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Science Trade Book Reading for 5th
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Enhancing Science Learning through Science Trade Book Reading for 5th Graders

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Abstract

This study explores the learning outcome of science learning with integrating science trade book reading of 5th graders. A quasi-experimental design was used in this study at an elementary school in New Taipei City. Students in the experimental group ($N=59$) were given instructional strategies on integrating science trade book reading into science learning, while the control group ($N=59$) received traditional instruction. Three science trade books were used in science reading strategies for the experimental group. Two research instruments were used in this study were a science achievement test (30 items, $KR_{21}=.80$), and an attitudes toward science scale (31 items, $Cronbach\ \alpha=.94$). The results were processed by ANCOVA analysis, finding that students in the experimental group got higher scores than students in the control group ($F=4.921, p < .05$). Although there was no significant difference between the two groups in the outcome of the attitudes toward science scale, feedback from students in the experimental group showed that they enjoyed and benefited from integrating science trade book reading into science learning and hoped can they could continue to learn more science by integrating science trade book reading. Thus integrating science trade book reading into science learning was beneficial for the 5th graders in this study.

Introduction

Lai (2012) pointed out that although science textbooks for elementary schools are filled with new and novel science experiments, inquiry activities that encourage students to explore the historical facts of natural sciences are limited. This makes it students less inclined to study scientific concepts and perform scientific experiments, or even worse, feeling averse to science learning (Lai, 2012). Therefore, finding effective ways to solve these problems caused by science textbooks, and strengthening students' interest in scientific inquiry are important topics for science educators.

The concept of using outside materials to enhance science is not new, introducing science units with a favorite read-aloud of a science trade book can be an effective way to engage students and to improve their reading skills, teach content, and connect learning to the real world and students' own interests (Adams & Phillips, 2016; DeVore-Wedding, 2016; Ford, Brickhouse, Lottero-Perdue, & Kittleson, 2006; Gee, 2004; Gulley, Thomas, Wulbur, & McMurry, 2014; Guthrie, Wigfield, & Von Seeker, 2000; Hapgood & Palinscar, 2007; Jagger & Yore, 2012; Marzano, Pickering, & Pollock, 2001; Mayberry, 2014; National Science Teachers Association, 2002). Mayberry (2014) noted that the Next Generation Science Standards and the Common Core State Standards in Language Arts encourage the use of content integration and promote the efficient use of classroom time.

In addition, the National Science Teachers Association (2015) states that science teachers and mentors continue to be challenged to meet the high expectations of the Framework for K-12 Science Education and the Next Generation Science Standards. To develop curricula that meet these challenges, literature is an essential partner. Ford, Brickhouse, Lottero-Perdue, and Kittleson (2006) indicated that informational science texts provide numerous ways for teachers to address both literacy and science standards, while supporting children's learning, engagement, and interest. Moreover, background knowledge and vocabulary are key components in a literacy-rich science curriculum, and are also important in providing the means to improve student understanding and achievement in science (Fazio & Gallagher, 2014; Fisher, Grant, & Frey, 2009; Gallagher, Fazio, & Ciampa, 2017; Gallagher, Fazio, & Gunning, 2012; Marzano, 2004; Romance & Vitale, 2012a). Recently, much attention has been given to reading activities in Taiwan, leading many primary and secondary school science teachers to integrate science history, science reading materials, and/or science reading and writing strategies into

science teaching. Lai and Wang (2016) found that incorporating these measures into science teaching did improve students' science learning performance. Therefore, this study is trying to explore the learning outcome of integrating science trade book reading into the science learning of 5th graders.

Literature Review

Science Trade Book Reading

Reading science trade books is a convenient way for students to build literacy skills while learning science content (National Science Teachers Association, 2015). Curriculum materials are an important tool to help teachers engage students in scientific inquiry (Davis & Krajcik, 2005). Adams and Phillips (2016) pointed out that using trade books in the science classroom can promote authentic science practices and comprehension of scientific concepts. According to Lai (2006), "science reading" involves the use of science reading materials, including science trade books, science articles, scientific fairy tales, science stories, and science picture books. It is hoped that the inclusion of these reading resources in science teaching will help students gain a fuller understanding of scientific topics, and will enhance their science learning effectiveness.

