Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 4, 11121–11130

EVALUATING THE LEVEL OF THEMATIC AND PEDAGOGICAL KNOWLEDGE OF STUDENT-MATH TEACHERS IN THE FIELD OF PROBABILITY

Vahid Alamian[1]
[1]Faculty member, Department of Mathematics, Farhangian University, Iran-Tehran

Fariba kaedi[2]
[2]Mathematics teacher, Lorestan education

Abstract

The present study aimed to investigate the probability level of thematic knowledge and student-teachers pedagogy. The research method was a descriptive survey. All undergraduate mathematics students at the Shahid Beheshti University of Culture in Tehran (n = 35) and undergraduate students at Shahid Mofatteh at Shahr Rey (n = 25) were included in the statistical population. As a sample, the sampling procedure and sample members were available. Data was gathered using an open-ended questionnaire. Experts and technicians evaluated and validated its face and content validity. General thematic knowledge, specialist thematic knowledge, content and student knowledge, and content and education knowledge were tested. Students' and instructors' written responses were gathered and examined. The descriptive frequency, percentage, and inferential binomial tests were employed to examine the data. The findings revealed that teachers in this field require more specific expertise. Most student instructors used the mathematical approach to probability when discussing the basic characteristics of probability, and their understanding of the mental approach to probability was limited. The objective approach to probability was more likely to elicit a response from elementary school students. Instrumental and procedural knowledge impacted research participants, who paid less attention to conceptual and relational knowledge, utilized more mathematical formulae, and did not use language as a tool for mathematical reasoning. They attempted to answer problems algebraically rather than through formal knowledge. They have minimal understanding of probability arithmetic topics like sample space, event independence, incompatibility, and complementarity.

Keywords: Thematic knowledge, pedagogical knowledge, probability, student-teachers

INTRODUCTION

One of any math teacher's key objectives is gaining the essential knowledge and comprehension of math topics since a thorough understanding of the concepts allows instructors to devise several ways for explaining arithmetic concepts to their pupils (EssamAbdou Ahmed Saleh, 2020). According to Mosvold & Fauskanger (2014), teachers play a critical role in ensuring the quality of students' education (Aliya, et. al., 2020). They want to demonstrate the content of mathematical knowledge that instructors require in teaching probability in the papers they have published on the subject (Brijlall, 2014). According to Krauss et al. (2008), instructors must grasp the mathematical ideas underpinning the questions pupils ask, and best explain them. Math teachers require a wide range of skills to provide students with the information they require, including the ability to understand teaching systems and structures, a variety of teaching methods, and be aware of math learning, as well as the ability to manage the classroom, use instructional resources, and evaluate assessment methods.

Some academics argue that instructors' thematic knowledge is not the sole determinant of their teaching effectiveness and that there is a disconnect between what they study and what they teach. It turns out that these individuals have difficulties comprehending the material being taught. This part of instructors' knowledge is the same as the knowledge of content pedagogy mentioned in educational books (Nadi, 2010).

Teachers sometimes fail to understand the link between their classroom experiences and the generalizations about teaching and learning taught at colleges. Most teachers claim that they did not learn anything useful about teaching until they began teaching themselves. Teachers with a thorough mastery of their disciplines are required by new standards and curriculum (Alipour, 2010).

Considering that mathematics comprises several disciplines, it is vital to examine subjects of choice and instructors' mathematical expertise in that field, given the rank and relevance of the subjects in mathematics textbooks and given the obstacles in teaching them. Since, according to experts, the combination between intuitive perception and educational experience can lead perceptions of probability to deteriorate with time, experiences that create accurate intuition are extremely crucial, especially in primary school. Teachers require a theme understanding of education and relevant content knowledge to produce these experiences, especially given the intricacy of the ideas and interrelationships of the notions of probability (Chick and Baker, 2005). According to research (Evan, 1990; Chick and Baker, 2005), student teachers and t and pedagogical knowledge instructors do not have enough material for teaching mathematics, and their thematic and pedagogical knowledge is frequently of poor probability. For example, when a student offers a probability concept, it is difficult for the instructor to explain it if the teacher's thematic knowledge of the concept is limited. It is possible that their academic degree is to blame for all of this.

