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# KOREAN SCIENCE TEACHERS' PERCEPTIONS AND ACTUAL USAGE OF EDUCATIONAL THEORIES/TEACHING STRATEGIES IN THEIR TEACHING

**Jongwon Park,**
**Youngmin Kim,**
**Jongseok Park,**
**Jin-Su Jeong,**
**Young-Shin Park**

**Abstract.** *Many researchers have reported that there is a significant gap between theory and practice in education. This research sought to contribute to this work by examining the theory/practice gap in secondary school science teaching in South Korea. To do this, a questionnaire was developed to investigate the gap between Korean science teachers' knowledge about Educational Theories and Teaching Strategies (ETTS) and the usage of it in their science classroom. The questionnaire was administered to 87 science teachers and results showed that even though participants were knowledgeable about many ETTS, only 26% of the teachers reported using it in their teaching. Major reasons reported for this gap in theory and practice were restrictive educational environments that did not support the use of ETTS, irrelevancy and difficulties of ETTS, and students' low interest in learning science. However, teachers' perception of the importance of ETTS positively affected their usage of ETTS. Implications of the results are discussed, and alternative in-service training program is suggested to activate science teachers' ETTS what they already know and to guide them to use ETTS in their actual science teaching.*

**Key words:** *theory-practice gap, science teacher education, secondary science teacher, teaching strategy.*

**Jongwon Park**
*Chonnam National University, Gwangju, Korea*
**Youngmin Kim**
*Pusan National University, Busan, Korea*
**Jongseok Park**
*Kyungpook National University, Daegu, Korea*
**Jin-Su Jeong**
*Daegu University, Daegu, Korea*
**Young-Shin Park**
*Chosun University, Gwangju, Korea*

## Introduction

This research investigates whether science teachers apply ETTS (*Educational Theories and Teaching Strategies*) in their science classrooms/laboratory teaching. It has been pointed out that there is a significant gap between theory and practice in education (e.g., De Corte, 2000; Roth, 2007). For example, educational researches reported in the literature are of little aid to science teachers' actual teaching in the classroom because the researches do not provide practical and teacher-friendly guidance (Berry & Milroy, 2002, pp. 200–201) or because teachers rarely search, utilize, or translate educational theories or research results to improve their teaching (Hiebert, Gallimore, & Stigler, 2002). Korthagen (2007) mentioned that this gap between educational research and practice has been a perennial problem since the time of Dewey. Even now, the efforts to reduce this gap are insufficient (Featherstone, 2007). Cheng, Cheng, and Tang (2010) also criticized the lack of studies on this gap in Asia.

To diminish this gap, many educators have emphasized the significance of the more effective pre-service training programs at universities. However, Zeichner and Tabachnick (1981) argued that the content teachers learn at university is "washed out" by the time they begin teaching at their respective schools. Although this comment is seemingly dated, many may still agree with the argument.

Then, it is worth asking why teachers do not apply the content they have learned at university in classroom teaching. Researchers have proposed various reasons for this. For example, some researchers note that university experiences are not as strong as those of the K-12 school days (e.g., Feiman-Nemser & Remillard, 1996; Korthagen, 2007) or that educational theories are too abstract (e.g., Loughran, Berry, & Mulhall, 2006; Vick, 2006), without consideration of the various and complex factors in the reality of classroom

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teaching (e.g., Hoban, 2005; Korthagen & Kessels, 1999). Others criticize the lack of sufficient and reliable evidence supporting the effectiveness of educational theory in actual classroom teaching (e.g., Biesta, 2007; Hiebert et al., 2002).

In addition to these reasons, researchers have pointed out the influence of teachers' perceptions or beliefs about teaching and learning on the actual teaching method (Joram & Gabriele, 1998). Korthagen (2004) noted that teachers can be influenced by "internal factors" such as their beliefs about teaching and learning, professional identity (e.g., reflection on such questions as "What kind of teacher do I want to be?"), and/or sense of mission (e.g., a deeper concern about the role or responsibility of a teacher in our society), as well as "external factors," such as behavior or competence based on their knowledge level and practical abilities.

For example, Ezer, Gilat, and Sagee (2010), who examined pre-service teachers' perceptions about teaching and learning, recognized no difference between the constructivist view of teaching and the traditional approach. If this finding is reliable, it is expected that teachers who have a traditional view of teaching will not use constructivist theories in their actual practice.

