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Research Regarding Science Learning in Asia: An Analysis of Selected Science Education Journals

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With the use of systematic content analyses of the publications from 2000 to 2009 in four international journals in science education, including *the International Journal of Science Education, Science Education*, *the Journal of Research in Science Teaching*, and *Research in Science Education* (RISE), this study explored the trends of research regarding science learning in Asia. A total of 228 papers were found to be related to the science learning of Asian students. First, it was found that about three quarters of the papers originated from Taiwan, Israel, Turkey and China. Analyses of the research topics revealed that in addition to research about students' conceptions of some specific scientific topics (Learning-Conceptions) and classroom contexts and learner characteristics (Learning-Contexts), cultural, social and gender issues are the most frequently investigated topics in the field of science learning. An increasing trend was found in "Learning-Contexts" from 2000 to 2009. Additionally, more research has been conducted to investigate the topics of "Educational Technology" and "Goals, Policy, and Curriculum" from 2000 to 2009. High school and middle school students were the most frequently researched samples. Research about nature of science is deemed as more influential for subsequent work worldwide.

Keywords: science education; science education research; trends in research; Asia

Science education has become a globalized research domain (Treagust, 2000). As advocated by Abell and Lederman (2007), the ultimate purpose of science education is the advancement of science teaching and learning throughout the world. According to their perspective, the understanding of progress in science teaching and learning globally will be of fundamental importance. To more fully document progress in science education throughout the world, research articles published in international science education journals may provide some important insights. As a result, some previous studies have explored the research trends in science education by reviewing selected international journals in science education (e.g., Lee, Wu, & Tsai;2009; Tsai & Wen, 2005).

With the results derived from international assessments, such as Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA), student progress in science education among

different countries or geographic areas were compared. It should be noted that some international science achievement tests, such as the TIMSS and PISA have repeatedly revealed that students from certain Asian countries such as China, Singapore, Taiwan, and Korea outperformed those from other continents in the past decade. Undoubtedly, the understanding of science education in Asian countries may provide some important insights into science learning for science educators worldwide. However, previous aforementioned review studies (Lee et al., 2009; Tsai & Wen, 2005) have mainly focused on international research trends in science education during a period of time by analyzing selected international journals. The exploration of science education research, particularly for Asian countries, in recent years may be informative to worldwide science educators and researchers. Therefore, this study aimed to review the studies regarding science learning in Asia.

In this study, papers regarding science learning in Asia published from 2000 to 2009 were selected from four prestigious international journals in science education: *the International Journal of Science Education* (IJSE), *Science Education* (SE), *the Journal of Research in Science Teaching* (JRST), and *Research in Science Education* (RISE). Then, systematic content analyses of the selected articles published in these four journals were conducted. Moreover, as in Lee et al. (2009), this study also analyzed the highly-cited papers selected from the four journals from 2000 to 2009. The analysis of highly cited papers could show relatively high-impact research work among the publications.

METHODOLOGY

Through a series of content analyses of the four selected international journals in science education, this study aimed to explore science education research regarding science learning in Asia from 2000 to 2009. The author nationality, research topic, and the participants of the selected papers were categorized. Also, the citations of selected papers were analyzed. The selection of research papers and coding methods for content analysis are described below:

Research papers selected for analyses

Research papers regarding science learning in Asia published in *IJSE*, *SE*, *JRST*, and *RISE* from 2000 to 2009 were selected for analysis. Only empirical papers were selected. Papers categorized as "editorial," commentary," "responses," and "book reviews" were excluded. Also, the studies were limited to those that collected data about Asian students' learning. (Turkish students were considered as Asian students in this study.) Hence, those studies of Asian teachers or teacher education without empirical information of Asian students were excluded from the analysis. Likewise, if Asian authors published data solely from UK or US, these publications were also excluded for this review. By the aforementioned criteria, a total of 228 papers were selected for analysis without further filtering.

Authors' nationality and research contribution by country

In this study, the nationality of the authors of each selected paper was identified, and a paper count for each country was calculated.

