opportunity to identify problems, form hypotheses, design experiments, and interpret data. This is not beneficial to the students' ability to truly grasp the advanced thinking skills related to scientific inquiry. Lederman (2000) argued that although students are able to develop a large volume of scientific inquiry techniques from courses, the contents and teaching methods of such courses place an exaggerated emphasis on results rather than processes of scientific inquiry. Students are not able to experience the real scientific inquiry process in these courses, so they do not acquire advanced inquiry skills. Chinn and Malhotra (2002) claimed that the majority of scientific inquiry activities in school do not reflect the core meaning of scientific reasoning. After analyzing scientific textbooks in the United States, Chinn and Malhotra (2002) found that few inquiry activities in these textbooks included the cognitive processes that are required in real scientific inquiry; as a result, the epistemology taught by the textbooks was completely opposed to that used in real scientific inquiry. For example, inquiry activities in textbooks neither ask students to carry out theory-driven observation nor encourage them to think about alternative interpretations of data; the scientific reasoning in textbooks are mainly algorithmic or formulaic, which involves drawing obvious conclusions based on simple experiments and observations. The methods to coordinate conflicts between scientific theories and data are not covered by these textbooks. In summary, the basis of the epistemology of many in-school scientific inquiry activities is inconsistent with that of real scientific inquiry. For that reason, schools need new types of scientific exploration tasks that involve processes closer to real scientific reasoning and that conform to real scientific epistemology. Germann, Haskins, and Auls (1996) revealed that experimental manuals rarely gave students opportunities to ask questions, form hypotheses, predict results, design observation processes, or understand measurement methods and procedures; in addition, they did not allow students to propose new research questions or carry out studies based on their own experimental designs. In addition, they also noticed that science textbooks generally do not allow students to use background knowledge and experience (for example, reading and reviewing relevant experiments and research reports, and exploring relevant experimental techniques) to ask research questions, form hypotheses, design observation processes and experimental procedures, and predict possible results. Scientific inquiry requires asking questions and investigating natural phenomena based on one's own knowledge and experience and constructing theories and generalizing conclusions(Wang, Jou, Lv, & Huang, 2018). However, scientific inquiry activities in science textbook fail to cultivate such abilities.

With the guidance of the national science education goals and relevant national curriculum standards, although many curriculum designers have included a number of inquiry activities in courses that enable students to participate in scientific inquiry processes (Edelson, Gordin, & Pea, 1999; Singer, Mar, Krajcik, & Chambers, 2000; Zion et al., 2004; Wang & Zhao, 2016), Abd-El-Khalick et al. (2004) argued that the essential elements should be included in inquiry-based science education remains unresolved. Chinn and Malhotra (2002) believed that although the National Science Standards of USA (AAAS, 1993; NRC, 1996) have emphasized the cognitive characteristics of real scientific inquiry, the standards fail to specify the detailed analytical criteria of real scientific inquiry. Existing analytical frameworks for scientific inquiry mainly focus on the classification of scientific reasoning processes, such as methods of controlling variables, interpreting results, and providing research evidences (Bybee, 2000; Germann, Haskins, & Auls, 1996; Wang, Guo, & Jou, M., 2015; Hafner & Stewart, 1995; Kuhn et al., 1995; Zimmerman, 2000; 2005). Nevertheless, these are the common features of all scientific inquiries rather than the distinctive characteristics of real scientific inquiry.

There are many analytical frameworks targeting the analysis and evaluation of inquiry-based activities in science textbooks; however, it is believed that only two of them have strong operationality: the framework proposed by Germann, Haskins, and Auls (1996) and that proposed by Chinn and Malhotra (2002). Referring to scientific inquiry classification of Herron (1971) and Schwab (1962), Germann, Haskins, and Auls (1996) put forward an analytical framework for the scientific inquiry activities in textbook. The framework classifies scientific inquiry activities in textbook into seven levels, which are based on whether the scientific inquiry activities in textbook are conducive to students take the initiative to participate in some processes of science inquiry (background, problems, variables, methods, performances solution, and extension). Chinn and Malhotra