Among the various beliefs about teaching, this research focuses on teachers' perceptions of the importance of ETTS. This is because if teachers think that the ETTS they learned at university are less important or irrelevant to their actual teaching, then it is likely they will not apply ETTS. In fact, Hobson et al. (2008) observed that some pre-service teachers considered what they learned at university (or higher education institutes) to be less relevant to actual classroom teaching or to their "being a teacher" in the future.

Sometimes, the importance of a theory does not necessarily relate to its feasibility or applicability. For instance, Hong, Chen, Chai, and Chan (2011) observed that many student teachers agreed with the importance of certain educational theories, such as the theory-building theory. However, when asked about the feasibility of a theory in actual classroom teaching, the student teachers demonstrated their practice that was relatively discordant to their perception of the theory's importance. Even when teachers believe that a theory is important and applicable to their teaching, some may be reluctant to apply it for various reasons. For example, Cheng et al. (2010) observed that, after student teachers had completed their four-year BEd programs and gained teaching experience, they all favored student-centered teaching strategies. However, about 25% of the student teachers (eight interviewees out of 31) reported that they would actually adopt teacher-centered strategies, for various reasons.

1. With the background described above, the research questions are as follows:
2. To what extent are Korean science teachers knowledgeable about ETTS?
3. Do they believe that ETTS are important?
4. Do they use and apply ETTS in their science classroom teaching?
5. If not, what are the reason(s) for this low usage of ETTS?

What conditions and supports are needed for their more active and effective use of ETTS in actual science classroom teaching?

## Methodology of Research

### *General Characteristic of Research*

This research was conducted using questionnaire and interview. Questions used in the questionnaire and interview were developed by us to obtain the answers to the research questions. The data was obtained from science teachers in South Korea, who were selected randomly and evenly in four areas of background majors, middle and high schools, different teaching years, and various areas of Korea. The data was analyzed quantitatively and qualitatively.

### *Participants*

In this research, eighty-seven science teachers were selected randomly from the ordinary middle and high schools located in widespread areas in Korea. They were recruited to be evenly distributed in four areas of background majors, two school levels, and teaching years, as shown in Table 1. As an ethical process, the following statement was provided in the questionnaire: "Participants' responses will be used only for research, and personal responses will be confidential."

**Table 1. Basic backgrounds of the participants (n = 87).**

| Major | Number | School level | Number | Teaching years | Number |
|---|---|---|---|---|---|
| Physics | 21 | Middle school | 39 | 1~5 | 27 |
| Chemistry | 20 | High school | 41 | 6~10 | 34 |
| Biology | 25 | No response | 7 | 11~15 | 16 |
| Earth Science | 21 | | | Over 16 | 10 |
| Total | | | 87 | | |

In Korea, teaching is one of the most popular occupations, and a large percentage of high-achieving high school students enter colleges of education to become teachers. After college graduation, these students must pass the national teacher recruitment examination to become teachers at public schools. Because the examination is highly competitive (Table 2), most students take their studies very seriously in college. Based on this circumstance for becoming a science teacher in Korea, it is expected that Korean science teachers have relatively high levels of knowledge and skills in teaching science.

**Table 2. National employment competition ratio for secondary school science teachers.**

| Major of Applicant | Competition ratio for each year | | | |
|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 |
| Physics | 1:11 (96/1013) | 1:9 (112/1012) | 1:8 (116/943) | 1:6(138/786) |
| Chemistry | 1: 14 (109/1513) | 1:11 (135/1459) | 1:10 (128/1301) | 1:8(122/1018) |
| Biology | 1: 16 (120/1878) | 1:12 (152/1985) | 1:12 (138/1720) | 1:9(148/1390) |
| Earth Science | 1: 9 (85/747) | 1:7 (114/769) | 1:7 (116/759) | 1:4(146/611) |

*Note. (96/1013) indicates that 96 of 1013 applicants were employed as physics teachers.*

*Instrument*

A questionnaire was developed to obtain data related to the research questions (Table 3). The questionnaire consists of essay-type questions and Likert-scale items. When teachers describe what they know about ETTS in Question 1, their descriptions do not necessarily guarantee their full understanding. However, as mentioned in the 'participants' section, it was assumed that the participants had a high level of knowledge about ETTS, since prospective science teachers in Korea needed to pass the competitive national test to be appointed to any public school. National examination consists of high levels of knowledge about ETTS and demonstration class including design of lesson plan, therefore, it is assumed that they are very qualified with strong theory and practice in science teaching.