Ross and Frey (2002) stated that science trade books can interpret a single science concept in a deeper perspective. Further, science trade books enable students with different levels of reading abilities to choose science trade books that are appropriate to them. Science trade books are more interesting and easier to understand than science textbooks. Butzow and Butzow (2000) further pointed out that narratives in the form of stories in science trade books are more effective in stimulating students' interest than scientific facts as commonly presented in textbooks. In addition, the colored pictures and charts included in science trade books are more effective than wordy descriptions of abstract concepts often included in textbooks. Mantzicopoulos and Patrick (2011) emphasized that frequent reading of science trade books can help children engage science learning and develop an interest in it. Royce (2016) noted that elementary-age children need opportunities to think about and develop an idea from its inception through to its conclusion in order to expand their thinking and engage in scientific processes. Generating and expanding on ideas allows children to consider problems or questions they would want to solve through experimentation, and it requires perseverance and practice.

Huang and Hsu (2003) studies children's books with topics on the history of science and found that: (1) students are highly interested in the history of science when presented in a children's book; (2) reading children's books about the history of science enables students to acquire more knowledge about scientists, and provides an opportunity for them to recognize the achievements of women scientists; (3) these books allow students to learn about the developmental process of science in addition to scientific concepts; and (4) studying the history of science can provide students with an opportunity to understand the nature of science.

Moreover, previous research on the integration of science reading into science teaching has revealed that: (1) reading about the history of science can enhance students' understanding of scientific concepts and their thinking ability (Chiu & Koa, 2006; Guthrie, Wigfield, & Von Seeker, 2000; Guzzetti & Bang, 2011; Guzzetti & Mardis, 2017; Lai, 2008, 2012; Lai & Wu, 2010; Marzano, Pickering, & Pollock, 2001; McNeill, 2009; Pringle & Lamme, 2005; Romance & Vitale, 2012a; Shiau & Hung, 2000; Vitale & Romance, 2012; Werderich, 2014); (2) science reading activities can encourage students to form their own viewpoints and opinions on the nature of science (Chan, 2003; Chen & Hung, 2003; Chen & Wang, 2004; Chiu & Koa, 2006; Ford, Brickhouse, Lottero-Perdue, & Kittleson, 2006; Lin, Cheng, & Chang, 2009; McNeill, 2009; Wang, Cheng, & Wang, 2003; Wang & Wang, 2004; Werderich, 2014); and (3) integrating science trade books into science teaching can enrich the lessons in science concepts, enhance students' problem-solving skills, provide students with an opportunity to verify scientific rules and experience surprises when they make unexpected discoveries, and stimulate students' creativity and thinking skills (Chin, Yang, & Tuan, 2010; Daisey, 1994; Ediger, 1995; Ford, 2006; Ford, Brickhouse, Lottero-Perdue, & Kittleson, 2006; Guzzetti & Bang, 2011; Lai, 2008, 2009; Lamond Price, 2014; Lo & Chang, 2004; Marzano, Pickering, & Pollock, 2001; McNeill, 2009; Nordstorm, 1992; Pringle & Lamme, 2005; Rice, 2002; Rice & Rainsford, 1996; Rice & Snipes, 1997; Romance & Vitale, 2012a; Rosberg, 1995; Scott, 1993; Short & Armstrong, 1993).

Strategies for Science Trade Book Reading

Gallagher, Fazio, and Ciampa (2017) evaluated the use of science trade books or other various texts in elementary science teaching, and indicated that as 21st-century learning through multi-modal literacies evolves,

the readability of online, content-based text should be evaluated to ensure accessibility to all readers. Gallagher, Fazio, and Ciampa (2017) emphasized that teachers should be aware of the limitations of readability indices and be well informed when making instructional decisions based on the most appropriate readability measures for content area texts: teachers are the last line of text scrutiny for instructional appropriateness.

Rice, Dudley, and Williams (2001) suggested that teachers should not only select interesting reading materials when choosing science trade books for science teaching, but should also consider the following factors: (1) whether science concepts are specifically presented in the book; (2) whether stories in the book are genuine; (3) whether it is possible to separate the scientific facts from science fiction; (4) whether there is hasty generalization; (5) whether the descriptions are accurate; (6) whether gender equality is considered in the characters; (7) whether the animal and plant roles are naturally presented; (8) whether the description of the era is correct; (9) whether the statement of the story can enhance a positive attitude toward science; and (10) whether students are willing to read or listen to the book.

