

## Changes of the Elementary Science Teaching with the Influence of the National Assessment of Educational Achievement

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**Abstract:** In this study, we investigated how elementary science teaching has changed with the introduction of the National Assessment of Educational Achievement (NAEA). Teachers are held accountable for student performance as measured by the mandatory nation-wide standards tests to satisfy the needs of accountability and quality assurance systems. In relation to the teaching of science in the elementary school, professionalism meets potential threats with the advent of national test. Through analysis of the classroom teaching and open-ended interviews, we explored the teacher's concerns about the national test and how their science classes have changed to prepare for this test. According to the results, the national test made elementary teachers accountable for the content of their science classes, limits teachers' autonomy in reconstruction of curriculum, and forced teachers to conduct conclusion-centered lessons even in elementary science classes. In addition, teachers argue that the national test precludes the possibility of differentiated education and differentiated assessment. Based on the results, we suggested a new professionalism in this accountability era, so called 'informed professionalism', which refers to the ability of teachers to interpret and implement curriculum and policy mandates at the local, school and classroom level to generate equitable and improved student outcomes through teaching and learning. We also suggested further research on the teacher professionalism in teaching science contents.

Keywords: accountability, national test, teacher professionalism, informed professionalism, elementary science teaching

### Introduction

Since the mid-1980s the development and implementation of strong accountability systems has been one of the most powerful trends in education policy in many countries including Korea. With increasing demands for more accountability for school and student results, teachers also need to focus more on professional and knowledge-based components (Darling-Hammond, 2000; Wills and Sandholtz, 2009). Preparing teachers for the increasing student diversity in their classrooms is a key priority for education leaders and policy makers. School education needs to adapt to the diversity of the student population through understanding of students' expectations and attitudes. The goals of teaching and learning research are to explore the examples of genuine innovation in teaching methods customized to students' individual

differences including interest, needs, and learning styles (KEDI, 2010). The NCLB policy in Korean context is in line with education welfare that considers the needs of every single student including students lacking basic academic competency and students of multicultural backgrounds. Major government policies directed reforms focused on accountability and improving student performance.

Teachers are held accountable for student performance as measured by the mandatory nation-wide standards tests to satisfy the needs of accountability and quality assurance systems (Darling-Hammond, 2000). In relation to the teaching of science in the elementary school, professionalism meets potential threats with the advent of national test. Teacher professionalism is a social construct which varies across time and place. No matter how good pre-service training for teachers is, it cannot be expected to prepare teachers for all the challenges they will face throughout their careers. Education systems therefore seek to provide teachers with opportunities for in-service professional development

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in order to maintain a high standard of teaching and to retain a high-quality teacher workforce. Teachers these days operate in a climate of quality control which affects their practice. Accountability systems, however, which depend purely on test results leave the teaching quality questionable. The social context, an environment of prescriptive accountability especially in relation to national test could induce de-motivating trends such as a concentration on 'teaching to a test'.

In this research, we endeavored to collect some data on how elementary science teaching has changed with the introduction of the National Assessment of Educational Achievement (NAEA). Also of interest were indications of the status of teacher professionalism in relation to the accountability demand. In this paper we analyzed teachers' views and practices of quality teaching in the elementary science classroom.

## Methods

This research has been conducted as part of a larger study which investigated elementary teachers' science teaching professionalism. In the larger study, we investigated the difference in pedagogical content knowledge (PCK) between secondary science teachers and elementary teachers. To compare the difference, 5 elementary teachers participated in the study where they videotaped their science lessons for a science unit of their choice. The participants were selected among those recommended by their colleagues in the elementary school or graduate school. In addition to 5 elementary teachers who videotaped their lessons, 5 other peer teachers and science educators participated in the research as teaching consultants.

With videotaped lessons, we conducted instructional consulting where the participants analyzed the features of PCK in elementary science teaching and ways to improve elementary school science teaching. Like other PCK research conducted at the KICE, we also utilized video-based discussions (Van Esa and Sherinb, 2008) where teachers and consultants watched videotaped lessons and analyzed the characteristics of the classroom practice through probing questions.