On the other hand, several research (Rabbani, 2013) have found that when answering probability questions, teachers and student teachers respond like students and have misconceptions. Modifying activities to handle difficult concepts like probability while still fulfilling students' needs and following the curriculum is a critical challenge intimately linked to thematic pedagogical expertise. According to research (Evan, 1990; Chick and Baker, 2005), student instructors lacking in thematic knowledge and pedagogical understanding cannot teach mathematics.

As a result, it is critical that instructors, planners, and teacher training institutes thoroughly understand the content's thematic knowledge and pedagogy. As a result, the central question in this research is whether student-teachers are aware of the two dimensions of topic knowledge and theme pedagogy knowledge prior to entering the classroom. Moreover, how well do they grasp and comprehend the idea of probability and the techniques they use to teach it?

Theoretical foundations

Thematic knowledge

In his research, Evan (1993) identified the components of thematic mathematical knowledge in the form of representations related to mathematical concepts to teach concepts, basic properties of alternative concepts, and methods while emphasizing the need for teachers to have a deep understanding of any subject they teach. To teach a certain subject, a skilled math teacher must understand the features of the rules and concepts utilized, the examples connected to the subject, and the many ways of teaching it. In their research, Ball and Bass (2000), Huddle, Ball, and Schilling (2008) separated topic knowledge into two categories: general and specialized thematic knowledge. In this study, general theme knowledge was defined as a thorough understanding of the topic, whereas particular thematic knowledge was characterized as a thorough understanding of mathematics (Shabanifar, 2012).

Content pedagogy knowledge

According to Shulman (1986), content pedagogy knowledge is the understanding of what makes studying a math subject simple or difficult and what pupils learn from it to master more general subjects and courses. According to Shulman (2004), this knowledge also includes knowing how to make a topic intelligible to others. The most relevant representations, examples, explanations, and techniques for presenting the subjects and lessons taught are also included in the knowledge of content pedagogy; knowledge of pedagogy integrates content and pedagogy and uniquely blends content with features of teaching and learning that subject (Reyhani, 2016). The three parts of content knowledge and learners, content knowledge and teaching, and curricular knowledge are considered by Ball et al. (2008) to be part of the knowledge of content pedagogy. Shabaniehfar (2012) examines mathematics teachers regarding their attitude to students' faults in research titled "Study of Student Mathematical Knowledge." Participants struggled to recognize errors and state the reasons for them, and they were unable to completely explain the reasons for the errors in terms of their understanding of mathematical principles.

Rules of chance or probability

The age at which children may understand probability concepts is a point of contention among researchers. Systematic understanding is unlikely to develop before the age of 9 to 12. During this time, toddlers answer issues instinctively rather than via formal reasoning. Probability thinking begins at the age of nine when they can recognize and construct the impossible sample space and the equal probability sample space and form inferences using simple reasoning. They also compare chance and probability, but they believe that mistake is still possible. Visual comparison or numerical estimation can also indicate the order of likelihood.

Probability is defined around the age of 11 years old. Children at this level comprehend the link between accident and likelihood better than they did at the previous two phases. The link between sample space and probability is built at this level. Children pay greater attention to numerical comparisons, apply multiplication, division, and proportionality procedures, and use probability language like chance, probably, and perhaps more frequently (Rabbani, 2014).