Research topic analysis

The research topic of each selected paper was categorized using the analysis scheme of Tsai and Wen (2005) and Lee et al. (2009) based on a modified form of the strand categories published by the National Association for the Research in Science Teaching conference in the years 2000-2003, and yielded the following nine categories that were used to analyze the publications:

1. *Teacher Education:* Preservice and continuing professional development of teachers; teacher education programs and policy; practicum experience; issues related to teacher education reform.
2. *Teaching:* Pedagogical knowledge and pedagogical content knowledge; teaching beliefs, teacher thinking; teaching behaviors and strategies.
3. *Learning-Conceptions* (*Learning-Students' conceptions and conceptual change*)*:* Methods for probing student understanding and conception; students' alternative conceptions; instructional approaches for conceptual change; conceptual change in learners; conceptual development.
4. *Learning-Contexts* (*Learning-Classroom contexts and learner characteristics*)*:* Learning environments (including laboratories); individual differences; motivation; reasoning;

learning approaches; teacher-student interactions; peer interactions; affective dimensions of science learning; cooperative learning; language, writing, and discourse in learning.

5. *Goals and policy, curriculum, evaluation, and assessment:* Curriculum development, change, implementation, dissemination and evaluation; social analysis of curriculum; alternative forms of assessment; educational measurement; effective schools; curriculum policy and reform.
6. *Culture, social, and gender issues:* Multicultural and bilingual issues; ethnic issues; gender issues; comparative studies; issues of diversity related to science teaching and learning.
7. *Philosophy, history, and nature of science:* Philosophy of science; history of science, nature of science; epistemological issues; ethical and moral issues.
8. *Educational technology:* Computers; web-based learning; interactive multimedia; game-based learning; integration of technology into teaching; learning and assessment involving the use of technology.
9. *Informal Learning:* Science learning in informal contexts (e.g., museums, outdoor settings, etc.); public awareness of science.

Similar to Tsai and Wen (2005) and Lee et al. (2009), the aforementioned nine categories were used when analyzing the research topic of each selected paper. As the scope of the present review concerns students' learning, the categories "Learning-Conceptions" (Learning-Students' conceptions and conceptual change) and "Learning-Contexts" (Learning-Classroom contexts and learner characteristics) are included as one major topic for each paper. Some papers in this study, such as those simply exploring students' alternative conceptions regarding a specific topic, were coded into only one research topic category (i.e., Learning-Conceptions). However, in addition to these procedures, a multiple coding method was used for certain papers. That is, multiple categories of research topics were possibly allocated for a selected paper if it involved more than one research topic. For example, the paper by Tsai (2007), which explored some Taiwan teachers' scientific epistemological views and how these views may be coherent with their instruction and students' views toward learning environments as well as students' epistemological beliefs toward science, was coded into the three categories: "Teaching," "Learning-Contexts," and "Philosophy, history, and nature of science." Some papers which probed Asian students' alternative conceptions and the role of learning contexts were coded into both "Learning-Conceptions" and "Learning-Contexts."

Analyzing the educational level of the participants

The educational level of the participants involved in each paper was coded into the following categories: (1) preschool; (2) elementary school (i.e., grades 1-6); (3) middle school (i.e., grades 7-9); (4) high school (i.e., grades 9-12); (5) college; (6) graduate school; and (7) pre-service teachers. It should be noted that pre-service teachers are included in the analysis as they are still students. However, when analyzing the educational levels of the participants, pre-service teacher is viewed as a separate category from the categories (5) college and (6) graduate. If a paper covers more than one category of participants, it was coded into multiple categories.

Identifying highly-cited papers

In this study, the highly-cited papers of 2000-2004 and those of 2005-2009 were also identified. To this end, the Social Sciences Citation Index (SSCI) database was used to obtain the total number of times each selected paper has been cited (retrieved at January 14, 2011). Based on the citation records, the 15 most-cited papers published in the periods of 2000-2004 and 2005-2009 were identified.

RESULTS AND DISCUSSION

Published papers by authors' nationality

In this study, the nationality of the authors of each selected paper was identified, and then the number of publications by each country was analyzed. It was found that three quarters of the publications were contributed by researchers from Taiwan, Israel, Turkey and China, as shown in Table 1. When analyzed by journal, *IJSE* authors from Taiwan and Israel published more papers regarding science learning during 2000-2009. For SE, most Asian authors came from Israel, Taiwan, and Singapore. For *JRST*, authors from Israel, Turkey, and Taiwan published more papers during 2000-2009, and in *RISE*, China and Turkey contributed more.

