

# TPACK and 21<sup>st</sup> Century Skills in Teaching: The Mediating Role of Implementing Authentic Assessment

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## ABSTRACT

This study was conducted to know the mediating role of authentic assessment between TPACK and 21st-century skills in teaching. The research design used is a non-experimental quantitative, descriptive-correlational method. Statistical tools were mean, Pearson correlation coefficient (r), Medgraph's Sobel z-test, and regression weight to analyze the data. Participated by 300 respondents and selected using a stratified sampling technique. The respondents are from varied schools in Governor Generoso, Davao Oriental. The questionnaires used were validated and verified by experts from the University of Mindanao. The study revealed a significant relationship between TPACK and Authentic Assessment; Authentic Assessment and 21<sup>st</sup> century skills in teaching; and TPACK and 21<sup>st</sup> century skills in teaching. Using the Medgraph's Sobel z-test and regression weight it shows that the mediating role of Authentic Assessment between the relationship of TPACK and 21st-century skills is Partial which means that there is a significant relationship between TPACK and 21st-century skills even if Authentic Assessment is not implemented, however, it will be better if Authentic Assessment will be utilized along with the used of TPACK by the teacher and the implementing skills in the 21<sup>st</sup> century in teaching.

**Keywords:** TPACK, 21<sup>st</sup>-century skills in teaching, implementing authentic assessment, mediating role

## INTRODUCTION

In today's education, there's a need for 21st-century skills in teaching along with the 21st-century society. Together with the skills in teaching, the expertise of teachers in the 21st century, however, there is a lack of knowledge and readiness in teaching in this century (Alhothali, 105 – 106; Care, et al., 15). In connection with the issue of the 21st century in teaching, in implementing teaching in the 21st century, there is a need for collaboration between school leaders and local authorities to engage this issue, in integrating technology as one of the factors in implementing 21st-century skills in teaching (Vebrianto, et al., 51; Wiraningshi & Santosa, 307; Ali, Ahmad & Sewani, 2952; Al, Ali at Mousa 563; Agustini & Ratminingsih, 8).

Integrating skills in 21st-century teaching is a challenge for the teacher because of the rapid changes in technology in this century and the change of teachings which is difficult to the teachers compared to the classical way of teaching, since in this century, most teachers were not skilled enough and mastered the methods needed in this century to be equipped with correct and clear concept of 21st century in teaching and learning Yancey, 125; Augustini, 1-2; Barrot, 12; Alhothali, 123). It was found out that not all of the teachers had a desire to integrate technology in teaching since there is an existing challenge in terms of technological things and other needs that will support the new system of education (Basaran 2212; 2213; Al, Ali & Mousa, 563; Halverson, 14-15; Ogardo-Zara 154).

In the context of the relationship between TPACK and authentic assessment, it shows that TPACK has its

assessment itself. It can be seen that the pedagogy category in the TPACK, does not only involve technology but also authentic assessment as part of the discussion process. According to Mumbing (306-307), the recent era is centered on technology, therefore teacher's must-have technology skills. Concerning online teaching, authentic assessment is not that much to select a variety of activities to conduct, yet authentic assessment gives clarity and smooth flow in teaching the challenged task and topics, thus it provides a better understanding and gives feedback also, it gives on-time feedback on grades and it shows the total performance assessment of the students (Baran, et al., 4; DeCoito Estaiteyeh,2; 4).

On the other hand, in the relationship between authentic assessment and 21st-century skills in teaching, authentic assessment gives students to improve their skills in giving solutions to problems, critical understanding, collaboration, and interaction. These skills were part of the 21st-century skills in teaching and learning. Also, authentic assessment encourages students to learn collaboratively, helps develop their skills in engaging with other students, and allows learning with the guidance of a teacher to instill 21st-century skills (Aziz, et al., 2; Care & Kim, 24, 25, 35; Murugiah, 42).

In the context of the relationship between TPACK and teaching in 21st-century skills, it shows that the 21st-century classroom has its relation to TPACK (Technological Pedagogical and Content Knowledge) in the 21st-century teaching of the teachers. According to the result of the study, technology is important to the students as technology is part of the TPACK in learning in the 21st-century classroom and has its impact on the process of teaching and learning that leads to the continuance of practices and honing the skills of teachers in securing quality education (Shafie et al., 24,30-31, 33; Natpitupulu & S.T. Sebayang, 9279-9280).

The experience of the teachers contributes a lot to teaching to have favorable learning with enough equipment in the digital era in consideration of TPACK and 21st-century teaching (Agustini & Ratminingsih, 8; Ilmi & Sunarno, 5). In the result of the study of Başaran, Bülent (2222) teachers who were equipped with knowledge are those having a high level of confidence in teaching that integrates technological knowledge and pedagogical knowledge. In the study of Valtonen, Sointu, Kukkonen at Kontkanen (21;23), using the 6-point Likert-type scale, it was believed that the elements of TPACK-21 aligned to the framework of TPACK.

It can be seen that the relationship between TPACK and Authentic Assessment shows that there were no differences in integrating and selecting assessments in every category of TPACK in teaching, it is believed that in implementing authentic assessment there is a need to consider the TPACK in targeting the learning outcome (Wang, 3,4; Besa & Limpot, 49). However, the decision of the teacher must consider in selecting assessment tools and the challenges in using these tools in assessment. Teachers evaluate their competencies in teaching TPACK and find out that they know the categories in TPACK (Arcueno et al., 1, 3).

The main theory of this study is anchored on the theory of constructivism by Jean Piaget in 1955, a guide that describes students in constructing knowledge from the task given by the teachers. This theory maintains the flow of accustomed teaching that is enriched by the process of learning that gives place to understanding and internalization. Also, it gives a challenge to the teachers to integrate activities with the students in this century (Orak, 169-171; Khuwzwayo & Kwanele,5-6). Besides Piaget, the concept of Lev Vygotsky and John Dewey in the realm of constructivism contributes. From the perspective of John Dewey, in constructivism, students will gain knowledge by interacting in reality and an environment that will engage another individual (Mattar,204).

