Measuring the Pedagogical Content Knowledge of the Third Grade Primary School Math Teachers

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Abstract

Teachers' knowledge is one of the main dimensions of their professional competencies. Among the different types of teachers' knowledge, having pedagogical content knowledge (PCK) has a special place due to its uniqueness for playing the role of a teacher and its effect on the students' performance. This study aimed to assess the PCK of the third grade primary school math teachers. The research population included all Iranian third grade primary school teachers, from which ۳۳۰ teachers were selected as the sample using stratified random sampling from four provinces of Khorāsān Razavi, Gilān, Yazd and the cities of Tehran province. Their knowledge was measured using standardized questions of the TEDS-M study. The quality of the tool was found to be appropriate based on the correlation of each question with a total score from ۰,۱۹٤ to ۰,۷۱۲ and the range of difficulty of the questions between ۰,۱٦۳ and ۰,۹۰٤. The results showed that the mean PCK of the third grade teachers is lower than the scale's midpoint. Consistency of the obtained score with the math performance of primary school students in TIMSS strengthens the possibility of a relationship between these two variables. Also, the knowledge of male and female teachers and teachers working in governmental and non-governmental schools did not differ. However, teachers with a bachelor's degree and higher had more knowledge than teachers with lower degrees. Also, teachers with the field of primary education showed less knowledge than teachers whose field was in areas other than primary education. Finally, the relationship between the teachers' age and working experience with their knowledge was negative. The last two findings contradicted the usual expectations.

Keywords: Teacher's Competence, Teacher's Knowledge, Pedagogical Content Knowledge (PCK), Survey, Mathematics (Math)

Introduction

The main motivation of Pedagogical policies in teacher training is to increase the quality of teaching and, as a result to improve the quality of students' learning. Professional competencies are the key element in improving the quality of teaching. Competence is considered a latent manifestation that empowers individuals to become proficient in job-related tasks (Blömeke & Delaney, ۲۰۱۴), which could be in the form of cognitive abilities, beliefs, and values. Teachers' knowledge forms one of the main cognitive abilities of cognitive competencies. The importance of teachers' knowledge is due to the role it plays in developing students' abilities. It is assumed that through keeping the other factors constant, students with more knowledgeable teachers would perform better at school.

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The roots of recognizing the knowledge needed for teaching go back to Lee Schulman's reflections. Schulman (۱۹۸۷, Quoted from Tatto et al., ۲۰۰۸) considered three categories of knowledge necessary for teachers: curricular knowledge, , and PCK. This categorization became the basis for later reflections on the types of knowledge required by teachers and, despite subsequent suggestions, became more popular among educational experts. Later, the addition of task knowledge (Chapman, ۲۰۱۳; Izadi and Reyhani, ۱۳۹۹) or technology knowledge (Hansson, ۲۰۱۳) was also suggested to the teachers' knowledge collections.

Pedagogical knowledge includes understanding how topics are organized over time. This knowledge consists of components such as pedagogical curricular knowledge including knowledge of teaching materials and resources, PCK including the knowledge of methods of demonstrating concepts and procedures, and pedagogical instructional knowledge including knowledge of educational strategies and classroom organizational models (Fan & Cheong, ۲۰۰۲; Quoted from Tatto et al., ۲۰۰۸).

In addition to the above knowledge, one of the oldest comments on teacher knowledge has been made by Dewey: Teachers should be familiar with the nature of inquiry into the subject they teach (Askew, ۲۰۱۴). This sentence shows that the first expectation from teachers' knowledge is having content-oriented knowledge or content knowledge. This knowledge is a set of basic assumptions, definitions, concepts, and procedures that forms the ideas learned (Tatto et al., ۲۰۰۸) and for this reason it is known as the cornerstone of teaching (Askew, ۲۰۱۴). Of course, the content knowledge of something like mathematics not only does not cover the actual knowledge of mathematics, but also the conceptual knowledge of structuring and organizing mathematics as a discipline. It also covers why a particular approach is important, and where it stands in the range of mathematics approaches (Blömeke & Delaney, ۲۰۱۴). Subsequent descriptions of this knowledge have identified two subtypes of this knowledge, which include general content knowledge and specialized content knowledge. General content knowledge includes knowledge that goes beyond teaching, it is used in any situation and it is relevant to the content of the curriculum. This subset includes the ability to present the correct solution to mathematical problems, to know mathematical concepts and procedures, to identify students' incorrect answers, to identify inaccurate definitions presented, to make proper use of oral and written symbols and terms. However, specialized content knowledge goes beyond what is expected of a person who has completed general education. In other words, the reasons and technical justifications of mathematical subjects are followed in this knowledge (Mortāzi, Mehrabāni & Gholāmāzād, ۲۰۱۵).

