

# The Professional Qualifications of Aligned and Non-Aligned STEM Teachers in DCS-Manila and its Relation to their Pedagogical Competencies: Input for Policy Recommendations

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## ABSTRACT

Teaching major science subjects such as Earth Science, General Biology, General Chemistry and General Physics in STEM requires knowledge, mastery and skills such as the integration of an educational technology like the Technology Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK) collectively known as TPACK (Koehler and Mishra, 2008). Solid educational background is indeed imperative if we want to deliver high-impact teaching. In the six districts of Manila, among STEM teachers from 12 public high schools handling major science subjects, 24 teachers are teaching according to their professional qualifications (aligned) while 12 teachers are teaching “in and out” of their field or professional qualifications (non-aligned). Most of the respondents have taken their post graduate studies and their status is either full-fledged or still in progress. About 23 respondents belong to 24-40 years old bracket. The mean composite of all respondents according to the three domains of TPACK showed High Competence.

When their professional qualifications (highest educational attainment, alignment of degree programs, STEM-related training and certification received) and pedagogical competencies TK, PK and CK) when compared to their profiles (years of teaching, subjects handled and age) mostly showed no significant difference. Also, most of the relationship of both the professional qualifications and pedagogical competencies of all respondents showed no significant relationship.

While the respondents recognize the effort (although not enough) being made by Department of Education to improve their well-being, there are issues and concerns related to their personal, professional and pedagogical well-being that must be addressed immediately. Thus, inputs for recommendations are forwarded that are deemed necessary for the formulation of new implementing rules and regulations as well as guidelines that will respond to the needs not only of science teachers but all teachers as well especially in the public schools nationwide.

**Keywords:** STEM Teachers, Technology Knowledge, Pedagogical Knowledge, Content Knowledge, Department of Education, Manila

## INTRODUCTION

**Education** is indeed vital for the transformation of the nation. It empowers people to be independent and success driven. An educated person could lead or influence others that can either make or break man’s future direction. The dynamism of education in and out of the classroom offers a vast latitude of opportunity for growth and development of the individual’s mindset. One proof of such dynamism is the globalization of education that ushered in the development of an educational system that is attuned to international standards and rooted in the application of one or more educational philosophy.

In the case of the Philippine educational system, the basic education was transformed from ten (10) years to twelve (12) years with the enactment of K-12 Basic Education Program (Enhanced Basic Education Act of 2013). Two years of the so-called Senior High School (SHS) program was added where high school students have the freedom to choose what specific strand, they would like to take that is aligned to their dream course in

the university. Furthermore, the Association of Southeast Asian (ASEAN) Integration of 2015 chartered the economic integration of the region and to meet the goals and objectives of this initiative, the region started working on a Qualifications Reference Framework (QRF) that compares the years of schooling among the countries in the ASEAN region. Since the Philippines is the only ASEAN country with less than twelve (12) years of basic education, this motivated the country to add two (2) more years on its secondary education (DO No. 021 s. 2019).

This enactment of Republic Act No. 10533 otherwise known as the Enhanced Basic Education Act of 2013 has exacted considerable adjustments to existing basic education teachers especially those who shifted from junior high school to senior high school where vertical articulation or alignment of major or specialization is a major factor to consider. Another concern of SHS program in the Philippines is the lack of infrastructure like buildings, laboratories, textbooks and other learning materials, qualified teachers, administrative staff, high number of students per class and the like. This is the reason why many higher education institutions offered Senior High School programs where our Department of Education (DepEd) offered free vouchers for public high school graduates. In the recent Commission on Higher Education Memorandum (CMO) dated December 18, 2023, said that SUCs and LUCs will no longer accept senior high school students effective SY 2024-2025 because of the absence of legal basis specifically not part of their university charter and policy. This means that high schools in Manila offering SHS program expect an increase of enrollment this coming SY 2024-2025. Despite this scenario, the SHS program that started eight (8) years ago, significant strides are being made to address the varied concerns of SHS from teacher recruitment and training to infrastructure development. Indeed, SHS is still a work in progress.

In the light of teacher qualification, SHS strands must be manned by teachers with specialization to the strand. Like the teachers handling major science subjects such General Biology, General Chemistry and General Physics under the strand Science, Technology, Engineering and Mathematics (STEM) must have a qualification perfectly suited to the subjects they are teaching. For example, for one to teach the major science subjects in STEM, the teacher must have a specialization in his undergraduate or post graduate studies aligned or related to these science major subjects. Likewise, recent, or new passers of Licensure Examination of Teachers (LET) must have a major either Physical Science or Biological Science major if one wants to teach in SHS under the STEM strand. In the case of the existing teachers prior to the introduction of SHS who teach major science who belonged to the old Professional Board Exam for Teachers (PBET) and other teachers who took the LET exams where no major in science is specified and those with General Science as LET major must be continuously trained along with newly recruited teachers. It is imperative that STEM teachers of major science subjects must be proficient if not expert in their own craft both in lecture and laboratory classes. Thus, teachers in these major science subjects of STEM, to be in their best form to meet the curriculum demands and satisfy the learning competencies of the students must have a **solid educational background and teaching credentials**.

As a teacher to be more effective, efficient, and encouraging must possess certain competencies. According to Tita P (2023), every teacher must have the following core competencies namely professional competence, pedagogical competence, social competence, and personality competence. These competencies are very vital and together they contribute to effective and responsive teaching and learning.

