Rethinking K-6 Scientific Literacy: A Case Study of Using Science Books as Tool to Cultivate a Fundamental Sense of Scientific Literacy

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Abstract: As the discourse of scientific literacy has broadly summed up the goals of science education in the current decade, this study attempts to question how we contextualize appropriate interpretations and feasible approaches to scientific literacy in K-6 science education. With respect to the complex praxis of scientific knowledge and practice, this study emphasizes the participatory framework of scientific literacy which interweaves children's everyday experiences and science learning. This study also concerns children's abilities to understand and enact scientific enterprises (i.e., children's fundamental sense of scientific literacy). As a way of developing K-6 scientific literacy, this study investigates how using science books can broaden the scope of children's understandings of science in life connections and promote a fundamental sense of scientific literacy through talking, reading, and writing skills in Grade two science classrooms in Canada. Second graders were engaged in learning "sound" for five weeks. During science lessons, children's talks were recorded and their writings were collected for data interpretation. This research finds that using science books can encourage children to become engaged in communicative activities such as talking, reading, and writing in science; furthermore, using science books develops children's inquiry skills. These findings open a further discussion on scientific literacy at the K-6 levels.

Key words: K-6 scientific literacy, science talks and writing, science books, children's inquiry skills

I. Introduction

1. The Overview of Scientific Literacy

The term 'scientific literacy' has been familiar to science educators for the last few decades. The term was suggested by Paul DeHart Hurd in 1958 in the United States to represent a broad and general understanding of scientific knowledge. The term was a response to the public interest in rapidly developing scientific and technological enterprises in modern society whether one was to become a scientist or not (DeBoer, 2000; Roberts, 1983). In other words, this term focused on the perceived need for scientific and technological power and public understanding of science in contemporary society (DeBoer, 2000). Since then, 'scientific literacy' has become one of the most general terms to discuss the issues of science education locally and globally.

Despite this initial interest in a broadly defined public understanding of science, advocates of scientific literacy became more keenly interested in the strategic roles of scientific knowledge in providing an adequate supply of technically trained scientists, mathematicians, and engineers for international competitiveness (DeBoer, 2000, Blades, 1995, 1997). Science education started focusing on instrumental values of the discipline for economic enterprises and the gaps between scientific knowledge and hence, its application became more problematic (DeBoer, 2000; Hodson; 2003; Hurd, 1998). Science educators in the 1970s and early 1980s became concerned about these gaps and started to emphasize the important roles of social contexts in science education. Science educators looked into students' knowledge and appreciation of science as possessing personal, social, and cultural dimensions that have the potential to connect students to their science learning and make it meaningful within their everyday contexts (DeBoer, 2000). The discussion of scientific literacy has been continued

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with the notion of 'science literacy for all' and of 'scientific literacy for citizenship' in recent times (Hodson, 2003). This emphasizes the roles of scientifically literate citizens who construct and criticize the knowledge of science and make decisions and act on issues of science and technology in their lifeworld (Hurd, 1998).

2. The Discourses of Scientific Literacy for All/Citizenship

Rosalind Driver *et al.* (1996) argued that the problem of contemporary science education remains where science educators try to achieve both sets of goals - aiming for scientific literacy as career preparation and as general access to scientific knowledge in our communities - within the same science curricula (Bybee, 1997). Both of these emphases have important roles in life and society and should not be ignored in science teaching, yet science education has put a strong emphasis on content-based knowledge, demanding from the science professions to seek students' acquisition of 'correct' scientific vocabularies, concepts, and skills. This emphasis has occurred at the expense of considering students' lifeworld knowledge and developing public capacity for understanding and participation in science contexts. Driver *et al.* (1996) also stated that "if science is a core subject for *all* pupils, the proportion who will use science for career purposes is likely to be relatively small. [Therefore,] the aim to improve scientific literacy is to increase public understanding of science" (p. 9). Therefore, it is appropriate for us to question the ways in which we consider the majority of students and their science and life in our teaching, i.e., the ways in which we enact *science for* all.

