

# TPACK Abilities of Mathematics Teachers: A Review Based on Teacher Certification and School Accreditation Status

Busnawir<sup>1\*</sup>, Mery Aryanti<sup>2</sup>, Nana Sumarna<sup>3</sup>, Kodirun<sup>4</sup>, Hafiludin Samparadja<sup>5</sup>

Mathematics Education Department, Pascasarjana, Universitas Halu Oleo  
Kampus Hijau Tridharma Anduonohu, Kedari, Sulawesi Tenggara, Indonesia

<sup>1</sup>*busnawir@uho.ac.id*; <sup>2</sup>*meryaryanti.ma@gmail.com*; <sup>3</sup>*nana@uho.ac.id*; <sup>4</sup>*kodirun@uho.ac.id*;

<sup>5</sup>*hafiludin.samparadja@uho.ac.id*

Article submitted: 30-03-2023, revised: 19-07-2023, published: 31-07-2023

## Abstrak

Keterampilan TPACK guru dapat dipengaruhi oleh status sertifikasi guru dan akreditasi sekolah. Guru bersertifikat diharapkan mampu mengintegrasikan TPACK dengan baik dalam pembelajaran. Tujuan penelitian ini untuk mengkaji kemampuan TPACK guru matematika sekolah menengah berdasarkan status sertifikasi guru dan akreditasi sekolah di Kabupaten Buton Utara. Penelitian ini menggunakan pendekatan deskriptif kuantitatif dengan metode survey. Populasi penelitian sebanyak 53 guru matematika sekaligus sebagai subyek penelitian. Data dikumpulkan melalui angket, observasi, wawancara dan dokumentasi. Hasil penelitian menunjukkan bahwa kemampuan penguasaan TPACK guru matematika sekolah menengah di Kabupaten Buton Utara termasuk kategori rendah; ada perbedaan kemampuan TPACK yang signifikan antara guru matematika di sekolah terakreditasi A dan B; terdapat perbedaan yang signifikan keterampilan TPACK antara guru matematika di sekolah terakreditasi A dan C; tidak terdapat perbedaan kemampuan TPACK antara guru matematika di sekolah terakreditasi B dan C; terdapat perbedaan yang signifikan kemampuan TPACK antara guru bersertifikasi dan tidak bersertifikasi di sekolah terakreditasi B; tidak ada perbedaan keterampilan TPACK antara guru bersertifikasi dan tidak bersertifikasi di sekolah terakreditasi A dan C.

Kata Kunci: Akreditasi Sekolah; Sertifikasi Guru; TPACK.

## Abstract

Teachers' TPACK skills can be influenced by teacher certification status and school accreditation. Certified teachers are expected to be able to integrate TPACK well in learning. The purpose of this study was to examine the TPACK ability of high school mathematics teachers based on teacher certification status and school accreditation in North Buton District. This research uses a quantitative descriptive approach with a survey method. The research population consisted of 53 mathematics teachers who were also research subjects. Data were collected through questionnaires, observations, interviews, and documentation. The results showed that the TPACK mastery ability of high school mathematics teachers in North Buton Regency was in a low category; there is a significant difference in TPACK ability between mathematics teachers in schools accredited A and B; there is a significant difference in TPACK skills between mathematics teachers in schools accredited A and C; there is no difference in TPACK abilities between mathematics teachers in schools accredited B and C; there is a significant difference in the ability of TPACK between certified and uncertified teachers in schools accredited B; there is no difference in TPACK skills between certified and uncertified teachers in schools accredited A and C.

Keywords: Schools Accreditation; Teacher Certification; TPACK.

## I. PENDAHULUAN

One of the characteristics of the independent curriculum revitalizes the Information and Communication Technology (ICT) learning at schools. Therefore, teachers are required to be literate in technology (Kresnadi, 2023), to be able to use and assist teachers' tasks in learning activities (Effendi & Wahidy, 2019; Rahayu et al., 2022). Mathematics teachers has always been highlighted in the educational issues (Maswar, 2019; Yeni, 2015), because they are highly related to both the components and the education system in which technology and communication elements are included (Husaini, 2017; Rahmawati & Afriansyah, 2023). Teachers play an important role in preparing students to face life changes that require skills in utilizing technology (Rahim et al., 2019). The success of mathematics teachers in 21st century learning is strongly supported by the ability to utilize technology and communication (Yuniarti et 2021).

Some of the problems encountered by certified mathematics teachers (having educator certification or serdik) are that they have not prioritized the self-development related to the competencies that must be possessed by professional educators (Habsyi, 2021); unable to motivate and encourage students to actively participate in the learning process, their technical skills are still relatively lacking in organizing learning activities (Isabella, 2019; Wijaya et al., 2021).

As professional educators, teachers should demonstrate Technological Pedagogical and Content Knowledge (TPACK) competencies as part of teachers' competencies (Hidayati et al., 2018; Nofrion et al., 2012; Akhwani & Rahayu, 2019; Mutiarahman, Edriati, & Suryani, 2023). TPACK is the integration of technological knowledge, pedagogical knowledge and content knowledge in the field of study (Koehler et al., 2013; Mardarani & Apriyono, 2023). TPACK consists of 7 (seven) components as shown in Figure 1.