TPACK supports the constructivism theory, this TPACK conducted by Mishra and Koehler in 2009, described and studied the professional knowledge of teachers in teaching. It allows the application of the methods in 21st-century teaching to 21st-century students (Napitupulu & Sebayang, 16; Basaran, 2214). Also, the framework of the 21st century in teaching and learning conducted in 2009 by Partnership for the

21st Century as 21st CSs shows the skills, knowledge, and experiences needed by the students in their real life, this will be implemented by interactive teaching to show the constructive learning to acquire 21st-CSs (Al Kandari & Qattan, 5554 – 555). Therefore, in 21st-century teaching, TPACK, and authentic assessment, among these variables, constructivism theory is a theory that encourages teachers in teaching to be interactive and integrated.

As we can see, the framework of this study shown in Figure 1, shows the relationship of the variables, in which, the independent variable is TPACK, the dependent variable is 21st-century skills in teaching, and the mediating role is the authentic assessment. In TPACK, its indicators are technological knowledge; content knowledge; pedagogical knowledge; pedagogical content knowledge; technological content knowledge; and technological pedagogical and content knowledge (Schmidt, Denise A., et al., 1-6; Basaran, 2214). In terms of the dependent variable which is the 21st-century skills in teaching, its indicators are critical thinking skills; collaboration skills; communication skills; creativity, and innovation skills; self-directive skills; global connection; local connection; using technology as learning tools (Jason Ravitz, Ph.D., 4-8). In authentic assessment as the mediating role of this study, its indicators are as follows: perception in authentic assessment (element); using authentic assessment (application/result); practiced in teaching; and activity or strategy in authentic assessment (Attom, 155-163).

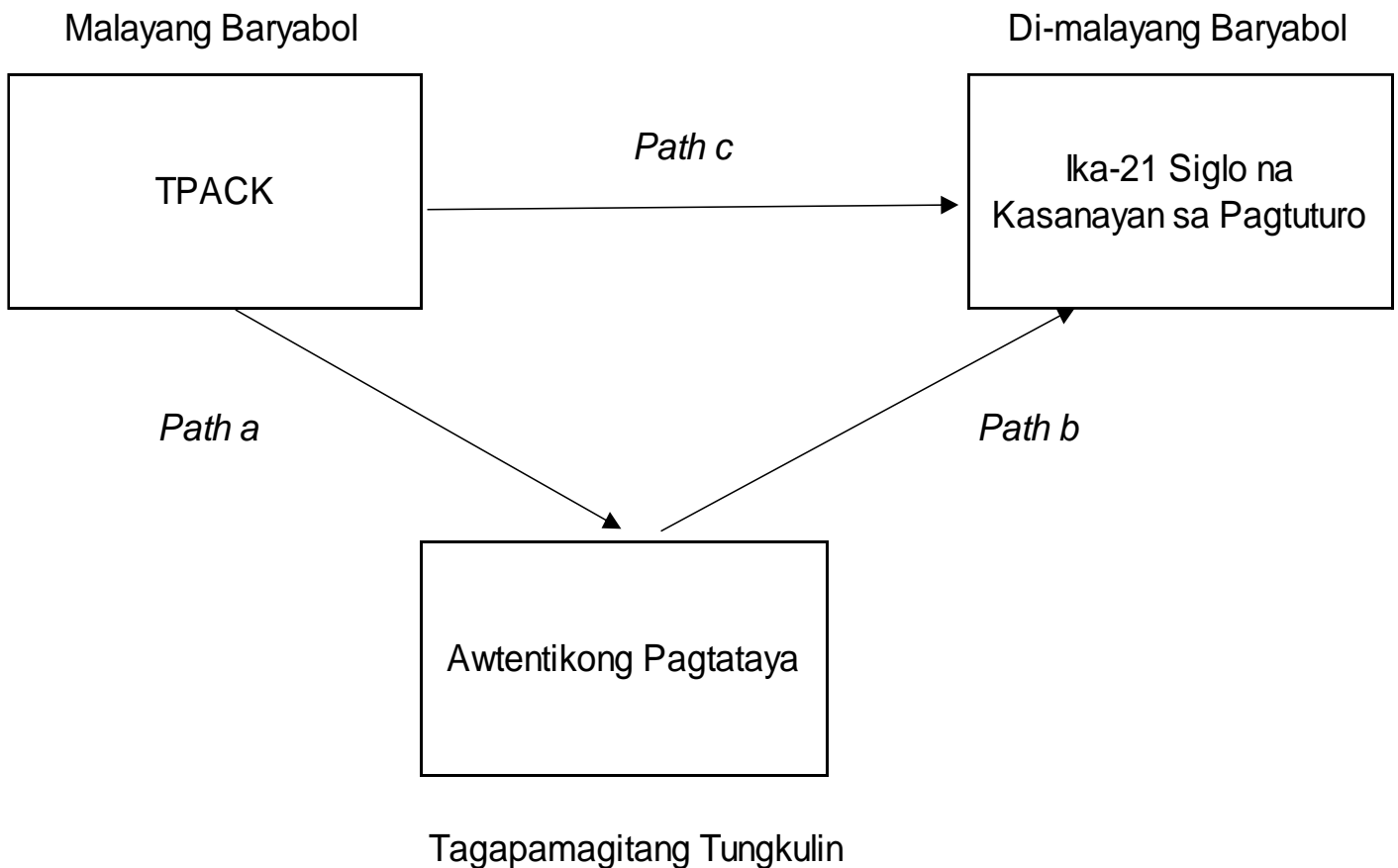


Figure 1. Conceptual framework

In the literature mentioned above in the context of TPACK, 21st-century skills in teaching, and authentic assessment, it is observed that there is a lack of enough facilities needed in 21st-century teaching that support and can apply technology in teaching. It was known too that not all teachers were experts in technology to teaching, also their knowledge and readiness in teaching 21st-century aligned to 21st-century skills. There is lacking seminars activity for 21st-century, also, there was limited assessment online that will

allow teachers to teach in this 21st -century (Agustini & Ratminingsi, 8; Basaran, 2213; Arcueno, et al, 1; Care & Kim, 36; Wang, 3; Wiraningshi & Santosa, 307; Agustini, 2; Care et al., 15; Ali, Ahmad & Sewani, 2952; Decoito & Estaiteyeh, 2).

