

Assessing Subject Matter Knowledge of Science Teachers

Wanpen Kamtet
IPST, Bangkok, Thailand
wkamt@ipst.ac.th
Jatupon Ngamman
IPST, Bangkok, Thailand
jngam@ipst.ac.th
Wiroj Liewkongsthaporn
IPST, Bangkok, Thailand
wliew@ipst.ac.th

Supattra Pativisan
IPST, Bangkok, Thailand
spati@ipst.ac.th
Precharn Dechsri
IPST, Bangkok, Thailand
pdech@ipst.ac.th

Abstract: In Thailand, the Office of the Basic Education Commission (OBEC) has launched a policy for assessing teachers' subject matter knowledge since 2009. This policy required in-service teachers from 185 educational service areas took an examination which related to their teaching subjects. For assessing science and mathematics teachers' knowledge, the Institute for the Promotion of Teaching Science and Technology (IPST) was assigned to develop instruments and analyzing testing results. This paper reported only subject matter knowledge (SMK) of lower secondary science teachers. Participating teachers took a science test for two hours. The test consisted of 90 selected-response items covered 8 content areas of science curriculum. Teachers' SMK scores were analyzed to determine levels of science competency, and to identify participating teachers into 3 groups: master, intermediate, and beginner. Percents of teachers in each group were 8.8, 81.1, and 10.1, respectively. A multiple regression analysis was employed to examine relationships between teachers' ages, gender, teaching experience in science, teacher qualification, and teachers' SMK. Results indicated that most of participants had bachelor degrees in science or science education. The average score of those teachers was higher than teachers who had bachelor degrees in other majors. Findings also showed a positive significant relationship between their teaching experience and teachers' SMK.

Introduction

Teachers' subject matter knowledge has been considered as an important component of teaching expertise. As Shulman (1986) introduced three components of content knowledge: subject matter content knowledge, pedagogical content knowledge, and curricular content knowledge. Kennedy (1990) addressed three aspects of subjects: the content of the subject, the organization of the content, and the methods of inquiry used in the subject. These constructs are the core of subject matter knowledge. Research on teaching and teacher education has indicated that several assessments were created to certify and investigate teachers' knowledge. Teacher testing can be provide evidence related what teachers know which associate to professional training and teaching effectiveness (Hill, Lewis & Ball, 2007). Teachers' understanding in their teaching matter also affects students' opportunities to learn (Grossman, 1988; Limpert, 1986).

In Thailand, assessing subject matter knowledge (SMK) of teachers has not been done before. Therefore, this policy has been launched by the Office of the Basic Education Commission (OBEC) under the Ministry of Education since 2009. It required in-service teachers from around the country areas took an examination which related to their teaching subjects. For science and mathematics subjects, the Institute for the Promotion of Teaching Science and Technology (IPST) was assigned to develop instruments and analyze testing results. This paper reported assessment findings of lower secondary science teachers' subject matter knowledge.

Data Collection Procedure

The examination was administrated by each of educational service areas around Thailand. There were 13,385 lower secondary science teachers from 185 educational service areas took a science test. Participants had two hours to complete the test which consisted of 90 multiple-choice items covered 7 content areas of science curriculum: Living Things and Processes of Life, Life and the Environment, Substances and Properties of Substances, Forces and Motion, Energy, Change Process of the Earth, and Astronomy and Space.

Data Analysis

Teachers' scores were analyzed using arithmetic mean and standard deviation to determine level of competency. A multiple regression analysis was employed to examine relationships between teacher's ages, gender, teaching experience in science, teacher qualification, and teachers' SMK.

Results

Participants' backgrounds consisted of gender, highest education degree, and major were displayed in Table 1. Most of the teachers were female. 81% of teachers had bachelor degrees. Around 82% had majors in science or science education. Analysis results found that teachers' ages were range from 23 to 61 years old with an average of 42.7 years. An average of teaching experience was 12.7 years. Teachers' average score and standard deviation were 69.7 and 11, respectively. Table 2 also showed numbers of items, average scores and standard deviations of each content area.