In the discussion on scientific literacy for all, Driver *et al.* (1996) pointed out that *scientists are citizens too,* a consideration which emphasizes people's responsible and participatory actions in their labs as well as in public. Presumably, those with science expertise carry more responsibility than the general public in terms of their influence on the rest of society and that added responsibility creates ethical dilemmas of knowledge and practice for scientists (Fleming, 1989). The public also needs to realize the collective role of the empowerment of scientific literacy in the network of socio-scientific and technological discourses. There should be no distinction between the special and general purposes of science education when it comes to the socio-civic responsibilities of scientific literacy. In this respect, 'scientific literacy for all' leads us to take into consideration our responsible participation with scientific knowledge as citizens. Accordingly, the goal of scientific literacy has been reexamined in the light of citizenship in socioscientific and technological enterprises and emphasized our responsible and active participation in modern global society (DeBoer, 2000; Hand *et al.,* 1999; Hodson, 2003; Hurd, 2002; Kolstø, 2001).

To achieve scientific literacy connected to all children and citizens, science educators have thrived to achieve better understandings of scientific literacy and reform science curricula. Hurd (2002), Jenkins (2000), Yager (2000) and many others note the need of connection between school science and learners' lifeworld, that is, a 'lived curriculum'. There has been a strong emphasis on ethical and ideological values of science and technology beyond the mere acquisition of scientific knowledge in modern society in science education, that is, STSE (Science-Technology-Society-the Environment) curriculum. In this approach, addressing controversial socioscientific issues is a key discipline to promote students' critical and responsible ways of thinking and action (e.g., the work of Aikenhead, Solomon, Pedrettii, Zeidler, and many others). To achieve scientific knowledge, critical thinking and decision making skills, and taking action in real life situations, it is crucial to question what would be a fundamental level for students to become scientifically literate. This determination focuses on students' abilities to access, interpret, and understand scientific knowledge as the basis of scientific literacy (more on this later). To briefly sum up the discourse of scientific literacy, Table 1 is suggested as follows.

II. Rethinking Scientific Literacy in Elementary Science Education

Despite the fact that there have been great efforts to discuss scientific literacy, there has been little agreement on the understanding of scientific literacy

Table 1
The current discourse of scientific literacy

Orientation		Issues	Researchers
Emphasis of scientific literacy	Scientific literacy for all	*Science education as preparation for the professions or as general public understanding of science?* Recognition of the disconnection between school science and everyday science	Driver et al., 1996; Galbraith et al., 1997 ; Roberts, 1983; Falk, 2001
	Scientific literacy for citizenship	*Scientific literacy as national competency or socio-civic knowledge?* Recognition of complex issues around STSE (science-technology-society-the environment) and the roles of current science curriculum	Aikenhead, 1994; Hodson, 2003; Hurd, 1998, 2002; Kolstø, 2000, 2001; Roth & Desautels, 2004; Yager, 2000; Zeidler et al., 2002, etc.
Strategic approaches to scientific literacy	STSE Education	- STSE curriculum to cultivate civic scientific literacy - Critical thinking and decision making on socioscientific issues - Decision-making and taking action as scientifically literate citizens in individual and public domains	Aikenhead, 1994; Hodson, 2003; Hurd, 1998, 2002; Kolstø, 2001; Pedrettii, 2003; Solomon, 1993; Yager, 2000; Zeidler et al., 2002, etc.
	Science as lived curriculum	- Context-bound science learning - Learning with a lived experiences & Science stories	Aikenhead, 1994; Hurd, 1998; Roberts, 1995; Yager, 2000
	Reading/understanding scientific texts	- As communicative skills of literacy: reading and writing abilities to understand and participate in public scientific discourses	Hand et al., 2003; Norris & Philips, 2003; Yore et al., 2003; Zimmerman et al., 1998, 2001

observed in classroom teaching (Hurd, 2002; Pedretti, 2003; Roberts, 1995; Shamos, 1995). It is critical to question where the difficulties surrounding scientific literacy lie, and in what ways these difficulties make the implementation of scientific literacy complex and challenging in classroom practice.

A critical issue lies in the broadness and crowdedness of the interpretation of scientific literacy. It is hard for us to understand what scientific literacy means operationally, and how to approach it where there is no solid single definition of scientific literacy – nor one that seems to include consideration of STSE issues and students' lifeworld contexts - but only science content knowledge and skills construed as scientific literacy in science curricula. Some would go so far as to suggest that the meaning of scientific literacy has become too big and abstract to achieve its goals or even to understand what it is (Shamos, 1995). Scientific literacy tries to serve too many different demands and societal agendas (Driver et al., 1996). Some critics argue that we cannot have a single understanding of scientific literacy. Having one would be only an illusion, says DeBoer (2000). He argues that each of us needs to comprehend how to creatively and mindfully understand scientific literacy among its multidimensional approaches. Under these circumstances, science teachers' attentive and critical decision-making processes are critical in terms of the directions and strategies they choose to approach scientific literacy in their practice.