PCK is a mixture of the subject being taught and pedagogy and it is considered a unique for teachers in terms of professional perception. That is, teachers need to know about students' prerequisites and how to present a topic in its best form. This knowledge is confused with the professional knowledge of teachers because it is similar to the teachers' general knowledge. However, it should be noted that PCK refers to the interaction of content knowledge with the pedagogical field that produces different outcomes and a specific field that is not the primary expertise of teachers. In sum, the methods of presenting and framing the subjects in a way that they could be understood are in the field of PCK (Loughran, ۲۰۱۴). Knowing the useful forms of displaying these ideas; strong comparisons, examples, and explanations; explanations that

make learning certain topics simple or easy; concepts that students bring to the learning process at a certain age or with a certain background; and performing activities that go beyond simple transfer of information fall within the realm of this knowledge (Tatto et al., ۲۰۰۸; Loughran, ۲۰۱۴). Knowledge on mathematical content is also included in this knowledge. Knowledge with which teachers should be able to select the content that is appropriate, simple, and relevant to the teaching strategies that remove learning difficulties or barriers that have led to misunderstanding the major math topics.

Knowledge of the methods that students learn is also influential in this selection. Such knowledge requires reviewing the students' responses, and teachers should ask questions of varying complexity that identify misconceptions, provide feedbacks, and react with appropriate strategies (Blömeke & Delaney, ۲۰۱۴).

Although the relationship between teachers' knowledge and students' performance seems evident at first glance, however, contradictory approaches have been presented in this regard. In a longitudinal study conducted in Germany, a significant effect of teachers' PCK on students' academic achievement has been observed, the effect which is distinguishable from the effect of general mathematical knowledge and the other factors such as membership in different types of schools (Blömeke & Delaney, ۲۰۱۴). Also, comparing the results of the TEDS-M study with the TIMSS showed many similarities among the ranking of countries in these two studies (Tatto et al., ۲۰۰۸). Moreover, review of studies conducted in this field showed that there is a strong relationship between subject knowledge and students' academic achievement, so that any standard deviation of the difference in the teacher knowledge has as much as ۲–۳ weeks of additional instructional time affecting students' math performance (Hill, et al., ۲۰۰۵; Quoted from Blömeke & Delaney, ۲۰۱۴). Although, there is evidence that there is no relationship between these two variables (Askew, ۲۰۱۴).

As mentioned before, PCK is a unique knowledge for teachers, and its importance is due to the emphasis on conveying the content taught to learners (Mavhunga, ۲۰۱۴). Because the PCK is different in each topic, the nature of PCK is highly dependent on the subject being taught. However, the conveying process is repeatable for each topic, and the same considerations are seen in all topics. Some authorities believe that PCK develops over time through trial and error, and that its uniqueness conflicts with teachability (Mavhunga, ۲۰۱۴). However, this view is not consistent with extensive studies which makes it possible to teach this knowledge through highlighting its constituent components. The latter view is followed by two groups that have directly measured teacher's knowledge: one at Michigan State University, which designed the study of teaching mathematics in the ۲۱st century, and the study of teacher education and development: learning to teach mathematics and the second one, i.e., a group who act from the University of Michigan in the context of ‘‘Learning Mathematics for Teaching (LMT)’’ (Blömeke & Delaney, ۲۰۱۴). It should also be noted that in projects that are implemented to assess the skills of teachers to select and recruit them, the assessment of teachers' knowledge forms part of these studies, which can include Praxis, Interstate Teacher Assessment, and Support Consortium (InTASC), and National Board for Professional

Teaching Standards (NBPTS, Tatto et al., ٢٠٠٨). Despite these efforts, there are many challenges in assessing teachers' knowledge, and there is no complete consensus on its measuring. These challenges include the lack of common theoretical foundations, limitations in measuring competencies such as cost and time, the difficulty of generalizing the results from one situation to another, and the emergence of test validity problems (Blömeke & Delaney, ٢٠١٤).

PCK has constituent components and dimensions. In Schulman's view, different types of PCK have been expressed which include three types of knowledge: propositional knowledge, containing students' errors or misconceptions without being related to a specific classroom context; case-based knowledge that includes prototypes, borderline cases, and analogies based on the individuals' experiences; and strategic knowledge for situations involving the teacher with what is going on in the classroom (Blömeke & Delaney, ٢٠١٤).