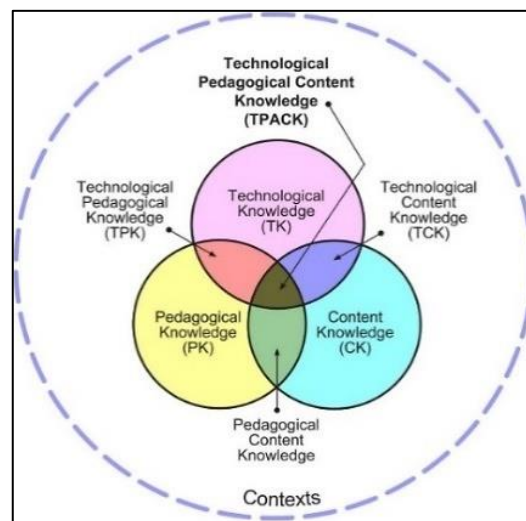


Figure 1. The TPACK framework

Figure 1 could be described as follows: (1) *Technological pedagogical knowledge* (TK) is teachers' knowledge of what and how technology, software or applications can be used for learning. TK also includes the ability to adapt and learn new technologies (Rosyid, 2015; Rahayu, Muhtadi, & Ridwan, 2022); (2) *Pedagogical knowledge* (PK), i.e. the ability to manage

a classroom well, as well as plan, direct and evaluate the learning achievement (Koehler et al., 2013); (3) *Content knowledge* (CK) is teacher's knowledge of the subject studied or taught (Koehler et al., 2013); (4) *Technological pedagogical knowledge* (TPK) is the knowledge regarding the knowledge of the existence and peculiarities of various technologies that enable non-specialized teaching approaches, such as the use of information and communication technologies as cognitive tools and computer-based collaborative learning (Strategi et al., 2017); (5) *Technological content knowledge* (TCK) is the integration of technology and content. This inclusive learning refers to materials that come with the appropriate technology for the classroom (Suryawati et al., 2014); (6) *Pedagogical content knowledge* (PCK) is teachers' comprehension of the alternative concepts and challenges encountered by students from various backgrounds and the ability to organize, compile, lesson materials, implement and evaluate the subject, all summarized in PCK (Purwianingsih et al., 2010); (7) *Technological pedagogical and content knowledge* (TPACK) is the basis of an effective technology teaching that requires an understanding of the concepts presentation through technology, pedagogical skills and constructive use of technology in the classroom, knowledge of technology to support or enhance some student problems, and knowledge of how

technology can be used to build on existing knowledge (Koehler et al., 2013; Restiana & Pujiastuti, 2019)

According to Koehler, Shin & Mishra (Rahmadi, 2019), there are five instruments that researchers used as a reference to determine teachers' TPACK, namely personal report measurement, open questionnaire, interview, observation (perception), and performance evaluation. According to Herizal et al. (2022), the indicators to measure teachers' TPACK skills are shown in Table 1.

Table 1.  
TPACK components and indicators

Components	Indicators
<i>Technological Knowledge</i> (TK)	the mastery of various elements of technology including the use of technology, technological developments and ICT-related issues
<i>Pedagogical Knowledge</i> (PK)	the mastery of various learning strategies, assessment methods and techniques, student cognitive development and the implementation in the classroom
<i>Content Knowledge</i> (CK)	the mastery of the subject, evidentiary knowledge and daily practice as well as the approach to the development of the mathematics subject to be taught
<i>Technological Pedagogical Knowledge</i> (TPK)	being able to integrate technology into lesson plans, learning processes and assessment of mathematics learning from the students' perspective.
<i>Technological Content Knowledge</i>	being able to integrate technology with various mathematical materials

(TCK)	
<i>Pedagogical Content Knowledge</i> (PCK)	being able to combine various learning strategies, approaches, methods and assessment techniques with mathematics materials
<i>Technological Pedagogical Content Knowledge</i> (TPCK)	being able to integrate technology effectively into lesson plans, implementation and assessment.

According to Cox & Graham, (2009), TPACK is teachers' knowledge to facilitate students in the learning processes through pedagogical and technological approaches. TPACK in education is a framework for designing learning models by integrating three main aspects, namely technology, pedagogy and content (Hidayati et al., 2018). Teachers' TPACK skills can be influenced by teacher certification status and school accreditation. Certified teachers are expected to be able to integrate TPACK well in learning (Martin, 2015; Joo et al., 2018); understand some TPACK components better than uncertified teachers (Yurinda & Widyasari, 2022). A-accredited schools have better TPACK component skills than B-accredited schools (Suryanto et al., 2022); school accreditation status determines the quality of services for students (Irawan et al., 2020); one of the qualities is mastery of TPACK in learning (Hayani & Utama, 2022).

Teacher certification is a recognition given by the state to a teacher who has met the requirements to provide educational services in certain educational units. Educational accreditation is an

activity of assessing the suitability of schools based on criteria (standards) set and carried out by the National Accreditation Board (BAN) and the results are announced as a ranking. Teachers, teaching staff and the school infrastructure itself are analyzed as part of the educational accreditation process (Kismeina & Persada, 2022; Asopwan, 2018; Awaludin, 2017; Corazon, 2017).

The researchers were motivated to investigate the issue that was considered necessary to study. It aimed to show the relationship between teacher certification and school accreditation with the TPACK skills of mathematics teachers. This study analyzed the TPACK skills of mathematics teachers in terms of teacher certification and school accreditation. In addition, this study would be a basis for stakeholders to improve the skills of mathematics teachers, especially their TPACK component.