On top of the issue of broadly termed scientific literacy, the discourses of scientific literacy in science education communities have taken place with the consideration of secondary and higher education such as scientific literacy for citizenship and public understanding of science education. There has not been much discussion on what scientific literacy means and what of scientific literacy needs to be focused for elementary science education. How do we as elementary science educators understand the goals of science education and classroom teaching in relation to the current discourse of scientific literacy?

In A Vision For What Science Education Should Be Like For the First 25 Years Of A New Mille-

nnium, Yager (2000) stresses the importance of new perspectives and approaches of scientific literacy, summing up the characteristics of scientific literacy – knowledge, skills, and attitudes; ***Concept*** (Knowing and understanding), ***Process*** (Exploring and discovering), ***Creativity*** (Imagining and creating), ***Affectiveness*** (Feeling and valuing), ***Application & connections*** (Using and applying), and ***World view*** (Viewing science and its history as human enterprise) – currently being discussed among science educators. He emphasizes the harmony of scientific knowledge and the lifeworld by stressing the significance of life experiences, a balance between epistemic knowing and emotive attitudes, and exploration of the creative implications of scientific literacy in world contexts.

These dimensions of scientific literacy also suggest a somewhat broad spectrum of science teaching and learning; therefore, researchers need to look for appropriate approaches in different contexts and levels of learners. To discuss the practice of scientific literacy for elementary levels, we first need to look into his emphasis on the necessity of the involvement of human life experiences. Scientific literacy as life knowledge needs to recognize children's lived experiences associated with scientific knowledge. Since the discourse of scientific literacy recognizes the participatory roles of scientific literacy and scientific literacy for citizenship, i.e., the connection between science and lifeworld, children's understanding of scientific phenomena in their everyday situations is a fundamental basis for the praxis of scientific knowledge.

The emphasis on scientific literacy in one's own life contexts leads us to look into our science teaching in relation to students' lived experiences and stories. When students' scientific knowledge is expected to be practiced in society, we also need to know how students experience science in their everyday lives in order to shape our teaching to enhance the connections between knowledge and life world. In *Science for All Children: A Guide to Improving Elementary Science Education in Your School District* (1997), science educators explicitly suggest that, "We now know that children construct understanding and develop theories about the world on the basis of their experiences…it is important to begin building children's experiential base in the primary grades by providing research based, inquiry based experiences (p.22)." Hurd (1998, 2002) emphasizes that the current curricula, however, are still very disconnected from children's life experiences and not effective and reflective enough to address rapid socio-civic changes in modern society. Through inviting, unfolding, and dialoging with students' experiences and perceptions on everyday science and technology, we attempt to approach scientific literacy as embodied and lived knowledge. To understand the life connections, humanistic science teaching is crucial (Aikenhead, 2006).

It is also important to develop children's abilities to read, interpret, and present the meanings of science texts to develop scientific literacy in fundamental levels. Norris and Philips (2003) argue that the fundamental sense of scientific literacy requires reading and writing skills since understanding science heavily depends on written texts. To be knowledgeable and educated in science, the fundamental sense of scientific knowledge should not be neglected; however, science teachers whose focus is not reading and writing often ignore how the process of learning science through reading and writing takes place in children's understandings of science (Hand & Prain, 2003; 1994; Norris & Philips, 2003; Yore *et al.,* 2003). To promote students' scientific literacy in terms of the interpretation and analysis of science texts in public domains, they emphasize the need for fundamental literacy skills in science education settings. Analyzing, interpreting, and discussing articles in newspapers, magazines and journals in science classrooms has been proposed as a way of enhancing students' abilities to understand contemporary science and its actions. Being knowledgeable of science means that children understand what the text of science indicates, and how it can be utilized.

In this regard, K-6 scientific literacy needs to take into account children's reading and writing skills in relation to children' lived experiences. That is, the ability of understanding scientific phenomena for K-6 levels very much depends on the phenomena that children experience in their everyday lives as well as capability of reading, researching, and interpreting the text of science. In her research on children's discourse of science learning, Gallas (1995) explored the meaning of scientific literacy in young children's science classrooms (Grade 1-2). She explained that young children's thinking, questioning and constructing their own theories of science were naturally engaged with their everyday experiences and those skills could be promoted though communicating their ideas with others. When topics of subjects are related to children's experiences, children can become more interested in scientific phenomena and engaged in inquiry process. In the process of scientific inquiry, children's capability of communicating skills can be a crucial tool to fulfill their curiosity and motivation to know.