(2002) argued that the framework of Germann, Haskins, and Auls (1996) included common processes of both simple and complex inquiry tasks, such as posing questions, forming hypotheses, designing an observation and experiment, controlling variables, and providing research evidence. Therefore, it cannot effectively distinguish real scientific inquiry tasks and simple inquiry tasks. On that account, Chinn and Malhotra (2002) proposed the concept of authentic scientific inquiry. They claimed that, compared with simple inquiry, authentic scientific inquiry refers to real implementation of scientific research, a complex activity that includes utilizing expensive equipment, elaborating detailed experimental procedures and theories, and utilizing highly specialized knowledge and advanced techniques for model construction and data analysis (Dunbar, 1995; Galison, 1997; Giere, 1988). However, due to limited time and resources, schools cannot provide students with such inquiry tasks. Hence, educators need to develop simplified inquiry tasks that can be implemented under conditions of restricted time, space, money, and expert knowledge, which can be called simplified school inquiry tasks. Even though school scientific inquiry tasks are relatively simple, they still contain core components of scientific reasoning. By doing these inquiry tasks, students can gradually obtain scientific reasoning skills. Chinn and Malhotra (2002) emphasized that there are two fundamental differences between authentic scientific inquiry and simple inquiry. One of the differences is the cognitive processes that are needed in authentic scientific inquiry with the cognitive processes that are needed in simple inquiry tasks. The difference in cognitive processes, and another difference is the cognitive differences between authentic science tasks and simple forms of school science tasks imply fundamental differences in epistemology.

Based on the analytical frameworks of Germann, Haskins, and Auls (1996) and Chinn and Malhotra (2002), this study proposed that the following two conditions need to be satisfied when a scientific inquiry task is considered beneficial to the cultivation of students' scientific inquiry abilities and scientific reasoning skills. (1) A scientific inquiry activity should be less teacher-oriented, with a high degree of student autonomy (NRC, 2000). In other words, scientific inquiry task is an open task rather than a recipe-style task (Hegarty-Hazel, 1986; Herron, 1971). However, as in Chinn and Malhotra's (2002) criticism of Germann, Haskins, and Auls' (1996) framework regarding the requirements of scientific inquiry tasks (generating research questions, forming hypotheses, designing experiments, controlling variables, and providing research evidences), these cannot distinguish authentic scientific inquiry and simple inquiry tasks. Hence, they cannot truly develop students' scientific inquiry abilities and scientific reasoning skills. A student-oriented scientific inquiry task (open scientific inquiry) is only one characteristic of authentic scientific inquiry task. It is more important that certain cognitive processes should be included in the task to help students develop students' scientific inquiry abilities and scientific reasoning skills. (2) An authentic scientific inquiry task should possess the cognitive features proposed by Chinn and Malhotra (2002). Integrating the aforementioned research results and the requirements of science inquiry activities proposed in *Nine-year Compulsory Education: Physics Course Standard (Provisional)* and *Physics Course Standard of Compulsory Education (2011 Edition)*, it is believed that the analytical framework of scientific inquiry activities in science textbooks should include two dimensions: openness and operationality of cognitive processes. Openness refers to the extent of autonomy that students have in scientific inquiry activities to generate research question, form hypotheses, select variables, control experiments, choose laboratory equipment, carry out observations, analyses data, interpret results, and communicate results and conclusions. The higher the extent of student autonomy and the lower the dominance of teachers, the greater the degree of openness becomes. Operationality of cognitive processes is defined as the cognitive level of operation when students do scientific inquiry tasks, which reflects the cognitive characteristics of authentic scientific inquiry. The aim of the present research is to apply the analysis framework to analyze and evaluate five physics textbooks approved by the Chinese Ministry of Education for the eighth-grade students to determine whether they satisfy the requirements of China's new curriculum reforms in terms of scientific inquiry.

Methodology of Research

Selection of Materials for Analysis

According to the course objectives established by the Chinese Ministry of Education, different regions or academic organizations have composed their own physics textbooks. The Chinese Ministry of Education gave these books strict reviews for approval according to the course objectives. Only textbooks approved

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by the Chinese Ministry of Education can be used. Currently, the most widely used eighth-grade physics textbooks that have earned the Chinese Ministry of Education's approval are the series published by People's Educational Press (PEP version), Jiangsu Science and Technology Publishing House (JST version), Beijing Normal University Press (BNU version), Educational Science Publishing House (ESP version), and a joint series published by Shanghai Science and Technology Publishing House and Guangdong Educational Publishing House (S-G version). This study analyzed these five series (Table 1).