Other researchers identified five components as subsets of PCK: students' prior knowledge such as their misconceptions; items that have remained silent in the curriculum; knowledge of what makes a topic simple or difficult; shows like analogies; and the conceptual teaching strategies (Mavhunga, ٢٠١٤). Later, another categorization of PCK was introduced which included content knowledge and student, content knowledge and teaching, and content knowledge and curriculum. Content and student knowledge combine knowledge of student and knowledge of mathematics. Content and teaching knowledge refer to a combination of mathematical knowledge with teaching knowledge, which includes choosing a poster to support teaching. Another case of knowledge has been mentioned in the content and curriculum knowledge (Ball et al., ٢٠٠٨, Quoted from Blömeke & Delaney, ٢٠١٤). Elsewhere, however, PCK has been considered to consist of four types of contextual, student knowledge, content, and pedagogical knowledge (Mavhunga, ٢٠١٤).

In the studies designed to assess teachers' knowledge, a specific classification of PCK has been expressed. For example, in the TEDS-M research, three sub-domains of math curriculum knowledge, the knowledge of planning to select the appropriate activity, and math demonstration for teaching and learning have been considered. In the sub-domain of curriculum knowledge, issues such as knowing math curricula, creating appropriate learning objectives, identifying key ideas in the learning plans, choosing possible paths, and considering connections within the curriculum, knowing different forms and assessment objectives are covered. In the sub-domain of knowledge of planning to choose the appropriate activity of teaching and learning mathematics, the following are under consideration: predicting students' common responses including their misconceptions, planning appropriate methods for demonstrating math ideas, linking teaching methods and instructional plans, identifying different approaches to solve math problems, and selecting assessment forms and questions. In the sub-domain of math demonstration for teaching and learning; there are things like explaining or demonstrating math concepts or procedures, developing helpful questions, recognizing students' questions such as their misconceptions, analyzing or evaluating students' math solutions or discussions, analyzing the content of students' questions, answering unexpected math questions or topics, and providing appropriate feedback (Tatto et al., ٢٠١٢; Ingvarson et al., ٢٠١٣). In a project called COACTIV and conducted in Germany, three aspects

of the professional knowledge of math teachers were defined, including knowledge of math tasks, knowledge of students' misconceptions and difficulties, and knowledge of math-specific teaching strategies (Tatto et al., ۲۰۰۸).

From what has been said, it could be concluded that teachers' mathematical knowledge is the most important source of mathematics teachers and should be considered. Given that there is little evidence about primary school teachers' knowledge using the representative samples (except for math task knowledge and content knowledge about the concept of fraction among ۱۳۷ primary school teachers in Tehran by Izadi and Reyhāni (۲۰۲۰) and the content knowledge and PCK about the concept of fraction among ۲۵۶ fifth and sixth-grade teachers by Kāzemi et al. (۲۰۱۹), doubts about the amount of teachers' knowledge along with its role in students' academic achievement is a serious challenge to educational planners and policy makers. This study tries to provide evidence for eliminating the first part of the above doubts and measure the level of teachers' PCK. Separately comparing the amount of knowledge in subgroups of teachers including their gender and teaching experience, types of schools (governmental and non-governmental), and the field of study and degree of teachers' education are the other objectives of this study.

Research methodology

A- Participants: The research population included all the teachers working in the third grade of primary school. The sample was selected through a stratified random sampling method. Several steps were followed to select the sample. In the first step, four provinces were chosen through cluster sampling. All provinces were divided into four clusters based on the percentage of private students, percentage of rural students, number of students, per capita student index, and building utilization index.

The first cluster included Khorasān Razavi, Khuzestān, and Tehrān provinces; the second cluster included Kermān, East Azerbaijān, West Azerbaijān, Sistān and Baluchestān, Fārs, Alborz, and cities of Tehrān province; the third cluster included Mazandarān, Isfahān, Hamedān, Kurdistān, Hormozgān, Guilān, Kermanshah, Lorestan and Golestan; and the fourth cluster were the provinces of Yazd, Bushehr, Zanjān, North Khorāsān, Chāharmahāl and Bakhtiāri, Markazi, Qazvin, Qom, Ardabil, Kohkiluyeh and Boyer-Ahmad, South Khorasān, Semnān, and Ilām. From each of the above clusters, Khorāsān Razavi, Guilān, Tehrān, and Yazd provinces were randomly selected, respectively.