With these respects, the understanding of K-6 scienztific literacy needs to be based on complex interrelationship of communicative skills and lived curriculum.

III. Research Question and Framework

To probe students' lived experiences and connect science learning to their everyday situations, it is important to get children involved in activities which bring children's everyday life contexts and science concepts in collaborate schema. With the concerns of integrated science learning, this study looks into the ways of cultivating scientific literacy through evoking interest to know and ability to know. Using science books as a tool, this study attempts to cultivate the connection between science and everyday lifeworld, interest in science, and communicative skills of talking, reading, and writing in children's learning. The study focus on the following questions:

a) In what way can children's everyday experiences be brought into science learning?
b) How can science books be used to promote a fundamental sense of scientific literacy in elementary science classrooms?
c) How do science books help children with inquiry and research skills?

To approach those questions, the study employed the framework of scientific literacy for young students as suggested in Fig. 1. To promote understanding and inquiry skills of science, this study uses science books as a tool to approach scientific literacy. Allowing children to choose their own research topic (their favorite animals' sounds), this study intended to promote children's motivation and interest in the inquiry process.

Children were provided with science books embodying scientific concepts, stories, and pictures of sound. The books were chosen by teachers and researcher in consideration of the curriculum, learners' levels and interests and quality of contents. Through using science books, this study attempted to embracing children's everyday life experiences and their curiosity and interest in sound in science classrooms.

IV. Research Process

The study was conducted in a public elementary school in Edmonton, Canada. Among twenty one second graders in one class, a group of four children was main participants in this study. Children were engaged in learning about sound in science classes for six weeks. To provide children with opportunities of talking, reading, and writing about their understandings of sound, the classroom teacher and researcher scheduled the following topics and activities which could encourage children to bring their experiences, discussion, and reflection.

In Period One, the study was focused on finding children's previous knowledge and experience of sound through children's science talks. To promote

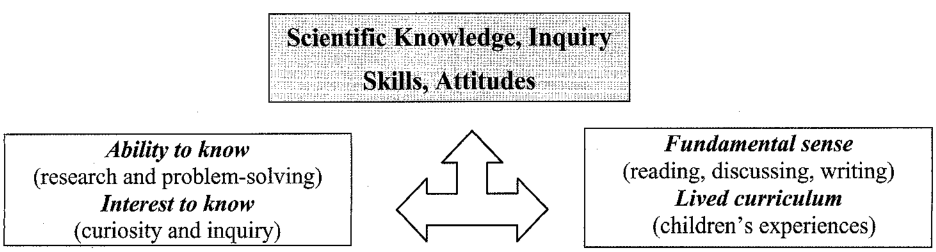


Fig. 1 *The framework of scientific literacy for K-6*

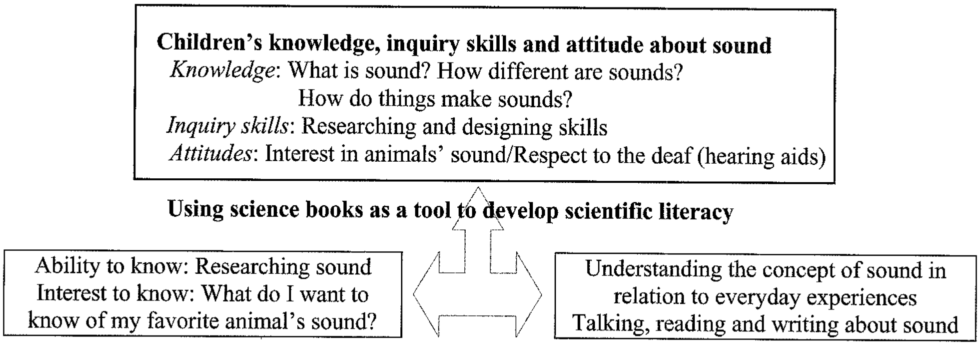


Fig. 2 *The framework of the study*

Table 2
The topics of children's learning

Period	Scientific literacy	Topics	Class activities
1	The concept of sound	- What is sound? - What makes sound?	Science talk Writing /drawing
2	Interest to know	- How does sound travel? - How do animals make and hear sounds?	Watching films of animals/ Reading/Researching/ Making a report
3	- Practice of sound - Connection to everyday	- How do musical instruments make low and high sound?	Watching a concert Dialoging with musicians
		- How is sound related to everyday life issues?	Talking/ Discussing / Drawing
4	Ability to know	How can I make a sound maker to mimic my favorite animals' sound?	Designing a sound maker