It was not advisable to randomly select content for analysis. Instead, relatively complete content was analyzed according to the research objectives. In addition, in order to conveniently compare the scientific inquiry activities in the various publishers' eighth-grade physics textbooks, the same content should be selected for analysis from each textbook. It should be noted that these five series of 8th grade textbooks all are divided into volume one and volume two. Furthermore, each series are different on the specific order of content for example, electricity may be placed to volume one chapter three in People's Educational Press, while it is placed to volume two chapter two in Jiangsu Science and Technology Publishing House. At last, when we analyzed the textbook, only volume one of all five series have earned the Chinese Ministry of Education's approval, while volume two of all five series have not earned the Chinese Ministry of Education's approval. Therefore, in order to compare scientific inquiry activities of various publishers' eighth grade physics textbooks, the same content of volume one of all five series was selected, and not the entire book. The scientific inquiry activities selected for analysis of the textbooks were as follows: People's Educational Press, Chapters 2–5; Beijing Normal University Press, Chapters 1, 4, and 5; Educational Science Publishing House, Chapters 3, 4, and 5; a joint publication by the Shanghai Science and Technology Publishing House and Guangdong Educational Publishing House, Chapters 2, 3, and 4; and Jiangsu Science and Technology Publishing House, Chapters 1–4.

Table 1. Number of scientific inquiry activities of various publishers' eighth-grade physics textbooks.

PEP version	S-G version	BNU version	JST version	ESP version	Sum
31	20	43	33	31	158

Analysis Procedures

The six encoders employed in this research were all master's degree students in physics curriculum theory. The first step in the analysis process consisted of the examination and discussion of the analytical framework and the scoring of details by the encoders. Second, in order to become familiar with the encoding process, the encoders practiced assigning classification codes. Third, they encoded the other sections of the textbooks (not covered in this research). This encoding was compared among encoders to ensure a consistent encoding practice among them. Next, each of the encoders worked independently to analyze and encode the sections of the textbook as covered in this study. Each code was supported by the corresponding content from the textbooks. Last, the authors and two other physics tutors (PhD professors) discussed each item of the encoders' analyses. Discrepancies between the encoders' analyses were analyzed and discussed until consensus was achieved among researchers. The validity of the analysis framework is based on theory and experience. Nevertheless, the analysis framework used in this research was still inferred. Therefore, when analyzing textbooks, other important factors, such as expert experience, it can be confirmed the reliability of the analysis (Babbie, 1998). For instance, as has been previously stated, all six of the analysts in this study were physics curriculum theory master's degree students. Another influential factor was the analytical process. A standardized analysis procedure helped to ensure reliability among the textbook analysts. First, each of the scorers conducted their analyses and scoring independently. In addition, each score correlated with supporting content from the textbooks. Finally, the authors and two other physics tutors (PhD professors) discussed the scores and analyses item by item. They also discussed and analyzed discrepancies between the scorers' results, and finally, consensus was achieved among researchers.

Results of Research

In order to cultivate students' scientific inquiry abilities and scientific reasoning skills, the inquiry tasks should satisfy two standards. The first is openness. Scientific inquiry activities should have a lower degree

of teacher involvement and a higher degree of student autonomy, meaning that they are open rather than following a recipe. Nevertheless, openness is only one characteristic of authentic scientific inquiry. It is more important to develop students' scientific inquiry skills and scientific reasoning skills are the operationality of cognitive processes. Scientific inquiry tasks should reflect all characteristics of cognitive processes that characterize authentic scientific inquiry. The following section is the results on these two dimensions of scientific inquiry tasks in five versions of eighth-grade physics textbooks.

The Results of Openness

The results of openness are exhibited in table 2. Among the 158 inquiry activities, only 6% required students to generate their own questions; 7% asked students to form their own hypothesis; 4% gave students freedom to choose variables; 6% let students propose their own experimental procedures; 3% allowed students to choose desired equipment; 4% permitted students to use their own method of recording observations; 4% required students to decide how to analyse the data; 7% allowed students to interpret results in their own words; and 5% gave students the option to decide how to communicate their results.