Videotaped lessons provide teachers' learning community with sharable materials and curriculum (Fullan and Hargreaves, 2002). In sum, through the teacher's conference with the purpose of instructional consulting, teachers conduct collaborative inquiry based on the evidence revealed in the videotaped lessons, and they could share reflective experiences, where the videotaped lessons serve as a catalyst to initiate teachers' conversation. Teaching conferences enabled participant teachers to form collegiality and to provide support and advice for one another's professional development. We triangulated these video-based discussions with open-ended interviews with teachers where we tested correspondences between the teacher's PCK as indicated by the interview and that we could observe in the classroom teaching. Open-ended interviews with the participants and group discussions taking place on a regular basis to analyze and compare classes of five elementary school teachers were audiotaped and transcribed.

There was a solid consensus in the data placing teachers' pedagogical content knowledge as an essential component to engaging students successfully in the classroom. The features of the elementary school teacher's PCK are as follows:

Firstly, elementary school teachers teach children while secondary school teachers teach subjects, whereby elementary school teachers are required to educate the student as the whole person. Secondly, elementary school teachers value pedagogical knowledge (PK) above content knowledge (CK). The elementary school PCK requires more of understanding of students and teaching methods that could be applied to diverse subject areas. Thirdly, PCK couldn't be displayed without content knowledge. Fourthly, the teacher's PCK is required for subject-specific teaching (Gess-Newsome and Lederman, 1999; Munby et al., 2001; Shulman, 1986; 1987). Compared with secondary school teachers, elementary school teachers utilize such subjects as Korean language or science to educate students properly. In addition, the elementary school PCK values transfer among subject areas, sets the teaching goals focused on the student's development

as the whole person, and changes its modes in line with students' developmental stages.

In this study, however, we will focus on the changes of elementary science teaching with the influence of the National Assessment of Educational Achievement. Among the results on elementary science classrooms, we will highlight the teacher's concerns about the national test and how their science classes have changed to prepare for this test.

## Results and discussion

Effective science teachers need to understand learning processes in addition to the science content knowledge. Based on the understanding of students' learning methods, teachers decide learning experiences and lesson structures. As a lesson designer teachers make decisions on how to teach. In light of the understanding of learners and learners' needs, the first and most important issue is improvement of students' academic achievement in the national test.

The influences of the national test on the elementary classroom practices are as follows:

1) The national test made elementary teachers accountable for the content of their science classes.

The national test is conducted based on the national curriculum, teachers should ensure the content coverage presented in the national curriculum and the test. The pressure of time, that is covering a given content in a certain amount of time, leads teachers to concentrate more on 'knowing what' rather than 'knowing why' through inquiry activities. Before the implementation of the national test, elementary teachers flexibly reconstructed the science content without any burden of the test. For example, with science activities and experiments it was sufficient to make active and exciting lessons. With the national test, however, elementary teachers should guarantee the knowledge formation through the activity and experiment since the knowledge parts are the focus of the national test. If teachers couldn't accomplish the

concept or knowledge formation through activities in everyday lesson, they should save some time at the end of the unit for content summary and problem solving to make students prepared to the test. Preparing to the test, for the elementary school teachers, means 'teaching not for conceptual or knowledge understanding but for problem solving techniques'.

- Z: One of the side effects of the national test is teachers' teaching to the test. Previously elementary school teachers have taught freely without any burden of content coverage shown in the test; however with the national test results teachers tend to make students solve problems through the cramming and repetition methods, and to retain underachieving students after school for extra study.
- G: To prepare for the test, students are to solve sample questions from previous or mock tests. Teachers tend to teach problem solving techniques at the school level.
- Z: elementary school teachers had freedom in terms of what to teach and content coverage in science lessons. They sometimes omitted some content with lack of time, or conducted science activities for fun without explaining the meaning of the activity. With the national test, however, teachers should reach knowledge formation through the activity unless students are to fail in the test, where students should prove the knowledge and conclusion part of the science activity.

The pressure of time led teachers to maintain that it is not necessary that elementary school students learn the reason why scientific procedures work. Teachers under the assessment regime now operate in a climate of quality control which affects their practice. The social context, an environment of prescriptive accountability especially in relation to national test could induce demotivating trends such as a concentration on 'teaching to a test' (Luke and Woods, 2007). Within this culture, teachers could be seen as 'semi-professionals and recipients of reform policies' (Luke and Woods, 2007). Teachers' professionalism and student learning could be compromised by the enforcement of bureaucratic

accountability agendas.