Then, five educational districts were selected from each of the provinces. The probability proportional sampling method was used to consider a more reasonable chance of being located in more extensive and more populated areas. The technique was to determine the number of students in each area, and then, based on regular intervals among students, five students were selected. The educational district of each of these students was used as the selected educational district in the research project. After selecting educational districts from among the primary schools with third grade, about ۱۵ schools were selected using a regular random sampling method.

Considering the balance among the small size of the sample and also the facilities related to their gathering in one session, it was decided that in schools with three and less than three third grades, all third grade teachers should be called, and in schools with more than three third

grade students, three teachers were selected by the school principal to complete the questionnaire. Thus, about ۱۵ to ۲۵ third grade teachers in each region and about ۷۵ to ۱۲۰ teachers from each province participated in the research. According to the mentioned arrangements, ۳۳۰ teachers participated in the study. This number was associated with ۷۵,۹۸٪ participation, with the highest participation in the two provinces of Guilān and the cities of Tehran province and the lowest participation in Khorasān Razavi province.

Sampling weight was used to assign the appropriate weight to each of the selected samples. The overall weight of the sample indicates the representativeness of each member of the sample than the individuals in the community. That is, a total weight of ۳۳۲ indicates that the teacher in question represents ۳۳۲ teachers in the statistical population. Teacher sampling weights included multiplication of several components such as baseline weight (inverse probability of teacher selection in the community) and sampling weights (based on a three-step procedure including calculation of area, school, and teacher selection probability).

B- Instrument: The published PCK questions of the TEDS-M study were used to measure the teachers' PCK. It consisted of **۱۳** questions, **۵** of which were multiple choice and eight answered questions. These questions were about numbers and algebra, geometry, and distributed data. Two-string or polyserial correlation was used to evaluate the quality of the question. Based on the obtained results, a range of correlations from **۰,۱۹۴** to **۰,۷۱۲** was obtained, based on which the quality of the questions was generally considered appropriate. The questions' difficulty level was also examined based on the rate of answering them, and the results showed that the range of difficulty of the questions is between **۰,۱۶۳** to **۰,۹۰۴**.

C. Assurance of the data quality: Numerous analyzes were performed on teachers' data to ensure their quality as much as possible. This was done as a guarantee of data quality and before analysis, in the form of two basic activities. The first was to examine the rate of white responses (without each individual's responses), and the second was to examine similar response patterns. Since the data collection stage was conducted and monitored directly by the researcher in the form of group completion sessions of the questionnaire in the regions and provinces, there was great confidence in the data quality. However, subsequent analyzes to ensure data quality were unavoidable because it was possible to consult respondents. Especially since it was possible for teachers not to answer some of the questions, another explanation was that they tried to persuade teachers to answer the questions accurately with incentives such as certificates.

Analysis of teachers' answers showed that ۳۰ people (۸,۸٪) did not answer the section related to PCK questions. Failure to respond to this section can be attributed to the explicitness of these questions in the direct assessment of teachers' knowledge and the feeling of danger or insecurity of teachers from their accurate information and knowledge. In addition, the study of repetitive response patterns was one of the cases that were used as a criterion for assessing the quality of data.

Since the process of completing the questionnaires was directly monitored, it was ensured that one person completed no items such as completing mass questionnaires. Still, doubts about consultation among teachers based on reviewing response patterns by grouping or filtering the

place of completion of the questionnaire (province or region) found that the response pattern of ۱۸ patients (۵,۳٪) was similar. Since accurately determining the uniformity of response patterns requires a qualitative examination of the responses and not merely reliance on correction codes, similar response patterns were not omitted, but the probability of overestimation was considered in interpreting the results of these questions.

Findings

In order to determine the status of PCK of third-grade teachers, ۱۳ designed questions were used. Due to the fact that some questions had one and others had two scores, the total score of the test was more than the number of questions, and it was ۱۷. The mean scores of PCK among teachers based on the score of ۱۷ were ۶,۶۹۵, and its standard deviation was equal to ۲,۵۶۳. These scores have been obtained with minimum and maximum of ۰, and ۱۴ and its skewness and kurtosis are ۰,۰۷۴ and -۰,۱۳۱, respectively, indicating its normal distribution.

