The Asia-Pacific Education Researcher 21:1 (2012), pp. 63-70

Locality-Based Science Education in Sociocultural Approach: 'Scientific Exploration in Culture' in the Context of Korea

Sungmin Im*, Sung-Jae Pak
Daegu University, South Korea
*ismphs@daegu.ac.kr

Numerous recent studies have attempted to highlight sociocultural aspects of science and education in research and educational practice. Despite widespread awareness that sociocultural aspects should be reflected in teaching science, it is still difficult to implement appropriately in everyday school situations. This perhaps highlights the issues of putting theoretical exploration into practice, where students are expected to learn science through a sociocultural lens. In this study, the authors introduce and discuss a practical approach in teaching science, focused on a Korean sociocultural context called 'Scientific Exploration in Culture (SEC)'. This concept is similar to the practical notion of a field trip where students get to learn through interactivity with the subject matter. In this case, SEC deliberately focuses on sociocultural aspects of science, in addition to focusing on scientific inquiry enacted at places that have historical heritage. For a decade this program has been employed by Korean teachers as an alternative activity to field trips, special curriculum of school science, and informal science education program. Although there are numerous studies and feedback from practitioners on the topic of inquiry-based teaching and its effectiveness, there is relatively little academic discussion on connections to sociocultural theory. In this paper the authors provide more details of this program and discuss their work in terms of a locality-based science education with a sociocultural perspective.

Keywords: scientific exploration, sociocultural, locality, place, field trip, cultural context, informal science education

Since learning in "real world" situation or "out-of-school" settings has been one of emerging issues in field of the learning science (Kolodner, 1991), informal science education is rapidly getting attention both in the practice and theory of science education. Although extensive literature addresses informal science education, predominant is educational potential that associated with museums and science centers (Jarman, 2005). However, much work is needed to support theoretical foundation and its implementation in actual educational settings (DeWitt & Storksdieck, 2008).

On the other hand, various approaches have been employed to highlight sociocultural aspects of science education, in research and practice (Lemke, 2001). More and more science education literature recognizes the need for science education to develop culturally sensitive curriculum with sociocultural perspectives (Im, 2005). Critical, historical, political, and socioecological views with post-modern and feminist thinking have been part of enlightened science education discourse (Wong, 2001). Significant literatures in science education with sociocultural perspective can be reviewed in the area of science studies, cultural diversity, and sustainability (Carter, 2007). Attempts have been made to improve science curriculum and instruction by focusing on sociocultural aspect of science and science education (Pak, 2001).

However, the majority of studies utilizing a sociocultural approach are generally Eurocentric. Relatively few studies have been conducted from a non-Eurocentric sociocultural perspective or context. Especially little has been studied of informal learning with sociocultural perspectives in actual educational settings of Asia.

In this paper the authors address the scientific field trip activity, so called "Scientific Exploration in Culture (SEC)" in the context of Korea, focusing on sociocultural aspects of the place where learning happens. In the light of informal

learning in sociocultural context, this study focuses on the following aspects to discuss.

Firstly, the authors reviewed the theoretical background of SEC from a sociocultural perspective. This includes the discussion of locality and place-based education, and also suggesting a new term; "locality-based education."

Secondly, the authors introduce the main features of SEC with some examples from a Korean context, and review related research findings.

Finally, we discuss the significances of SEC on science education with its sociocultural lens.

LOCALITY AND SOCIOCULTURAL PERSPECTIVES ON SCIENCE EDUCATION

General universality and sociocultural locality

Knowledge and learning are dominantly represented in science curricula, as fragmented bodies of canonical knowledge to seek universally applicable objective truth. This approach is mainly derived from highly abstract and fragmented statements of Western science. However, science and science education do not take place in a cultural vacuum, but rather within a geographical, historical and social context (Pak, 2001). Science education should be presented chronotopically at a specific localized site and a specific time in a sociocultural background, shared by practitioners of education. In this view, science education inevitably has "sociocultural locality" while science itself seems to be oriented toward "general universality."