## II. METHOD

The approach used in this study was a quantitative approach using the survey method, which was carried out from November 2022 to February 2023 in North Buton Regency Junior High School. The participants of the study were 53 junior high school mathematics teachers in North Buton District. The state of the population based on the teacher certification status and school accreditation is presented in Table 2.

Table 2.  
Total Population Based on Teachers' Certification and School Accreditation Status

School accreditation	Teachers' certification		Total
	Certified	Uncertified	
A	8	4	12
B	8	14	22
C	10	9	19
Total	26	27	53

The research instruments used in this study were questionnaires and observation sheets. The questionnaire consisted of 38 items, including components of TK (10 items), PK (6 items), CK (4 items), TPK (4 items), TCK (3 items), PCK (6 items) and TPACK (5 items). It was first validated through a panelist test by two lecturers from the mathematics education department of FKIP, Halu Oleo University, then an empirical test was carried out on 20 teachers as a trial sample. Empirical validity was calculated using product moment correlation (Purba & Purba, 2022), and reliability using the Alpha formula (Prihono, 2020). The results of the pilot test showed that 38 instrument items met the validity elements with a reliability coefficient of 0.971.

The data were collected using questionnaires that were distributed directly to the participants (53 mathematics teachers). After collecting the data, they were analyzed using descriptive and inferential statistics. The

descriptive analysis was conducted by finding the minimum value, maximum value, mean, standard deviation and criteria. The scores for each TPACK component were converted into points with the following conditions.

$$\text{Score} = \frac{\text{gained score}}{\text{maximum score}} \times 100\%.$$

To determine the category of TPACK of mathematics teachers, the results of the questionnaire and observation sheet were converted into a scale of 100 (Aini, 2016), as presented in Table 3.

Table 3.  
TPACK Classification

Interval	Classification
$90 \leq \underline{X} \leq 100$	Very High (VH)
$75 \leq \underline{X} < 90$	High (H)
$55 \leq \underline{X} < 75$	Fair (F)
$40 \leq \underline{X} < 55$	Poor (P)
$0 \leq \underline{X} < 40$	Very Poor (VP)

To determine the differences in TPACK ability, inferential analysis of one-way ANOVA and independent sample t-test was used with a probability value smaller than 0.05 (Delacre et al., 2020).

### III. RESULTS AND DISCUSSION

#### A. TPACK Ability

The mastery of TPACK components was measured using a questionnaire given to the teachers as the participants. Descriptive scores of teachers' TPACK abilities are summarized in Table 4.

Table 4.  
The characteristics of the teachers' TPACK ability

Statistic	TPACK Components
-----------	------------------

	TK	PK	CK	TPK	TCK	PCK	TPACK
Total	2880,99	3349,61	2987,61	1679,92	1880,69	4703,01	1592,01
Mean	54,36	63,20	56,37	31,70	35,48	88,74	30,04
Median	51,87	59,07	52,50	31,22	34,52	90,07	32,85
Mode	49,85	58,41	50,89	31,22	36,67	100,00	21,93
Highest score	88,09	80,15	84,50	69,61	80,15	100,00	50,40
Lowest score	18,73	57,59	36,00	17,30	17,30	69,81	17,30
Variance	205,66	36,09	148,62	92,69	106,94	114,53	95,45

Based on Table 4, it was implied that the TPACK ability of junior high school mathematics teachers in North Buton Regency had a varied average score where the PCK component had the highest average score, followed by PK, CK, TK, TCK, CPK, and the lowest TPACK ability. This illustrated that the mathematics teachers had been able to integrate various learning strategies, approaches, methods and assessment techniques with the mathematics material being taught; achieved mastery of various learning strategies, methods and assessment techniques, understood the cognitive characteristics of students, and were able

to apply them in class; but overall were able to integrate technology quite effectively into lesson plans, lesson plan implementation, assessment and learning outcomes.

### B. Implementing TPACK Ability

The ability to apply TPACK was measured using an observation sheet which was conducted during the learning classroom in the classroom. The data was obtained in TPACK application ability scores, then the values that described the characteristics of these ability scores were summarized in Table 5.

Table 5.  
The characteristics of the implementation of TPACK ability

Statistic	Components						
	TK	PK	CK	TPK	TCK	PCK	TPACK
Total	800,00	5300,00	5300,00	2033,33	2033,33	5300,00	800,00
Mean	13,46	100,00	100,00	37,18	37,18	100,00	13,46
Median	0,00	100,00	100,00	33,33	33,33	100,00	0,00
Mode	0,00	100,00	100,00	33,33	33,33	100,00	0,00
Highest score	0,00	100,00	100,00	0,00	0,00	100,00	0,00
Lowest score	100,00	100,00	100,00	100,00	100,00	100,00	100,00
Variance	1306,24	0,00	0,00	828,90	828,90	0,00	1306,24

The average score of the TPACK application ability of mathematics teachers in North Buton District as shown in Table 4 could be implied that the

mathematics teachers had mastered various learning strategies, methods and assessment techniques, the students' cognitive development, and the

implementation in the classroom; mastered the learning materials, knowledge of evidence and practices in daily life, and approaches to develop a mathematics topic taught; had been able to adjust various learning strategies, approaches, methods and assessment techniques with the learning topics. However, they were still very lacking in terms of mastery of various technological elements which included the use of technology, technological developments, and matters related to ICT; and were still very lacking in integrating technology effectively in the process of planning, implementing, and evaluating learning to make it easier.