Thus, there is a need to study further in the context of teaching using TPACK that considers authentic assessment aligned with the 21st century, especially in integrating TPACK in teaching considering the implementation of authentic assessment in promoting teaching in the 21st century. Therefore, there is a need to give attention to this problem and suggest a solution to this problem of the teachers in the said location of its study.

This study aimed to answer the following: first, to know the level of teaching using TPACK; second, to know the level of 21st-century teaching; third, to know the level of authentic assessment; fourth to know the significant relationship between TPACK and authentic assessment; Authentic assessment and 21st century teaching skills; and TPACK and 21st century teaching skills; and fifth, to know the mediating role of Authentic Assessment in the relationship of TPACK and 21st century teaching skills. In the significance level of 0.05, the hypothesis was analyzed in terms of: there was no statistically significant relationship between TPACK and Authentic Assessment; Authentic Assessment and 21st-century teaching skills; TPACK and 21st-century teaching skills.

This study will help society in the context of education which will contribute to promoting quality education, and also to establish a strong foundation of education in the community in the context of 21st century skills. Not only in the community but also in the teachers, the result of this study will benefit them for a reference in their teaching. Also, to future researchers, this study may benefit them as their literature may related to their study.

## **METHOD**

This part, discussed the respondents of the study, materials and research instrument, research design, inclusion, exclusion, and withdrawal of respondents, research locale, statistical tools, Cronbach alpha test score result, data gathering procedure, and ethical considerations.

### **Research Respondent**

The respondents of this study were the public teachers of Governor Generoso, Davao Oriental, with a total respondent of 300. In the study of the variables that have mediation, explained and showed in the Monte Carlo (Simulation) Method that the basis of the respondents of this study is acceptable. A stratified sampling method was used in selecting respondents (Sim, M., Kim, S.-Y., & Suh, Y, 76,80,94; Etikan & Babatope, 51; Pandey & Pandey, Mishra, 46, 49).

Respondents were based on the nine (9) public schools in the municipality of Governor Generoso in the province of Davao Oriental. In School A, there were 1; School B, 48; School C, 10; School D, 44: school E, 16; School F, 19: school G, 73; School H, 11; and School I, 60, with a total of 300 respondents. This includes all permanent public-school teachers teaching junior high and senior high, regardless of the years in service, age and gender. This excludes private teacher, and if there were objections, the respondents were free to withdraw in the study.

The municipal of Governor Generoso was selected since the issue on 21st century teaching skills is existing in this locality. Since internet access is interlinked in technology in implementing teaching that needed in this century that results to a challenged implementation of TPACK in teaching and integrating authentic assessment that befit in 21st century teaching skills.

## Materials and Instrument

The questionnaires were anchored on the three different studies in education. In the first part of the questionnaire, it was anchored on the study of Schmidt, Denise A., et al. (1-6) has 46 total items, it has Cronbach's Alpha based on standard items of .968, and its Cronbach's Alpha Test Scores/Result of .967 with the internal consistency of excellent. In the second part of the questionnaire on 21st-century skills, was anchored on the study of Jason Ravitz, Ph.D, (4-8), which has 46 total questions and has a Cronbach's Alpha based on the standard items of .974 and Cronbach's alpha test score/result of .974 with the equivalent description of excellent. The last part of the questionnaire is based on the study of Attom (155-163), with a total number of 49, its Cronbach's alpha based on the standard items of .982, with the Cronbach's alpha test scores 'result of .982 with its equivalent description of excellent.

The questionnaire for this study used a single interpretation scale as the interpretation applied to all parts of the questionnaire. A five-point Likert Scale was used with the following descriptions along with interpretative meanings: 4.20 – 5.0 is the highest, always expressed or demonstrated; 3.40 – 4.19 is high, often expressed or demonstrated; 2.60 – 3.39 is moderate, sometimes expressed or demonstrated; 1.80 – 2.59 is low, rarely expressed or demonstrated; 1.0 – 1.79 is the lowest, seldom expressed or demonstrated. Reliability statistics were assessed based on the Cronbach's Alpha Test Scores/Results, and the Cronbach's Alpha based on its Standardized Items was presented. In this section, the result of Cronbach's Alpha was used as a basis: 0.90 and above with internal consistency equivalent to excellent; 0.80 – 0.89, good; 0.70 – 0.79, acceptable; 0.60 – 0.69, uncertain; 0.50 – 0.59, not good; and below 0.50, unacceptable.

Experts also reviewed the manuscript, the original, and the contextualized questionnaire. Five experts from the graduate school and one external reviewer examined it. The validation rating sheet of the University of Mindanao was used as a basis, with a scale of 5 corresponding to excellent; 4, very good; 3, good; 2, moderate; and 1, not good. As a result of the review, the overall score was 4.6, corresponding to very good. Before the actual data collection, the Cronbach's Alpha Test Scores of the instrument used were assessed. The TPACK questionnaire scored .967. The 21st Century Teaching Skills scored .974. The Authentic Assessment Performance scored .982. Overall, the questionnaire has a very good internal consistency.