the knowledge of sound and vibration, this period investigated the nature of sound and relationship among sound, sound source, and air vibration. At this point, science books were introduced to children with the stories of sound such as different kinds of sounds, sound & materials, animals and so on. The total number of science books was 36 and all of them contained different content. There was no limit or restriction for children to obtain access to any books in spite of the different levels and depth of the content in order to take into consideration children's various interest and levels of understanding.

In Period Two, the teacher used science books to help children interested in sound, focusing on inquiry and research skills through reading and writing. Children were asked to choose their favorite animals and make a report on animal sounds. In this period, children also watched video clips of those animals' behaviors and sounds in wild life environments. After watching the video clips, children were given science books and chose which animals they would like to research. Children decided which animal they wanted to research and make a report on.

In Period Three, the study focused on appreciation and application of science. Children were trying to find the implication of scientific knowledge in life contexts. This attempt was developed through using science story books which have human values and implication of scientific and technological knowledge to improve human life. For instance, a story of a deaf girl and hearing aid was provided to children. During this period, a local musician group visited the class to help children learn different sounds from different instruments; the strings, woodwinds, brass, and percussion.

In Period Four, children were asked to design a sound maker to mimic their favorite animals' sound. This activity was given after musicians' visit. They designed a sound maker and came up with materials they would need. Then children prepared the materials and made sound makers according to their designs. This activity was to help children bring forth what they had learned throughout their previous lessons.

V. Findings

1. Science Learning Connected to Everyday Experiences

Children bring their own experiences in science talks and writings of science. Story books of sound were provided to children before the first lesson and children partially read them. One part of the story was chosen and read by teachers in the introduction of lesson. As they understood the concept of sound reading story books of sound, children reflected their previous experiences related to sound. Children's perceptions of sound were related to their bodily and home-based experiences. They elaborated their experiences with guitar strings, voice, throat and ears. When children started talking about the vibration of sound in a group discussion, the researcher asked how they understood vibration.

Kelly: Every sound makes vibrations.
Mijung (Interviewer): How do you know it makes vibrations?
Don: I could see an elastic band vibrating like this (pointing at a picture on the book) when I plunked it at home.
Clara: Yes, I've seen it too.
Don: I have played the guitar and the strings made vibrations too.
Mijung: You can see the elastic band and the strings vibrating but how do you know your voice makes vibrations? You can't see your voice's vibration.
Don: Ummm…. I know it is vibrating because….I can touch my throat when I am talking like this, "ahhhhhhh…" I can feel my throat vibrating.
Kelly: Ya, when my little brother whispers right into my ear, it tickles. It's itchy. That's vibration.

Gallas (1995) indicates that science talks develop co-constructing knowledge and theories among children. During science talks, children's individual ideas are shared and children expand their understandings to indirect experiences, that is, others' experiences and stories. Furthermore, they co-construct the understandings of new knowledge. In this study, through sharing their familiar experiences, children verified their understandings of vibration with each other. In this verified proposition, children understood that sound is/makes vibration and voice vibrates. They developed reasoning, explanations, and theorizing scientific phenomena of sound.

Using science books was used as a tool to provide new information and knowledge and broaden children's talks and understandings of sound beyond their own experiences. Children discussed the structure of ear, eardrum, and hearing disabilities reading 'human hearings' in the books.

Kelly: my grandpa is wearing one of those.
Cory: Angelica (a deaf girl) is little. But she got a high fever when she was a baby so she lost her hearing, right?
Kelly: yes, she got sick in her eardrum (she is pointing the picture of eardrum).
Cory: I had never seen this picture. Oh, this is the eardrum.
Don: I have seen it before, that makes us hear sound.
Kelly, Cory: Ya, I know.
…
Don: Look! Here, this makes vibration so that the deaf can hear sounds. Good!
Cory: It (science) really helps people.

Children understood how we hear sound and how science and technology of sound could help the deaf hear by inventing hearing aid. Children mentioned the roles of science and technology could be used to improve human life. In this case, children's science talks could open opportunities to consider science in terms of human life experiences and its implications.