**C. TPACK Ability based on School Accreditation**

The results of the TPACK ability test on the mathematics teachers in A-accredited

schools, mathematics teachers in B-accredited schools, and mathematics teachers in C-accredited schools is summarized in Table 6.

Based on the One-Way Anova test results in Table 5, it was discovered that the significance value in the components of TK, PK, CK, TCK, and PCK was greater than  $\alpha = 0.05$ . Thus, there was no significant difference in the average ability of TK, PK, CK, TCP, and PCK in mathematics teachers in accredited A schools, accredited B schools, and accredited C schools. While the significance value on the TPK component and TPACK component was smaller than the value of  $\alpha = 0.05$ , which implied that there was a significant difference in the average ability of the TPK and TPACK components of mathematics teachers among all schools.

Table 6.

The Test of TPACK Ability of Mathematics Teachers Based on the Level of School Accreditation

Components	TK	PK	CK	TPK	TCK	PCK	TPACK
F-count	0,227	0,367	0,514	5,804	0,102	1,206	5,429
Sig.	0,798	0,695	0,601	0,005	0,903	0,308	0,007

Furthermore, to find out the differences in the TPK component and TPACK component of mathematics teachers in A-accredited schools, B-accredited schools, and C-accredited schools, an independent sample t-test was conducted. The test results can be seen in Table 7.

Table 7.

The test result of TPK and TPACK ability in A-accredited and B-accredited schools

Components	TPK	TPACK
Sig. (2-tailed)	0,009	0,002
n	34	

The test results shown in Table 7 provided evidence or indication that there was a significant difference in the ability in the TPK and TPACK components between

the mathematics teachers of both schools as indicated by the significance values of 0.009 and 0.002, respectively, which were smaller than  $= 0.05$ .

Table 8.  
The test result of TPK and TPACK ability in B-accredited and C-accredited schools

Components	TPK	TPACK
<i>Sig. (2-tailed)</i>	0,461	0,720
n	41	

The test results presented in Table 8 implied that there was no significant difference in the TPK and TPACK ability components between the mathematics teachers of B-accredited and C-accredited schools, as indicated by the significance values of 0.461 and 0.720, respectively, which were greater than  $= 0.05$ .

Table 9.  
The test result of TPK and TPACK ability in A-accredited and C-accredited schools

Components	TPK	TPACK
<i>Sig. (2-tailed)</i>	0,012	0,019
n	31	

Table 9 showed that there was a significant difference in the ability in the components of TPK and TPACK between the mathematics teachers in A-accredited schools and in C-accredited schools, which was illustrated by the significance value of

0.012 and 0.019, respectively, which was smaller than  $= 0.05$ .

#### D. TPACK Ability between of Certified and Uncertified Teachers

The results of the TPACK ability test on the certified and uncertified mathematics teachers based on the 7 (seven) components analyzed is presented in Table 10.

Based on Table 9 on the PK, CK, TPK, TCK, PCK and TPACK components, the significance value was greater than  $= 0.05$  so it was concluded that there was no difference in the average TPACK ability between mathematics teachers who were certified and uncertified. The difference in the ability only appeared in the TK component as indicated by the significance value of  $0.004 < = 0.05$ . This illustrated certified and uncertified had different abilities in terms of Technological Knowledge (TK) only, while the other components were not significantly different, which included Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK).

Table 10.  
The test results of TPACK Ability of Certified and Uncertified Mathematics Teacher

Components	TK	PK	CK	TPK	TCK	PCK	TPACK
t value	-3,016	0,702	1,212	1,136	-0,768	0,094	-1,222
<i>Sig. (2-tailed)</i>	0,004	0,486	0,231	0,255	0,446	0,926	0,227



**E. TPACK Ability of the Mathematics Teachers in A-accredited Schools**

The test results of the test TPACK abilities of the mathematics teachers in A-accredited schools is presented in Table 11. Based on Table 11, it was implied that all TPACK components provided

significance values greater than = 0.05, so it was concluded that there was no significant difference in the average TPACK ability between certified and uncertified mathematics teachers in A-accredited schools.

Table 11.  
The test result of TPACK Ability of the Mathematics Teachers  
In A-Accredited Schools

Components	TK	PK	CK	TPK	TCK	PCK	TPACK
t value	-1,978	-0,036	1,984	1,149	-0,439	-0,008	-1,459
Sig. (2-tailed)	0,076	0,972	0,075	0,285	0,670	0,994	0,175

**F. TPACK Ability of the Mathematics Teachers in B-Accredited Schools**

The test results of the TPACK ability test for certified and uncertified mathematics teachers in B-accredited schools is presented in Table 12. Based on Table 12, it was implied that the PK, CK, TPK, TCK, PCK and TPACK components provided a significance value greater than = 0.05 so

that it was stated that there was no significant difference in the average ability in all these components between certified and uncertified mathematics teachers in B-accredited schools. The difference in ability only occurred in the Technological Knowledge (TK) component as indicated by a significance value of  $0.001 \leq 0.05$ .