**Table 3. Contents of the questionnaire.**

| Content | Question | Type |
|---|---|---|
| What teacher knows | 1. What do you know about kinds of educational theories and teaching strategies (ETTS)? Describe the ETTS what you know. | E |
| Importance | 2. Do you think ETTS are important for actual science teaching in schools? Describe the reasons why you think so. | L & E |
| Practical use | 3. Do you use ETTS for actual science teaching in schools? If so, please describe the instances of use or application. If not, please describe the reasons why you do not use or apply it. | L & E |
| Conditions & support | 4. What conditions or supports are needed for application of ETTS for actual science teaching in schools? | E |

*Note. E = Essay type, L = Likert scale.*

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For the Likert-scale items in Table 3, the participants responded to a five-point scale from 5 to 1, where "5" corresponded to "strong agreement," "3" to a neutral answer, and "1" to "strong disagreement." For the essay-type questions, the participants submitted written answers. The questionnaire required about 30 minutes to complete.

During the questionnaire development, the research group held several discussions to improve its validity. It was checked whether the intentions of the questions matched the research goal in content validity and whether the questions were readable and clear to teachers in face validity. Furthermore, the first draft of the questionnaire was given to two science teachers as a pilot test. In this pilot test, the science teachers gave written responses and were then interviewed about their written responses to construct the validity of the questionnaire.

*Interviews*

To elaborate teachers' written responses in the questionnaire, 15 science teachers, at least three from each science area, were voluntarily selected for the interview. Even though they did not participate in the questionnaire survey, they gave written responses in the questionnaire at first and took interview based on their responses.

The interview lasted about 20 minutes per person on average. Before beginning the interview, the researcher read the written responses and checked whether there was a gap between what the interviewees knew about ETTS and their actual use of ETTS in their teaching practice. When the respondents said they did not use some of ETTS mentioned in Question 1, the following main questions were used to obtain more information about the reason(s) for the gap and to determine requirements to diminish it:

*"Why don't you use ETTS when teaching science in your class or laboratory?"*

*"What kinds of supports or conditions do you need to use ETTS in your science teaching?"*

*Analysis*

The responses from Likert-scale items were analyzed quantitatively by using SPSS (20.0.0) statistics and responses from essay-type questions were analyzed qualitatively by categorizing the responses according to their common features. The data obtained from the Likert-scale questions were averaged according to various categories such as the school level, teacher's teaching years, etc. Next, it was analyzed whether there were any differences in the results according to the categories. To test whether the teachers' perception of the importance of ETTS was an important factor in their actual use of ETTS, the correlation coefficient between the "importance" and "use" of ETTS was calculated. In addition, to explore whether there was a gap between the theory and practice of ETTS, a paired t-test between the "importance" and "use" of ETTS was carried out.

All qualitative data from the responses to the essay-type questions were summarized and categorized according to their common features. The response frequencies for each category were calculated. Interview excerpts were also used to provide more detailed information.

## Results of Research

*What Science Teachers Know about ETTS*

In Question 1, participants mentioned a total of 465 items about ETTS; therefore, since 87 participants gave responses, an average of 5.3 ETTS items was mentioned per respondent. And the participants responded that they knew various kinds of ETTS, that is, they mentioned 65 kinds of ETTS in total. Among the 65 kinds of ETTS, Table 4 shows the ETTS items most frequently mentioned, i.e., by more than 20% of the respondents. The most frequently mentioned ETTS items were those related to teaching scientific inquiry (e.g., learning cycle/5E, discovery learning, inquiry learning, and induction/deduction/abduction).

**Table 4. ETTS items frequently mentioned by the science teachers (n = 465).**

| ETTS | Percentage (%) |
|---|---|
| Learning cycle/5E | 67 |
| Discovery learning | 60 |
| Constructivism | 45 |
| Cognitive conflict/Conceptual change/Generative learning | 38 |
| Ausubel's theory | 37 |
| Cooperative learning/Jigsaw/STAD | 37 |
| STS learning | 29 |
| Cognitive Development | 24 |
| Inquiry learning | 24 |
| Induction/Deduction/Abduction | 21 |

*Importance of ETTS as Perceived by Science Teachers*

As the science teachers' responses to Question 2, Table 5 shows that they generally perceived that ETTS are important for their science teaching (average = 3.98). This perception was nearly the same across all school levels ($t = 1.09$, $df = 78$, $p > .05$), regardless of the teachers' length of teaching years ($t = 1.07$, $df = 85$, $p > .05$).

