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# Science and Mathematics Teachers' Perceptions and Opinions Related to Professional Development Needs

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## Abstract

*Science and mathematics teachers need to respond to increasingly complex challenges today, such as adapting to a rapidly changing technology-based environment, or teaching many varied student populations. In Mongolia, educational reforms in science require changes in teaching and professional development. This study examines how science and mathematics teachers perceive their development needs by exploring what development needs do teachers identify; how are the evaluation of professional needs and the perceptions of the importance of specific teacher knowledge components related; and whether there are differences among teachers by background variables. Data came from a questionnaire of open and closed items, administered to 203 Mongolian teachers in 2017. The model of teacher knowledge used proved to be appropriate. Of professional development need areas, the declarative domain was most emphasized in open responses, but its dominance disappeared in the closed items. As for background variables, no remarkable differences emerged by gender and length of work experience. By qualification level, perceptions were more heterogeneous regarding procedural knowledge only. By professional status, several differences emerged between sub-samples regarding the declarative domain. The findings indicate that science and mathematics teachers' specific professional development needs may call for more flexibility in compulsorily IST training.*

**Keywords:** *science teachers, mathematics teachers, professional development needs;*

## 1. Introduction

Science and mathematics teachers all over the world face constant challenges in our era of advances in technology. Therefore, constant professional development may be an even more acute issue for them than for other teacher groups. In Mongolia a new core curriculum has recently been implemented, which introduced new contents and necessitated new instructional and assessment methods. While this situation presents new demands, there is little information about teacher development needs in this country [c.f. 14;15]. Diversity within subject teacher groups has not been investigated, although such information would be necessary to design effective in-service teacher (IST) curricula.

Formerly, IST in science highlighted instructional skills rather than decision making, pedagogical knowledge, and reasoning e.g., [6]. Despite the abundant literature, Bouwma-Gearhart's review [1] on the effectiveness of teachers' professional development identified only a few studies about science teachers' perceptions regarding the demands of their professional development. Also, the available publications do not aim to explore this area in depth. Therefore, the objectives of this study are collecting information on the opinions of science and mathematics teachers regarding their own professional development needs related to IST and identifying differences among teachers.

A model of teacher knowledge was synthesized on the basis of the literature. The appropriateness of this model was first investigated. Information on teachers' development needs was collected with closed and open items. This allowed to relate the evaluation of professional needs to the perceptions of the importance of specific teacher knowledge components in practice. Finally, the effect of background variables was analysed. While the closed items showed more similarity, the open-ended responses revealed greater diversity and unexpected emphases. This information can be useful for teacher trainers and educational policy makers.

## 2. Theoretical background

Teachers' professional development is defined by several authors in conceptually similar ways. In this study, this growth is understood in terms of knowledge, skills and attitudes, in accordance with the literature e.g., [3; 5; p.41; 11 p.49; 16].

Researchers usually take a narrower focus and compare opinions of stakeholder groups concerned e.g., [2; 9]. A few studies use statistical methods to map the effect of background variables e.g., [8].

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The OECD TALIS survey showed the influence of some background variables, e.g., gender on status, job satisfaction and self-efficacy [12; p.72]. They also found primary and secondary teachers were significantly different in these aspects, except for their self-efficacy [12; p.85]. They found no significant difference between BA and MA holders in the amount of days devoted to IST. Novice and experienced teachers were significantly different in their expectations from IST. However, novice teachers indicated higher needs in all given areas except for ICT skills. In addition, it emerged that courses and workshops are equally effective to novice and experienced teachers, and these were less effective activities than research or informal dialogue [7; pp.54-55].
Recent empirical studies [e.g., 15] revealed that female teachers reported higher levels of subject matter knowledge and were more aware of using their knowledge in classroom instruction.

## 3. Methods

A questionnaire was administered to a sample of 203 Mongolian secondary teachers in 2017. The sample was nationally representative for gender, length of working experience and teacher qualification level (age M=33.83 years, SD=7.65). The range of teaching experience was from one year to thirty-three years (M=11.21 years, SD=7.3). Teachers with up to seven years of work experience were labelled novice, and they made up 35.5% of the sample. Their responses were compared to the others', labelled experienced teachers. As for qualification level, the sample comprised of diploma holders 4.2% (a BA equivalent in a previous degree), BA holders 68.4% and MA holders 27.4%. As for status in professional progress determined by local and national IST boards; [10], 36.4% of the sample were yet Unqualified. 40.8% were Methodologists and 22.8% were Leading Teachers. No Consulting Teachers were included in the sample, but their number is very small, so their absence did not distort the sample.
The instrument of the study was self-developed [13; Table 2]. The literature on models of teacher knowledge was consulted e.g., [17] Standards of teacher knowledge were compared and analysed e.g., [4] Common components of teacher knowledge were identified. Participants rated these on five point Likert scales (1–least, 5–most favourable) in response to two questions: perceptions of (a) importance of professional knowledge in everyday practice, and (b) necessity to be included in formal IST. Responses were analysed at the item and the domain levels. In addition, an open-ended question was asked regarding development needs. Teachers' responses were analysed to separate the issues they contained. A total of 624 (M=3.5 per person) development issues were found and organized into themes.