Elementary school teachers told that they 'couldn't help paying excessive attention on the test result'. In order to meet the demands of accountability, teachers could help teaching to the test, which in turn limits quality interactions with students in science classes.

- A: It's hard to measure good teaching because test results do not always indicate students' understanding level. And there is some pressure to carry out teaching to the test and solving problems.
- B: Test items are designed in a set-up or forced situations, it's difficult to judge students' science understanding.
- D: We become very nervous about what types of test items show up in the national test, and most of teachers approach science lessons and teaching materials with achievement in mind.
- C: The principal emphasize the national test too much since the report shows the school rank and the percentage of underachieving students. These test results are reflected in the assessment of the principal, schools and local education offices, which makes the principal so nervous about the test.

2) The national test limits teachers' autonomy in reconstruction of curriculum or textbook.

The national test made science teaching practices conform to the textbook up to the tedious details, even with the already strict national curriculum. For example, if teachers reconstructed and implemented lab activities on their own without following the textbook prescription by using their professional judgment, their students could be in trouble when the national test items ask experimental procedures and specifics of the activity shown in the textbook.

- A: We skip some experiments since students could experience them in their daily lives and we don't have enough time to conduct all textbook experiments. In that case students would miss science contents related to the experiments. With the national test, we have to pay attention to trifles and minor details that could be shown in the national test items.
- B: For example, students would make mistakes when

they were asked ways to use fountain pen fillers in the national test if we used straws instead of fountain pen fillers in the science experiment. They would miss the test item since they didn't use the instrument. With the national test, teachers could suffer a great loss and should be accountable when they reconstructed and taught differently from the textbook.

- A: We feel so burdened with the national test although I haven't skipped textbook contents or activities. The contents of the test items are from the curriculum so they are not so difficult to solve. When I have tried, however, some alternative experimental methods or tools or tried different activities other than the textbook activities, I could be in trouble. ... I tried those activities and methods because I thought those alternatives are better for my students. The problem is when the test items are about experimental procedures or tools, my students couldn't answer the question. Our national curriculum is too strict compared with other countries.

When teachers reconstructed the curriculum or textbook content in their science teaching, they should 'reserve some extra time and provide summary session with printed materials covering main points in the textbook'. In particular, when two teachers conducted science classes separately, they should come to a compromise in terms of assessment contents and directions.

- A: There are sometimes holes and uncovered contents and then worksheets or summary notes are provided at the end of the unit to supplement the missing contents. Those summary notes are devoted to the textbook so that students do not miss any content in the textbook.
- D: The first priority is textbook coverage for each lesson since we couldn't fulfill the exam coverage unless we meet the textbook coverage schedule.
- A: Since two science-specific teachers teach 10 classrooms and we accommodate each other regarding what to teach and how to teach to prepare the national test as well as school-level tests. If the other science teachers stick to the textbook, I worry about if I missed some textbook content since we will have the same test.

3) Even in the elementary school classes, teachers are forced to conduct conclusion-centered lessons and to cram students with knowledge.

With the lack of time and schedule it is hard to deliver classroom practices as the teacher wants and the classroom teaching eventually degenerated into cramming and memorization. That is, the science teaching becomes test-prep course focused around what's going to be on the exam. Teachers raised concerns about the national test and how the need to prepare for this test restricts opportunities for quality interactions in science classes including process-oriented or inquiry-oriented activities. The participants explained the situation as follows:

- Z: The test would be multiple-choice and short-answer questions so to help students get better scores the lesson centers on conclusion or knowledge cramming.
- B: When you teach respiration for the 6th graders, the movement of diaphragm is not important. Teachers, however, emphasize that so much since that's going to be one the national test. Because students often make mistakes in the mechanism of the respiration, teachers couldn't ignore that part.
- G: If you want boost students' academic performance, it's better to make students solve lots of problems. The more students solve problems, the better their scores are. Frequent exposure to similar problems enhances students' problem solving skills not just for mathematics but for science. Teachers are faced with the dilemma of time allotment for problem solving and test-taking skills.
- D: When I implemented inquiry-based activity, I have students finish their lab note, whereby students have a chance to recognize scientific concept or knowledge relevant to the inquiry activity. Science sessions focused on hands-on activities or inquiry activities feel like missing knowledge part, which makes me nervous. Whenever I conducted activity session, therefore, I have students write down the essential points or conclusion part in their lab notebooks. When the exam comes up, I hope students should go back to the notebook and review it to prepare for the exam. ... Lessons are oriented towards the test where the content and knowledge

of science matters. There are always conflicts but in the end teachers choose the exam and the knowledge. Due to the national test, teachers are pressed for time and content coverage for the test. Since the national test, I couldn't conduct lessons as I wanted. Most of the lessons are degraded to memorization and cramming sessions.