This should not be confused with a dichotomy like indigenous knowledge verses science in colonial discourse with its subtext of "winners and losers" (Aikenhead & Ogawa, 2007). Many science educators admit that Eurocentric science possesses a powerful way of knowing about nature and has greatly influenced professional science and education, including that of non-European cultures such as Asian. And many agree that school science education should reveal the virtues of rationality, openness, and reasoning based on evidence, etc., which is oriented toward universality. The point of this argument is not to deny the universality of science, but to examine universalism in order to see if there are other effective ways of understanding nature.

All activities in science are implemented collectively by people, within a subculture that frame their thinking and practice (Traweek, 1992), whether it be a professional scientist or student, and whether it can be conducted in Eurocentric or non-Eurocentric countries. It is generally accepted that most scientists' subculture is Eurocentric in nature regardless of their geographic location (Aikenhead & Ogawa, 2007). In case of school science, sociocultural locality is a more important feature because most students have their own subcultures, different to those of scientists and affected by local environment and time. An increasing number of science education literature suggests the sociocultural influence on science achievement by students whose cultures and languages differ from the predominant Eurocentric culture and language of science. However, many aspects of school science are more oriented to seek universality and do not fully consider locality. The so-called "normative canonical knowledge and skills" have dominated the agenda of school science (Carter, 2007). This inevitably results in limitation or cultural gap between school science and students, which is often considered as one reason in ineffective science education. Though many studies on effective science teaching are focused on bridging this gap, very often they are confused with student-friendly or context-based approach (Gunston, 2001). However, student-friendly or context-based approach would be limited if it does not fully consider the chronotopical aspect of learning and teaching science in context of 'here and now' where real learning and teaching occurs.

Place-based and locality-based education

An alternative approach in consideration of the locality of science education to bridge the gap would be a place-based education, where local settings become the integrating element in students' education (van Eijck & Roth, 2010). Place-based education is often associated with typical natural scientific aspects of the outdoors, that is, environmental education or ecological place-based education. In critical pedagogy approach, the notion of place is presented as "a complicated amalgam" that involves social, cultural, and political aspects (Lim & Barton, 2006), and place is replaced with the "sense of place". However, van Eijck and Roth (2010) reconceptualized place as a chronotope, that is, as "a lived entity that results from a transaction between the forms of narratives available in, and constitutive of a community and its material environment".

Thus, the notion of place can be a sociocultural construct, rather than a universalized abstract space. The authors want to suggest the notion of "locality" and "locality-based" rather than "place-based" in order to avoid scholarly debate about the notion of place, but focus on specific location itself, where learning and teaching in science has occurred. A specific place can be localized geographically and culturally. Locality-based education adopts an educational approach that utilizes the geography and culture of that location, such as a historical site, as a resource for learning and a venue where learning is occurring in an out-of school context. Accordingly, the notion of locality in science education can also imply the sociocultural aspect of science learning.

The authors here have adopted a sociocultural perspective that treats science and science education as human practices rather than as universal ways of knowing. This approach has a stance that learning and teaching in science are socio-cultural activities deeply based on locality, while science itself seems to be based on or oriented towards universality. In particular, cultural places including those with historical heritage, natural environment, and industrial

(a) (b)

(a) Hwaseong Fortress (at Suwon, 18c, UNESCO World Heritage) is an outstanding example of early modern military architecture, incorporating the most highly developed features of that science from both east and west.
(b) Changdeokgung Palace Complex (at Seoul, 15c, UNESCO World Heritage) is an outstanding example of Far Eastern palace architecture and garden design, exceptional for the way in which the buildings are integrated into and harmonize, with the natural setting, adapting to the topography and retaining indigenous tree cover.

Figure 1. UNESCO world heritages as scientific exploration in culture sites (http://www.unesco.or.kr/heritage)

complexes, can be a good location where authentic learning can occur. Thus sociocultural theory helps us to acquire a new epistemology of knowing and knowledge in science education in context of culture, from objectified knowledge in school to subjective knowing in cultural sites as a living entity.