Table 1
Country Ranks and Percentages of Publications for the Four Journals and In Individual Journals (top five groups) from 2000 to 2009

All (n=228)		IJSE (n=120)		SE (n=36)		JRST (n=46)		RISE (n=26)	
Country	**Number of articles**	**Country**	**Number of articles**	**Country**	**Number of articles**	**Country**	**Score**	**Country**	**Score**
Taiwan	66 (28.9%)	Taiwan	44 (36.6%)	Israel	14 (38.9%)	Israel	20 (43.5%)	China	6 (23.1%)
Israel	56 (24.6%)	Israel	18 (15.0%)	Taiwan	12 (33.3%)	Turkey	8 (17.4%)	Turkey	5 (19.2%)
Turkey	29 (12.7%)	China	14 (11.7%)	Singapore	4 (11.1%)	Taiwan	7 (15.2%)	Israel	4 (15.4%)
China[1]	21 (9.2%)	Turkey	14 (11.7%)	India	2 (5.6%)	Korea	4 (8.7%)	Korea	4 (15.4%)
Others	56 (24.6%)	Others	30 (25.0%)	Others	4 (11.1%)	Others	7 (15.2%)	Others	7 (26.9%)

Note: [1] China includes the work from Hong Kong

Published papers by research topic

Within these ten years, the research topic most frequently coded was "Learning-Contexts" (68%), followed by "Learning-Conception" (54.8%) and "Culture, social and gender issues" (23.3%) (Table 2). The topics of "Learning-Contexts" and "Learning-Conceptions" are quite reasonable as this review covers research in science learning. The topic of "Culture, social and gender issues" is frequently investigated along with the study of science learning among Asian students.

Moreover, the research topics of the selected papers regarding science learning in Asia were also analyzed by journal in this study. Table 3 reveals that, in addition to the topics "Learning-Contexts" and "Learning-Conceptions," the research topic with the third highest occurrence in *IJSE, SE, JRST*, and *RISE* are "Culture, social and gender issues" (27.5%), "Educational Technology" (19.4%), "Culture, social and gender issues", (23.9%), and "Philosophy, history, and nature of science" (26.9%), respectively.

This study further compared the research topics involved in the selected papers in the periods of 2000-2004 and 2005-2009 (Table 4). As expected, the topics of "Learning-Contexts" (62.8% and 71.1%, respectively), "Learning-Conceptions" (54.7% and 54.9%, respectively), and "Culture, Social and Gender issues" (23.3% and 23.2% ,respectively) ranked as the top three both in 2000-2004 and in 2005-2009. Moreover, from 2000 to 2009, an increasing trend was found in "Learning-Contexts" (from 62.8% to 71.1%), "Educational Technology" (from 10.5% to 15.5%), and "Goals, Policy, and Curriculum" (from 15.1% to 19.0%), while a declining trend was revealed for "Teaching" (from 10.5% to 5.6%), and "Philosophy, history and nature of science" (from 19.8% to 15.5%). Clearly, science educators from Asian countries have somewhat shifted their research foci during this ten year period.

Participants in the selected papers regarding science learning in Asia during 2000-2009

Table 5 shows that, during 2000-2009, the participants in most papers regarding science learning in Asia published in *IJSE, SE, JRST*, and *RISE* involved participants at the "high school level" (41.2%), followed by "middle school level" (33.3%), and "elementary school level" (18.9%). Moreover, relatively fewer papers regarding preschool science education (2.2%) and science learning at the graduate school level (2.6%) were published in the four international science educational journals during these ten years.

A similar distribution of the participants in the selected papers across the four international journals was found (Table 6). "Middle school" and "high school" students were consistently the top two categories of research participants of the selected papers across the four international journals during 2000-2009. However, compared with the other categories of participants (excluding "middle school" and "high school") relatively more papers regarding elementary school science learning were published in the three journals, *IJSE, SE*, and *JRST* during

Table 2

Frequencies and Percentages of Research Topics from 2000 to 2009 for the Four Journals (IJSE, SE, JRST, and RISE)