Atkinson, Matusевич, and Huber (2009) proposed a rubric to assist teachers in making informed decisions about science trade books for use in classrooms. Criteria in the rubric relate to science content, genre, writing style, illustrations, readability, and text features. The National Science Teachers Association (2014) made some suggestions for the selection of science trade books for science teaching, including (1) the book has substantial science content, (2) information is clear, accurate, and up-to-date, (3) theories and facts are clearly distinguished, (4) facts are not oversimplified to the point that the information is misleading, (5) generalizations are supported by facts, and significant facts are not omitted, and (6) books are free of gender, ethnic, and socioeconomic bias. Mayberry (2014) suggested that using trade books to enrich science content and inquiry investigations can be done by combining three elements: (1) teachers who are enthusiastic readers of their favorite books; (2) high-quality trade books on current science topics; and (3) effective strategies to follow the read-aloud to enhance science learning. In addition, Ford, et al. (2006) emphasized that using science trade books should be accompanied by rich discussion and opportunities for retellings and rereadings.

In addition, Lai (2012) suggested other strategies for improving the effectiveness of students' science reading and learning, which include: (1) problem-oriented discussions that can deepen students' understanding of science reading content; and (2) a science corner set-up to help integrate science reading into students' campus life. Rice (2002) also suggested the use of the learning cycle as a teaching model. The learning cycle involves general science teaching paradigms included in the stage of concept exploration and application, and the science reading strategies added in the stage of concept introduction to strengthen students' understanding of science concepts and recognition of the development of science. Miller, Steiner, and Larson (1996) advocated adopting the KWL model to clarify students' scientific misunderstandings. This model integrates science into reading through strategies of K (what I Know), W (what I Want to know), and L (what I Learned). Crook and Lehman (1990) suggested using a five-phase instructional model to enhance students' science and reading comprehension. Moreover, Short and Armstrong (1993) suggested implementing the inquiry cycle approach to explore science by alternating scientific fiction readings and other fiction. Beck, Mckeown, Hamilton, and Kucan (1997) suggested the QtA (Questioning the Author) model, wherein teachers use questions to guide discussions, and students are required to identify, determine, and understand different scientific topics to clarify their misunderstandings of scientific concepts.

Romance and Vitale (2012b) suggested using the Science IDEAS model to promote students' achievement outcomes in science and reading comprehension. This model combines science, reading comprehension, and writing through multi-day science lessons that integrate six Science IDEAS instructional elements (hands-on activities, reading comprehension, journaling/writing, propositional concept maps, prior knowledge/cumulative review, and application activities). To make science reading-aloud successful, Mayberry (2014) emphasized the following procedures: (1) Preview the book to ensure the content is correct, engaging, and developmentally appropriate. (2) Set the stage for the students prior to the reading-aloud. They should be able to witness the reader's enthusiasm. (3) Celebrate the author, illustrator, and subject matter by sharing interesting facts with the students. (4) Read with great expression! Characters portrayed in different voices provoke interest and curiosity for the listeners. (5) Share the pictures. Visuals are an integral part of the read-aloud procedure. (6) Keep the book available. Students enjoy rereading great books that have been read aloud to them. It has been found that students' understanding of different scientific concepts can be enhanced by reading science trade books. Therefore, it is logical to assume that properly using scientific readings into science teaching and learning can help improve students' science learning effectiveness.

Method

A quasi-experimental design was used in this study at an elementary school in New Taipei City. The students of 5th graders included in this study were divided into two groups: an experimental group and a control group. Students in the experimental group ($N=59$) were given instructional strategies on integrating science trade book reading into science learning, while the control group ($N=59$) received traditional instruction. Both groups were given 27 sessions of teaching classes that spanned nine weeks. A total of 13 sessions were allotted for teaching *The Influence of Heat on Matter*, and 14 sessions for *Air and Burning*. Three science trade books were used in science reading for students in the experimental group. Science trade books used during the research included *Amazing Experiments in Textbooks-Comic Chemistry*, *The Heat of the Three Caves of Rabbits*, and *The Passionate Fire*. The science reading strategies provided in the experimental group, included reading science trade books, conducting scientific experiments, drawing mind maps, and participating in group discussions. The research was conducted in three steps: (1) Teachers were asked to use the aforesaid three science trade books to supplement their teaching of *The Influence of Heat on Matter* and *Air and Burning*, extending students' knowledge on the concepts of heat and combustion. (2) Students were asked to conduct scientific experiments on heat and combustion every week to engage in inquiry activities, experience heat and combustion, and better understand the concepts of heat and combustion. (3) Students were asked to create mind maps about heat and combustion, to discuss this in groups, and to report in class everything they had learned from the three science trade books. While the control groups also were provided of three sets of science trade books in the science corner of their classrooms for their individual reading.