## Design and Procedure

This study employed a non-experimental quantitative design, specifically a descriptive-correlational method, which aims to determine the relationship between two or more variables. The descriptive method is a primary approach that explains events and current conditions, aiming to investigate the relationships and phenomena through the collection of numerical data and analysis using statistical methods. This approach was used to understand the intervening relationships between variables and to address the study's objectives (Baluyos et al., 211; Taherdoost, 58; Akinlua, 5).

In data collection, Medgraph's Sobel z-test and regression weights were used, which expressed the mediation approach in this study. It described the data from a large number of respondents. In the conducted analysis, it was found that there was partial mediation in the intervening role. This indicated the partial role of Authentic Assessment between TPACK and 21st Century Teaching Skills. This means that even without including Authentic Assessment in the study, there was still a relationship between TPACK and 21st Century Teaching Skills, but the relationship was not as strong compared to when authentic assessment was maintained in the study.

In the process of data collection, the following steps were taken: permission to conduct the research at UMPS was sought; the completed advisor forms were reviewed; the study was reviewed by UMERG and granted certification of approval; pilot testing was conducted; Cronbach's alpha test scores were examined;



permission via email was requested from the Department of Education of the Division of Davao Oriental to conduct the study, and a certification of approval was granted; permission was requested from the heads of schools, and the questionnaires were distributed; data were recorded and analyzed. This process was conducted during the second semester of the academic year 2022-2023.

In analyzing the data, the following statistical tools were used: Mean, Pearson correlation coefficient ( $r$ ), Medgraph's Sobel  $z$ -test, and Regression Weights. The mean was used for the descriptive expression of the variables. The Pearson correlation coefficient ( $r$ ) was used to show the relationship between TPACK, 21st-century teaching skills of teachers, and Authentic Assessment. To determine the mediating role of Authentic Assessment between TPACK and 21st-century teaching skills of teachers, Medgraph's Sobel  $z$ -test and Regression Weights were used.

Before the data collection and interpretation were conducted, it was ensured that the requirements for data collection approval were met. A draft manuscript and the required forms were submitted to UMERC. These were reviewed and underwent an initial examination, and a UMERC certification number, UMERC-2023-061, was granted. At this point, the actual data collection was carried out.

## RESULT AND DISCUSSION

In this section, the results and findings of the study related to the descriptive discussions of TPACK, 21st-century teaching skills of teachers, and Authentic Assessment were presented and elaborated. Also discussed was the role of Authentic Assessment between TPACK and 21st-century teaching skills of teachers.

### Level of TPACK (Technological Pedagogical and Content Knowledge)

Table 1 shows the level of Teachers' Teaching using TPACK. It has a total standard deviation of 0.44 and a total mean of 4.12. The overall descriptive level is High. The pedagogical Knowledge indicator has the highest descriptive level with a standard deviation of 0.55 and a mean of 4.27. The lowest indicator, Content Knowledge, has a standard deviation of 0.59 and a mean of 4.01, with a descriptive level of high.

Table 1 Level of Teachers' Teaching Using TPACK

Indicator	SD	Mean	Descriptive Level
Technological Knowledge	0.53	4.10	High
Content Knowledge	0.59	4.01	High
Pedagogical Knowledge	0.55	4.27	Highest
Pedagogical Content Knowledge	0.58	4.13	High
Technological Content Knowledge	0.62	4.11	High
Technological Pedagogical Knowledge	0.52	4.20	Highest
Technological Pedagogy and Content Knowledge	0.59	4.03	High
<b>Total</b>	<b>0.44</b>	<b>4.12</b>	<b>High</b>

The study results have shown that the highest level of teachers' teaching using TPACK is in Pedagogical

Knowledge. Specifically noted in the statement ‘I adapt my teaching to what students already know and do not yet know,’ this indicates that teachers consistently express or demonstrate this in their teaching. In contrast, it was found that the indicator Content Knowledge had the lowest results in two statements with similar means of 3.76, stating ‘I have sufficient knowledge in Mathematics’ and ‘I use my mathematical approach.’ These statements have the lowest means, but they still have a high descriptive level. This suggests that teachers often only occasionally express or demonstrate these aspects in their teaching.

Similar to Basaran’s findings (2221), indicating a perceived deficiency in content knowledge among teachers, especially in subjects like science and mathematics, potentially impacting their teaching effectiveness, Ogardo-Zara’s study (154) offers a contrasting view. It suggests that despite initial shortcomings, teachers can enhance their understanding through daily teaching, emphasizing the need for ongoing professional development to strengthen content knowledge in crucial subjects like science and mathematics.

### The level of 21st Century Teaching Skills among teachers

In Table 2, the level of 21st Century Teaching Skills among teachers is presented. It has a total standard deviation of 0.46 and a mean of 4.25, indicating an overall descriptive level of Highest. The indicator Creativity and Innovation has the highest standard deviation of 0.65 and a mean of 4.31, with a descriptive level of Highest. On the other hand, the indicator Global Connection has a standard deviation of 0.61 and a mean of 4.12, with a descriptive level of High, which is the lowest among the indicators shown.

Table 2 Level of 21st-Century Teaching Skills Among Teachers

Indicator	SD	Mean	Descriptive Level
Critical Thinking Skills	0.51	4.25	Highest
Collaboration Skills	0.59	4.25	Highest
Communication Skills	0.64	4.30	Highest
Creativity and Innovation	0.65	4.31	Highest
Personal Direction Skills	0.59	4.30	Highest
Global Connection	0.61	4.12	High
Local Connection	0.59	4.21	Highest
Use of Technology as a Learning Tool	0.56	4.25	Highest
<b>Total</b>	<b>0.46</b>	<b>4.25</b>	<b>Highest</b>

Based on the study results, the indicator of Creativity and Innovation, specifically in the statement “I use creative methods such as brainstorming and concept mapping,” obtained the highest score with a standard deviation of 0.73 and a mean of 4.39. This indicates the Highest descriptive level, suggesting that teachers consistently demonstrate or express this skill in their teaching. In contrast, in the indicator of Global Connection, the statement “I have studied the geography of distant countries” received the lowest score. It has a standard deviation of 0.75 and a mean of 4.05, with a High descriptive level, indicating that teachers often only occasionally express or demonstrate this aspect in their teaching.