Research topic	2000-2009 (n=228)	2000 (n=12)	2001 (n=11)	2002 (n=17)	2003 (n=20)	2004 (n=26)	2005 (n=28)	2006 (n=20)	2007 (n=30)	2008 (n=29)	2009 (n=35)
Teacher Education	13 (5.7%)	0 (0.0%)	0 (0.0%)	1 (5.9%)	1 (5.0%)	2 (7.7%)	3 (10.7%)	0 (0.0%)	5 (16.7%)	1 (3.4%)	0 (0.0%)
Teaching	17 (7.5%)	1 (8.3%)	0 (0.0%)	4 (23.5%)[3]	2 (10.0%)	2 (7.7%)	0 (0.0%)	1 (5.0%)	5 (16.7%)	1 (3.4%)	1 (2.9%)
Learning-Conceptions	125 (54.8%)[2]	4 (33.3%)[3]	6 (54.5%)[1]	11 (64.7%)[2]	11 (55.0%)[2]	15 (57.7%)[1]	12 (42.9%)[2]	10 (50.0%)[2]	19 (63.3%)[2]	17 (58.6%)[2]	20 (57.1%)[2]
Learning-Contexts	155 (68.0%)[1]	7 (58.3%)[1]	5 (45.5%)[2]	12 (70.6%)[1]	15 (75.0%)[1]	15 (57.7%)[1]	22 (78.6%)[1]	15 (75.0%)[1]	21 (70.0%)[1]	19 (65.5%)[1]	24 (68.6%)[1]
Goals, Policy, and Curriculum	40 (17.5%)	3 (25.0%)	0 (0.0%)	4 (23.5%)[3]	4 (20.0%)	2 (7.7%)	6 (21.4%)	0 (0.0%)	7 (23.3%)	2 (6.9%)	12 (34.3%)
Culture, Social, and Gender	53 (23.3%)[3]	5 (41.7%)[2]	2 (18.2%)	2 (11.8%)	5 (25.0%)[3]	6 (23.1%)[3]	9 (32.1%)[3]	4 (20.0%)[3]	11 (36.7%)[3]	4 (13.8%)	5 (14.3%)
Philosophy, History, and Nature of Science	39 (17.1%)	1 (8.3%)	4 (36.4%)[3]	3 (17.6%)	3 (15.0%)	6 (23.1%)[3]	8 (28.6%)	2 (10.0%)	2 (6.7%)	6 (20.7%)[3]	4 (11.4%)
Educational Technology	31 (13.6%)	2 (16.7%)	0 (0.0%)	0 (0.0%)	3 (15.0%)	4 (15.4%)	4 (14.3%)	3 (15.0%)	5 (16.7%)	4 (13.8%)	6 (17.1%)[3]
Informal Learning	8 (3.5%)	2 (16.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (10.0%)	3 (10.3%)	0 (0.0%)

Notes: x%[1] Top one topic, x%[2] Top two topic, x%[3] Top three topic. A paper may be coded into multiple topics.

Table 3
Frequencies and Percentages of Research Topics in Individual Journals from 2000 to 2009

	IJSE (n=120)	SE (n=36)	JRST (n=46)	RISE (n=26)
Teacher Education	3 (2.5%)	1 (2.8%)	7 (15.2%)	1 (3.8%)
Teaching	8 (6.7%)	1 (2.8%)	3 (6.5%)	5 (19.2%)
Learning-Conceptions	60 (50.0%)[2]	24 (66.7%)[1]	23 (50.0%)[2]	19 (73.1%)[2]
Learning-Contexts	81 (67.5%)[1]	18 (50.0%)[2]	33 (71.7%)[1]	26 (100.0%)[1]
Goals, Policy, and Curriculum	27 (22.5%)	2 (5.6%)	7 (15.2%)	3 (11.5%)
Culture, Social and Gender	33 (27.5%)[3]	2 (5.6%)	11 (23.9%)[3]	5 (19.2%)
Philosophy, History, and Nature of Science	17 (14.2%)	6 (16.7%)	9 (19.6%)	7 (26.9%)[3]
Educational Technology	10 (8.3%)	7 (19.4%)[3]	9 (19.6%)	5 (19.2%)
Informal Learning	3 (2.5%)	2 (5.6%)	3 (6.5%)	1 (3.9%)

Notes: x%[1] Top one topic, x%[2] Top two topic, x%[3] Top three topic. A paper may be coded into multiple topics.

Table 4
Comparisons of Frequencies and Percentages of Research Topics Between 2000-2004 and 2005-2009 for the Four Journals (IJSE, SE, JRST, and RISE)

	2000-2004 (n=86)	2005-2009 (n=142)
Teacher Education	4 (4.7%)	9 (6.3%)
Teaching	9 (10.5%)	8 (5.6%)
Learning-Conceptions	47 (54.7%)[2]	78 (54.9%)[2]
Learning-Contexts	54 (62.8%)[1]	101 (71.1%)[1]
Goals, Policy, and Curriculum	13 (15.1%)	27 (19.0%)
Culture, Social and Gender	20 (23.3%)[3]	33 (23.2%)[3]
Philosophy, History, and Nature of Science	17 (19.8%)	22 (15.5%)
Educational Technology	9 (10.5%)	22 (15.5%)
Informal Learning	2 (2.3%)	6 (4.2%)

Notes: x%[1] Top one topic, x%[2] Top two topic, x%[3] Top three topic. A paper may be coded into multiple topics.