**Table 5. Teachers' perceptions of the importance of ETTS and their use of ETTS (n = 87).**

| Variable | Importance | Independent t-value | df |
|---|---|---|---|
| School level | | | |
| Middle school | 4.05 | 1.09 | 78 |
| High school | 3.83 | | |
| Teaching years | | | |
| Less than 5 years | 3.79 | 1.07 | 85 |
| More than 5 years | 4.00 | | |
| Total | 3.98 | | |

Table 6 provides the reasons ETTS were considered important (Question 2 in Table 2). The data were obtained from 77 (89%) of the 87 teachers. According to Table 6, the science teachers placed great importance on ETTS because ETTS benefited the students more than the teachers.

**Table 6. Reasons the science teachers think ETTS are important (n = 77).**

| | The ETTS are important because they help … | Percentage (%) |
|---|---|---|
| Student | • Achieving the learning goals (ex. Understanding concept or the nature of science, enhancing the interest, changing misconception, improving inquiry skills, and so on) | 58 |
| | • Students' learning (ex. Students' active participation, cooperative and independent learning, and so on) | 43 |
| Teacher | • Designing a teaching plan (ex. Analyzing teaching materials, preparing teaching schedule.) | 22 |
| | • Improving teacher's profession/belief (ex. Developing new teaching approaches, more systematic teaching, decreasing errors, understanding students, and so on) | 19 |
| Others | | 1 |

*Note. The percentage is calculated as the number of responses divided by the total number of respondents (77); the total value exceeds 100% because one respondent could give multiple answers.*

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However, 15% of the respondents (13 out of 87) described why ETTS were not important, as shown in Table 7. Most of the respondents (12 teachers, 92%) mentioned that ETTS were irrelevant to their actual science teaching, and three teachers (23%) said that the teaching skills of the teacher were more important than ETTS itself.

**Table 7. Reasons the science teachers think ETTS are not important (n = 13).**

| | The ETTS are not important because of ... | Percentage (%) |
|---|---|---|
| Irrelevance of the theory | • The theory's feasibility to actual teaching is very low, theories do not consider different levels and abilities of students, more practical guidance for good teaching is necessary, the ETTS are not helpful for college entrance exam, and so on. | 92 |
| Teacher's practical ability | • Teacher's own teaching plan is more important, teacher's skills for applying a theory are more important | 23 |

*Note. The percentage is calculated as the number of responses divided by the total number of respondents (13).*

*The Use of ETTS in Actual Science Teaching*

In regard to the actual use of ETTS (Question 3 in Table 2), the responses were a little higher than 3.0 "neutral" (average = 3.26) as shown in Table 8. This tendency was nearly the same across all school levels ($t = 0.72$, $df = 79$, $p > .05$).

Table 8, however, shows that the longer a participant had worked as a teacher, the more frequently he/she applied ETTS in science teaching ($t = 2.05$, $df = 82$, $p < .05$). This means that, to use the ETTS learned in college, many and various teaching experiences are necessary because the ETTS learned in college cannot be used in their original form in schools because of various and unpredictable practical situations.

**Table 8. Teachers' use of ETTS (n = 87).**

| Variable | Use | Independent t value | df |
|---|---|---|---|
| School level | | | |
| Middle school | 3.30 | 0.72 | 79 |
| High school | 3.15 | | |
| Teaching years | | | |
| Less than 5 years | 2.92 | 2.05* | 82 |
| More than 5 years | 3.39 | | |
| Total | 3.26 | | |

*Note $p < 0.05$*

*Correlation between Teachers' Perception of the Importance of ETTS and Practical Use of it*

Checking the correlation between the teachers' perception of the importance and practical use of ETTS, the correlation coefficient was 0.54 ($p < .01$). Therefore, it was found that the teachers who thought ETTS were important for actual science teaching in schools tended to apply ETTS more in their own teaching.

This tendency occurred across all school levels (for middle school teachers, $r = 0.64$, $p < .01$; for high school teachers, $r = 0.49$, $p < .01$) and for all lengths of teaching years (for less than 5 years, $r = 0.62$, $p < .01$; for more than 5 years, $r = 0.50$, $p < .01$). Therefore, it was found that teachers' belief about the importance of ETTS is a common factor influencing their use of ETTS in teaching, regardless of the school level and length of teaching years.

However, it was a little weak for the high school teachers ($r = 0.49$) compared to the middle school teachers ($r = 0.64$). This means that the teachers' perception of the importance of ETTS had less influence on their use of ETTS for high school teachers compared to middle school teachers. In Korea, high school teachers and their teaching are primarily focused on preparing students for college entrance examinations; therefore, teaching problem-solving skills is emphasized more than teaching for other learning objectives such as improving scientific literacy, inquiry skills, or creativity, and so on. As a result, external requirements (e.g., necessity for teaching to improve problem-solving skills) can obstruct the application of ETTS at the high school level.