Based on the study by Mugot, Daisy, and Elvira Sumbalan (25), Communication, Collaboration, and Critical Thinking skills are consistently demonstrated in all instances, as they are believed to be integral to the teaching duties of educators. On the other hand, Global Connection is rarely demonstrated, primarily due

to challenges in international communication, which require various types of technology and internet access.

### Level of Implementation of Authentic Assessment by Teachers

In Table 3, the level of Implementation of Authentic Assessment by Teachers is presented, with a total standard deviation of 0.50 and a mean of 4.25, indicating the Highest descriptive level, meaning it is consistently demonstrated or expressed by teachers in their teaching. According to the findings of this study, the highest indicator is the Activity or Strategy of Authentic Assessment, with a standard deviation of 0.55 and a mean of 4.30, also at the Highest descriptive level. Meanwhile, the lowest indicator is the Perception of Authentic Assessment, with a standard deviation of 0.52 and a mean of 4.17, categorized as High at the descriptive level.

Table 3 Level of Implementation of Authentic Assessment by Teachers

Indicator	SD	Mean	Descriptive Level
Perception of Authentic Assessment	0.52	4.17	High
Use of Authentic Assessment	0.64	4.27	Highest
Proficiency in Assessment	0.56	4.27	Highest
Activity or Strategy of Authentic Assessment	0.55	4.30	Highest
<b>Total</b>	<b>0.50</b>	<b>4.25</b>	<b>Highest</b>

In the indicator of Activity or Strategy of Authentic Assessment, the statement “I ensure that students can write reports in class” obtained the highest result with a standard deviation of 0.65 and a mean of 4.38. This is categorized as the Highest descriptive level, indicating that teachers consistently demonstrate or express this in their teaching. On the other hand, in the indicator of Perception of Authentic Assessment, the statement “Authentic Assessment demonstrates students’ cognitive ability to respond to meaningful tasks” showed the lowest result. It has a standard deviation of 0.73 and a mean of 4.10, categorized as High in descriptive level.

The overall findings are supported by Murugiah’s study (41, 43), emphasizing the need for guidance to facilitate the shift towards assessments focused on developing 21st-century skills among students. The study also mentions the challenges of clarity in using authentic assessment due to technological changes and concerns about training in authentic assessment.

### Significance of the Relationship between Teachers’ Use of TPACK and 21st Century Teaching Skills

Table 4.1, shows the significant relationship between Teachers’ Use of TPACK and 21st Century Teaching Skills. The relationships are as follows: Technological Knowledge with a total result of .519\*\*, Content Knowledge, .503\*\*; Pedagogical Knowledge, .677\*\*; Pedagogical Content Knowledge, .563\*\*; Technological Content Knowledge, .626\*\*; Pedagogical Technological Knowledge, .723\*\*; and Technological Pedagogical Content Knowledge, .534\*\*.

On the other hand, in terms of 21st-century teaching skills concerning TPACK, significant correlations are evident: Critical Thinking Skills, .673\*\*, Collaboration Skills, .603\*\*, Communication Skills, .629\*\*, Creativity and Innovation Skills, .634\*\*, Personal Direction Skills, .572\*\*, Global Connection, .607\*\*,



Local Connection, .418\*\*, Use of Technology as a Learning Tool, .617\*\*. The overall result shows an r-value of .760\*\* and a p-value of (.000), which is below the .05 significance level. The correlation coefficient ranging from 0 to 1, with values close to 1, indicates a strong positive relationship between the variables. The symbol of two asterisks (\*\*) indicates that these correlation coefficients have significant relationships.

Table 4.1 Significance of the Relationship between Teachers’ Use of TPACK and 21st Century Teaching Skills

TPACK	21st Century Teaching Skills								Overall
	KKP	KP	KK	KPI	KPD	GK	LK	PTKP	
TK	.544**	.389**	.368**	.408**	.299**	.355**	.347**	.559**	.519**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
PK	.487**	.402**	.377**	.404**	.347**	.382**	.321**	.442**	.503**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
PK	.607**	.531**	.579**	.585**	.549**	.519**	.372**	.490**	.677**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
PKP	.482**	.453**	.464**	.502**	.496**	.452**	.275**	.388**	.563**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
TKP	.394**	.556**	.611**	.611**	.626**	.534**	.191**	.352**	.626**
	.000	.000	.000	.000	.000	.000	.001	.000	.000
KTP	.591**	.561**	.627**	.551**	.483**	.645**	.484**	.578**	.723**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
TPKP	.577**	.391**	.401**	.390**	.304**	.426**	.314**	.573**	.534**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
Overall	.673**	.603**	.629**	.634**	.572**	.607**	.418**	.617**	.760**
	.000	.000	.000	.000	.000	.000	.000	.000	.000

Legend:

TK - Technological Knowledge

PK - Content Knowledge

PK - Pedagogical Knowledge

PKP - Pedagogical Content Knowledge

TKP - Technological Content Knowledge

KTP - Technological Pedagogical Knowledge

TPKP - Technological Pedagogical Content Knowledge

KKP - Critical Thinking Skills

KP - Collaboration Skills

KK - Communication Skills

KPI - Creativity and Innovation Skills

KPD - Personal Direction Skills

GK - Global Connections

LK - Local Connections

PTKP - Use of Technology as a Tool for Learning

Overall, the data shows a positive relationship between TPACK and 21st-century teaching skills. The hypothesis suggesting no statistically significant relationship between TPACK and 21st-century teaching skills among teachers is not supported, as this study’s findings demonstrate a significant correlation between these variables. The study’s results had a significant impact on the teaching and learning process, emphasizing the need for continuous training and development of teachers to ensure educational quality. Technology as part of TPACK also proved beneficial for students learning in 21st-century classrooms (Shafie et al., 24-33; Natpitupulu & S.T. Sebayang, 9279-9280).