A cross-version comparison showed that the JST version gives students more autonomy in generating questions (13%). The BNU version (10%) and JST version (19%) give students more freedom in forming hypotheses, while the science inquiry activities in the other three versions allowing students to form their own hypotheses was less than 5%. Less than 5% of the activities in all versions allow choice of experimental instruments. The BNU version ranked relatively higher in the degree of openness in observation methods (10%), whilst the ESP version was found to have higher degree of openness in analyzing observed data (9%). The BNU version (10%) and the JST version (13%) have a higher degree of openness in allowing students to interpret results themselves. The S-G version seems to provide more freedom to communicate theirs results (9%), whereas less than 5% of the activities in the other versions provide this autonomy.

The Results of Operationality of Cognitive Processes

The results regarding operationality of cognitive processes are presented in Table 3. Generally, the operationality of cognitive processes is relatively stronger in permitting students to analyze observed data (16%) and interpreting experimental results (11%). The results in other dimension, however, do not meet ideal standards. Compared with other versions, the JST version attaches more importance to allow students generate research questions based on their own experience and knowledge (13%), to form alternative hypotheses (13%), and to apply complex methods to control variables (13%). The BNU version puts more emphasis on predicting experimental results based on hypotheses (10%). In using simple mathematics to analyse the data and checking whether the results are consistent with existing theories, all five versions have a stronger requirement. However, none of the five versions embodied other cognitive processes required for authentic scientific inquiry.

Table 2. The results of openness in five textbooks (%).

Openness	BNU	PEP	ESP	JST	S-G
Providing research questions to students	95	94	93	87	94
Requiring students to generate their own research questions	5	6	7	13	0
Providing research hypotheses to students	90	97	98	81	97
Requiring students to form their own research hypotheses	10	3	2	19	3
Providing research variables to students	95	100	91	97	100
Requiring students to define research variables by themselves	5	0	9	3	0
Providing specific experimental procedures and methods of controlling variables	95	100	91	94	97

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Openness	BNU	PEP	ESP	JST	S-G
Requiring students to design their own experimental procedures and methods of controlling variables	5	0	9	6	3
Instructing students to use specific experimental equipment	95	100	95	97	97
Allowing students to select experimental equipment by themselves	5	0	5	3	3
Informing students what variables are to be observed and recorded as well as recording methods	90	100	93	94	100
Informing students what variables are to be observed and recorded and let them determine the recording methods	0	0	0	3	0
Permitting students to decide what variables are to be observed and how to record the data of observations	10	0	7	3	0
Providing students how to analyze the data of observations	95	100	100	97	97
Allowing students to decide how to analyze the data of observations	5	0	9	3	3
Telling students how to interpret results	90	94	95	87	97
Requiring students to interpret results by themselves	10	6	5	13	3
Instructing students how to communicate the results	95	97	95	97	91
Allowing students to communicate the results in their own ways	5	3	5	3	9

Table 3. The results of operationality of cognitive processes in five textbooks (%).

Operationality of Cognitive Processes	BNU	PEP	ESP	JST	S-G
Asking students to generate research questions based on his own experience and knowledge	5	6	7	13	0
Asking students to generate research questions based on background and knowledge after reading relevant reports	0	0	0	0	0
Asking students to alternative hypothesis	5	3	5	13	3
Asking students to predict the research results based on hypotheses	10	9	5	3	3
Permitting students to select and operationalize variables	5	0	7	0	0
Permitting students to propose and operationalize their own variables	0	0	0	0	0
Providing a simple procedure and asks students to detail some simple methods of controlling variables	5	0	0	0	0
Providing a simple procedure and ask students to detail some complex methods of controlling variables	5	0	9	13	0
Asking students to design an experimental procedure and the method of controlling variables by themselves	0	0	0	0	3
Asking students to understand the functions and limitations of the equipment provided	5	0	0	0	0
Asking students to design their own experimental equipment or devices	0	0	7	0	0
Asking students to take measure to avoid observers' bias	0	0	0	0	0
Asking students to conduct simple mathematical processing on the data	30	19	9	13	18
Asking students to conduct complex mathematical processing on the data	0	0	0	0	0
Asking students to propose alternative interpretations of the results	0	0	0	0	0