*Gap between Theory and Practice in Science Teaching*

In Question 3, the total number of examples of ETTS applications in their school teaching was 119. Because the total number of ETTS items that they knew was 465 in Question 1, the percentage of ETTS knowledge they used (frequency = 119) out of the total ETTS knowledge they held (frequency = 465) was only 25.6%.

This low use of ETTS in actual science teaching can be also seen in Table 9. Comparing these applications to the amount of knowledge they had about ETTS, it was found that only 24% of what the teachers knew about the 10 ETTS items (in Table 4) were applied in their actual teaching.

**Table 9. A comparison between what the teachers know about ETTS and what they apply in their teaching (n = 60).**

| ETTS | A: What teachers know (in Table 4) | B: Application of the ETTS | Ratio (B/A)x100 (%) |
|---|---|---|---|
| Learning cycle | 58 | 25[a] | 43 |
| Discovery learning | 52 | 7 | 13 |
| Constructivism | 39 | 5 | 13 |
| Cognitive conflict/Conceptual change/Generative learning | 33 | 11 | 33 |
| Ausubel's theory | 32 | 5 | 16 |
| Cooperative learning/Jigsaw/STAD | 32 | 11 | 34 |
| STS learning | 25 | 4 | 16 |
| Piaget's theory | 21 | 0 | 0 |
| Inquiry learning | 21 | 12 | 57 |
| Induction/Deduction/Abduction | 18 | 0 | 0 |
| Average | | | 24 |

*Note.* [a] *Twenty-five science teachers mentioned that they had used the learning cycle when teaching science.*

Table 10 shows another gap between teachers' perception of the importance of ETTS and their actual use of ETTS in their teaching. That is, even though the respondents believed ETTS were important for their science teaching (average of importance = 3.98), they did not use ETTS in their actual teaching as much as might be expected based on their perception of the importance of ETTS (average of actual use = 3.26). And this difference was statistically significant ($t = 7.87$, $df = 85$, $p < .01$). According to Table 10, this tendency is observed at all school levels, regardless of the length of teaching experience.

**Table 10. A gap between teachers' perception of the importance of ETTS and practical use.**

| Variable | Importance | Use | Paired t value | df |
|---|---|---|---|---|
| School level | | | | |
| Middle school | 4.05 | 3.30 | 6.13* | 37 |
| High school | 3.83 | 3.15 | 4.68* | 40 |
| Teaching years | | | | |
| Less than 5 years | 3.79 | 2.93 | 6.89* | 26 |
| More than 5 years | 4.00 | 3.39 | 4.72* | 57 |
| Total | 3.98 | 3.26 | 7.87* | 85 |

*Note. $p < 0.01$*

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*The Reasons of the Gap*

For Question 3 in Table 3, 28% of the teachers (24 out of 87) presented the reasons they did not use ETTS even though they knew of various kinds of ETTS. To obtain more detailed information about the reasons, 15 randomly selected science teachers (who did not complete the questionnaire reported in Table 3) were interviewed. The results are summarized in Table 11.

**Table 11. Reasons for the gap between theory and practice (n = 39[a]).**

| Reasons | | Percentage (%) |
|---|---|---|
| External environment | • Curriculum (ex. Too much content to be learned.)<br>• Job condition (ex. Workloads besides teaching are excessive.)<br>• Classroom/laboratory environment (ex. Laboratories or experimental equipment is insufficient. There are too many students in a single class.) | 82b |
| Features of the ETTS | • Irrelevance (ex. ETTS do not reflect actual teaching/learning situations.)<br>• Difficulty (ex. ETTS are difficult to understand.)<br>• No confidence (ex. The effectiveness of the ETTS are uncertain.) | 74 |
| Student | • Students' activity/level (ex. Students are not familiar to new teaching approaches using the ETTS.) | 18 |
| Teacher | • Teachers' effort (ex. Teacher efforts are insufficient.) | 15 |
| Assistance | • Teaching materials (ex. Teaching materials are insufficient.)<br>• Administrative procedure (ex. Administrative procedure is too complicated.) | 8 |
| Others | | 8 |

*Note. [a] In this number, 15 interviewees are added. [b] The percentage is calculated by dividing the number of responses by the number of respondents (39).*