Table 12.  
The test results of TPACK Ability of the Mathematics Teachers  
in B-Accredited Schools

Components	TK	PK	CK	TPK	TCK	PCK	TPACK
t value	-3,780	0,035	-1,498	-1,099	-0,927	-1,221	-1,067
Sig. (2-tailed)	0,001	0,972	0,150	0,285	0,365	0,236	0,299

**G. TPACK Ability of the Mathematics Teachers in C-Accredited School**

The results of the TPACK ability test between the certified mathematics teachers and non-certified mathematics teachers in C-accredited schools are shown in Table 13.

In Table 13, it was found that in C-accredited schools, there was no difference in ability between educator certified teachers and non-certified teachers in all components of TK, PK, CK, TPK, TCK, PCK and TPACK, this was indicated by a significance value greater than = 0.05.

Table 13.  
The test results of the mathematics teachers in C-accredited schools

Components	TK	PK	CK	TPK	TCK	PCK	TPACK
t value	0,206	1,180	1,596	0,844	-0,110	1,170	-0,388
Sig. (2-tailed)	0,839	0,254	0,129	0,410	0,913	0,258	0,703

### H. Discussion

The results showed that the TPACK management skills (including the 7 components of TPACK) of the mathematics teachers in the North Buton region were descriptively poor. Based on the results of the analysis of the TPACK skills of secondary school mathematics teachers in North Buton Regency based on school accreditation, there was a difference in the TPACK skills of mathematics teachers in A-accredited schools and B-accredited schools, then between A and C-accredited schools, but not different between the TPACK skills of teachers in B-accredited and C-accredited schools.

The ability of TPK could be illustrated by the teachers' strategies to adjust the use of technology (TK) with models, methods, learning environments and the use of technology adapted to student characteristics (PK). B-accredited school teachers and C-accredited school teachers could not fully use ICT-based learning environments in the learning process. Some teachers were limited to "Power-Point" which contained a lot of text that they did not understand.

The performance of TPACK skills was poorly demonstrated by the utilization of IT in learning, and the teachers were

unfamiliar with utilizing technology properly. This was revealed in the limited technical resources that teachers used in the learning process. Ariani (2015) stated that teachers were quite confident to integrate technological elements into the learning process, but they still failed to apply technological elements in the appropriate strategy. Tekege (2017) stated that teachers played a very important role in the learning process, therefore skills in mastering information and communication technology (ICT) to support learning activities were something that was inevitable for teachers to know in the current technological era (Wicaksono, 2020).

A-accredited schools were located in the district capital or closest to the district, with adequate access and facilities. Meanwhile, B-accredited schools and C-accredited schools lacked the ICT supporting facilities. One of them was the lack of electricity and free internet sockets, as later to be challenges for the teachers to learn and to implement TPACK. Some teachers did not know or had never even heard of the word "TPACK". Yusof et al., 2008, suggested that in an information system there were three important and fundamental components

that affected the success of learning in information systems, namely human components, organization, and technology availability (Nasir & Syaputra, 2014). Hardware and software components were supporting factors for optimized ICT utilization (Diasti, 2021).

Based on the analysis results of the TPACK abilities among the mathematics teachers based on the certification status, it implied that there were differences in the TPACK abilities of certified mathematics teachers and uncertified mathematics teachers. The difference was in the TK component, where the TK ability of uncertified teachers was higher than that of certified ones. This was an expected result because certified teachers were considered more knowledgeable, capable and qualified (Malik, 2011; Wawin et al., 2021). The purpose of teacher certification was to determine the eligibility of teachers to carry out their duties as learning agents in schools and improve the quality of education (Fransisca, 2018).

Based on the observation, the uncertified teachers were still relatively young, so they were significantly more up-to-date than certified ones who were mostly older. Kalogiannakis (2010) found that age might affect teachers' perceptions of ICT use in learning. Wijaya et al. (2021) found that the teacher certification policy had an important role in improving the quality of education, this was in line with the main objectives of this

policy as an effort to prosper teachers, train teacher skills, improve teacher competence and professionalism.

In A-accredited and C-accredited schools, there was no difference in TPACK skills between certified and uncertified teachers. The difference only occurred in B-accredited schools, especially in the TK component. It was due to the characteristics of teachers in B-accredited schools, which had 8 certified teachers, 4 of whom were senior teachers who were about to retire and did not utilize technology well. Meanwhile, 14 uncertified teachers were young teachers aged 23-35 years. They learned how to utilize technology very easily, followed the latest technological developments, understood the basic components of computers/laptops and could even solve various technical problems. Wicaksono et al. (2020) explained that the age factor affected the ability of teachers to master technology, communication and information (ICT); young teachers were relatively easier to master ICT.

#### IV. CONCLUSION

Based on the results of the study and discussion, this study concluded that based on school accreditation, there was a significant difference in TPACK ability between mathematics teachers in A-accredited school and mathematics teachers B-accredited school ; there was a significant difference in TPACK ability between mathematics teachers in A-

accredited school and mathematics teachers in C-accredited schools; there was no difference in TPACK ability between mathematics teachers in B-accredited school and mathematics teachers in C-accredited schools; there was a significant difference in TPACK ability between certified teachers and uncertified teachers in B-accredited schools; there was no difference in TPACK ability in A-accredited schools and C-accredited schools; TPACK ability of teachers in A-accredited school was the highest. The limitation of this study was the uneven distribution of the research population (sample) based on the status and age of certified and uncertified teachers, in schools accredited A, B, or C. In this case, it was well distributed due to the limited population. It is recommended for further studies to choose a larger and proportional population (sample). The implication of this study was that to improve the TPACK ability of mathematics teachers it was necessary to develop the ICT ability of teachers by providing the supporting factors of both hardware and software so that teachers could access and apply ICT in the learning process.