Much study has focused on whether or not teachers are knowledgeable about the substance of the subject matter when it comes to explaining the outcomes of students' academic performance. On the other hand, Ball et al. (2008) argue that to define what is to be stated and done in a valid subject, instructors must comprehend the organization of concepts, institutions, and regulations. Teachers are required to understand some of the concepts and understand why they are understood. This condition defines the idea of educational content knowledge. The primary goal of educational content knowledge is to establish a link between material and education (Brijlall, 2014). As a result, the theoretical foundation for this study is based on the knowledge of instructional material defined by Shulman (1986), Ball et al. (2008), and Brijlall (2014). The study also drew on information from various sources to assess instructors' understanding of probability. Evan (1990) used a framework that contained seven characteristics to assess teachers' conceptual understanding of probability. Various researchers, including Kola and Bokova et al. (2015), Brijlall (2014), and Chick and Baker (2005), each considered dimensions for pedagogical knowledge, which were combined to consider items like providing various examples, intuitive misunderstandings, and recognizing students' basic knowledge. Many studies have looked at mathematics instructors' expertise. No research in Iran compares the performance of teacher students in secondary and elementary schools in terms of topic knowledge and pedagogy in the field of probability.

METHOD

In terms of purpose, the current study is used, and it is a part of field research in terms of method. All undergraduate students of Farhangian University of the Shahid Beheshti University of Tehran and undergraduate students of Shahid Mofatteh at Shahr Rey in the previous year, i.e., students who entered Farhangian University in 2013-2014, are included in the statistical population of this study. A total of 35 undergraduate math students and 25 undergraduate students were present. A sample of the sampling procedure and sample member selection is offered. Following the collection of the surveys, 30 questionnaires were obtained from math students, and 30 questionnaires were supplied from primary school kids. The total number of surveys in this range was reduced by 22.

Cases such as lack of conceptual knowledge, lack of familiarity with representations of key concepts, lack of knowledge of students' preconceptions, and misunderstandings about probability were found in the introductory stage research conducted among students in the introductory stage, which was conducted from 10 students. As a result, the data collecting technique in this study, which is an open-ended questionnaire, was developed in a more conceptual manner using current articles and books on the topic. In the first stage, a test with 12 questions was constructed once the questionnaire was prepared. The same questionnaire was then checked on ten students to see whether it might be improved or edited. After the exam, four questions were deleted from the original twelve, and eight questions with a 45-minute duration were evaluated.

Statistics and probability textbooks, as well as related English articles, tenth-grade textbooks for the 96-95 academic year, and telegram groups related to the study. Secondary books were chosen for the Thematic Knowledge Assessment and Content Pedagogy Knowledge Questionnaire for Undergraduate Mathematics Teachers (Questionnaire A). The major emphasis of the inquiry was arranged around thematic knowledge and content pedagogical knowledge, which included general teacher knowledge and particular teacher knowledge, content knowledge and students, and content knowledge and teaching. Different types of knowledge and understanding, basic characteristics, and basic treasures were considered in the field of teachers' thematic knowledge, and different examples, students' basic knowledge, and common mistakes and misunderstandings were considered in the field of teachers' pedagogical knowledge.

Undergraduate Teachers' Thematic Knowledge Assessment and Content Pedagogy Knowledge Questionnaire (Questionnaire B) statistics and probability textbooks, as well as relevant English publications, were among the open-ended questions on this questionnaire for the 96-96 school year. A total of 95 people were chosen.

FINDINGS

Students' level of teacher knowledge in each dimension of thematic knowledge, such as basic characteristics, knowledge of knowledge and understanding, and knowledge of basic treasure, as well as dimensions of pedagogical knowledge, such as knowledge of different examples, knowledge of basic knowledge of students and their knowledge of misconceptions and common mistakes are studied, and the gap between student performance and instructor performance in both primary and secondary school is assessed using these characteristics.