The above values show that the obtained mean is lower than the theoretical mean of the PCK Scale (۸,۵). The minimum and maximum values also confirm this so that the minimum score among the scores is the same as zero on the theoretical scale. Still, the full score is less than the total possible score of the scale. This means that no one has received the top score. A single-group t-test was used to evaluate the significance of the difference obtained from the theoretical mean of the scale. The results of this study showed that the value of t-statistic is equal to -۸,۷۸ with a standard error of ۰,۱۳۲, which is a significant value. As a result, it could be concluded that third-grade primary school teachers have a low PCK (lower than mean) for teaching math topics. Subgroup comparisons could be one of the topics that help to understand more accurately how to acquire PCK. The table below shows the types of these comparisons.

Table ۱. Subgroup comparisons in terms of teachers' pedagogical content knowledge (PCK)

Type of comparison	Level	Number	Mean	t	Df	Significance	Standard deviation
Being employed in an urban or rural school	urban	243	6.74	-1.248	292	0.213	0.397
	rural	50	7.24				
Type of school	Governmental	265	6.80	-0.234	292	0.815	0.496
	Non-governmental	30	6.92				
Gender of teacher	female	303	6.64	-0.824	369	0.411	0.346
	male	68	6.92				
Relevance of the field of study	unrelated	217	7.05	3.212	374	0.001	0.265
	related	158	6.20				
Educational status	Under bachelor	169	6.20	-3.424	374	0.001	-0.897

	Bachelor and higher	207	7.10

In this table, it is clear that there is no difference in the PCK of teachers working in rural and urban schools, government and non-government schools, and male and female teachers and this group of teachers have the same amount of PCK. However, there is a significant difference between primary education teachers and others. The strange thing about this study is that teachers with a degree in primary education are weaker than teachers with a degree in other disciplines in terms of mastering the PCK of mathematics, while the opposite was expected. The results also showed that teachers with a bachelor's degree or higher are more proficient in PCK compared to teachers with an associate degree. The last analysis is related to the relationship among teachers' PCK scores, their age, and working experience.

Table ۲. Correlation of teachers' age and working experience with pedagogical content knowledge (PCK)

	Teacher's PCK
Teachers age	-0.270**
Teacher's experience	-0.214**
Experience in teaching third-grade	-0.173**

The above table results show that teachers' PCK has a significant negative relationship with age, teaching experience, and teaching experience in the third grade. This means that the less the teachers' age and working experience, the more PCK they have. Therefore, younger teachers have more knowledge of how to teach math topics to students.

Discussion and conclusion

Appropriate professional knowledge is one of the most important dimensions of teachers' competencies. Teachers' knowledge also includes a set of necessary knowledge for teaching, among which PCK is a special knowledge for teachers and therefore is of special importance for this group. In this study, the measurement of PCK of primary school teachers was intended. For this purpose, after extracting the questions, the math PCK in accordance with the content of the third-grade primary school mathematics textbook out of the study of teacher development and education in mathematics (TEDS-M), a representative sample consisting of ۳۳۰ third grade primary school teachers in four provinces of Khorāsān Razavi, Guilān, Yazd and the cities of Tehran province were selected. They were asked to answer the questions.

After scoring the questions and analyzing the data, the results showed that, in general, the teachers' math PCK is not acceptable; With the description that the mean score of teachers is significantly lower than the middle score of the scale. In addition, the results of the comparison of teachers' subgroups showed that most of the comparisons related to different classes were not statistically significant. These comparisons included the employment of teachers in urban or rural schools, the type of employed school (public or non-profit schools), and the teacher's gender. However, teachers with a bachelor's degree or higher had shown more knowledge than teachers with an associate degree. Also, teachers with the field of primary education showed less knowledge than other teachers whose field was in areas other than

primary education. Finally, teacher's age and teaching experience in general and teaching experience in the third grade had a significant negative relationship with teachers' PCK in mathematics.

Among the considerable results of this study was insufficient PCK of teachers. Since this knowledge is one of the main requirements of a teacher, its inappropriate status could, to a large extent, have adverse consequences on the students' performance. The fact that teachers do not have enough mastery of the knowledge specific to them and vital to their work could bring great concern for all those who strive to develop the quality of education. The obtained scores could be compared with the performance of Iranian students in the only study that currently measures the educational quality of Iranian students at the primary school level (TIMZZ study).