This study used two research instruments: the science achievement test and the attitudes toward science scale. The science achievement test was compiled by the author of this study and consists of 30 items to assess students' understanding of the concepts of heat and combustion. The attitudes toward science scale was also compiled by the author of this study and consists of 31 items to evaluate students' attitude towards science on five-point Likert scales. Statistical analyses showed that both the science achievement test ($KR_{21} = .80$) and attitudes towards science scale ($Cronbach \alpha = .94$) had good reliability. In addition, three science education researchers confirmed that both research instruments had good validity. The results of both instruments underwent ANCOVA analysis. In addition, learning feedbacks from the teacher and students in the experimental group were collected and analyzed.

Results and Discussion

Students' Outcomes on the Science Achievement Test

Learning outcomes on the science achievement test were collected, analyzed, with the following results. There were 118 5th graders who participated in this study. The learning outcomes of the science achievement test are presented in tables 1 and 2.

Table 1. *Mean & SD of Science Achievements Test Scores by Groups*

Group	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Experimental group	59	15.05	5.28	22.20	4.59
Control group	59	15.46	4.71	21.08	4.94

Table 2. *ANCOVA of Science Achievements Test Scores by Groups*

Source	SS	df	MS	F	p
Within	1303.967	1	1303.967	112.564	.000
Between	57.011	1	57.011	4.921	.028*
Error	1332.178	115	11.584		

* $p < .05$

The results show that students in the experimental group had higher scores than students in the control group ($F=4.921$, $p<.05$). This indicates that students in the experimental group did better in science achievement test by integrating science trade book reading. That is, integrating science trade book reading with science learning improved students' science understanding.

Students’ Outcomes of the Attitudes toward Science Scale

Learning outcomes of the attitudes toward science scale were collected, analyzed, and stated as follows. There were 118 5th graders who participated in this study, and learning outcomes of the attitudes toward science scale are presented in tables 3 and 4.

Table 3. *Mean & SD* of Attitudes toward Science Scale by Groups

Group	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Experimental group	59	115.56	19.81	120.03	18.81
Control group	59	116.95	17.90	117.78	20.99

Table 4. *ANCOVA* of Attitudes toward Science Scale by Groups

Source	SS	df	MS	F	p
Within	24348.415	1	24348.415	128.800	0.000
Between	324.863	1	324.863	1.718	0.192
Error	21739.625	115	189.040		

Although the post-test score of students in the experimental group were higher scores than students in the control group, there was no significant difference between two groups on the outcomes of the attitudes toward science scale.

Feedback from Students and the Teacher

Students in the experimental groups gave the following feedback after science trade book reading was incorporated into science teaching and learning. According to a student named Jeremy:

Science trade books are more interesting since they contain dialogues and illustrations. They also provide more information. For instance, one of the science trade books gave a clear introduction on a thermos bottle. My knowledge was further broadened by reading the science trade books because they offered additional information on the topic discussed on our textbook.

Jeremy’s statements show that students find the science trade books selected by this study and used as supplementary reading materials interesting because they contain exciting dialogues, pictures and illustrations. Further, the science trade books presented scientific information vividly, which piqued students’ interest in reading books and exploring the concepts of heat and combustion.

Reading science trade books also promoted students’ interest in topics, which encouraged them to borrow more books from the library for supplementary reading. A student named Anthony stated:

The quiet library has many books, which makes me want to read books. I borrowed additional books from the library which were about heat transfer coefficients and oxygen.

Another student named Madeleine said:

The library has many books related to the topics that we discussed in class. The library allows us to select books by ourselves. It allows me to look for science books that I find easy to understand. One of the books that I borrowed from the library was about burning.