**Significance of the Relationship between Teachers’ Use of TPACK and Implementation of Authentic Assessment**

Table 4.2 shows the significant relationship between Teachers’ Use of TPACK and Implementation of Authentic Assessment by Teachers. It illustrates the correlation between TPACK indicators and Authentic

Assessment. For the TK indicator, a correlation with Authentic Assessment is shown with an r-value of .484\* and a p-value of .000; for PK, an r-value of .422\*\* and p-value of .000; for the second PK, an r-value of .555\*\*, and p-value of .000; for PKP, an r-value of .443\*\* and p-value of .000; for TKP, an r-value of .539\*\* and p-value of .000; for KTP, an r-value of .626\*\* and p-value of .000; and TPKP, an r-value of .426\*\* and p-value of .000.

Table 4.2 Significance of the Relationship between Teachers' Use of TPACK and Implementation of Authentic Assessment

TPACK	Awentikong Pagtataya				
	PAP	PAP	KP	GEAP	Overall
TK	.445** .000	.386** .000	.400** .000	.480** .000	<b>.484**</b> <b>.000</b>
PK	.466** .000	.356** .000	.312** .000	.358** .000	<b>.422**</b> <b>.000</b>
PK	.508** .000	.473** .000	.486** .000	.487** .000	<b>.555**</b> <b>.000</b>
PKP	.449** .000	.414** .000	.372** .000	.319** .000	<b>.443**</b> <b>.000</b>
TKP	.546** .000	.603** .000	.456** .000	.267** .000	<b>.539**</b> <b>.000</b>
KTP	.580** .000	.493** .000	.643** .000	.495** .000	<b>.626**</b> <b>.000</b>
TPKP	.389** .000	.278** .000	.384** .000	.464** .000	<b>.426**</b> <b>.000</b>
<b>Overall</b>	<b>.621**</b> <b>.000</b>	<b>.552**</b> <b>.000</b>	<b>.557**</b> <b>.000</b>	<b>.523**</b> <b>.000</b>	<b>.640**</b> <b>.000</b>

Legend:

TK - Technological Knowledge

PK - Pedagogical Knowledge

PKP - Pedagogical Content Knowledge

TKP - Technological Content Knowledge

KTP - Technological Pedagogical Knowledge

TPKP - Technological Pedagogical Content Knowledge

PAP - Perception of Authentic Assessment

PAP - Use of Authentic Assessment

KP - Competence in Assessment

GAEP - Activity or Strategy of Authentic Assessment

On the other hand, in Authentic Assessment concerning TPACK, in PAP, there is an r-value of .621\*\* and a p-value of .000, in the second PAP there is an r-value of .552\*\* and a p-value of .000, in KP there is an r-value of .557\*\* and a p-value of .000, GEAP has an r-value of .523\*\* and a p-value of .000. Overall, the significant relationship between TPACK and Implementation of Authentic Assessment has an r-value of .640\*\* and a p-value of .000, which is lower than the .05 significant level, indicating a strong positive relationship between the variables.

Furthermore, there is a strong positive relationship between teacher instruction using TPACK and teacher implementation of Authentic Assessment, affirmed by Wang (3-4), emphasizing that in conducting authentic assessment, TPACK should be considered in achieving instructional goals. Thus, the hypothesis that there is no significant relationship between TPACK and Authentic Assessment is not accepted; rather, teacher instruction using TPACK has a strong positive relationship with the implementation of authentic assessment in teaching.

### The Significance of the Relationship in Conducting Authentic Assessment by Teachers and 21st Century Teaching Skills

In Table 4.3, it demonstrates the significant relationship between Teachers' Implementation of Authentic

Assessment and 21st Century Teaching Skills. Within the realm of Authentic Assessment, the relationship with indicators of 21st Century Teaching Skills was shown based on its r-value and p-value. For the indicator PAP, there was an r-value of .804\*\* and a p-value of .000. For the second PAP, there was an r-value of .729\*\* and a p-value of .000, for KP, an r-value of .758\*\* and a p-value of .000, and for GAEP, an r-value of .620\*\* and a p-value of .000.

On the other hand, in the context of 21st Century Teaching Skills concerning the Implementation of Authentic Assessment, the indicators show the following relationships: for KKP, there was an r-value of .560\*\* and a p-value of .000, for KP, an r-value of .580\*\* and a p-value of .000, for KK, an r-value of .720\*\* and a p-value of .000, for KPI, an r-value of .701\*\* and a p-value of .000, for KPD, an r-value of .697\*\* and a p-value of .000, for GK, an r-value of .674\*\* and a p-value of .000, for LK, an r-value of .563\*\* and a p-value of .000, and PTKP, an r-value of .655\*\* and a p-value of .000.