Table 5

Frequencies and Percentages of Sample's Educational Level from 2000 to 2009 for the Four Journals (IJSE, SE, JRST, and RISE)

	2000-2009 (n=228)	2000 (n=12)	2001 (n=11)	2002 (n=17)	2003 (n=20)	2004 (n=26)	2005 (n=28)	2006 (n=20)	2007 (n=30)	2008 (n=29)	2009 (n=35)
preschool	5 (2.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (3.6%)	1 (5.0%)	2 (6.7%)	0 (0.0%)	1 (2.9%)
elementary	43 (18.9%)[3]	1 (8.3%)	2 (18.2%)[2]	2 (11.8%)[3]	0 (0.0%)	9 (34.6%)[2]	5 (17.9%)	5 (25.0%)[1]	8 (26.7%)[3]	1 (3.4%)	10 (28.6%)[3]
middle	76 (33.3%)[2]	5 (41.7%)[2]	4 (36.4%)[1]	7 (41.2%)[2]	7 (35.0%)[2]	8 (30.8%)[3]	10 (35.7%)[1]	5 (25.0%)[1]	12 (40.0%)[2]	7 (24.1%)[2]	11 (31.4%)[2]
high	94 (41.2%)[1]	7 (58.3%)[1]	2 (18.2%)[2]	9 (52.9%)[1]	12 (60.0%)[1]	10 (38.5%)[1]	8 (28.6%)[2]	5 (25.0%)[1]	13 (43.3%)[1]	15 (51.7%)[1]	13 (37.1%)[1]
college	31 (13.6%)	2 (16.7%)[3]	2 (18.2%)[2]	2 (11.8%)[3]	0 (0.0%)	1 (3.8%)	6 (21.4%)[3]	3 (15.0%)	5 (16.7%)	6 (20.7%)[3]	4 (11.4%)
graduate	6 (2.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (7.7%)	1 (3.6%)	0 (0.0%)	0 (0.0%)	1 (3.4%)	2 (5.7%)
pre-service teachers	17 (7.5%)	0 (0.0%)	2 (18.2%)[2]	1 (5.9%)	2 (10.0%)[3]	1 (3.8%)	1 (3.6%)	2 (10.0%)	2 (6.7%)	3 (10.3%)	3 (8.6%)

Notes: x%[1] Top one topic, x%[2] Top two topic, x%[3] Top three topic. A paper may be coded into multiple types of samples.

Table 6
Frequencies and Percentages of Sample's Educational Level in Individual Journals from 2000 to 2009

	IJSE (n=120)	SE (n=36)	JRST (n=46)	RISE (n=26)
preschool	3 (2.5%)	0 (0.0%)	1 (2.2%)	1 (3.8%)
elementary	26 (21.7%)[3]	9 (25.0%)[3]	6 (13.0%)[3]	2 (7.7%)
middle	38 (31.7%)[2]	14 (38.9%)[1]	17 (37.0%)[2]	7 (26.9%)[2]
high	46 (38.3%)[1]	12 (33.3%)[2]	24 (52.2%)[1]	12 (46.2%)[1]
college	16 (13.3%)	7 (19.4%)	4 (8.7%)	4 (15.4%)[3]
graduate	4 (3.3%)	2 (5.6%)	0 (0.0%)	0 (0.0%)
pre-service teachers	12 (10.0%)	2 (5.6%)	2 (4.3%)	1 (3.8%)

Notes: x%[1] Top one topic, x%[2] Top two topic, x%[3] Top three topic. A paper may be coded into multiple topics.

Table 7
Comparisons of Frequencies and Percentages of Sample's Educational Level between 2000-2004 and 2005-2009 for the Four Journals (IJSE, SE, JRST, and RISE)

	2000-2004 (n=86)	2005-2009 (n=142)
Preschool	0 (0.0%)	5 (3.5%)
Elementary	14 (16.3%)[3]	29 (20.4%)[3]
Middle	31 (36.0%)[2]	45 (31.7%)[2]
High	40 (46.5%)[1]	54 (38.0%)[1]
College	7 (8.1%)	24 (16.9%)
Graduate	2 (2.3%)	4 (2.8%)
pre-service teachers	6 (7.0%)	11 (7.7%)

Notes: x%[1] Top one topic, x%[2] Top two topic, x%[3] Top three topic. A paper may be coded into multiple topics.

2000-2009, while relatively more papers concerned with college science learning were published in *RISE* during these years.