Teachers believed that the pressure on schools to meet their targets and to demonstrate improved student attainment in the national test has had a negative impact on what and how to teach science in the classroom. In particular, the 6th grade teachers felt enormous pressure to prepare their students to the tests. Before the national test, students were unlikely to engage in inquiry or hands-on activities which might slow down their science content coverage. Teaching to the test, however, is against the teacher's professional judgment but is deemed necessary to meet the accountability demands (Darling-Hammond, 2000).

4) The national test precludes the possibility of differentiated education and differentiated assessment.

Unlike the secondary school, the elementary school was free from the academic reports or assessments and teachers could implement differentiated teaching or performance assessment without any burden of grades. The teachers argued that with recent introduction of the national test, however, it is hard to implement differentiated teaching or performance assessment. The participants contended since the national test focuses on the objectives without examining the processes or levels of students, it ruins differentiated teaching or performance assessment that is about to take root in the field.

- B: Thankfully in the elementary school differentiated teaching or performance assessment has been implemented since we are free from the assessment. If it were secondary school, teachers would be in trouble if they implemented differentiated assessment or performance assessment on their own. Process assessment was possible in the elementary school, which was blocked by the national test.

- A: The least important thing is the knowledge centered assessment and even that knowledge is not scientific one but memorized one. The most important things in science are curiosity and interest in natural phenomena and inquiry mind, which could be only assessed through performance assessment.
- B: If we had implemented differentiated instruction then we should have implemented differentiated assessment. Because the starting point is different among students we need performance assessment to examine the attainment as well as the starting point. The national test only examines the attainment, and these days what we taught and what we assess are different.

Overall, there was a feeling among elementary school teachers that the implementation of the national test reinforced the teacher's adherence to the curriculum and textbooks as well as government policies rather than experimenting with alternative teaching approaches including differentiated teaching and learning.

5) We should watch out standards such as standardized curriculum and assessment.

The standardized test is introduced to examine if individual students have reached the national standards set for all students. The US national science standards emphasize inquiry processes rather than discrete knowledge itself by the expression 'less is more', which means it is meaningful for students to delve into one topic and to understand knowledge structure within the context. That is, they value inquiry processes than fragmentary knowledge itself. Having experienced in-depth inquiry on a topic and used data as evidence to support or reject their own explanations helps investigating another topic, which emphasizes development of insights rather than accumulating wide range knowledge. This way of teaching science, in turn, narrows down the content coverage for all students to learn, that is, less is more where students are encouraged to understand concepts rather than memorizing fragmentary knowledge.

The standardized national test is to examine whether students have reached the standardized curriculum

(Barber, 2004). Teachers, however, contended that it can be difficult to assess students' understandings or inquiry abilities using a multiple choice format. It is important to remember a student's high score in the test doesn't indicate her abilities (Wills and Sandholtz, 2009). Teachers therefore should investigate how to design more appropriate assessment tools after implementing inquiry-based instructions. Teachers argued that first of all, we need to remember the national level test couldn't be an ideal assessment.

- G: Even with demands for objective exam results and grades, we need more reliable methods and valid evidence for students' attainment. Taking measurement or producing numerical value is such poor evidence. We need better assessment and better assessment methods where we could assess students' comprehension and understanding rather than reflecting sheer memorization.
- X: In sum, teachers' responsibility is to develop better assessment system. If we need to assess and score students, we need to articulate assessment criteria. For example, we should clarify whether it's grade for efforts or correct answers, what the grade indicates, and what's the relationship between the grade and the student's abilities.
- G: We need to find how to measure what students have learned. After teaching, we should search for the evidence that could prove students' learning through focus group interviews or probing questions.

6) If we want change classroom practices, we need to change assessment at the same time.