Operationality of Cognitive Processes	BNU	PEP	ESP	JST	S-G
Asking students interpret the results based on a complex logical reasoning between results and research questions	0	0	0	0	0
Asking students to check whether the results are consistent with existing theories	25	3	2	16	18
Asking students to construct theories to explain the results	0	6	0	0	0
Asking students to integrate the results of various researches	0	0	0	0	0
Asking students to generalize the research results	0	0	0	0	0
Asking students to find the limitations of the experiment	5	3	2	3	0
Asking Students to propose new research questions and hypotheses based on the results	5	0	2	0	0

Discussion

The results of this research correspond to the findings of other studies (Chinn & Malhotra, 2002; Germann, Haskins, & Auls, 1996). Germann, Haskins, and Auls (1996) found that few scientific inquiry activities in science textbooks require students to form hypotheses, design experiments, control variables, and obtain evidence to support hypotheses independently (therefore employing a low degree of openness). Specifically, according to Germann, Haskins, and Auls (1996), 13.3% of the textbook inquiry activities required students to form their own hypotheses, 4.4% asked students to design their own experiments and methods to control variables, and less than 1% expected students to determine their own independent variables. Chinn and Malhotra (2002) also found that no inquiry activities in science textbooks allowed students to choose research questions, and only 2% allowed them to define their own independent variables. For that reason, Germann, Haskins, and Auls (1996) and Chinn and Malhotra (2002) argued that inquiry-based activities in science textbooks are neither beneficial to develop students' scientific inquiry processes skills nor beneficial to cultivate their scientific reasoning skills. The present study analyzed 158 scientific inquiry activities from five versions of eighth-grade physics textbooks, which are approved by the Chinese Ministry of Education. The results showed an overall low degree of openness in the activities. Only 4-7% of activities provide sufficient autonomy to students in nine elements of scientific inquiry (processes). A cross-version comparison showed that the BNU version has a higher degree of openness in terms of allowing students to form their own hypotheses and record observations in their own manner. The JST version has a higher degree of openness in the formation of hypotheses and interpretation of results. The ESP version is more open in the control of experiments and data processing. However, it should be noted that the overall percentage of scientific inquiry tasks that require student autonomy was still very low. The highest was only 19%, while most of the others were less than 10%.

The results showed that 6% of the 158 activities require students to generate research questions based on their experience and knowledge. None of the activities requires students to read research reports before proposing research questions. Although 16% of the tasks ask students to use simple mathematical techniques to analyze the data, while relatively complex mathematical processing methods were not covered. Students are required to interpret results in 11% of the tasks; however, the interpretation is mainly focused on whether the results comply with given theories rather than involving the cognitive processes of authentic scientific inquiry, such as providing alternative interpretations, conducting complex chains of inferences to explore the relationship between results and research questions, integrating results from several studies, proposing generalizations based on results, or constructing theoretical models to explain results. The percentage of activities that allowed students to choose, define, and operationalize variables, design experimental procedures and control variables, choose and design laboratory instruments, seek solutions to avoid observers' bias, uncover limitations of the study, or propose new research questions and hypotheses based on the results is quite low. Few of the cognitive processes that are required for authentic scientific inquiry are involved in school scientific inquiry activities. Chinn and Malhotra (2002) found that inquiry activities in science textbooks did not even provide opportunities for students to how control variables, not to mention more complex experimental

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control techniques; only 4% of the activities allow students to use simple methods of controlling variables by themselves. More complex variables control techniques, such as counterbalanced design, blind experiment, and matching techniques, are not mentioned in any activities. Although 17% of inquiry activities include a variety of observations, almost all of them are simply observations that do not consider how to avoid observers' bias. Few inquiry activities require students to analyze the data themselves. Basically, students are only asked to investigate some simple and superficial phenomena, such as size, weight, distance, speed, and color. While some professional and complicate skills, for example, how to construct a scientific theory to interpret an observation, are not covered at all. Students are often provided with detailed and precise information about a specific scientific theory and its interaction with the physical world. Inquiry activities rarely require students to carry out any form of multiple, progressive researches and also do not require students to read real research reports.