This study further compared the participants of the selected papers in the periods of 2000-2004 and 2005-2009. Table 7 shows that, among the selected papers regarding science learning in Asia, relatively more papers regarding "high school science" were published both in 2000-2004 and in 2005-2009 (46.5% and 38% respectively), followed by "middle school science" (36% and 31.7%, respectively), and "elementary school science" (16.3% and 20.4%, respectively). Moreover, a clear growing research trend was found in "college science education" (from 8.1% to 16.9%), "elementary school science" (from 16.3% to 20.4%), and "preschool science education" (from 0% to 3.5%), while a likely declining trend was observed for "middle school science" (from 36% to 31.7%). The findings seem to indicate that research regarding high school science education has always been the most highlighted issue for researchers in Asian countries during the ten-year period; however,

some science educators may have shifted their focus from issues at high school level to other educational levels, such as preschool and college.

Highly-cited papers in the periods of 2000-2004 and 2005-2009

As aforementioned, with the use of Social Sciences Citation Index (SSCI) database, this study examined the total times each selected paper was cited, and highly-cited papers were further identified. In this study, 15 highly-cited papers in the four international journals in 2000-2004 and 15 highly-cited articles in 2005-2009 were identified. The 15 most frequently cited papers of 2000-2004 and of 2005-2009 are presented in Appendices A and B, respectively. According to Appendix A, publications in 2000-2004 about argumentation (#1) and the nature of science (#2, #3, and #6) are more influential for subsequent research of science learning worldwide. For the publications from 2005-2009 (Appendix B), the papers about the nature of science continue to be highly cited (#5, #7, #12, #13), and those related to affective domains (e.g., learning interest or motivation, #2, #8, #11) and educational technology (#3, #10) are also deemed as more influential work.

SUMMARY AND CONCLUSIONS

This study aimed to provide deeper insights into science education research regarding science learning in Asia during the period from 2000 to 2009. With systematic content analyses of science education journals, this study revealed the trends of research regarding science learning in Asia. It was found that about three quarters of the papers regarding science learning in Asia in these journals originated from Taiwan, Israel, Turkey, and China.

Regarding research topics, it was revealed that in addition to the research about students' conceptions of some specific scientific topics (Learning-Conceptions) and classroom contexts and learner characteristics (Learning-Contexts), cultural, social and gender issues are the most frequently investigated topics in the field of science learning. As Asia is often perceived as having unique cultures and learning environments, the cultural and social issues for Asian science learning are well-liked in international science education journals.

Moreover, an increasing trend was found in "Learning-Contexts" from 2000 to 2009. Although the study of students' conceptions is still quite popular in science learning research (around 55%), researchers may recognize that careful investigation about learning contexts is essential for the possible enhancement of science learning. Furthermore, the research foci of some researchers from Asian countries have shifted from "Teaching", and "Philosophy, history and nature of science" to others such as "Educational Technology" and "Goals, Policy, and Curriculum" from 2000 to 2009. In the last decade, the potential of utilizing educational technology in improving teaching and learning has been widely examined (Lee et al., in press). More research will be suggested to address relevant issues in Asian educational contexts. That is, how technology should be used to support teaching and learning in Asian educational contexts may also be significant for researchers.

The increase of "Goals, Policy, and Curriculum" research may also provide some directions for future research. The preparation for future citizenship with the aim of enhancing students' ability to solve the problems arising from real life has gradually become the goal of science education (Roberts, 2007). Moreover, the rapid development of science and technology has raised a variety of socio-scientific issues (SSIs) for inclusion in science curricula (Zeidler, Sadler, Applebaum, & Callahan, 2009). These controversial issues will provide learners with meaningful contexts for practicing their informal reasoning or thinking skills and applying what they have learned in science classrooms to solve real-world problems they have encountered in daily life (Wu & Tsai, 2007). In the last two decades, many SSI-related studies have been conducted in Western countries (e.g., Bell & Lederman, 2003; Sadler, 2004; Sadler & Zeidler, 2004), currently, however, few relevant studies have been conducted in Asian countries (e.g., Yang, 2004; Wu & Tsai, 2011, in press).

Improving the scientific literacy of learners at different academic levels is a well-recognized science educational goal worldwide (National Research Council, US 1996; Ministry of Education, Taiwan, 2008). The research reported here indicates that research regarding high school science education has always been the most highlighted issue for researchers in Asian countries during the last ten year period; however, some science educators may have shifted their focus from issues at the high school level to other

educational levels, such as preschool and college. According to the findings of this review, more research involving preschool and college science students should be highlighted by Asian researchers.