The participating teachers contended that classroom practices tend to be that way because of the assessment framework; therefore assessment framework including the national test should change toward thought-provoking and reasoning-oriented assessment. Teachers explained unless the assessment framework changes, the classroom practices are hardly likely to change. These days even elementary school students try to solve a given problematic situation with their knowledge database rather than through reasoning, which makes it urgent to change the science assessment framework towards assessing the student's

inquiry capability.

Conventional multiple-choice or short-answer questions typically ask students to identify facts, concepts, or vocabulary. Such tests have proven too broad in their coverage, too shallow in the depth of reasoning required. The national science tests are more likely to require recognition and recall rather than in-depth reasoning and application of underlying concepts. As such, they can pose a serious obstacle to inquiry-based science teaching. Teachers are less likely to focus on the goals of inquiry if their students' performance is evaluated on a national-level tests that assess isolated facts (NRC, 2007). Furthermore, when large-scale external examinations including the national test take these forms, teachers tend to create similar assessments for their classes (Barber, 2004). The national test, therefore, needs to develop test items that could assess students' inquiry abilities. In other words, teachers argued, the national test should be more aligned with classroom practices and student needs.

- Z: It will be an alternative solution to develop sample assessment tools that encourage reasoning and thinking. If assessment items do not require students thinking, then classroom practices would move toward that direction.
- V: If the assessment items change, the instruction would change correspondingly.
- W: The current results-oriented assessment drives classroom practices.
- C: The national test drives the school to buy workbooks and to solve sample questions from previous tests. If possible, however, the national test should avoid knowledge-oriented assessment tools. At least for science tests, we should be able to assess students' basic inquiry abilities such as abilities of observation, classification, etc. For that purpose, the science assessment items in the national test should be the ones that could be solved through the student's reasoning and thinking.

Teachers raised concerns about the national test and how the need to prepare for this test restricts opportunities for quality interactions in the classroom.

Teachers explained how systems for assessment should be reorganized to better support science learning. There was a solid consensus in the data placing teachers' pedagogical content knowledge as an essential component to engaging students successfully in the classroom (KICE, 2008; 2009). On the one hand, teachers pointed out, if elementary school teachers lack inquiry abilities with inquiry type of questions on the national test, teachers could enforce students to memorize inquiry abilities and processes. Teachers without subject specific expertise limit quality science teaching and learning opportunities for their students. The teacher's lack of expertise on how to manage an active, inquiry-oriented science classroom can lead her to turn to passive tactics that make students busy with workbooks rather than complex tasks that require more skill to orchestrate (Darling-Hammond, 2000). In other words, teachers with science pedagogical content knowledge can facilitate and maximize student learning as they guide students through the skills and procedures of science. In sum, elementary teachers contended that the national test hinders development of students' scientific understanding and inquiry abilities, which they viewed as the core of science classes in the elementary school.

## Conclusions

The results indicate that the movement of test-based accountability through high-stakes standardized test has moved teachers away from teacher professionalism and toward the adoption of standardized practices, which in turn reduces teachers' autonomy and control over their classroom practices (Wills and Sandholtz, 2009). Under the test-based accountability system, elementary school teachers struggled with how to develop students' scientific understanding through activities while also efficiently conveying a body of scientific knowledge specified in the textbook. Moreover, whenever there was insufficient time for scientific activities and discussions, teachers reduced their scientific instruction to transmission of scientific knowledge that present in the textbook. Participant

teachers contended that the introduction of the national test has resulted in narrowing of the curriculum, teaching to a test, etc. (Luke and Woods, 2007). After all, the current climate of accountability appears to reinforce the image of teachers as passive recipients of government initiatives, and conform to the national curriculum and textbooks.

In this concluding section, we will discuss about how teacher professionalism is affected by the national test, based on which we want to establish a new professionalism for elementary teachers.

Firstly, the pedagogical studies should build on a scientific analysis of teacher's work and the knowledge to be mediated in the work. Although different researchers use different terms, such as 'research-based teacher education', 'evidence-based teacher education' or 'teacher as a researcher', what is common to all these definitions is that they all emphasize research knowledge as a basis for all teacher education (Niemi 2002; Wills and Sandholtz, 2009). The nature of a teacher's work is much like the activities of a practitioner-researcher. One of the aims of research-based teacher education is the ability to make decisions based on rational argumentation. In order to do that, the teacher should need knowledge about research-based thinking skills and competences to conduct and understand the research practice. To be effective, teachers should have a chance to develop capacities to interpret research results and evidences. For example, teacher education programs in Finland have emphasized the teacher's research competences and Finnish teacher education programs provide teachers with research competencies (Niemi, 2002). Unless the teacher has her own research experiences, research-based thinking is hardly possible.