Conclusions

In summary, regardless of the degree of openness or operationality of cognitive processes, the inquiry activity in the five versions of textbooks in China cannot meet the requirements of authentic scientific inquiry and are not conducive to develop students' scientific inquiry skills and scientific reasoning skills. In addition, according to the requirements of scientific inquiry defined by the *Physics Course Standard of Compulsory Education (2011 Edition)*, none of the five versions meet the standard, particularly in generating questions, designing experimental procedures and variable-control methods, screening and analyzing the data, interpreting and reflecting the results. Furthermore, the present research constructs an analytical framework, which is based on theoretical and empirical research, and included openness and operationality of cognitive processes. The analytical framework could be a tool which can analyze and compare the inquiry tasks in textbooks among different countries.

The results of this research have some implications for future research in this field, as well as the authors and reviewers of textbooks. For the author of the textbook, they must first realize the importance of authentic scientific inquiry tasks in the science textbook. Secondly, they should realize that inquiry tasks in Chinese science textbooks almost are simple scientific inquiry tasks, not authentic scientific inquiry tasks. This situation not only does not meet the international requirements of scientific inquiry teaching, but also does not meet Science Education curriculum standards of the Chinese Ministry of Education (Chinese Ministry of Education, 2011). Finally, we suggest that authors of science textbooks take note of the latest insights from the world of academia and update textbooks in a prompt manner in order to assimilate new information into science textbooks, how to develop some new authentic scientific inquiry tasks in the science textbook. For the textbook reviewers, our research not only provides them with specific findings, but also provides them with a method to evaluate textbooks.

Although our research has some conclusions and should provide some reference for future research in this field, there are some limitations in this research. First, although the analytical framework in this research is based on theoretical and empirical research, the analytical framework is still tentative and needs to be further refined. Secondly, in order to improve the reliability of the research, the future researches further refine the operational definition of openness and operationality of cognitive processes and coding rule. Thirdly, in order to understand fully the development trend of authentic scientific inquiry tasks in the Chinese science textbooks, the future research should analyze and compare different periods of science textbooks in China. Fourthly, in order to uncover the problems and deficiencies of authentic scientific inquiry tasks in the Chinese science textbooks, it is necessary to compare the high-quality science textbooks of other countries with the Chinese science textbooks.

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References

Abd-El-Khalick, F., & Akerson, V. L. (2004). Learning as conceptual change: Factors mediating the development of preservice elementary teachers' views of nature of science. *Science Education, 88* (5), *785–810.*

Abd-El-Khalick, F., BouJaoude, S., Duschl, R., Ledennan, N.G., Mamlok-Naaman, R., Hofstein, A., et al. (2004). Inquiry in science education: International perspectives. *Science Education, 88* (3), 397-419.

American Association for the Advancement of Science [AAAS]. (1993). *Benchmarks for science literacy: A Project 2061 report*. New York: Oxford University Press.

Babbie, E. (1998). *The practice of social research*, 8th ed. Wadsworth Publishing Company.

Bybee, R. W. (2000). Teaching science as inquiry. In J. Minstrell & E. H. van Zee (Eds.), *Inquiring into inquiry learning and teaching in science* (pp. 20–46). Washington,DC: American Association for the Advancement of Science.

Chiappetta, E. L., Fillman, D. A., & Sethna, G. H. (1991). A method to quantify major themes of scientific literacy in science textbooks. *Journal of Research in Science Teac*hing, *28,* 713-725.

Chiappetta, E. L., & Fillman, D. A. (2007). Analysis of five high school biology textbooks used in the United States for inclusion of the nature of science. *International Journal of Science Education, 29* (15), 1847–1868.

Chinn, C. A., & Malhotra, B. A. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education, 86* (2), 175-218.

Domin, D. S. (1999). A review of laboratory instruction styles. *Journal of Chemical Education, 76* (4), 543-547.

Dunbar, K. (1995). How scientists really reason: Scientific reasoning in real-world laboratories. In R. J. Sternberg & J. E. Davidson (Eds.), *The nature of insight* (pp. 365–395). Cambridge, MA: MIT Press.

Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of inquiry-based learning technology and curriculum design. *The Journal of the Learning Science, 8* (3), 391-450.

Galison, P. (1997). *Image and logic: A material culture of microphysics*. Chicago: University of Chicago Press.