An analysis of highly-cited 2000-2009 papers indicated that the papers about the nature of science appear to be more influential as foci for subsequent research on science learning worldwide. Nature of science is still a prevalent research topic in science education internationally; hence, these research papers have a higher possibility of citation. Moreover, the analysis of the publications from 2005-2009 related to student learning interest or motivation were found to be among the more influential work. As stated previously, many Asian students express low interest and motivation in learning science. Research about this topic has gained more international recognition.

For researchers in science education, the results of this study, admittedly limited to the period of 2000-2009, has illuminated some of the major trends in the fields and pointed toward new areas that may provide some innovative directions for their further research, particularly for researchers outside of Asian countries. However, this review only analyzed the publications in four international science education journals. More comprehensive reviews are needed in the future.

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REFERENCES

Abell, S. K., & Lederman, N. G. (Eds.). (2007). *Handbook of Research on Science Education.* Mahwah, NJ: Lawrence Erlbaum Associates.

Bell, R. L., & Lederman, N. G. (2003). Understandings of the nature of science and decision making on science and technology based issues. *Science Education, 87*, 352-377.

Lee, M.-H., Wu, Y.-T., & Tsai, C.-C. (2009). Research trends in science education from 2003 to 2007: a content analysis of publications in selected journals. *International Journal of Science Education, 31,* 1999-2020.

Lee, S. W.-Y. , Tsai, C.-C., Wu, Y.-T., Tsai, M.-J., Liu, T.-C., Hwang, F.-K., Lai, C.-H., Liang, J.-C., Wu, H.-C., & Chang, C.-Y. (in press). Internet-based science learning: A review of journal publication. *International Journal of Science Education*. (Available online 11 February 2011) doi: 10.1080/09500693.2010.536998

Ministry of Education, Taiwan (2008). *General guidelines of Grade 1–9 curriculum: Science and Technology.* Taipei: Author.

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

Roberts, D. (2007). Scientific literacy/science literacy. In S. K. Abell & N. G. Lederman (Eds.), *International handbook of research on science education* (pp. 729–780). Mahwah, NJ: Lawrence Erlbaum Associates.

Sadler, T. D. (2004). Informal reasoning regarding socio-scientific issues: A critical review of research. *Journal of Research in Science Teaching, 41*, 513-536.

Sadler, T. D., & Zeidler, D. L. (2004). The significance of content knowledge for informal reasoning regarding socioscientific issues: Applying genetic knowledge to genetic engineering issues. *Science Education, 88*, 683-706.

Treagust, D. (2000, day month). Our development as an international community. *NARST News, 43*, 1-2.

Tsai, C.-C. (2007). Teachers' scientific epistemological views: The coherence with instruction and students' views. *Science Education, 91*, 222-243.

Tsai, C.-C., & Wen, L. M. C. (2005). Research and trends in science education from 1998 to 2002: A content analysis of publication in selected journals. *International Journal of Science Education, 27*, 3-14.

Wu, Y.-T., & Tsai, C. -C. (2007). High school students' informal reasoning on a socio-scientific issue: Qualitative and quantitative analyses. *International Journal of Science Education, 29*, 1163-1187.

Wu, Y.-T., & Tsai, C.-C. (in press). The effects of different on-line searching activities on high school students' cognitive structures and informal reasoning regarding a socio-scientific issue. *Research in Science Education.* (Available online 10 September 2010) doi: 10.1007/s11165-010-9189-y

Wu, Y.-T., & Tsai, C.-C. (2011). High school students' informal reasoning regarding a socio-scientific issue, with relations to scientific epistemological beliefs and cognitive structures. *International Journal of Science Education*, *33*, 371-400.

Yang, F. Y. (2004). Exploring high school students' use of theory and evidence in an everyday context: The role of scientific thinking in environmental science decision-making. *International Journal of Science Education, 26*, 1345-1364.

Zeidler, D. L., Sadler, T. D., Applebaum, S., & Callahan, B. E. (2009). Advancing reflective judgment through socioscientific issues. *Journal of Research in Science Teaching, 46*(1), 74-101.