#### ACKNOWLEDGMENT

The researchers would like to thank the North Buton District Education Office, all Principals and Junior High School Mathematics Teachers in North Buton

District who have participated and assisted in the data collection of this study.

#### REFERENCES

- Aini, I. N. (2016). Upaya Meningkatkan Kemampuan Pemecahan Masalah Matematik Siswa Melalui Pendekatan Open-Ended. *JES-MAT (Jurnal Edukasi Dan Sains Matematika)*, 2(2), 29–40. <https://doi.org/10.25134/jes-mat.v2i2.345>
- Ariani, D. N. (2015). Hubungan antara Technological Pedagogical Content Knowledge dengan Technology Integration Self Efficacy Guru Matematika di Sekolah Dasar. *Muallimuna*, 1(1), 79–91. <https://doi.org/10.31602/muallimuna.v1i1.277>
- Asopwan, D. (2018). Studi Tentang Akreditasi Dalam Meningkatkan Produktivitas Sekolah. *Indonesian Journal of Education Management and Administration Review*, 2(2), 264–271.
- Awaludin, A. A. R. (2017). Akreditasi Sekolah sebagai Suatu Upaya Penjaminan Mutu Pendidikan di Indonesia. *SAP (Susunan Artikel Pendidikan)*, 2(1), 12–21. <https://doi.org/10.30998/sap.v2i1.1156>
- Corazon Diaz Segismundo, M. (2017). Measuring Accreditation Experience: Impact on the Quality of Education of Selected ASAS Member-Schools In Luzon and the NCR. *International Journal of Education and Research*, 5(7).
- Delacre, M., Leys, C., Mora, Y. L., & Lakens, D. (2020). Taking parametric

- assumptions seriously: Arguments for the use of welch's f-test instead of the classical f-test in one-way ANOVA. *International Review of Social Psychology*, 32(1), 1–12. <https://doi.org/10.5334/IRSP.198>
- Diasti, Kermi. (2021). Faktor-Faktor Pendukung Dan Penghambat Belajar Dalam Jaringan (DARING). *Jurnal Pendidikan Islam Al-Affan*, 1(2 march), 151–162.
- Effendi, D., & Wahidy, D. A. (2019). Pemanfaatan Teknologi Dalam Proses Pembelajaran Menuju Pembelajaran ABAD 21. *Prosiding Seminar Nasional Pendidikan Program Pascasarjana Universitas PGRI Palembang*, 125–129.
- Evianti, N., Jafar, J., Busnawir, B., & Masi, L. (2019). Analisis Kesalahan Siswa Kelas IX MTs Negeri 2 Kendari Dalam Menyelesaikan Soal-Soal Lingkaran. *Jurnal Pendidikan Matematika*, 10(2), 138. <https://doi.org/10.36709/jpm.v10i2.7247>
- Fransisca, M. (2018). Pengaruh Sertifikasi Pendidik terhadap Kinerja Konselor dalam Pelaksanaan Layanan Bimbingan dan Konseling di Sekolah. *Widya Warta*, 02(XLII), 197–216.
- Habsyi, I. (2021). Total Quality Management Dalam Peningkatan Mutu Sertifikasi Profesi Guru. *JUPEK: Jurnal Pendidikan Dan Ekonomi*, 2(2), 16–30.
- Hayani, S. N., & Utama, S. (2022). Pengembangan Perangkat dan Model Pembelajaran Berbasis TPACK Terhadap Kualitas Pembelajaran Daring. *Jurnal Basicedu*, 6(2), 2871–2882. <https://doi.org/10.31004/basicedu.v6i2.2512>
- Herizal, H., Nuraina, N., Rohantizani, R., & Marhami, M. (2022). Profil TPACK Mahasiswa Calon Guru Matematika dalam Menyongsong Pembelajaran Abad 21. *JISIP (Jurnal Ilmu Sosial Dan Pendidikan)*, 6(1), 1847–1857. <https://doi.org/10.58258/jisip.v6i1.2665>
- Hidayati, N., Setyosari, P., & Soepriyanto, Y. (2018). Kompetensi Technological Pedagogical Content Knowledge (TPACK) Guru Kimia. *JKTP: Jurnal Kajian Teknologi Pendidikan*, 1(4), 291–298.
- Irawan, S., Tagela, U., & Windrawanto, Y. (2020). Hubungan akreditasi sekolah dan supervisi oleh kepala sekolah dengan kualitas sekolah. *Jurnal Akuntabilitas Manajemen Pendidikan*, 8(2), 165–174. <https://doi.org/10.21831/jamp.v8i2.33905>
- Isabella. (2019). Implementasi Kebijakan Sertifikasi Guru Pada Sekolah Menengah Atas Di Kota Palembang. *Jurnal Pemerintahan Dan Politik*, 1(1).
- Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice teachers' intention to use technology: TPACK, teacher self-efficacy, and Technology Acceptance Model. *Educational Technology and Society*, 21(3), 48–59.
- Kalogiannakis, M. (2010). Training with ICT for ICT from the trainee's perspective. A local ICT teacher training experience. *Education and Information Technologies*, 15(1), 3–17. <https://doi.org/10.1007/s10639-008-9079-3>
- Kismeina, A., & Persada, A. R. (2022).