Germann, P. J., S. Haskins, et al. (1996). Analysis of nine high school biology laboratory manuals: Promoting scientific inquiry. *Journal of Research in Science Teaching, 33* (5), 475-499.

Garcia, T. D. (1985). An analysis of earth science textbooks for presentation of aspects of scientific literacy. Unpublished dissertation, University of Houston.

Giere, R. N. (1988). *Explaining science: A cognitive approach.* Chicago: University of Chicago Press.

Hafner, R., & Stewart, J. (1995). Revising explanatory models to accommodate anomalous genetic phenomena: Problem solving in the context of discovery. *Science Education, 79,* 111-146.

Hegarty-Hazel, E. (1986). *Lab work. SET: Research information for teachers, number one. Canberra*, Australia: Australian Council for Education Research.

Herron, M. (1971). The nature of scientific enquiry. *School Review, 79,* 171-212.

Kuhn, D., Garcia-Mila, M., Zohar, A., & Andersen, C. (1995). Strategies of knowledge acquisition. *Monographs of the Society for Research in Child Development, 60* (4), Serial No. 245.

Lederman, N. G. (2000). Problem solving and solving problems: Inquiry about inquiry. *School Science & Mathematics, 100* (3), *113-116.*

McComas, W. F., & Olson, J. K. (1998). The nature of science in international science education standards documents. In W.F. McComas (Ed.), *The nature of science in science education: Rationales and strategies* (pp. 41–52). Dordrecht: Kluwer.

National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council (NRC). (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. Washington, DC: National Academy Press.

Schwab, J. J., & Brandwein, P. F. (1962). The teaching of science as inquiry. In *The teaching of science*, eds. J. J. Schwab and P. F. Brandwein, 3–103. Cambridge, MA: Harvard University Press.

Singer, J., Marx, R. W., Krajcik, J. S., & Chambers, J. C. (2000). Constructing extended inquiry projects: Curriculum materials for science education reform. *Educational Psychology, 35(3),165-170.*

Tarr, J. E., Reys, R. E., Reys, B. J., Chavez, O., Shih, J., & Osterlind, S. J. (2008). The impact of middle-grades mathematics curricula and the classroom learning environment on student achievement. *Journal for Research in Mathematics Education, 39* (3), *247–280.*

The Ministry of Education of the People's Republic of China (MOE). (2001). *Compulsory education physics course standards (draft)*. Beijing: Beijing Normal University Press.

The Ministry of Education of the People's Republic of China (MOE). (2011). *Compulsory education physics course standards (2011 edition).* Beijing: Beijing Normal University Press.

Valverde, G. A., Bianchi, L. J., Wolfe, R. G., Schmidt, W. H., & Houang, R. T. (2002). *According to the Book - Using TIMSS to investigate the translation of policy into practice through the world of textbooks.* Dordrecht: Kluwer.

Wang, J. Y., Guo, D. H., & Jou, M. (2015). A study on the effects of model-based inquiry pedagogy on students' inquiry skills in a virtual physics lab. *Computers in Human Behavior*, *49*, 658-669.

Wang, J. Y., & Zhao, Y. (2016). Comparative research on the understanding of nature of science and scientific inquiry between science teachers from Shanghai and Chicago. *Journal of Baltic Science Education, 15* (1), 97-108.

ANALYSIS AND COMPARSION OF SCIENTIFIC INQUIRY ACTIVITIES IN EIGHT-GRADE PHYSICS TEXTBOOKS IN CHINA
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Wang, J.Y., Jou, M., Lv, Y.Z., Huang, C. C. (2018). An investigation on teaching performances of model-based flipping classroom for physics supported by modern teaching technologies. *Computers in Human Behavior, 84*, 36-48.

Zimmerman, C. (2000). The development of scientific reasoning skills. *Developmental Review, 20,* 99–149.

Zimmerman, C. (2005). *The development of scientific reasoning skills: What psychologists contribute to an understanding of elementary science learning?* Illinois: Illinois State University.

Zion, M., Shapira D., Slezak, M., Link, E., Bashan, N., Brumer, M., Orian, T., Nussinovitch, R., Agrest, B., & Mendelovici, R. (2004). Biomind - A new biology curriculum that enables authentic inquiry learning. *Journal of Biological Education, 38* (2), 59-67.

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