Although the scales of these two studies are not consistent with each other; TIMSS's study was performed in the fourth grade and the present study in the third grade, but in general, the results of both studies show that both students 'math academic achievement and teachers' math PCK are lower than the midpoint of their scale. In other words, not wanting to consider the two findings essential to each other, we could conclude that the current state of the quality of students' learning in mathematics can be, to some extent, the result of their teachers' insufficient knowledge. Although the knowledge of fourth-grade teachers has not been measured separately to examine its relationship to the TIMSS study results, there is no reason to think that the knowledge of third-grade teachers is different from that of the fourth-grade ones. Therefore, from the result of this study, we can estimate the PCK of fourth-grade teachers.

Compared to the results of the TEDS-M study, the results showed that in the countries that have a high performance in the TIMSS study, the mean PCK of their teachers in the TEDS-M study was higher than the midpoint of the scale. For example, Russia, China, Taipei, Singapore, and the United States are among the countries where the mean PCK of their primary school teachers is above the midpoint of the scale. The TIMSS study also has higher-than-mean academic achievement, while Chile and Georgia both have a mean lower than the midpoint of the scale (Tatto et al., ۲۰۱۲). Of course, there are some exceptions, such as the mean PCK of teachers in Spain and Thailand, which is not entirely consistent with the recorded mean scores of students in these countries in the study of the TIMSS. These studies show that there is consistency between teacher's knowledge and students' academic achievement that even if we do not consider the two to be related to each other, at least show that the flow of education takes place in an environment where many factors, including these two variables, are weak.

One of the unexpected results of this study is the lack of knowledge of teachers who have studied in the relevant field. The relevant field in this study was considered primary education. It is assumed that teachers who have studied in primary education have more preparation and knowledge to teach primary school students. For this reason, when formulating recruitment policies, the emphasis is placed on the appropriateness of teachers' field of study with the subject being taught. However, the results of this study showed that this group of teachers not only do not have a special advantage in terms of PCK compared to the other groups, but also are less informed than them. If this result was being obtained for the other sciences, especially in terms of subject knowledge, its explanation could be more justifiable due to the general weakness of humanities graduates as well as the field of educational sciences and primary

education in mathematics. however, explanation of weakness in the PCK which is the basis of teacher's learning and experience is very difficult. This finding could probably be related to fundamental problems in teacher training. For example, training primary education teachers to teach math is limited to a course on "content analysis of math textbooks" (formerly known as the math teaching method), in which the page-by-page review of books and the explanation of the best way to teach the concepts of that page are emphasized. In this form of education, there is no opportunity to explain the other aspects of the PCK, such as the misunderstandings of primary school students in any of the concepts and preferred methods to eliminate these misunderstandings. In other words, cases such as the gradual process of teaching each concept, empowering teachers to design multiple explanatory methods, and providing teachers with a treasury of solutions to overcome lack of learning are among the things that are neglected or not emphasized in this method of teacher training. As a result, the PCK of teachers does not improve well. Of course, along with these justifications, it could be hypothesized that the teachers who stated their field of study as primary education are teachers who did not continue their education, and they had started their last degree of education. Among primary school teachers, some may have continued their education and studied in the other fields due to the limited development of the primary education field at higher levels. When describing their field of study, this group states the other disciplines based on their last degree of education. In contrast, in the first group, they have studied for primary education and may have been motivated to continue their education due to more cognitive and mental prominence.

In addition to this result, the negative relationship between age and teaching experience with teachers' PCK should be considered. This finding shows that having experience as a source of PCK has not been able to increase teachers' knowledge, as expected. Perhaps this is because teachers do not experience many opportunities to challenge the previous practices and learnings. This leads to having the experience be used to repeat previously learned methods rather than expanding a treasure of educational measures. In this case, teaching experience could not be effective in improving professional skills.

As a result of these discussions, it becomes clear that the PCK of third-grade teachers is not acceptable as one of the dimensions of the professional characteristics of teachers, and this weakness naturally leads to the inadequate quality of students' learning. In order to solve this problem, special attention should be paid to reviewing the common teacher training methods to benefit from a more qualified education and improving the country's teacher training outputs, and paying attention to recruiting and providing talented teachers with logical methods and appropriate teacher training. Considering the assessment tests at the end of teacher training courses, in part of which the PCK of teachers is measured, is one of the strategies that could arouse the sensitivity of the student-teacher. Examples of such tests are currently administered after the article ۲۸ skill-training course at Farhangiān University. However, first, this test could be expanded to all students at Farhangiān University, and secondly, more emphasis could be placed on its concrete parts, including the PCK test. In addition, the provision of professional development opportunities through in-service courses and especially opportunities of learning from colleagues in the form of methods such as lesson study could effectively improve the knowledge of current teachers, especially their PCK.

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