- Keterampilan guru matematika Se-Kabupaten Kuningan dalam pemanfaatan platform pembelajaran online masa pandemic. *Mosharafa: Jurnal Pendidikan Matematika*, 11(2), 269-280.
- Koehler, M. J., Mishra, P., & Cain, W. (2013). What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, 193(3), 13–19.  
<https://doi.org/10.1177/002205741319300303>
- Kresnadi, H. (2023). *Deskripsi Proses Pembelajaran IPAS Dengan Memanfaatkan Teknologi Informasi dan Komunikasi di Sekolah Dasar Negeri 28 Pontianak Kota*. 06(01), 5868–5878.
- Malik, I. (2011). Kebijakan Sertifikasi Guru (Tawaran Solusi Pendidikan Profesi Guru). *Otoritas: Jurnal Ilmu Pemerintahan*, 1(1), 72–76.  
<https://doi.org/10.26618/ojip.v1i1.21>
- Mardarani, F. D., & Apriyono, F. (2023). Kemampuan berpikir kritis dalam pemecahan masalah ditinjau dari self-concept matematis. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 2(2), 243-252.
- Martin, B. (2015). *Barbara Martin Illinois State University, United States*. 4(1), 17–26.
- Maswar, M. (2019). Strategi Pembelajaran Matematika Menyenangkan Siswa (Mms) Berbasis Metode Permainan Mathemagic, Teka-Teki Dan Cerita Matematis. *Alifmatika: Jurnal Pendidikan Dan Pembelajaran Matematika*, 1(1), 28–43.  
<https://doi.org/10.35316/alifmatika.2019.v1i1.28-43>
- Mutiarahman, W., Edriati, S., & Suryani, M. (2023). Lembar Kerja Peserta Didik Berbasis Realistic Mathematics Education pada Materi Peluang. *Plusminus: Jurnal Pendidikan Matematika*, 3(1), 159-170.
- Nasir, M., & Syaputra, H. (2014). Faktor-Faktor Pendukung Dalam Penerapan Sistem Paket Aplikasi Sekolah Pada Pendidikan SMA Negeri Di Palembang. *Prosiding SNaPP: Sains, Teknologi*, 4(1), 475–482.
- Nofrion, Wijayanto, B., Wilis, R., & Novio, R. (2012). Analisis Technological Pedagogical and Content. *Jurnal Geografi*, 10(2), 105–116.
- Prihono, E. W. (2020). Validitas Instrumen Kompetensi Profesional pada Penilaian Prestasi Kerja Guru. *Ekspose: Jurnal Penelitian Hukum Dan Pendidikan*, 18(2), 897–910.  
<https://doi.org/10.30863/ekspose.v18i2.529>
- Purba, D., & Purba, M. (2022). Aplikasi Analisis Korelasi dan Regresi menggunakan Pearson Product Moment dan Simple Linear Regression. *Citra Sains Teknologi*, 1(2), 97–103.
- Purwianingsih, M. W., Rustaman, N. Y., & Redjeki, M. S. (2010). Pengetahuan Konten Pedagogi (Pck) Dan Urgensinya Dalam Pendidikan Guru. *Jurnal Pengajaran Matematika Dan Ilmu Pengetahuan Alam*, 15(2), 87.  
<https://doi.org/10.18269/jpmipa.v15i2.285>
- Rahayu, A. dan D. W. (2019). Analisis Komponen TPACK Guru SD sebagai Kerangka Kompetensi Guru