FEATURES OF SCIENTIFIC EXPLORATION IN CULTURE

Brief history of Scientific Exploration in Culture

Scientific Exploration in Culture was originally suggested and developed by a group of science educators, led by one of the authors as a main program in the first Asia-Pacific Economic Cooperation (APEC) Youth Science Festival held in 1998 in Korea with over 500 student participants from 12 APEC member countries (Pak, 2004). Science educators participating in the development of program, had inquired for more original and creative activity only possible in the context of Korea. By that time, the developing members came to know that Hwaseong Fortress and Changdeokgung Palace had been newly designated as UNESCO World Cultural Heritages and one of the reasons of designation was its "scientific" value (cf. Figure 1). These two sites are common places for school trips, or tourists. However, it appears that even science educators had not considered their scientific values. This fact was the inspiration for idea of scientific inquiry in the context of Korean historical sites. After a series of research and development procedures for over a year, "Scientific Exploration in Korean History" was settled as a main program of APEC Youth Science Festival. This program served as a scientific inquiry, and also as a cultural trip for foreign participants, which had been held in four different Korean historical sites such as, Changdeokgung Palace, Icheon Old Ceramic Art Village, Cheongju Old Printing Museum and Korean Folk Village. It had drawn much attraction and positive feedback from most participants.

Since then for over a decade, this program has been extended to "Scientific Exploration in Culture (SEC)' as it includes modern industrial and environmental sites, as well as many other historical sites. SEC has been spread among teachers and educators in Korea, as an alternative program of field trip, special curriculum of school science, and informal science education program. And also it has led to several research articles and many instructional materials, as well as a favorite professional development program for in-service science teachers.

Procedure: An illustration of SEC at Changdeokgung Palace

Scientific Exploration in Culture can be practiced by following an instructional model with 4 phases; introduction, exploration, discovery and appreciation. In this section we will illustrate the detailed procedures of SEC, according to these instructional phases with a case of Changdeokgung palace.

(1) Introduction: From motivation to afford narrative

During the introduction phase, instructors briefly introduce scientific, social, historic, and cultural background of the site, while overall orientation of the site can be

(a) (b)

(a) Demonstration and hands-on experiments are often utilized to invite participants into inquiry.
(b) An instructor shows the structure and principle of "Gongpo" using simple stationary items.

Figure 2. Examples of exploration phase in SEC.

provided to participants before the visit. Introduction phase is important because it can induce interest and positive atmosphere for inquiry. Because SEC is an activity in an informal educational setting, the participants' interests and motivation are more critical than that in a formal setting. Often an instructor starts the introduction with interesting history or popular TV drama related to the site. In case of Changdeokgung Palace, because of its history as the most beloved palace through Korean history, there are plenty of "stories" to introduce the palace. As such, it is a location that can afford narratives to instructors and participants (Kim & Kim, 2002). Using narrative in educational setting is important for it can contribute to enhance imagination, self-identity, and interactive learning community (Lee, 2004).

(2) Exploration: Making room to engage inquiry

During the exploration phase, participants are invited to explore scientific and sociocultural aspects of the site by listening, questioning, and reasoning. Each exploration phase usually takes 10 minutes following a brief introduction. In the case of Changdeokgung Palace there are at least 10 explicit inquiry topics according to each site: Structure and function of "Gongpo[1]" in main gate, stability of royal stone bridge, observation and illusion shown in two-tier roof design, reflection effect of sound and light in ceremonial building, science of "Ondol[2]" heating system, palace design using micro-climate, relation between the shape of eaves and latitude, ecosystem in royal pond, principle of sundial and local time, measurement standards and everyday life, etc. For example, to explain some feature of the "Ondol" structure, an instructor can encourage participants to demonstrate the principle of Bernoulli with just a sheet of paper.

In an open inquiry within sociocultural settings, most exploratory questions have no explicit answers. However, the exploration phase can make room for the participants to engage in scientific and/or sociocultural inquiry through questioning and discussion.