APPENDIX A

Top 15 highly-cited papers (by citation counts in total, as at January 14, 2011) in 2000-2004

2000-2004 Rank	Citation times	Title	Authors	Journal (year), page.
1	98	Fostering students' knowledge and argumentation skills through dilemmas in human genetics	Zohar A, Nemet F	JRST (2002), 35-62
2	46	Influence of explicit and reflective versus implicit inquiry-oriented instruction on sixth graders' views of nature of science	Khishfe R, Abd-El-Khalick F	JRST (2002), 551-578
3	28	The effects of STS-oriented instruction on female tenth graders' cognitive structure outcomes and the role of student scientific epistemological beliefs	Tsai CC	IJSE (2000), 1099-1115
4	24	Learners' knowledge in optics: interpretation, structure and analysis	Galili I, Hazan A	IJSE (2000), 57-88
5	20	Problem-based learning: Using students' questions to drive knowledge construction	Chin C, Chia LG	SE (2004), 707-727
6	20	Promoting preservice chemistry teachers' understanding about the nature of science through history	Lin HS, Chen CC	JRST (2002), 773-792
7	20	Dynamic processes of conceptual change: Analysis of constructing mental models of chemical equilibrium	Chiu MH, Chou CC, Liu CJ	JRST (2002), 688-712
8	19	Providing high school chemistry students with opportunities to develop learning skills in an inquiry-type laboratory: A case study	Hofstein A, Shore R, Kipnis M	IJSE (2004), 47-62
9	17	A cross-age study of junior high school students' conceptions of basic astronomy concepts	Trumper R	IJSE (2001), 1111-1123
10	17	Constructivist learning environments in a cross-national study in Taiwan and Australia	Aldridge JM, Fraser BJ, Taylor PC, Chen CC	IJSE (2000), 37-55
11	16	Taiwanese science students' and teachers' perceptions of the laboratory learning environments: exploring epistemological gaps	Tsai CC	IJSE (2003), 846-860
12	15	Senior high school students' preference and reasoning modes about nuclear energy use	Yang FY	IJSE (2003), 221-244
13	15	Algorithmic, LOCS and HOCS (chemistry) exam questions: Performance and attitudes of college students	Zoller U	IJSE (2002), 185-203
14	15	Linking phenomena with competing underlying models: A software tool for introducing students to the particulate model of matter	Snir J, Smith CL, Raz G	SE (2003), 794-830
15	15	Multidimensional analysis system for quantitative chemistry problems: Symbol, macro, micro, and process aspects	Dori YJ, Hameiri M	JRST (2003), 278-302

APPENDIX B

Top 15 highly-cited papers (by citation counts in total, as at January 14, 2011) in 2005-2009

2005-2009 Rank	Citation times	Title	Authors	Journal (year), page.
1	21	Developing students' ability to ask more and better questions resulting from inquiry-type chemistry laboratories	Hofstein A, Navon O, Kipnis M, Mamlok-Naaman R	JRST (2005), 791-806
2	15	Characterizing children's spontaneous interests in science and technology	Baram-Tsabari A, Yarden A	IJSE (2005), 803-826
3	15	Enhancing undergraduate students' chemistry understanding through project-based learning in an IT environment	Barak M, Dori YJ	SE (2005), 117-139
4	14	Development of system thinking skills in the context of earth system education	Assaraf OBZ, Orion N	JRST (2005), 518-560
5	13	Students' perceptions of the nature of evolutionary theory	Dagher ZR, Boujaoude S	SE (2005), 378-391
6	13	Text genre as a factor in the formation of scientific literacy	Baram-Tsabari A, Yarden A	JRST (2005), 403-428
7	12	Developing a multi-dimensional instrument for assessing students' epistemological views toward science	Tsai CC, Liu SY	IJSE (2005), 1621-1638
8	11	The influence of students' cognitive and motivational variables in respect of cognitive conflict and conceptual change	Kang S, Scharmann LC, Noh T, Koh H	IJSE (2005), 1037-1058
9	10	Taiwanese science and life technology curriculum standards and earth systems education	Chang CY	IJSE (2005), 625-638
10	10	The interplay between different forms of CAI and students' preferences of learning environment in the secondary science class	Chang CY, Tsai CC	SE (2005), 707-724
11	9	The development of a questionnaire to measure students' motivation towards science learning	Tuan HL, Chin CC, Shieh SO	IJSE (2005), 639-654
12	9	Teachers' scientific epistemological views: The coherence with instruction and students' views	Tsai CC	SE (2007), 222-243
13	8	Examining students' views on the nature of science: Results from Korean 6th, 8th, and 10th graders	Kang S, Scharmann LC, Noh T	SE (2005), 314-344
14	8	Effect of bead and illustrations models on high school students' achievement in molecular genetics	Rotbain Y, Marbach-Ad G, Stavy R	JRST (2006), 500-529
15	8	Exploring the effects of cognitive conflict and direct teaching for students of different academic levels	Zohar A, Aharon-Kravetsky S	JRST (2005), 829-855