Secondly, research-based or evidence-based teacher education means that teacher professionalism is based on scientific knowledge and teachers have capacities to extend their professional capacity through inquiry and critical reflection on their professional practices. Teachers with research competencies mean that they can examine and deepen their knowledge and understanding through experiences and critical

reflections. In addition, teachers should also utilize knowledge construction experiences based on wide professional knowledge base to make reasonable decisions in the classroom. Teachers' learning and professionalism can be effectively translated into improved practice through opportunities for reflection, theory-practice links, and sustained opportunities to apply new knowledge (Feinman-Nemser, 2001; Timperley et al., 2007). Consequently, schools as learning centers provide the context where teachers can experience critical reflection on practice and increase knowledge base for teaching.

Thirdly, teacher professionalism could be enhanced through school-based, inservice training and research in a school-based learning community where teachers research on promoting students' learning. In this school-based learning community, teachers take control of the nature and direction of their professional development. Student achievement can depend more on team collaboration than on a single teacher (Darling-Hammond, 2000). To enhance teaching quality teachers should have ongoing opportunities for application of new teacher knowledge and skills, which requires durable support in the teacher's learning community and extended time as well as the teacher's reflective practices. Through the analysis of critical incidents in a teachers' learning community, teachers can develop both the reflective practice in the analysis of teaching dilemmas and the development of a knowledge base for teaching (Darling-Hammond, 2000; Luke and Woods, 2007).

Teacher professionalism means the teacher's responsibilities to control and develop their own knowledge and actions for the benefit of their clients. What is needed for teachers is to extend beyond standardized test results and scientific claims around a particular pedagogical method. In conclusion, teacher professionalism so called 'informed professionalism' (Luke and Woods, 2007; Barber, 2004) or 'adaptive expertise' (Darling-Hammond and Bransford, 2005) is urgently called for in this assessment regime. The teacher professionalism required for this accountability era is 'informed professionalism' where teachers could



interpret and implement curriculum and policy mandates at the local, school and classroom level to generate improved student outcomes (Luke and McArdle, 2009). That is, teachers are required to implement evidence-based education through analyzing data constantly and choose implementation methods based on the revealed evidences. Teachers with informed professionalism have the capacity to respond to new educational challenges using evidence to engage with and generate innovative and effective approaches to teaching (Barber, 2004).

Informed professionalism requires persistent analysis of the data and the adoption of practice on the basis of evidence. In fact, informed professionalism is an extremely demanding concept, above all because it places responsibility for outcomes firmly in the hands of teachers. The ultimate goal of the informed professionalism is that teachers' professional judgments should inform national decision-making and policies (Luke and McArdle, 2009). The intention of empowering teacher professionalism is to enable teachers to influence the direction of educational reform (Darling-Hammond and Bransford, 2005). Teachers with expertise should act not as passive recipients of government initiatives, but as research-based professionals. Teachers continue to try to find the best way to engage students into quality science education and to allow the test to be more aligned with classroom contexts.

### Further research on teacher professionalism in content teaching

After all, accountability has moved the whole concept of professionalism forward by enhancing professional knowledge about best practice. A desirable accountability system, therefore, should focus on teaching quality. Along with the 'evidence-based teaching', teachers are encouraged to show 'informed professionalism'. To enhance the quality and the accountability of teachers, we need further research in the following areas:

First, we need to raise the teaching competency in a multicultural setting. Recently our society has had concerns about teaching in a multicultural setting and teaching students with special learning needs. Teachers may have to use teaching methods that adapt to meet these needs. However, compared with the government's concern and increasing percentages of students with multicultural backgrounds, teaching in a multicultural setting was a rare concern among teachers and teacher appraisal. We need to conduct more research on the extent of the teacher's professional development needs in these areas, and need to take actions following the identification of the teacher's needs.

Second, we need to develop online professional development programs and nationally known offline teacher training programs. Since the government places teachers at the center of school improvement and accountability efforts of the public education, the educational reform policy focuses on raising teacher performance, which in turn raises students' performance level. Like students, teachers also need customized professional development programs that are accorded to each teacher's needs. In particular, we need to develop an online system to identify best practices which can then be disseminated and adopted.