1. Findings related to thematic knowledge

Table 1. Frequency distribution and percentage of answers provided to questions related to basic features

Type of answer	Elementary		High school		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Correct	8	36.4	20	66.7	28	53.8
Incorrect	6	27.3	5	16.7	11	21.2
Not-answered	8	36.4	5	16.7	13	25
Total	22	100%	30	100%	52	100%

Table 2. The results of the binomial test to compare the subjects according to the type of their answers

Answer	Correct	Incorrect	Significance level	Result
Elementary	8 (36%)	14 (64%)	0.286	No significant difference
High school	20 (0.67)	10 (0.33)	0.099	No significant difference
Total	28 (0.54)	24 (0.64)	0.678	No significant difference

As shown, there is no significant difference between the rate of subjects who answered the necessary questions properly and subjects who did not respond correctly ($P>0.05$) in elementary, high school, and two courses in total. As a result, the proportion of student instructors who are aware of the fundamental elements of thematic knowledge in the study population is the same as the number of students who do not have the requisite knowledge in this field.

Table 3. Frequency distribution and percentage of answers provided to questions related to different types of knowledge and understanding

Type of answer	Elementary		High school		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Correct	13	59.1	25	83.3	38	73.1
Incorrect	6	27.3	4	13.3	10	19.2
Not answered	3	13.6	1	3.3	4	7.7
Total	22	100	30	100	52	100

Table 4. The results of the binomial test to compare the subjects according to the type of their answers

Answer	Correct	Incorrect	Significance level	Result
Elementary	13 (59%)	9 (41%)	0.523	No significant difference
High school	25 (83%)	5 (17%)	0.001	No significant difference
Total	38 (0.73)	14 (0.27)	0.001	No significant difference

According to the results of the above table, there is no significant difference in the rate of subjects who replied properly and subjects who did not answer correctly in elementary school ($P>0.05$). However, there is a significant difference between the rate of subjects who replied properly and subjects who did not answer correctly in high school and in general ($P<0.01$). As a result, it can be concluded that the majority of student teachers (73 percent) in the study population have the essential knowledge of various forms of knowledge and topic information comprehension. The majority of high school student teachers (83%) have a variety of knowledge and comprehension. The necessary knowledge is thematic knowledge, but there is a considerable difference between the proportion of students who do not have the necessary knowledge in this area and the proportion of those who do not have the necessary knowledge in this field in elementary school.

Table 5. Frequency distribution and percentage of answers provided to questions related to the basic treasure of thematic knowledge

Type of answers	Elementary		High school		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Correct	9	40.9	10	33.3	19	36.5
Correct	0	0	11	36.7	11	21.2
Not-answered	13	59.1	9	30	22	42.3
Total	22	100	30	100	52	100

Table 6. The results of the binomial test to compare the subjects according to the type of their answers

Response	Incorrect	Correct	Significance level	Result
Elementary	9 (0.41)	13 (0.59)	0.523	No significant difference
High school	10 (0.33)	20 (0.67)	0.099	No significant difference
Total	19 (0.37)	33 (0.63)	0.070	No significant difference

According to the above data, there is no significant difference between the rate of subjects who answered the necessary questions correctly and subjects who did not ($P<0.05$) in elementary, high school, and a total of two courses. As a result, the proportion of student teachers who are aware of the fundamental wealth of topic knowledge in the study population is the same as the proportion of student teachers who do not have the requisite information in this field.

2. Pedagogical knowledge-related findings

Table 7: Frequency distribution and percentage of answers provided to the representation questions and various examples

Type of answer	Elementary		High school		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Correct	7	31.8	4	13.3	11	21.2
Incorrect	5	22.7	0	0	5	9.6
Not answered	10	45.5	26	86.7	36	69.2
Total	22	100%	30	100%	52	100%

Table 8. The results of a binomial test to compare the subjects according to the type of their answers

Result	Significance level	Incorrect	Correct	Response
No significance difference	0.134	15 (0.68)	7 (0.32)	Elementary
No significance difference	0.001	26 (0.87)	4 (0.13)	High school
No significance difference	0.001	41 (0.79)	11 (0.21)	Total