Table 1: Participants' Backgrounds

Gender (%)		Highest education degree (%)				Major (%)		
male	female	Bachelor degree	Master degree	Doctoral degree	Not specified	Science / Science education	Others	Not specified
31.1	68.9	81.0	17.4	0.1	1.5	82.2	15.8	2.0

Table 2: Teachers' average scores

Content areas of science	Numbers of items	\bar{X} (S.D.)
Living Things and Processes of Life	21	16.7 (3.0)
Life and the Environment	5	3.9 (1.0)
Substances and Properties of Substances	17	13.4 (2.6)
Forces and Motion	10	7.6 (2.1)
Energy	19	14.7 (2.8)
Change Process of the Earth	9	7.4 (1.6)
Astronomy and Space	8	5.9 (1.6)
Total	90	69.7(11.0)

Multiple regression analysis (see Table 3) showed that most of participants had bachelor degrees in science or science education. The average score of those teachers was higher than teachers who had bachelor degrees in other majors. Findings also showed a positive significant relationship between their teaching experience and teachers' SMK. However, there was a negative significant relationship between teachers' age and score. It should be noted that female teachers had higher average score than male teachers. But when controlling other variables, the average score of male teachers is higher than female teachers.

Table 3: Results of multiple regression analysis ($R^2 = 19.8\%$)

Parameter	Estimate	Standard Error	t	p-value
Intercept	87.256	0.601	145.085	< 0.001
Age	-0.572	0.013	-43.677	< 0.001
Gender (male = 1, female = 0)	1.361	0.190	7.144	< 0.001
Education level (bachelor degree = 1, higher than bachelor degree = 0)	-1.562	0.226	-6.920	< 0.001
Subject major (science / science education = 1, others = 0)	4.529	0.257	17.615	< 0.001
Teaching experience in science	0.317	0.012	25.571	< 0.001

Assessment results were used to divide participating teachers into 3 groups: master (higher than " $\bar{X} + 1.12 SD$ "), intermediate (between " $\bar{X} - 1.32 SD$ " and " $\bar{X} + 1.12 SD$ "), and beginner (lower than " $\bar{X} - 1.32 SD$ "). Teachers identified in each particular group are required to attend training programs of their levels. Numbers of teachers in each group were 8.8%, 81.1% and 10.1%, respectively.

Conclusion

Research findings suggested that teaching experience and major in science or science education influenced teachers' SMK. These factors could be considered for preparing lower secondary science teachers. Assessment's results gave an overview of teachers' SMK in Science. It should be noted that participating teachers might not competence in all curriculum content areas because what they usually taught only one grade of grades 7-9. Normally, teachers usually perform well in content they taught and low perform in other areas that not frequently used. Teachers' SMK in each curriculum content area could be indicated what teachers know and their level of competency. Their scores also used as evidence for planning in-service professional development.

References

- Ball, D.L., & McDiarmid, G.W. (1990). The subject matter preparation of teachers. In W.R. Houston, M. Haberman, & J. Sikula (Eds.) *Handbook of research on teacher education* (pp. 437-449). New York: Macmillan.
- Grossman, P. L. (1988). *Sources of pedagogical content knowledge in English*. Unpublished doctoral dissertation, Stanford University.
- Hill, H.C., Ball, D.L., Sleep, L. & Lewis, J.M. (2007). Assessing Teachers' Mathematical Knowledge: What Knowledge Matters and What Evidence Counts? In F. Lester (Ed.), *Handbook for Research on Mathematics Education* (2nd ed), p. 111-155. Charlotte, NC: Information Age Publishing.
- Kennedy, M. (1990). A survey of recent literature on teachers' subject matter knowledge. *East Lansing, MI: National Center for Research on Teacher Education*.
- Limpert, M. (1986). Knowing, doing, and teaching multiplication. *Cognition and Instruction, 3*, 305-342.
- Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15* (2), 4-14.