According to Table 11, the reasons for the gap between theory and practice can be classified into five categories. Among these, the "external environment" (32 science teachers; 82%) was the category mentioned most frequently. Excerpts from the interviews are as follows:

> *"When I applied inquiry learning or the cooperative learning model instead of the traditional approach, students… worried about the slow progress of learning (because there are many contents to be learned, but inquiry or cooperative learning requires too much time)."*
>
> *"I have to spend a lot of time handling administrative documents instead of preparing lessons."*
>
> *"In my school, there are only two laboratories; moreover, one laboratory is not well-equipped."*

The above excerpts are closely related to the educational situation in South Korea. Regarding the curriculum, many Korean science teachers criticized the large volume of the required teaching content and, therefore, requested a reduction of the contents in the national science curriculum.

And regarding the teaching environment, Korean science teachers desired a reduction in their excessive workload so that they could focus on preparing study plans.

As the second reason for the gap, twenty-five science teachers (64%) mentioned the irrelevancy of ETTS in their actual teaching as well as the difficulty of applying ETTS. Regarding these points, the following responses were obtained from the interviews.

> "It (in-service course) provides just a general guide for the application (of ETTS) rather than providing more time and opportunities for developing teaching plans for actual application."
>
> "The theories (ETTS) themselves are good, but they are far from reality. Applying them is difficult."

Above responses mean that good teaching needs something more than general, ideal, or theoretical models. That is, teacher needs to consider various aspects of the classroom context, such as teaching situation and facilities, students' learning level and interest, and educational culture, as well as ETTS.

Regarding the second reason for the gap, four science teachers (10%) mentioned "no confidence" in Table 11. The following is an example from an interview: "*When I try to develop my teaching plan using ETTS, I am unsure of whether my plan will be effective for students' learning.*"

As the third reason for the gap, the student aspect was mentioned by 18% of the science teachers. For example, in the interview, the respondents complained that many students showed low motivation and interest, with only passive participation in their learning.

Finally, 15% of the respondents mentioned that some teachers showed insufficient effort in using ETTS in their teaching, and 8% cited insufficient teaching materials and the complex administrative process.

*Supports and Conditions Needed for the Use of ETTS in Science Teaching*

When asked what supports or conditions science teachers desired for their utilization of ETTS in actual science teaching, 94% of the respondents (82 out of 87) gave responses. Table 12 shows the responses, including those of the additional 15 interviewees, and Figure 1 summarizes Table 12.

**Table 12. Supports or conditions needed for actual use of ETTS (n = 97[a]).**

| | Supports/ Conditions | Percentage (%) |
|---|---|---|
| Teaching assistance | • Teaching materials (ex. We need various teaching materials applying educational theories, using easy explanations/ interesting contents/everyday activities/multimedia/ IT materials. We need a more concrete model or kit.) | 76[b] |
| | • Guidance (ex. We need concrete guides developed by teachers' communities, professors, or educators) | |
| | • Sharing system (ex. We need sharing systems using network systems or the internet to recommend examples. We need to observe good teaching.) | |
| | • Laboratory assistant (ex. We need laboratory assistants) | |
| Environ -mental change | • Classroom/laboratory environment (ex. The number of students in a class should be decreased, and learning time or laboratory time should be increased. We need more modern laboratories, and so on. | 58 |
| | • Job condition (ex. Workload or teaching time should be decreased. The number of science teachers should be increased.) | |
| | • Curriculum (ex. Science learning should aim for "improvement of creativity or inquiry" rather than getting high scores on a test. Contents need to be reduced in the curriculum.) | |
| Developing profession | • Training program (ex. We need more long-term in- or pre-service programs to learn teaching skills applying theories in actual teaching. Pre-service course should be more effective.) | 47 |
| | • Community activity (ex. We need professional counseling or coaching. We need to participate in teachers' study club or academic association. Interaction with other teachers is necessary.) | |
| | • Effort (ex. Teacher's effort is necessary.) | |
| | • Role model or leader (ex. A model of a good science teacher is necessary) | |

*Note. [a] Fifteen interviewees are added in this number. [b] The percentage is calculated by dividing the number of responses by the number of respondents (97).*