## 4. Results

### Research question 1 – the validity of the model

Table 1 shows how teachers' themes and the presented items of the model of teacher knowledge match. With one exception (sustainable development), all themes could be paired with the components of the model used. This exception has only recently become a policy issue in Mongolia.

### Research question 2 – reported development needs

Altogether, 88.67% of the sample mentioned development needs (Table 1). The dominance of the declarative domain is an important signal for pre-service training. Remarkably, one fourth of all responses belonged to pedagogical content knowledge. Many teachers raised issues of subject matter knowledge.

### Research question 3 – the relationship of professional needs and practice

Ratings of the presented knowledge components were analyzed; only domain level results are discussed. Paired sample t-tests showed significant but small differences between the means. However, the correlation analyses indicated a mediate relationship between these two variables. Item level analyses revealed same tendencies.

### Research question 4 –differences among teachers

No remarkable differences were expected and no significant ones were found by gender in the closed items ($p>.05$).
Previous empirical studies consistently found gaps between teacher qualification levels (Bachelor's and Master's). In this study, only small differences surfaced. In addition, there were no significant differences in the opinions regarding the necessity to include knowledge components in formal IST. These findings may be explained by the homogeneity of the sample by subject taught – other empirical studies typically targeted teachers of different subjects.

In this study, even though novice means were somewhat higher, there were no significant differences in the two closed questions between the novice and the experienced groups.
Regarding the three professional status groups, each of them placed great emphasis on the importance of the listed knowledge components in their everyday teaching practice. Methodologists had significantly lower means than the other groups.

Table 1. Presented knowledge components and the frequencies of teacher responses by domain and themes

| Presented teacher knowledge components (Closed items) | Themes (Open-ended responses) | Frequency **(%)** |
|---|---|---|
| Declarative domain totals | | 325 **(52.92)** |
| Knowledge of specific teaching and learning processes in a given content area / in your subject fields | *same* | 152 |
| Knowledge of subject-specific content | *same* | 78 |
| | *Theoretical, advanced subject matter knowledge (for the 10th- 12th grades curricula)* | 74 |
| Knowledge of the psychology of the learning process | *Knowledge of educational concepts* | 4 |
| Knowledge of current educational acts and policies | *same* | 8 |
| | *Knowledge of the new core curriculum* | 9 |
| Procedural domain totals | | 180 **(28.84)** |
| Organizing effective learning groups | *n.a.* | - |
| Selecting teaching methods appropriate to the curriculum and the students' needs | *Instructional methods* | 49 |
| | *Competency and methods* | 47 |
| Motivating students to learn | *n.a.* | - |
| Educational planning skills | *Planning skills (to teach the new core curriculum)* | 21 |
| Educational assessment | *Assessment in the classroom* | 11 |
| Effective use of technologies for facilitating learning ICT | *ICT knowledge* | 39 |
| | *Desire for efficiency in using ICT as an instructional medium* | 3 |
| Classroom management skills | *n.a.* | - |
| Leadership and organization skills | *n.a.* | - |
| Interaction with students, parents and colleagues | *Better communication with students and parents* | 10 |
| Affective domains totals | | 119 **(19.07)** |
| Commitment to promoting the learning of all students | *n.a.* | - |
| Understanding the effect of family background on children's academic development | *Understanding students views and beliefs* | 8 |
| Using information from research to improve practice | *Research methodology knowledge* | 23 |
| Commitment to self-improvement | *Improving self-efficiency; development based on experiences* | 5 |
| | *Wishing to learn about 'best' practices (development opportunities)* | 25 |
| | *Wishing to improve science terminology in foreign languages* | 17 |
| Professional ethics and morality | *same* | 39 |
| *n.a.* | *Including the concept of sustainable development in each lesson* | 2 |
| | **Total number of remarks** | 624 **(100)** |