(3) Discovery: Authentic inquiry in the context of lived experiences

In the discovery phase, students look for tentative answers to questions and explain their reasoning, if needed, including designing experiments and investigations about their ideas. Sometimes it can be done as an advanced inquiry on site or as a post-visit activity at school or home. Instructors can design a SEC program in consideration of how to utilize the discovery phase in field or at school. The characteristics of discovery phase depend on the differentiated nature of inquiry, which can be divided as basic, convergent, and divergent inquiry. In this phase, participants are encouraged to utilize a variety of devices and materials to support their idea empirically. Microcomputer-based laboratory (MBL), using laptop computers and sensors, is often recommended to collect and analyze data during SEC. For example, measuring continuous varying temperature by time, at certain locations, or analyzing sound reflected by corridor of ceremonial hall, can be effectively done using MBL. Where possible, using real objects on site is effective, but sometimes models can be used to explore scientific aspects if real objects are prohibited to touch for protection. Such a kind of empirical approach is important, as this approach can reveal the nature of an authentic scientific inquiry, in the context of lived experiences and socio-historical settings, not just confined to a classroom or laboratory isolated from everyday life.

(4) Appreciation: Discursive participation in sociocultural context

Lastly, during appreciation phase, students present their ideas about SEC, including inquiry topics or cultural features, in order to discuss with other participants. Although this phase can be a finishing step during the visit it can also be followed by in-depth inquiry after the visit. In general, SEC gives plenty of discussion issues and offers more chances to present one's idea about not only scientific, but also various sociocultural aspects.

Affective domain of SEC as educational practice can be well revealed in this appreciation phase, but it can also offer possibilities of discursive participation. Students' discursive participation as a positive sign of learning has increasing concerns in science education literatures, especially from sociocultural (Vygotsky, 1978) and historical perspectives (Lave & Wenger, 1991). In appreciation phase, participants can be explicitly involved in a discursive activity. Moreover, this discursive participation is based on both scientific and sociocultural background.

RESEARCH FINDINGS ON SCIENTIFIC EXPLORATION IN CULTURE

Since its development in 1998, many descriptive writings have introduced SEC, but relatively little has been studied on its efficacy. SEC has not only been suggested as a well-constructed strategy but has evolved to be applied to various educational contexts. The educators who initiated SEC have put more focus on long-term qualitative and practical feedback rather than statistical and short-term responses in a certain context. However, we can induce its educational significances on science education from several analytic researches on SEC.

Scientific inquiry

Some researchers have described the educational significance of SEC as an inquiry. For example, Lee (1998) insisted that SEC could develop students' inquiry skills, as well as perception of relationship between science and everyday life. Lee (1999) described secondary students' engagement in SEC at Yeongreung as an open inquiry, for it could offer a kind of open question that has no explicit answers, and students should make their own questions to explore by themselves. Park (2000), concluded that SEC could be designed to improve students' "diverse" inquiry skills, which include open conclusions that has room for further investigations.

Affective engagement

Other researchers have focused on more diverse aspects of SEC, including students' affective engagement. For example, Yoon (1999) focused on SEC's informal learning environment and suggested, that this informal setting can help to raise students' volition and inquiry motivation during scientific activity. Pak (1998) added that its effects on science education can be similar to merit like enjoyment, such as out-of-school activity. Choi and Pak (2004) examined ninth grade students' scientific perspectives on historical heritage through SEC at Hwaseong fortress. They investigated changes in students' perspectives after the SEC program, and found that most students showed positive changes in their perspectives in that they could recognize the proper criteria for scientific excellence, and the influence of science and technology of that age on society.

Educational values

According to analysis of 97 teacher responses in a professional development study on SEC (Oh, Jo, Park, & Pak, 1999), teachers recognized that SEC has educational values in teaching science, such as helping to understand Korean culture, acquire investigative processing skills, experiencing divergent investigations and cooperative learning, enhancing integrated thinking skills in science and other subjects, and helping to learn contents related to science curriculum. In particular, teachers pointed out that SEC also had advantages of caring for students.

Teachers' feedback and follow-up development

Many teachers have pointed out the difficulty of management due to lack of teaching materials (Oh et al., 1999). For example, such research has resulted in the following development: Seoul Metropolitan and Gyeonggido Province, the biggest provincial governments in South Korea, developed a series of teacher's resources for SEC to utilize its own cultural historical sites as venues for science education (cf. Korea Science Foundation [KSF], 2007; Gyeonggi Provincial Office of Education, 2008; Seoul Metropolitan Office of Education, 2009).