As shown, there was no significant difference between the ratio of subjects who replied properly and those who did not answer correctly in the elementary phase ($P<0.05$). However, there is a significant difference between the rate of subjects who replied properly and the rate of subjects who did not answer right in high school and in general ($P<0.01$). As a result, it can be deduced that the majority of student instructors (79 percent) in the study population are unaware of pedagogical information linked to representation and varied examples. Most student teachers in secondary school (87 percent) lack the necessary knowledge of pedagogy related to representation and various examples, whereas, in primary school, there is a proportion of students who lack the necessary knowledge in this field, but there is no significant difference between those who do and those who do not.

Table 9. Frequency distribution and percentage of answers provided to questions related to students' basic knowledge

Total		High school		Elementary		Type of answers
Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	
19.2	10	6.7	2	36.4	8	Correct
42.3	22	42.3	22	0	0	Incorrect
38.5	20	38.5	6	63.6	14	Not answered
100%	52	100%	30	100%	22	Total

Table 10. The results of the binomial test to compare the subjects according to the type of their answers

Response	Correct	Incorrect	Significance level	Result
Elementary	8 (0.36)	14 (0.64)	0.286	No significance difference
High school	2 (0.07)	28 (0.93)	0.001	No significance difference
Total	10 (0.19)	42 (0.81)	0.001	No significance difference

According to the results of the above table, there is no significant difference in the rate of subjects who replied properly and subjects who did not answer correctly in elementary school (P>0.05). However, there is a significant difference between the rate of subjects who replied properly and subjects who did not answer correctly in high school and in general (P<0.01). As a result, it can be inferred that the majority of student instructors (81%) in the research population lack the requisite pedagogical skills connected to pupils' fundamental knowledge. Most student-teachers in secondary school (93 percent) lack the requisite pedagogical understanding connected to pupils' fundamental knowledge, although there are instructors in elementary school who lack this information. There is no discernible difference between individuals who lack the requisite information and those who do.

Table 11. Frequency distribution and percentage of answers provided to questions related to common mistakes and misunderstandings

Type of answer	Elementary		High school		Total	
	frequency	Percentage	frequency	Percentage	frequency	Percentage
Correct	13	54.5	19	63.3	32	61.5

Incorrect	6	27.3	5	16.7	11	21.2
Not-answered	3	13.6	6	20	9	17.3
Total	22	100%	30	100%	52	1005

Table 12. The results of the binomial test to compare the subjects according to the type of their answers

Response	Correct	Incorrect	Significance level	Result
Elementary	13 (0.59)	9 (0.41)	0.523	No significance difference
High school	19 (0.63)	11 (0.37)	0.200	No significance difference
Total	32 (0.62)	20 (0.38)	0.126	No significance difference

According to the above data, there is no significant difference between the rate of subjects who answered the necessary questions correctly and subjects who did not (P>0.05) in elementary, high school, and a total of two courses. As a result, the proportion of student teachers who are aware of typical pedagogical blunders and misconceptions is the same as the proportion of student teachers who do not have the requisite expertise in this subject in the study population.

CONCLUSION

In the basic qualities of topic knowledge, there was no significant difference between the rate of subjects who answered the necessary questions correctly and those who did not answer them properly in elementary, secondary, and a total of two periods (P>0.05). In terms of theme knowledge and understanding, most high school instructors (83 percent) have the requisite knowledge of different types of thematic knowledge and understanding, but there is a ratio of pupils who do not have the essential information in this sector in elementary school. There is no discernible difference in rate between individuals who lack the requisite information and those who do.