Table 4.3 The Significance of the Relationship in Conducting Authentic Assessment by Teachers and 21st Century Teaching Skills

Authentic Assessment	21st Century Teaching Skills								Overall
	KKP	KP	KK	KPI	KPD	GK	LK	PTKP	
PAP	.532**	.590**	.667**	.693**	.667**	.644**	.589**	.624**	.804**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
PAP	.358**	.558**	.705**	.690**	.739**	.597**	.374**	.479**	.729**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
KP	.523**	.513**	.697**	.597**	.612**	.664**	.553**	.556**	.758**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
GEAP	.580**	.374**	.450**	.476**	.412**	.465**	.489**	.662**	.620**
	.000	.000	.000	.000	.000	.000	.000	.000	.000
Overall	.560**	.580**	.720**	.701**	.697**	.674**	.563**	.655**	.827**
	.000	.000	.000	.000	.000	.000	.000	.000	.000

**Legend:**

PAP - Perception of Authentic Assessment

PAP - Use of Authentic Assessment

KP - Assessment Literacy

GEAP - Practice or Strategy of Authentic Assessment

KKP - Critical Thinking Skills

KP - Collaborative Skills

KK - Communication Skills

KPI - Creativity and Innovation Skills

KPD - Personal Direction Skills

GK - Global Connections

LK - Local Connections

PTKP - Use of Technology as a Learning Tool

Overall, the relationship between Teachers' Implementation of Authentic Assessment and 21st Century Teaching Skills yielded a total r-value of .827\*\* and a p-value of .000. The overall result falls below the .05 significance level, indicating a significant relationship. The coefficient ranges from 0 to 1, with a value close to 1, suggests a strong positive correlation between the variables. The symbol of two asterisks (\*\*) indicates that the coefficient relationship is statistically significant.

The study's findings indicate a significant relationship between Teachers' Implementation of Authentic Assessment and 21st Century Teaching Skills. Therefore, the conclusion stating that there is no statistically significant relationship between Teachers' Implementation of Authentic Assessment and 21st Century Teaching Skills is not accepted. This simply means that there is indeed a relationship between teachers' implementation of authentic assessment and their 21st-century teaching skills. This relationship was evident in the study, which explains that teachers engage in assessment in their teaching. It recommends guiding teachers in using appropriate assessments (Kim, Raza, and Seidman 4; 99; Care & Kim, 36; Mugot &

Sumbalan, 27).

### Mediating Role in Implementing Authentic Assessment in the Relationship between TPACK and 21st Century Skills

In Table 2, the illustration of the relationship between TPACK and 21st Century Teaching Skills is presented, as well as in Table 5.1, which shows information regarding the calculation of the following: standard error (S.E), critical ratio (C.R.), and p-value (P Label) for the variable Teaching Skills in relation to TPACK. In Table 5.1 below, an estimated value of .793 is shown, indicating a positive relationship between 21st Century Teaching Skills and TPACK. This coefficient suggests that as TPACK levels increase, Teaching Skills also increase.

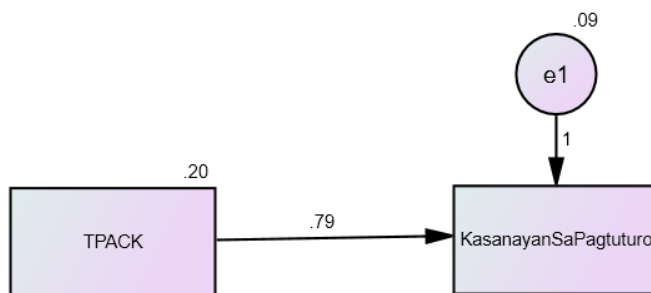


Figure 2. Relationship between TPACK and 21st Century Teaching Skills

The standard error value of 0.39 represents the total amount of error in estimation, with a lower value indicating a more precise estimate. The critical ratio of 20.193 measures the statistical relationship, indicating that the relationship between Teaching Skills and TPACK is statistically significant as it surpasses the critical value. While not directly stated in the table, the “\*\*\*” label indicates that the p-value is low, specifically below .001. This suggests a significant relationship between the variables mentioned.

Table 5.1 Analysis of the Relationship Between TPACK and 21st Century Teaching Skills

**Regression Weights: (Group number 1 - Default model)**

Variable	Variable	Estimate	S.E.	C.R.	P Label
21st Century Teaching Skills	<--- TPACK	.793	.039	20.193	***

Overall, it simply indicates a positive and significant relationship between Teaching Skills and TPACK. This finding suggests that an increase in TPACK correlates with an increase in teachers’ teaching skills in the learning and teaching process. It signifies the importance of Technological Pedagogical Content Knowledge (TPACK) in effective teaching. Related to this teaching is the use of technology as part of promoting 21st century teaching skills and expertise in its development (Al, Ali, & Mousa, 563; Halverson, 14-15; Ogardo-Zara, 154). Başaran’s study (2222) revealed that teachers with sufficient knowledge have higher confidence in teaching technological and pedagogical knowledge. Valtonen, Sointu, Kukkonen, and Kontkanen’s research (21; 23) aligns elements of TPACK-21 within the TPACK framework.

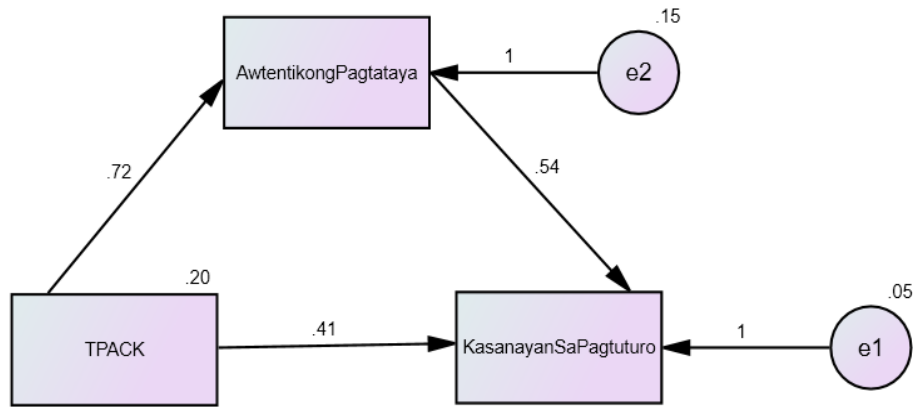


Figure 3. Mediating Role of Authentic Assessment in the Relationship between TPACK and 21st Century Teaching Skills

On the other hand, in Figure 3, related to Table 5.2, the analysis of the mediating role of Authentic Assessment in the relationship between TPACK and 21st Century Teaching Skills is presented. The table shows the estimate, standard error (S.E), critical ratios (C.R), and P Label. These metrics illustrate the relationship between Authentic Assessment, TPACK, and Teaching Skills. The table shows estimates representing the strength of the relationship between the variables. Thus, the relationship between Authentic Assessment and TPACK has an estimate of 0.718, while the relationship between Teaching Skills and TPACK has an estimate of 0.407. The relationship between Teaching Skills and Authentic Assessment has an estimate of 0.537.