SIGNIFICANCE OF SCIENTIFIC EXPLORATION IN CULTURE

Scientific Exploration in Culture can be utilized as a special adaptation for out-of-school visits at various sociocultural sites so long as it takes the format of a field trip. School field trips in science education are a well known instructional strategy, especially in many Western K-12 education systems where they enhance students' cognitive learning outcomes (Nielsen, Nashon, & Anderson, 2009; Falk, 2004). However, few studies have to date reflected on sociocultural aspects (e.g., Adams, 2007) and even less from an Asian perspective (Kang, Anderson, & Wu, 2010). Here we briefly reviewed the value of SEC, as an instructional strategy or sociocultural pedagogy by focusing on its locality and sociocultural context. Each review was backed up with various participants' voices excerpted from previous articles.

An effective strategy for scientific inquiry within sociocultural aspects of science

During SEC, students can 'explore' various levels of scientific inquiry because it offers convergent and divergent inquiry skills (Park, 2000). Students can observe and appreciate real aspects of their sociocultural heritage, as a lived entity, which might induce intrinsic curiosity and questions (Yoon, 1999). Following excerpts indicate students' and teachers' responses about inquiry in SEC.

> *At the start, we had nothing to refer, so it was very hard for us to even know how to start this inquiry. …. But it was a 'real' inquiry! (Student participant: KSF, 2007)*

> *I was personally astonished to find students' inquiry skill during SEC, which was unexpected in school settings. (Teacher: KSF, 2007)*

SEC does not only seek the value of authentic inquiry, but also focuses purposefully on sociocultural aspects of science so as to foster the understanding of the nature of science and the relationship between STS (science, technology and society) and the history and philosophy of science (Choi & Pak, 2004).

A sociocultural pedagogy connecting formal and informal education setting

By using a regional site as a resource for science education, we can bridge the gap between science and students. This can be achieved by highlighting the fact that science is a culture enacted in the context of society and history, thus requiring a more holistic view so as to overcome the limitation of school science. This approach can also expand the concept of learning in science across formal and informal settings, so as to provide insights into approaches for the innovation of science education, and to expand the concept of place, where learning takes place to informal cultural places as well as formal institutes.

As an outdoor activity SEC enables students to have the time, or face-to-face experience to make sense of the students' culture, and see their culture in terms of capital. Through creating culturally adaptive ways of transacting, teachers can provide opportunities for their students to generate positive emotional energy, and group solidarity in the learning of science at an informal setting (Lebak, 2007). With all these positive aspects of informal science education setting, SEC as a purposefully designed inquiry activity, links with formal school science as shown in below excerpt.

> *Important feature of SEC is not only scientific inquiry, but also sociocultural aspect to relate science with everyday life of participants… (Developer: Yoo, 2004)*

> *Our effort to make 'learning science in everywhere', to connect formal and informal education, could it contribute on educational innovation that needed in the future? (Developer: Pak, 2004)*

An alternative view about learning and teaching science based on locality.

From a sociocultural perspective, "we can know nature only through culturally constituted conceptual or epistemological frameworks, enabled and limited by local cultural features such as discursive practices, institutional structures, interests, values, cultural norms, and so on" (Turnbull, 2000). It is therefore imperative to develop culturally sensitive and sociocultural perspectives, beyond the normative canonical knowledge and skills that have traditionally dominated its agenda. SEC can offer students tools to personally face "a world" and experience or inquire about "a science" embedded in their inherited culture (Choi, 1999). Through this authentic inquiry embedded in SEC, students can understand nature and the world surrounding them, appreciate joy of knowing, develop intellectual ability or inquiry skills, and foster intellectual patience (Pak, 1998). The following excerpts show participants' views on learning through SEC.