Children's science talks occasionally took place as reading together the stories and drawings and pictures of sound in science books provided. This tendency indicates science books could broaden children's understandings of scientific phenomena in relation to their as well as others' experiences, feelings and emotions, and lifeworld situations.

2. Writing in science learning

Science books encouraged children promote children's writings for reflection and research giving them new ideas and imaginations. They read books and wrote their reflection or tried to find answers to their questions. As well as the opportunities of talking out loud, expressive writing in science is important for children's understanding, meaning making, and expressing ideas of science (Hand & Prain, 2003; Wheatley, 1991). This activity is critical to develop children's self-examination of their own understandings and for teachers to understand children's knowledge construction and pedagogical scaffolding strategies (Hand & Keys, 1999). Writing in science learning can help students make connections between their concepts, think deeply, and facilitate conceptual change (Keys, 1999). Keys (1999) continues to emphasize that,

> Writing in scientific genres promotes the production of new knowledge by creating a unique reflective environment for learners engaged in scientific investigations… Writing can provide opportunities for understanding the relationship of evidence to knowledge claims, and the tentative nature of the scientific enterprise… provides the opportunity for in-depth scientific thinking and will promote the crystallization of new understandings. (p. 117-119)

Rennie & Jarvis (1995) noted that drawing and writing was useful to collaboratively develop children's understandings in their study of children's drawing and writing. In this study, the combination of drawing and writing was implicated to help the children learn to organize, construct, and express their understandings of how sound occurs and how it travels. Children articulated their understandings of sound through drawing and writing. Children used the terms of vibration, molecules, energy and sound waves to articulate sound travel. These terms were discussed in classroom and group discussions to scaffold their understandings and were continually used in further activities.

Children's usage of scientific terms was developed and became more sophisticated over time. The following work, Fig. 3 is their early work in the beginning of the study. Their work contains their ideas of sound based on their everyday places, materials, and experiences such as the lunch room, home, pets, cars, clocks, and so forth. This tendency indicates their expressions were based on rather direct, material, and concrete experiences.

In later children's work, children's ideas were expanded to abstract scopes of sound (see Fig. 4). They started to elaborate scientific terms such as vibration, molecules, sound waves, and energy. To enhance their usage of terms from scientific noises (which are simply mimicking sound from teachers, books, and other references) to meaning understanding,