- Profesional di Abad 21. *Jurnal Basicedu*, 3(2), 524–532.
- Rahayu, R., Iskandar, S., & Abidin, Y. (2022). Inovasi Pembelajaran Abad 21 dan Penerapannya di Indonesia. *Jurnal Basicedu*, 6(2), 2099–2104. <https://doi.org/10.31004/basicedu.v6i2.2082>
- Rahayu, D. V., Muhtadi, D., & Ridwan, I. M. (2022). Pedagogical content knowledge guru dalam pembelajaran matematika daring. *Mosharafa: Jurnal Pendidikan Matematika*, 11(2), 281–292.
- Rahmadi, I. F. (2019). Technological Pedagogical Content Knowledge (TPACK): Kerangka Pengetahuan Guru Abad 21. *Jurnal Pendidikan Kewarganegaraan*, 6(1), 65. <https://doi.org/10.32493/jpkn.v6i1.y2019.p65-74>
- Rahmawati, D., & Afriansyah, E. A. (2023). Kemampuan Pemecahan Masalah Matematis Melalui Proses Planning, Execution, Dan Revision Ditinjau dari Kemampuan Awal Matematis Siswa. *Plusminus: Jurnal Pendidikan Matematika*, 3(2).
- Restiana, N., & Pujiastuti, H. (2019). Pengukuran Technological Pedagogical Content Knowledge untuk Guru Matematika SMA di Daerah Tertinggal. *Mosharafa: Jurnal Pendidikan Matematika*, 8(1), 83–94.
- Rivalina, R. (2015). Kompetensi Teknologi Informasi Dan Komunikasi Guru Dalam Peningkatan Kualitas Pembelajaran. *Jurnal Teknodik*, 4, 165–176. <https://doi.org/10.32550/teknodik.v0i0.121>
- Rosyid, A. (2015). Prosiding Seminar Nasional Inovasi Pendidikan Inovasi Pembelajaran Berbasis Karakter dalam Menghadapi Masyarakat Ekonomi ASEAN Pedagogical Content Knowledge: Sebuah Kerangka Pengetahuan Bagi Guru Indonesia di Era MEA. *Prosiding Seminar Nasional Inovasi Pendidikan*, 446–454.
- Strategi, ", Pembelajaran, P., Sains, P., Mengasah, U., Abad, K., Sukaesih, S., Ridlo, S., & Saptono, S. (2017). *Seminar Nasional Pendidikan Sains Analisis Kemampuan Technological Pedagogical and Content Knowledge (Tpack) Calon Guru Pada Mata Kuliah Pp Bio*. 21, 58–64.
- Suryanto, H., Sartika, S. B., & Nashrullah, M. (2022). The Analysis Technological Pedagogical Content Knowledge (TPACK) of Natural Science Secondary School Teachers' Based on School Accreditation. *SEJ (Science Education Journal)*, 6(2), 129–134. <https://doi.org/10.21070/sej.v6i2.1631>
- Suryawati, E., L.N, F., & Hernandez, Y. (2014). Analisis Keterampilan Technological Pedagogical Content Knowledge (TPCK) Guru Biologi Sma Negeri Kota Pekanbaru. *Jurnal Biogenesis*, 11(1), 67–72.
- Wawin, C., K., N., & Astuti, C., W., R. (2021). Analisis Perbedaan Motivasi Kerja dan Kinerja Guru pada Guru Yang Bersertifikat dan Tidak Bersertifikat di SMA Negeri 1 dan 2 Nubatukan Kabupaten Lembata. *Jurnal Pendidikan Ekonomi Dan Akutansi*, 15(1), 43–54.
- Wicaksono, V. (2020). Analisis Penguasaan Guru Terhadap Teknologi Informasi Dan Komunikasi (Tik) Di Sekolah Dasar. *Jurnal Pendidikan Tematik*,

5(1), 41–51.

Wijaya, C., Nasution, T., Al Qadri, M., Fuadi, A., & Anwar, K. (2021). Persepsi Guru RA Ali Mahfudz tentang Kebijakan Sertifikasi Guru dalam Peningkatan Mutu Pendidikan. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 6(2), 738–751. <https://doi.org/10.31004/obsesi.v6i2.1551>

Yeni, E. M. (2015). Kesulitan Belajar Matematika Di Sekolah Dasar. *Jupendas*, 2(2), 1–10.

Yurinda, B., & Widayari, N. (2022). Analisis Technological Pedagogical Content Knowledge (Tpack) Guru Profesional Dalam Pembelajaran Matematika Di Sekolah Dasar. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika*, 8(1), 47.

## AUTHORS' BIOGRAPHY

### Dr. Busnawir, M.Si.



Born in Lainea Konawe Selatan on June 8<sup>th</sup>, 1966. Lecturer in Mathematics Education at FKIP Universitas Halu Oleo Kendari. Completed S1 Mathematics Education FKIP Universitas Halu Oleo Kendari in 1990, Masters in Statistics Study Program at IPB Bogor in 2000, and Doctoral Degree in Research and Education Evaluation at UNJ Jakarta in 2006.

### Mery Aryanti, S.Pd., M.Pd., Gr.



Born in Labuan Buton Utara on May 13<sup>th</sup>, 1995. Mathematics teacher at SMPN 1 Kulisusu Utara Middle School, North Buton Regency. Completed Bachelor of Mathematics Education FKIP Universitas Halu

Oleo in 2016 and Master of Mathematics Education Universitas Halu Oleo in 2023.

### Dr. Nana Sumarna, S.Pd., M.Kes.



Born in Kendari, Southeast Sulawesi Province on March 13<sup>th</sup>, 1968. Lecturer in PGSD FKIP, Universitas Halu Oleo Kendari. Received a Bachelor of Mathematics Education from FKIP Universitas Halu Oleo

Kendari in 1993 and a Masters in Health in the Field of Biostatistics in 2000 at Airlangga University. In 2016 he completed his doctoral program studies, the Basic Education study program at Universitas Pendidikan Indonesia Postgraduate School concentrating on Mathematics Education.

### Dr. Kodirun, M.Pd.



Born in Cilacap, June 15<sup>th</sup>, 1961. Teaching staff at the UHO FKIP Mathematics Education Department. Bachelor of Mathematics Education Study, Universitas Haluoleo, Kendari graduated in 1987; Master of

Mathematics Education, Universitas Negeri Malang, graduated in 2002; and Doctor of Mathematics Education at Universitas Pendidikan Indonesia in Bandung, graduating in 2015.

### Dr. Hafiludin Samparadja, S.Si., M.Si.



Born in Buton on June 24<sup>th</sup>, 1974. Lecturer in Mathematics Education at FKIP Universitas Halu Oleo Kendari. Completed S1 Mathematics FMIPA, Universitas Gadjah Mada, Yogyakarta in 1998, Masters in Mathematics

Study Program at Universitas Gajah Mada, Yogyakarta in 2002, and Doctoral Degree in Mathematics Education at Universitas Pendidikan Indonesia Bandung in 2014.