Note: n.a.= not applicable

## 5. Conclusion and recommendations

About 10% of participants did not answer the open-ended questions. This might have been the result of a lack of experience with empirical studies, or cultural differences in interpreting the task. The questionnaire followed a model of teacher knowledge which was based on international literature. The findings confirm that this model is appropriate for studying teachers.
In the open-ended question, respondents clearly focused on declarative knowledge as a field to be improved. Skills and attitudes received much smaller attention. However, when rating a list of knowledge components from all three domains, the results favoured these latter two.
The evaluation of professional needs corresponded to the perceptions of the importance of specific teacher knowledge components in practice when considering the opinion of the sample as a whole. However, at the individual level, there are great differences. Given these results, it is possible that teachers participate in IST with greatly varied motivations.
As for differences among teachers by background variables, similarly to previous empirical studies, no remarkable differences were found within the sample. The clearest differences were found by professional status; these concerned skills and attitudes. These may be attributed to the overlap

between higher professional status and expert knowledge. Interestingly, Unqualified and Leading teachers had similar outlooks on formal IST. Methodologists seemed less confident about such professional development.

The findings indicate that science and math teachers' specific professional development needs may call for more flexibility in compulsory IST. The following considerations may be of interest to teachers, trainers and policy makers: Modular curricula could be used; IST instructional methods based on active learning could be strengthened; Various forms of assessment could also be offered; Discussing and sharing best practices by teachers and schools could be encouraged; and The use of various communication channels (off-line and on-line) could be helpful.

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## References

[1] Bouwma-Gearhart, J. Science Faculty Improving Teaching Practice: Identifying Needs and Finding Meaningful Professional Development. *International Journal of teaching and Learning in Higher Education, 24* (2), 2012, 180-188.

[2] Chval, K., Abell, S., Pareja, E., Musikul, K., & Ritzka, G. Science and mathematics teachers' experiences, needs, and expectations regarding professional development. *Eurasia Journal of Mathematics, Science & Technology Education*, *4*(1), 2007, 31-43

[3] Day. C., & Sachs. J. (Eds.). International handbook on the continuing professional development of teachers. McGraw-Hill International, 2004

[4] DfE. Teachers' standards: Guidance for school leaders, school staff and governing bodies. [UK] Department for Education, 2013.

[5] Glatthorn, A. Teacher development. In: Anderson, L. (Ed.), International encyclopaedia of teaching and teacher education (second editions). London: Pergamon Press, 1995

[6] Guerriero, S. (ed.) Pedagogical Knowledge and the Changing Nature of the Teaching Profession, OECD Publishing, Paris, 2017

[7] Jensen, B., et al. The experience of New Teachers: Results from TALIS 2008, OECD Publishing, 2012

[8] Lyons, T. More equal than others? Meeting the professional development needs of rural primary and secondary science teachers. *The Journal of the Australian Science Teachers. 54*(3), 2008, 27-31.

[9] Mansour, N., El-Deghaidy., Alshamrani, S., Aldahmash, A. Rethinking the Theory and Practice of Continuing Professional development: Science Teachers' Perspectives. *Research in Science Education Journal, 44*(6), 2014, 949-973.

[10] MES. Bagšlax èrx, mèrgèžlijn zèrèg olgox, xasax žuram A/305. [Teaching certification rule for allocating professional degrees A/305]. Ulaanbaatar, Mongolia: Ministry of Education and Science, 2013, Retrieved from http://www.legalinfo.mn/annex/details/6168?lawid=9745

[11] OECD Creating Effective Teaching and Learning Environments: First Results from TALIS, 2009, Retrieved from https://www.oecd.org/edu/school/43023606.pdf /

[12] OECD Supporting Teacher Professionalism: Insights from TALIS 2013. Paris: OECD Publishing, 2016, doi: http://dx.doi.org/10.1787/9789264248601-en

[13] Purevjav, D., & Molnár, E. K. A Pilot study of needs assessment for in-service teacher training Molnár, G. & Bús, E. (Eds.) *CEA 2016 14th Conference on educational Assessment: Program*, 2016, p. 138.

[14] Purevjav, D., & Molnár, E. K. What do teachers learn from in-service teacher training? Molnár, É. & Vígh, T. (Eds.) *CEA 2017 15th Conference on Educational Assessment: Program*, 2017a, p. 82.

[15] Purevjav, D., Kis, N., & Molnár, E. K. The relationships of background variables and teachers' perceptions of their professional knowledge and development needs. Molnár, É. & Vígh, T. (Eds.) CEA 2017 15th *Conference on educational Assessment: Program*, 2017, p. 51.

[16] Schleicher, A. *Building on High-Quality Teaching Profession: Lessons from around the world*, OECD. Publishing, 2011, Retrieved from http://dx.doi.org/10.1787/9789264113046-en

[17] Shulman, L. Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review 57*(1), 1987, 1-23.