> *I had thought that inquiry was hard, boring and in the classroom only, but through this exploration course I realized it was a very natural process that is surrounding me. (Student: KSF, 2007)*

> *This kind of activity is unique, in that it uses historical and cultural things as scientific inquiry. And also its openness is very impressive and helpful both to students and teachers. (Teacher: KSF, 2007)*

By reconceptualization of place chronotopically as a lived entity (van Eijck & Roth, 2010), SEC at a sociocultural sites can make students not only inquiry about its scientific aspects, but also share inherited culture embedded in the place. We can find indigenous or localized knowledge as valuable in many "local" sociocultural sites, like in the case of SEC in the context of Korea.

DISCUSSION

Although there are numerous studies outlining feedback from practitioners on the topic of inquiry-based teaching in the sociocultural context, there is relatively little academic discussion on connections to sociocultural theory. According to its historical background, SEC was suggested as a kind of inquiry-based outdoor activity. When SEC had been developed as a special program for APEC Youth Science Festival, science educators who were involved in this program had not fully considered its inherited significance from a sociocultural perspective. However, it is certain that SEC has provoked follow-up efforts to design more effective ways of teaching science in the context of culture and has

ignited academic discourse from a sociocultural perspective in science education, at least, in Korea. For example, the International Conference of Physics Education, organized by International Union of Pure and Applied Physics held in 2001, adopted the theme of "Physics Education in Cultural Context", where most research presentations and workshops were focused on cultural aspects of physics in education (Park, 2004). At present, many informal science education programs, including SEC, have been practiced by teachers or organizations in Korea, which is another sign that SEC has stimulated approaches in science education.

However, there are still few academic discourses about learning and teaching in science with sociocultural theory or perspectives in the context of Asian countries. Accordingly, it is hard to find studies that reconceptualize the meaning of science learning and teaching, as a cultural enactment in the context of Asia. Although "here and now" seem to hardly matter in science education as Lim and Barton (2006) criticized, bridging "there and then" to "here and now" seemed to be a crucial aspect of learning, especially science learning for where many students feel some cultural gap. Taking this in to account, SEC has the potential to ignite another discourse about learning, for it can break down the distinction between "there and then" and "here and now" by insisting on a slogan such as "learning science in everywhere". In addition, it concretely suggests an inclusive approach "across formal and informal setting", which can induce another research agenda for learning science in the context of locality-based education.

NOTES

[1] A kind of traditional structural artifact to bridge the gap between the roof and pillars.

[2] Ondol, also called gudeul, in Korean traditional architecture, is underfloor heating which uses direct heat transfer from wood smoke to the underside of a thick masonry floor. (by Wikipedia)

REFERENCE

Adams, J. (2007). The historical context of science and education at the American Museum of Natural History. *Cultural Studies of Science Education, 2*, 393-440.

Aikenhead, G. S., & Ogawa, M. (2007). Indigenous knowledge and science revisited. *Cultural Studies of Science Education, 2,* 539-620.

Carter, L. (2007). Sociocultural influences on science education: Innovation for contemporary times. *Science Education, 92*, 165-181.

Choi, J. (1999). *Instruction for scientific perspectives on cultural assets through scientific exploration at Hwaseong fortress* (A master thesis). Seoul National University, South Korea.

Choi, J., & Pak, S.-J. (2004). The development of students' scientific perspectives on historical heritages through the science field trip of Hwaseong fortress. *Journal of the Korean Association for Science Education, 24*(5), 930-936.

DeWitt, J., & Storksdieck, M. (2008). A short review of school field trips: Key findings from the past and implications for the future. *Visitor Studies, 11*(2), 181-197.

Falk, J. H. (2004). The director's cut: Toward an improved understanding of learning from museums. *Science Education, 88*(S1), S83–S96.

Gunston, R. (2001). Physics education past, present and future: An interpretation through cultural context. In Y. Park (Ed.), Teaching and learning of physics in cultural contexts (pp. 25-45). Hackensack, NJ: World Scientific.

Gyeonggi Provincial Office of Education (2008). *A guide to science exploration in culture at Gyeonggido*. Gyeonggi, South Korea: Bolog Media.

Im, S. (2005). Trends and significance of research about beliefs in physics education and cultural approaches. *Journal of the Korean Association for Science Education, 25*(3), 371-381.