Third, based on the establishment of the PCK database and research-based teacher education, teaching professionals should make a system where they have an authority in educating and quality-controlling the next generation of teachers. We need to remember that the teacher learning is praxis, where the teacher develops her own concept about teaching and learning through principle-based practices. In this reflective process, previous theory and belief act as reflective tools, which are in turn incorporated into the knowledge base of teaching (Schon, 1983). Research-based teacher education could be another version of raising teaching quality through praxis (i.e., reflective practices).

Finally, we need to investigate the extent to which the teacher's professionalism affects student outcomes. Recently the government puts a high emphasis on student outcomes in teachers' appraisal and feedback.

Thus, we need to collect data on student outcomes and to find critical factors affecting students' learning and outcomes, many of which are policy-relevant aspects of education systems. To achieve complex objectives such as quality of education requires a sound research basis.

## References

- Barber, M., 2004, The virtue of accountability: System redesign, inspection, and incentives in the era of informed professionalism. *Journal of Education*, 185, 7-38.
- Darling-Hammond, L., 2000, Teacher quality and student achievement: A review of state policy evidence. *Educational Policy Analysis Archives*, 8, Retrieved from June 15, 2011, <http://epaa.asu.edu/epaa/v8n1>.
- Darling-Hammond, L. and Bransford, J. (eds.), 2005, *Preparing teachers for a Changing World*. Jossey-Bass, CA, USA, 328 p.
- Feinman-Nemser, S., 2001, From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record*, 103, 1013-1015.
- Fullan, M. and Hargreaves, A., 2002, *Teacher development and educational change*. Routledge, NY, USA, 264 p.
- Gess-Newsome, J. and Lederman, N.G. (eds.), 1999, *Examining Pedagogical Content Knowledge*. Kluwer Academic Publishers, Dordrecht, Netherlands, 320 p.
- KEDI, 2010, School accountability policy and use of student academic assessment data. *KEDI Research Material RRM 2010-03*, 335 p.
- KICE, 2008, Research on Pedagogical Content Knowledge (PCK) in Social Studies, Mathematics, Science and English with Focus on Instructional Consulting for Secondary Beginning Teachers. *KICE Research Report RRI 2008-3*. 348 p.
- KICE, 2009, Research on mentoring system to improve teaching professionalism - centering around Korean language, social studies and science subject. *KICE Research Report 2009-7*, 348 p.
- Luke, A. and Woods, A., 2007, Accountability as testing: Are there lessons about assessment and outcomes to be learnt from no child left behind? *Literacy Learning: The middle years*, 6, 11-19.
- Luke, A. and McArdle, F., 2009, A model for research-based State professional development policy. *Asia-Pacific Journal of Teacher Education*, 37, 231-251.
- Munby, H., Russell, T., and Martin, A.K., 2001, Teachers' knowledge and how it develops. In Richardson, V. (ed.), *Fourth handbook of research on teaching*. American Educational Research Association, Washington, DC, USA, 877-904.
- National Research Council., 2007, *Taking science to school: Learning and teaching science in grades K-8*. National Academy Press, Washington, DC., USA, 348 p.
- Niemi, H., 2002, Active learning-a cultural change needed in teacher education and school. *Teaching and Teacher Education*, 18, 763-780.
- Schon, D.A., 1983, *The reflective practitioner: How professionals think in action*. Basic Books, NY, USA, 384 p.
- Shulman, L.S., 1986, Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15, 4-14.
- Shulman, L.S., 1987, Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57, 1-22.
- Timperley, H., Wilson, A., Barrar, H., and Fung, I., 2007, A teacher professional learning and development: Best evidence synthesis iteration. *New Zealand Ministry of Education, Wellington, New Zealand*, 344 p.
- Van Esa, E.A. and Sherinb, M.G., 2008, Mathematics teachers' "learning to notice" in the context of a video club. *Teaching and Teacher Education*, 24, 244-276.
- Wills, J.S. and Sandholtz, J.H., 2009, Constrained professionalism: Dilemmas of teaching in the face of test-based accountability. *Teachers College Record*, 111, 1065-1114.

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Manuscript received: July 4, 2011

Revised manuscript received: August 29, 2011

Manuscript accepted: September 15, 2011