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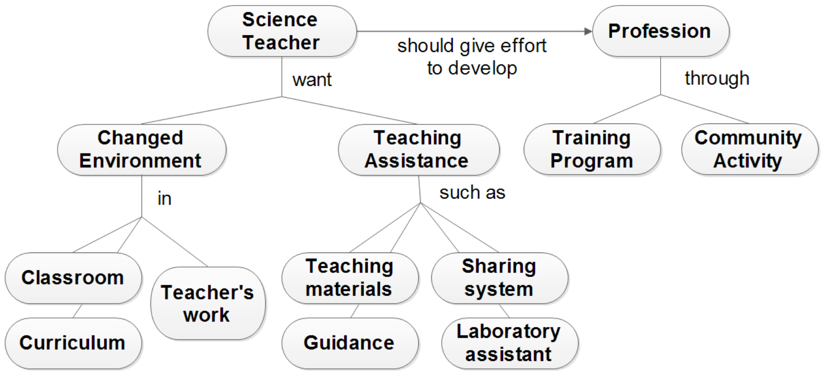


**Figure 1: Graphical summary of the teachers' responses shown in Table 12.**

According to Table 12, supports to diminish the gap between theory and practice can be summarized into three categories: sufficient teaching assistance, change of educational environment, and teachers' professional development. Among these, most of the respondents (76%) wanted various types of effective teaching assistance for the use of ETTS. The following is an excerpt from an interview.

*Teacher:* *We need various teaching materials that can be used immediately.*
*Researcher:* *In fact, I know that many teaching materials are provided to teachers.*
*Teacher:* *This (the reason the materials are not usually used by teachers) may be because teachers need to put in the effort to understand it (the content) first. And also, they (teaching materials) are usually unfamiliar to us; therefore, we have to revise our usual teaching plan (according to the teaching materials).*

Regarding the first support mentioned in the above, a network system can be considered for more direct support for teachers. For example, the internet site "What Works Clearinghouse" is a potential model (http://ies.ed.gov/ncee/wwc/). This site introduces research-based teaching programs with information such as an improvement index, the program effectiveness, and extent of the evidence. While sufficient programs are not yet in place, the intention and format for sharing and distributing developed teaching programs in Korea based on research can be considered positive.

As the second support, 58% of the respondents stated that the environment, for example, classroom/laboratory, job conditions, and/or curriculum, need to be changed for more effective use of ETTS in schools. For example, in the interviews, teachers said, "*We have only two laboratories. Therefore… we need more laboratories to teach more inquiries or experiments"* and *"The amount of content (of the science curriculum) needs to be decreased… to allow more inquiry-based teaching (because inquiry-based teaching takes more time).*"

Finally, 47% of the science teachers responded that efforts and opportunities to improve their teaching profession were needed. For example, in the interviews, some teachers said that, *"An in-service program is good for me… because I can gain (many and various) experiences indirectly from other teachers' experiences… Therefore, I would like to have discussions or conversations with other teachers even during break time*" or *"Teacher community groups or study groups are necessary also. I can learn about easy methods (from other teachers), and it would not take much time (to meet with such a group).*" Interestingly, many of these teachers mentioned an effective in-service program (24 teachers) or a community activity (13 teachers) rather than a pre-service program (only two teachers). From this, it is found that they wanted professional development after becoming science teachers.

**Discussion**

Many educators have noted there is a gap between theory and practice. In this research, only 26% of Korean science teachers in the research sample reported they applied ETTS theories into their science teaching practice. This gap was consistent for teachers at all school levels and with varying years of teaching experience.

To obtain the information about what teachers knew about ETTS and their use of ETTS, responses to Likert-scale items, written responses to open-ended questions, and some simple interviews were analyzed. However, this research only sought to obtain teachers' responses without measuring teachers' actual understanding of ETTS and observing how to skillfully implement ETTS in their actual science teaching. In order for teacher candidates to become public school teachers in South Korea, they must pass a very competitive national exam that asks high levels of questions related to ETTS. For this reason, researchers did not directly measure teachers' knowledge of ETTS. However, the results of this research could be improved by measuring teachers' actual understanding about ETTS and observing their actual teaching in classroom and laboratory.

As mentioned in the introduction, teachers' beliefs can impact on their use of ETTS in teaching in classrooms. This research found that South Korean science teachers' perceptions about ETTS was a critical factor for determining how likely they were to apply any particular ETTS in their own science teaching. That is, teachers who believed that the ETTS was important for actual science teaching in schools tended to use the ETTS more often. This tendency was a little stronger for middle school teachers than for high school teachers. This may be because high school teachers are more likely to rely on didactic teaching methods to prepare students for the college entrance examination.