Jarman, R. (2005). Science learning through scouting: An understudied context for informal science education. *International Journal of Science Education, 27*(4), 427-450.

Kang, C., Anderson, D., & Wu, X. (2010). Chinese perceptions of the interface between school and museum education. *Cultural Studies of Science Education, 5*, 665-684.

Kim, M., & Kim, B. (2002). Narrative thought and its implication on the science education. *Journal of the Korean Association for Science Education, 22*(4), 851-861.

Kolodner, J. L. (1991). The Journal of the Learning Science: Effecting changes in education. *The Journal of the Learning Science, 1*(1), 1-6.

Korea Science Foundation (2007). *A guide to scientific exploration for elementary school students*. Gyeonggi, South Korea: Bolog Media.

Lave, W., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. New York, NY: Cambridge University Press.

Lebak, K. (2007). Mediating cultural borders during science field trips. *Cultural Studies of Science Education, 2*, 847-882.

Lee, H.-J. (2004). Bruner's mode of narrative thought and education. *The Journal of Research in Education, 20*, 73-91.

Lee, J.-W. (1999). *An analysis on open inquiry of secondary students through scientific exploration at Yeongreung*. A master thesis. Seoul National University.

Lee, S.-K. (1998). Evaluation of 'Scientific Exploration in Korean History'. Report on '98 Annual meeting of Korean science educators. *Korean Federation of Science Education Societies,* 150-155.

Lemke, J. L. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching, 38*(3), 296–316.

Lim, M., & Barton, A. C. (2006). Science learning and a sense of place in an urban middle school. *Cultural Studies of Science Education, 1*, 107-141.

Nielsen, W. S., Nashon, S., & Anderson, D. (2009). Metacognitive engagement during field-trip experiences: A case study of students in an amusement park physics program. *Journal of Research in Science Teaching, 46*(3), 265-288.

Oh, K., Jo, K., Park, S.-W. & Pak, S.-J. (1999). Teachers' perception about science field trip to Korean Historical sites. *Journal of the Korean Association for Science Education, 19*(3), 461-470.

Pak. S.-J. (1998). Educational issues on 'Scientific Exploration in Korean History' [Report on '98 Annual meeting of Korean

science educators]. Korean Federation of Science Education Societies.

Pak, S.-J. (2001). Physics education in cultural context: Issues, approaches, and perspectives. In Y. Park (Ed.), *Teaching and learning of physics in cultural contexts* (pp. 3-14). Hackensack, NJ: World Scientific.

Pak, S.-J. (2004). Scientific exploration in the context of Korean history. Seoul, South Korea: Korea Association for Science Education.

Park. S.-W. (2000). *A model on the improvement of diverse inquiry skill through scientific exploration in Korean history* (A doctoral thesis). Seoul National University, South Korea.

Park, Y. (Ed.). (2004). *Teaching and learning of physics in cultural context.* Hackensack, NJ: World Scientific.

Seoul Metropolitan Office of Education (2009). *Regional science education resource map for scientific exploration in culture.* Gyeonggi, South Korea: Bolog Media.

Traweek, S. (1992). Border crossings: Narrative strategies in science studies and among physicists in Tsukuba science city, Japan. In A. Pickering (Ed.), *Science as practice and culture* (pp. 429–465). Chicago, IL: University Chicago Press.

Turnbull, D. (2000). *Masons, tricksters and cartographers*. Amsterdam, The Netherlands: Harwood Academic Publishers.

van Eijck, M. W., & Roth, W.-M. (2010). Towards a chronotopic theory of "place" in place-based education. *Cultural Studies of Science Education, 5*, 869–898.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wong, D. (2001). Perspectives on learning. *Journal of Research in Science Teaching, 38*(3), 279 – 281.

Yoo, J. (2004). *Scientific exploration at Korea National Folk Museum*. Gyeonggi, South Korea: Bolog Media.

Yoon, H.-K. (1999). *A process of inquiry motivation of secondary students through expanded scientific inquiry activities* (A doctoral thesis). Seoul National University, South Korea.