Table 5.2 Analysis of the Mediating Role of Authentic Assessment in the Relationship between TPACK and 21st Century Teaching Skills

**Regression Weights: (Group number 1 - Default model)**

			Estimate	S.E.	C.R.	P Label
Authentic Assessment	<---	TPACK	.718	.050	14.389	***
21st Century Teaching Skills	<---	TPACK	.407	.037	10.908	***
21st Century Teaching Skills	<---	Authentic Assessment	.537	.033	16.160	***

The standard errors (S.E) indicate the precision of the estimate. Therefore, the S.E for the relationship between Authentic Assessment and TPACK is 0.050, for Teaching Skills and TPACK is 0.037, and for Teaching Skills and Authentic Assessment is 0.033. Regarding the critical ratio (C.R), it indicates the significant relationship of the variables. A C.R value greater than 1.96 is recognized as indicating a significant relationship. Hence, the resulting C.R values for the variables were all greater than 1.96, which means that they have a significant relationship. Regarding the P label, it indicates the level of significance, and the study results showed that all variables had the symbol “\*\*\*,” meaning they have a high level of significant relationship.

Overall, the table indicates a strong and significant relationship between Authentic Assessment, TPACK,



and 21st Century Teaching Skills of teachers. The specific values of the estimates, S.E, C.R, and P label signify the strength and importance of each relationship. Based on the regression weights, both Authentic Assessment and Teaching Skills have a significant relationship with TPACK, evidenced by high estimates and low p-values. The estimate values represent the strength of the relationship, while the p-value indicates the statistical significance of the relationship. Both variables show a positive relationship with TPACK, suggesting that Authentic Assessment and Teaching Skills scored high in TPACK.

Similarly, the regression weight between 21st Century Teaching Skills and Authentic Assessment also demonstrated a significant relationship between the variables. An increase in the estimate value score of Teaching Skills corresponds with an increase in the score of Authentic Assessment. Overall, based on the table and figure presented, it can be said that there is Partial Mediation in the mediating role between the variables. This means that the relationship between Authentic Assessment and TPACK is partially explained by Teaching Skills, as shown by the regression weights. Therefore, the hypothesis stating that Authentic Assessment has no significant role in the relationship between TPACK and 21st Century Teaching Skills is not accepted. The results of the study indicate that Authentic Assessment has a significant role in the relationship between the two variables.

Therefore, the studies by Arcueno et al. (3) and Kim et al. (4; 99) confirm that teachers gain knowledge in TPACK and utilize assessment in teaching. Additionally, authentic assessment encourages simultaneous learning and active participation, providing opportunities for students to learn while considering 21st-century skills. This benefits both the teachers' use of technology in 21st-century classrooms and the students' learning (Aziz et al., 2; Care & Kim, 24, 35; Shafie, Faizah & Izaham, 30). Thus, it can be said that teachers' experience contributes to achieving effective learning, considering TPACK and 21st-century teaching and learning skills (Agustini & Ratminingsih, 8; Ilmi & Sunarno, 5).

## CONCLUSIONS AND RECOMMENDATION

Overall, this study demonstrated that the level of teachers' instruction using TPACK is at a high descriptive level, while the level of 21st-century teaching skills and the level of teachers' implementation of Authentic Assessment both achieved the highest level. Additionally, the study showed a positive and significant relationship between teachers' use of TPACK and their 21st-century teaching skills. It was also found that there is a strong positive relationship between teachers' 21st-century skills and the implementation of Authentic Assessment. Furthermore, there is a significant relationship between teaching using TPACK and the implementation of Authentic Assessment.

Most importantly, this study showed that the mediating role of Authentic Assessment between TPACK and 21st Century Teaching Skills of teachers is only Partial Mediation. This confirms that even without explicitly implementing Authentic Assessment, there is still a significant relationship between TPACK and 21st Century Teaching Skills of teachers. However, the relationship between these two variables would be stronger with the mediation of Authentic Assessment.

Based on the results of this study, it was found that the following indicators have low scores: Content Knowledge, Global Connection, and Teachers' Perception of Authentic Assessment. Based on the study results, the following recommendations are made:

Regarding Content Knowledge, teachers might explore more methods to use in teaching in this century. The item indicated a low level of sufficient knowledge in Mathematics and mathematical methods. Therefore, it is recommended to allocate time to attend training sessions related to this subject.

Regarding Global Connection, to gain sufficient knowledge on global issues, it is suggested that teachers connect with experts from different countries. This way, teachers can establish strong relationships with

experts from various parts of the world. The knowledge gained from these interactions and experiences in a global context can be utilized. Consequently, this will play a significant role in promoting knowledge in this century.

Similarly, regarding teachers' Perception of Authentic Assessment, teachers should recognize the strengths of Authentic Assessment that can be used in teaching. Authentic Assessment can be used to improve cognitive abilities in language learning among students, thereby addressing meaningful tasks.

Overall, it is suggested that teachers increase their awareness of Content Knowledge, Global Connection, and Perception of activities that promote Authentic Assessment linked to 21st-century skills necessary for teaching. This awareness is crucial for both teachers and students in this century.

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