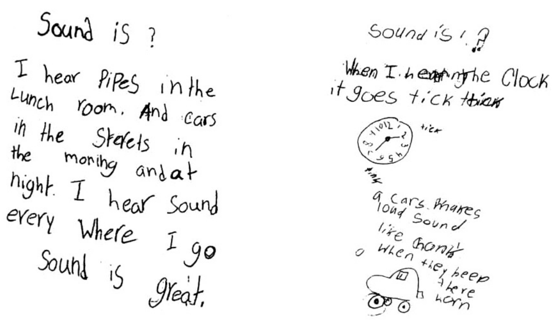


Fig. 3 *Samples of children's early work*

2.1 Don's drawing 2.1 Cory's drawing 2.1 Kelly's drawing

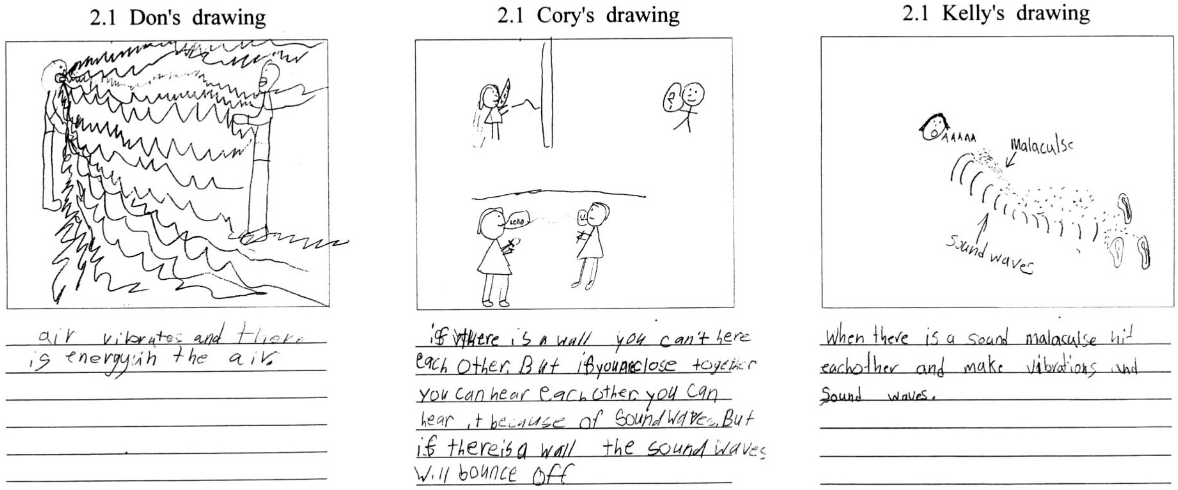


Fig. 4 *Children's work in the second period*

teacher and researcher questioned, explained and read books together.

Science talks and writing. They were also occasionally exposed to knowledge and terms during book reading. The meanings of the terms were followed by teachers' on-going instructions throughout lessons.

Compare to their beginning work, the children's explanations in later work included more scientific terminologies. They articulated a sophisticated scope of explanation with some understanding of energy transformation, sound waves, and molecules as medium in sound travel. Their writings also showed the levels of children's understandings varied and science books were useful to provide them various contents considering the levels of children's understanding and interest.

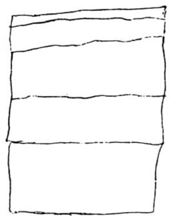
3. Children' s Inquiry and Research Skills

Reading, interpreting, and analyzing abilities are rudimentary for the potential of young children's inquiry and research skills. When they were asked to write up a report, they read the science books to search for appropriate information to make a report on their favorite animals' sounds (see Table 3 and 4). They circulated the books voluntarily and found the answers to questions on research exercise sheets. In this activity, children became a researcher and designer to find out how animals make, hear, and use sounds and later designed an instrument to imitate animals' sounds. They chose their favorite animals and researched their sounds. They searched answers, collected considerable information. The designing activity was conducted a few lessons later. That was

Table 3
Summary of children's reporting on animal hearing and sounds

	Don	Cory	Kelly	Clara
Animals	Hyena	wolf	Great horned owl	Dolphin
…Have ears?	yes	yes	yes	yes
What shapes of the ear?	Triangular circular	Pointed ears	Triangular with pointed top	Tiny slits
What does this animal hear?	They have big ears.	Sharp ears helps wolves hear prey. They prick up their ears so they can hear sound.	They lift the flaps that cover their ears that help them find where the sound is coming from. The owl can pinpoint the sound by moving its head and the flaps on its ears until the sound is the same in both ears.	Echo They make clicking and ticking noise and listen to the echoes.
What is the range of hearing for this animal?		Up to 30,000 Hertz	Very good	Up to 170,000 Hertz, They hear the highest sound.
How does this compare to human hearing?	They can hear things human cannot hear	Dogs can hear higher than humans	Hoot, whistle, wheeze, whimper, trill, moan, Baby owls make chirping or hissing sound to let the parents know they are hungry or cold	They can hear echoes in the water. They can hear sound human cannot hear.
How does this animal use sound to communicate?	They can whine or snarl. They sniff others or they can hold their body in a way to show who is boss by raising their hair.	Ahooooooo, Ahooooooo, howling to warn the pack	-What sounds does your animal need to hear to survive or protect itself? Whimper, bark, howl	Clicks, ticking, squeaks, whines -Does your animal substitute hearing for some other sense? The lower jaws

Table 4
Design of sound makers to mimic animals' sound

	Don	Cory	Kelly	Clara
Describe your project	I am making an instrument made to sound like a shining hyena.	This is to who how wolves sound. I am going to blow in to this thing and make low and high sounds.	It is a glass jar put different of water in it, then blow in the jar to make the sound hooh hooh.	You need a balloon then blow up. Then stretch it out and it will make a squeaking sound like a dolphin.
Material needed	Fishing wires, one elastic and a box	Cardboard and a little piece of wood or cork, tape, drinking straw, tracing paper, pencil, scissors	Glass jars, water	balloons
Your design (a reduced size from the original)				

because that activity would be done better after musicians' visit. After experiencing different sounds from different instruments, children attempted to design a sound maker to produce their animals' sounds. They recalled the dialogues with the musicians and watched videotapes of animals. They asked for help from the teachers and researchers; however, the children were mainly guided to collect information from books and children were capable to conduct their research utilizing various resources. Science books provided multilayered experiences of the process of fundamental scientific literacy for the children to learn the concept of sound and brought ideas which were beyond the children's own experiences, but grounded within the children's interests and classroom topics.