Based on the results obtained in elementary, high school, and a total of two courses, there is no significant difference between the rate of subjects who answered the relevant questions correctly and the rate of subjects who did not answer correctly in terms of the basic treasure of thematic knowledge (P>0.05). As a result, the proportion of student teachers who are aware of the fundamental wealth of topic knowledge in the study population is the same as the proportion of student teachers who do not have the requisite information in this sector. In terms of pedagogical knowledge, it is likely that most student teachers (87 percent) do not have the necessary knowledge of pedagogical knowledge related to different examples in high school, but there is a ratio of students to teachers who have the necessary knowledge in this field in elementary school. There is no discernible difference between individuals who lack the requisite information and those who do. According to the results of the students' basic knowledge, most student instructors (93 percent) do not have the necessary pedagogical knowledge connected to students' basic knowledge in high school, although the ratio of students to teachers in elementary school is the necessary knowledge. In this regard, they lack, and there is no discernible distinction between their rate and that of people who lack the requisite understanding. There is no significant difference between the rate of subjects who answered the relevant questions properly and subjects who did not respond correctly (P0.05) in terms of frequent student blunders in elementary school, high school, and a total of two courses.

When questioned about the essential qualities of probability, the majority of the students and primary school instructors who took part in the survey mentioned the mathematical approach to probability. Their understanding of probability's mental approach was limited. Subjects appear to be prioritized by students' teachers based on the amount of instruction they will provide in the future. Teachers, according to Brigid (2014), should evaluate not only the subject they teach at a certain level but also what is being taught in higher education. This is what content knowledge and curriculum are all about. Instrumental and procedural knowledge affected participants in this study in high school, but conceptual and relational knowledge received less attention. These findings are in line with Nadi's findings (2010). When confronted with the phrases minimum and maximum, etc., student instructors employed the mathematical formula more and did not use language as a tool for mathematical reasoning. Instead of employing formal knowledge, they solved the issues algebraically. Some professors have never heard of sample space, event independence, incompatibility, or complementarity, which are all mathematical notions in probability. The knowledge and understanding used in elementary school are instrumental and falls under the scope of the CCK, and this lack of knowledge about the concepts of probability, as well as having instrumental and procedural knowledge, causes teachers to be content with teaching in this concept and will not be able to teach these concepts to students in the future. Poor results were obtained in the basic treasure dimension in terms of student-teacher awareness of various meanings of terms, description, and expression of key concepts of probability in elementary school and the concept of independent event in high school, and using examples to understand the concept of teacher; these findings demonstrate the importance of specialized content knowledge (SCK). When asked to give examples to explain a subject, student-teachers had limited experience in this area and utilized brief, repeated examples. Participants in a research performed by Yusuoff and Zakaria (2009) reported that high school math teachers employ simple and repetitious examples that they find in textbooks or test problems (Kula et al., 2015).

Before teaching a subject, some professors seldom review students' past knowledge and instead focus on the students' experiences and understanding of the subject. Only 7% of high school pupils responded to this research with knowledge of and a link between their backgrounds and the issue in question. Meaningful learning occurs when pupils have this knowledge and can link new content to what they have already studied. The degree of understanding of students and teachers concerning frequent mistakes made by students when answering probability issues was low in this study. In addition, they lacked the capacity to explain the causes for the errors in completing mathematical problems in terms of thematic knowledge, although they were aware of intuitive misconceptions in this study.

Considering the significance and application of probability science in everyday life, it is suggested that when developing any curriculum or unit, they should consider the real world; in other words, create a program that allows students and teachers to see the application and importance of probability in everyday life. It assists student-teachers in identifying common student errors and misconceptions, as well as determining the reason and base of the problem. The necessity of selecting and implementing examples should be stressed while educating student instructors. Students should be taught how to utilize examples to illustrate teaching concepts and processes, as well as how to deliver tasks.

REFERENCE

Alipour Nodooshan, Fatemeh (2009): A Survey of Teachers' Mathematical Knowledge: Journal of Mathematical Education Development, 107, Educational Assistance Publications Office of the Educational Research and Planning Organization, Ministry of Education.