This research also found that teachers with more teaching experience (number of years in teaching) were more likely to try to implement ETTS in their teaching. However, it is worth noting that the importance of actual teaching practice does not mean that theory is completely ineffectual in schools. Rather, practice should be based on theories. That is, teaching design and development should be based on cognitive and educational theories (Bednar, Cunningham, Duffy, & Perry, 1995, p. 101; Kearns et al., 2010). Hascher et al. (2004, p. 624) noted that "becoming a good teacher requires not only practice but professional learning environments which also foster advance theoretical knowledge."

In this research, it is found that the factors hindering the use of ETTS in science teaching can be classified into five categories: external environment such as too much contents in science curriculum, excessive workload for teachers, and poor learning environment; irrelevancy and difficulty of ETTS; students' low interest in science learning; teachers' insufficient efforts; and ineffective and insufficient assistance. Among them, first two factors can be easily understood because they have been pointed frequently in literatures. Interesting result is that South Korean students' low interest for learning science can hinder teachers from implementing innovative teaching strategies in their classrooms. According to PISA, Korean students are ranked 55th among 58 countries in terms of their general interest in science (OECD 2007, p. 141). This phenomenon is peculiar because they rank very high in science achievement tests: Korean students ranked 6th in Science, according to PISA 2009 (OECD, 2010, p. 529), and 4th according to TIMSS 2007 (Martin, Mullis, & Foy, 2008, p. 35). Therefore, it was found that, especially in Korean situation, special teaching strategies that promote students' interest in science is especially necessary for more effective science teaching and learning.

In addition, for more active use of ETTS, sufficient, cumulative, and reliable evidence supporting certain ETTS are required (Korthagen & Kessels, 1999). Slavin (2008) criticized that "the adoption of instructional programs and practices has been driven more by ideology, faddism, politics, and marketing than by evidence." Biesta (2007, p. 1) also noted that "education should be or become an evidence-based practice and that teaching should be or become an evidence-based profession."

**Conclusions**

This research found that even though Korean science teachers had knowledge of ETTS and they agreed ETTS was important for their science teaching, these teachers' knowledge and positive beliefs did not necessarily translate into the application of ETTS in their teaching practices. Regarding this result, this research found various factors hindering the use of ETTS, and also what conditions or supports are necessary for more effective use of ETTS.

To diminish the gap between theory and practice, the efforts of policy makers, educational administrators as well as teachers are necessary to reduce or delete the hindering factors and to prepare and encourage the supports and conditions for more effective use of ETTS. However, important point is that teachers already know many and various knowledge and skills about ETTS. This means that it is needed to activate the ETTS already known by the teacher, and guide them on the practical application of ETTS in actual teaching situations.

Regarding this, this research suggests an alternative in-service program, that is, the Practical On-site Cooperation Model (POCoM) (Park et al., 2015). In the POCoM, researchers observe science classes directly at first, and cooperate with science teachers to improve their teaching. This cooperation is conducted just after the observation of the classes, and try to activate what teachers already know about ETTS without any pre-determined or pre-developed teaching methods or materials, but with the consideration of the features of the real situation of

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teaching and context-dependent and practical knowledge. Then the science teachers try to apply the improvement ideas discussed in the cooperative meeting to the just next classes. As a result, this research team observed that POCoM was effective to facilitate considerable quantitative and quantitative improvement in science teaching. Therefore, we hope that POCoM will be more widely used for diminishing the gap between theory and practice in education.

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| ***Jongwon Park*** | Ph.D., Professor, Department of Physics Education, College of Education, Chonnam National University, Gwangju, 500-757, Republic of Korea.<br>E-mail: jwpark94@jnu.ac.kr |
| ***Youngmin Kim***<br>*(Corresponding author)* | Ph.D., Professor, Department of Physics Education, College of Education, Pusan National University, Busan, 609-735, Republic of Korea.<br>E-mail: minkiyo@pusan.ac.kr |
| ***Jongseok Park*** | Ph.D., Associate Professor, Department of Chemistry Education, College of Education, Kyungpook National University, Daegu, 702-701, Republic of Korea.<br>E-mail: parkbell@knu.ac.kr |
| ***Jin-Su Jeong*** | Ph.D., Associate Professor, Department of Biology Education, College of Education, Daegu University, Gyeongbuk, 712-714, Republic of Korea.<br>E-mail: jjs@daegu.ac.kr |
| ***Young-Shin Park*** | Ph.D., Assistant Professor, Department of Earth Science Education, College of Education, Chosun University, Gwangju, 501-759, Republic of Korea.<br>E-mail: parkys@chosun.ac.kr |