Though using science books over weeks, the study attempted to improve children's skills of researching and utilizing information. In the designing process, children combined their knowledge of what makes sound and how things make different sounds. They indicated their understandings of high and low sounds and vibrations of the strings and tubes that they learned from the musician's visit.

VI. Discussion

Considering the domains of scientific literacy-concept (knowing and understanding), process (exploring and discovering), creativity (imagining and creating), affective-ness (feeling and valuing), application & connections (using and applying), and world view (viewing science and its history as human enterprise), this study attempted to raise several issues of scientific literacy and teaching strategies in elementary science classrooms. Using science books as a tool to cultivate the interconnection of science and children's lifeworld, this study suggests the following discussion.

Firstly, science books open up opportunities for children to connect scientific knowledge and lifeworld experiences. This connection is a critical aspect of K-6 scientific literacy to bring forth scientific knowledge in life contexts. As children's learning is interconnected to their everyday experiences, it is crucial to provide the opportunities to bring children's stories, lived experiences and feelings attached in science learning. Science books embracing familiar and interesting stories of scientific phenomena evoked and encouraged children to recall, share, and relate their own experiences to what they were reading and learning. Children were also encouraged to imagine and question beyond their own experiences. For instance, children brought other's experiences and stories to learn about hearing abilities and the role of science and technological implications in human lives.

Secondly, using science books can promote young children's scientific literacy to be more integrated with a fundamental sense and interrelated knowledge of science with the lifeworld. This study showed science books were used to promote various activities to learn the concept of sound and inquiry process and to promote fundamental skills of scientific literacy. Through various activities of talking, reading, and writing around sound topics, children's skills to interpret and express scientific ideas among peers were promoted and this could improve children's scientific literacy as both fundamental sense and development of knowledge, inquiry, and social aspects of science. When elementary science education aims to teach science as integrated life subject, using science books can be an interdisciplinary approach to provide children with opportunities of connecting their experiences (lived curriculum), relating to others' lives (social aspects of knowledge), interpreting/expressing and inquiring/researching.

Thirdly, science books can be a guide for individuals to pursue further levels of scientific literacy in terms of understandings and interests in scientific phenomena. For example, a child was curious about Hertz while researching animal hearing. Teachers provided the child with books with the explanation of Hertz and also discussed with other children to introduce the meaning of it. There are limited conditions in class that teachers can address information and skills as much as children want and need. Moreover, it is difficult to deal with different degrees of developmental stage and interest of each individual. Supporting children with various science books can be a way to overcome the limitation of class situations.

To make using science books effective in classrooms, thorough preparation and an investigation of the appropriate levels of books for learners is needed. That is, teachers are required to pay attention to what levels of learners' reading skills are, whether the content of science is correctly presented in books, whether books are organized to attract readers, and how feasible books are for teachers to use in classrooms. This need requires teachers to scrutinize the relevance of books to science curriculum, the content and organization of books, and economical aspects. In addition to this preparation, teachers also need to look for effective ways of using science books with teachers' scaffolding and guidance.

VII. Conclusion

As the discourse of scientific literacy has been discussed in science education broadly, this study attempted to examine the goals and practice of scientific literacy at the K-6 level. With concern of disconnected science to lifeworld contexts, this study proposed that K-6 scientific literacy needs to be concerned with making connections between science and children's everyday lives. When children understand science as disconnected school subject from their own lives, their science knowledge is likely neither practical nor accessible in real life situations: this is not a desirable situation in objectives of scientific literacy as responsible and citizenry knowledge. Taking into account children's lived experiences, elementary science teaching also needs to develop fundamental skills of understanding, i.e., reading and interpreting science texts. These two aspects - everyday connection and fundamental sense of scientific knowledge - need to be cooperatively emerged in elementary science teaching.

This study suggests that using science books can be a feasible tool to promote scientific literacy which is concerned of the connection of lifeworld and participation of scientific knowledge. Creating a place for science stories, lived experiences, and new information, science books invited children to learn reading, writing, researching and designing of science. This way of learning is critical for elementary students to develop their knowing and inquiring skills of science. Teaching along with concepts of science, examining how to heuristically access, learn, and understand knowledge is also crucial in the development of K-6 scientific literacy. Hopefully, this study will be seen as one example of these exertions which look for feasible ways of cultivating connected and practical scientific literacy at the elementary level.

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