Aliya N. Sankhayeva, Larissa A. Shkutina, Nataliya V. Mirza, Zhasbulan K. Salikov, Maral B. Iskakova. (2020). A comparative analysis of Kazakh and European teachers' readiness to corporate governance in the education system. *Journal of Advanced Pharmacy Education and Research, 10*(1), 120-127.

Ball, D.L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J.Boaler (Ed.) Multiple Perspectives on Mathematics of Teaching and Learning. (pp. 83-104). Westport, Conn.: Ablex Publishing

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content Knowledge for Teaching: What Makes It Special? Journal of Teacher Education, 59, 389-407

Brijlall, D. (2014). Exploring the Pedagogical Content Knowledge for Teaching Probability in Middle School: A South African Case Study

Chick, H. L. & Baker, M. (2005). Teaching elementary probability: not leaving it to chance. In P.C. Clarkson, A. Downtown, D. Gronn, M. Horne, A. McDonough, Pierce, & A. Roche (eds.), building connections: Theory, research and practice (Proceedings of the 28th annual conference of the mathematics education research group of Australia, pp. 233-240). Sydney: MERGA.

EssamAbdou Ahmed Saleh. (2020). The Effect of Using the Mental Maps on The Academic Achievement in Mathematics Among the Educable Intellectually Disabled Students in Rafha Province. *Journal of Organizational Behavior Research*, *5*(1), 164-183.

Even, R & Kvatinsky, T. (2002). Framework for Teacher Knowledge and Understanding About Probability Proceedings of the Sixth International Conference on Teaching Statistics (CD). Cape Town, South Africa: International Statistical Institute

Evans, Jeff (2000) Adults' mathematical thinking and emotions: a study of numerate practices. Studies in mathematics education series, 15 . Routledge, New York. ISBN 0750709138

E. Zakaria, N. Yusoff Attitudes and problem solving skills in algebra among Malaysian Matriculation College students

European Journal of Social Sciences, 8 (2) (2009), pp. 232-245

Heidari Arjloo, Afsaneh (2019). Examining the thematic knowledge of the pedagogical knowledge of the student of mathematics teachers in the subject of function, thesis for obtaining a master's degree.

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. Journal for Research in Mathematics Education, 39(4), 372–400

Kazem Nadi, Safoura (2010). Evaluation of pedagogical educational knowledge of middle school math teachers in Khomeini Shahr to teach conventional deduction, dissertation for obtaining a master's degree

Krauss, S., Baumert, J., & Blum, W.. Secondary mathematics teachers' pedalogical content knowledge and content knowledge: Vali- dation of the COACTIV constructs. The International Journal on Math- ematics Education

Kula, S& Bukova, E&. (2015). A Student Teacher's Choice and Use of Examples in Teaching Probability

Mosvold, R., & Fauskanger, J. (2014). Teachers' beliefs about mathematical horizon content knowledge. International Journal for Mathematics Teaching and Learning, 9(3), 311-327

Paul Kustos, Jeremy Zelkowski: Grade-continuum trajectories of four unknown probabilistic misconceptions: What are students' perception of self-efficacy in completing probability tasks, 2013, The university of Alabama, secondary mathematics education, Box 870232, Tuscaloosa, AL 35487-0232 United states.

Rabbani, Sanaz. Aminifar, Elahe (2013). Investigating students' misunderstandings on conditional probability. Thesis for obtaining a master's degree.

Reyhani, Ibrahim, (2015). Analysis of policies, approved documents, research, and credible resources related to the field of mathematical learning

Semiha Kula Ünver, Esra Bukova Güzel, Ayşe Tekin Dede, Çağlar Naci Hidiroğlu (2010). Sufficiency of Undergraduate Education in Developing Mathematical Pedagogical Content knowledge: Student teachers' Views. Procedia Social and Behavioral Sciences

Shabaniyafar, Samad (2012). A Survey of Mathematical Teachers 'Knowledge on Their Performance in Correcting Students' Exam Papers, Sixth National Conference on Education, May 2014.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4 –14