The statements by Anthony and Madeleine, students who borrowed books from the library, suggest that reading the science trade books selected by this study increased the students’ level of interest and encouraged them to borrow supplementary science books from the library after school for further reading.

As part of the teaching strategy adopted in this study, students were required to conduct relevant scientific experiments every week. Some of the feedback from students is as follows;

One of the students named Stewart said:

Interesting experiments reinforced our impression about what we learned in class. After the experiment, we obtained a firm understanding on heat and burning.

Another student, Teresa, stated:

The experiment that the teacher asked us to do gave us a chance to verify the phenomenon that we learned in the textbook. After the hands-on practice, I now have a better understanding of heat and burning.

The statements from Stewart and Teresa show that experiments and personal observations allow students to better understand scientific concepts. They obtained a stronger impression about heat and combustion due to hands-on practice and observation. This also shows that students like to learn science via hands-on experiments, allowing them to have fun while learning through experimental exploration.

Teaching strategies used in this study also include group discussion and group sharing. A student named Howard said:

Group discussions are very interesting. We were able to share our thoughts with our classmates after reading and we were able to learn more during the discussions.

Another student, Rebecca, noted:

There were times when we had difficulty understanding the information on the science trade books, so we needed to discuss it with our classmates. Through discussion, I was able to understand concepts that I was not able to grasp on my own. Drawing mind maps deepened my understanding of the information on the book.

Howard and Rebecca's statements show that students have a positive opinion towards group discussions and drawing mind maps after reading science trade books. These statements demonstrate that the use of these methods can help them better understand the narrative and science concepts contained in science trade books. Drawing mind maps can only be done by finding keywords on science concepts for which students have a clear understanding. The feedback from the students regarding drawing mind maps shows that their reading and scientific inquiry abilities also improved.

This study also obtained feedback from the teacher, Katharine, who said:

The reading materials (science trade books) included in this study are in accord with the topics in science class. Therefore, the supplementary reading materials facilitated students' development of science concepts. In addition, the implementation of multiple teaching strategies helped students further understand the scientific materials they have read. The combination of textbooks with experiments enabled students to verify what they have learned from the textbook, the group discussions enabled them to have meaningful learning, and drawing mind maps enabled them to construct their own views and opinions about the scientific knowledge gained and to develop their understanding of the concepts of heat and combustion. In addition, students also proposed that they continue to read science trade books in class; these books can be selected by teachers for them to read, while they also borrow additional books of their own choice in the library.

The feedback of Katharine reveals that students showed great interest in reading science trade books that have vivid vocabulary, dialogues, and illustrations. Students were also able to better understand concepts of heat and combustion because of the strategies used in this study, which included reading science trade books, conducting experiments, discussing in groups, and drawing mind maps, in conjunction with the teachers' explanation and guidance during class. In addition, experiential learning through conducting experiments also deepened students' understanding of science concepts. This shows that the students have a positive attitude towards the integration of science trade books into science class, and they hope that they can continue to learn science through these science trade books. The teacher and students who participated in this study all had a positive and supportive attitude towards the integration of science trade books into science class.

Conclusion

This study integrated three science trade books into science learning and instruction for 5th graders. The results of the science achievement test found that students in the experimental group had significant higher scores than students in the control group. This findings add support to the perspective that using science trade book reading into science learning can enhance students' understanding of scientific concepts (DeVore-Wedding, 2016; Guzzetti & Bang, 2011; Guzzetti & Mardis, 2017; Lai, 2008, 2012; Lai & Wang, 2016; Romance & Vitale, 2012a, Vitale & Romance, 2012; Werderich, 2014). With the attitudes toward science scale, although the post-test score of students in the experimental group were higher scores than students in the control group, there was no significant difference between the two groups on the outcome of the attitudes toward science scale. Finally, students' feedbacks showed that they enjoyed and benefited from integrating science trade book reading into science learning and would like to do more science trade book reading. These feedbacks also support that frequent reading of science trade books can help children engage science learning and develop their interest (Adams & Phillips, 2016; Davis & Krajcik, 2005; Lai, 2012; Lai & Wang, 2016; Mantzicopoulos & Patrick, 2011; Romance & Vitale, 2012a). Therefore, it can be conclude that integrating science trade book reading into science learning is beneficial for 5th graders.

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