Furthermore, this study seeks to determine and analyze the professional qualifications of SHS-STEM teachers handling major science subjects such as Earth Science, General Biology 1&2, General Chemistry 1&2, and General Physics 1&2 and its relation to their pedagogical competencies using the framework model of Technology, Pedagogy and Content Knowledge or TPACK. This study will also look at the different issues and challenges being experienced by these teachers in relation to their professional qualifications and pedagogical competencies. It is the hope of the study that based on the findings, programs, policies and standards as well as other approaches maybe developed in order to minimize if not “close the gap” between professional qualifications and pedagogical competencies not only among science teachers but to all teachers in the country in order to effect for a more dynamic, productive, inspiring, and potent teaching and learning process or educational system as a whole that will have far reaching consequences especially for the benefit of the teachers, learners and other stakeholders.

Therefore, this study hopes to contribute to the general rejuvenation and strengthening of science education in the country's entire educational system at par with international standards.

## Theoretical Framework

In the light of the intent, purpose, aim and objective of the K-12 system, pedagogical competencies, and professional qualifications of the teachers especially in the SHS programs where there are different strands for specialization reason are of prime importance. Professional qualifications and pedagogical competencies are very much essential to the teaching and learning process because nowadays most of the teaching methodology is more of student-centered and training the students to become dynamic digital natives. Globalizing education demands teachers to be highly competent and efficient in order to produce world class professionals in the future. The theoretical framework model of the study is based on Technology, Pedagogy and Content Knowledge (TPACK) model. This Education Technology model integrates technological, pedagogical, and content knowledge needed by the teachers to become more effective in the dynamics of teaching and learning. TPACK is consist of seven domains namely Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Technological Content Knowledge, Pedagogical Content Knowledge, Technological Pedagogical Knowledge and Technological Pedagogical and Content Knowledge (TPACK). The focus of the study is the first three domains of the TPACK model namely Technological Knowledge, Pedagogical Knowledge, and Content Knowledge. They are considered as the three basic components of knowledge (Koehler & Mishra, 2008; Mishra & Koehler, 2006).

In **Technological Knowledge**, the teachers must have knowledge in different levels of technology “from low-tech to high-tech”. Low-tech like the use of traditional teaching materials like pen or chalk and paper and high-tech refers to the use of internet, smart board, different web-based applications that delve into virtual world of teaching and learning and the like. This technological knowledge can also influence the richness and substance of the **Content Knowledge** because this guides the teacher to acquire mastery of knowledge related to specific learning areas or topics that must be learned and taught. These two components of knowledge define and solidify the pedagogical competence of the teacher. **Pedagogical knowledge** includes the teacher's methods and processes of teaching, making of target specific lesson plan, executions of various assessment techniques and teaching strategies related to the learner's diverse outputs, knowledge and abilities, classroom management and the like. All these can lead to optimizing the learning of the students, essential in transforming their mindset, behavior, and their overall personality.

## METHODOLOGY

This study employed a descriptive correlational research design. This is a type of research design that explains the relationship between two or more variables without making any claims about cause and effect. Data are collected and analyzed on two or more variables to find a link or relationship between them. The main objective of this research design is to identify if the variables are related to one another without changing them or assuming a cause-and-effect relationship.

In this research design, the researchers collected data via survey (face-to-face and via google form) and did not change any variables or try to find any connections as to cause-and-effect. The variables (independent and dependent) or data are measured quantitatively and find out if there are any relationships that emerge. Therefore, this research design focus in describing the variables thoroughly, finding relationships between the variables, analyzing the data quantitatively, requiring no manipulations and the design can either be cross-sectional or longitudinal design (where data are collected over a long period of time).

## Sampling Technique

Purposive sampling technique was applied in this study. It is a form of non-probability sampling where the respondents are chosen consciously by the researcher based on his knowledge and understanding of the research question at hand or the goals of the study.

## Respondents of the Study

The respondents of the study are the STEM science teachers from twelve (12) different high schools in the Division of Manila. Ten (10) of these schools are offering STEM strand. The teachers must be teaching major science subjects such as Earth Science, General Biology 1& 2, General Chemistry 1&2 and General Physics 1 & 2 regardless of their ranks, years, or seniority in the service from 2016-present. Moreover, there are two respondents who were previously teaching science in STEM Senior High School but were transferred to other schools that are not offering STEM strand (Felipe Calderon High School and EARIST High School). Therefore, the total respondents of SHS STEM teacher are thirty-six (36). Of this number, twenty-one (21) teachers shifted from JHS to SHS and fifteen (15) teachers are exclusively teaching in SHS. Among the respondent school only Manila Science High School with all STEM teachers are aligned and one has a PhD in Physics Education- the only STEM teacher in DCS-Manila with such qualification. While Claro M. Recto High School has only one teacher in STEM handling General Chemistry 1 & 2 and General Biology 1 & 2.

Furthermore, as to the alignment of major there are 24 teachers who are aligned. Of this number thirteen (13) teachers have a major in biological sciences and eleven (11) teachers have a major in physical sciences. Among non-aligned teachers who majored in General Science is ten (10). There are two (2) teachers who have not taken the LET, and both are scholars of the Department of Science and Technology with Baccalaureate degrees in Biology and Chemistry.

## Research Instrument

The data were gathered by way of interview via google form and face-to-face. Also, on-line survey was conducted using a Likert-scale focused on the respondent's personal knowledge regarding their level of competency in accordance with the three domains of TPACK model with emphasis on their pedagogical competence as well as their professional qualifications.

## Data Gathering Procedure

The researcher made his own questionnaires in both interview and survey portion. Expert's opinion was sought for validity and reliability. The questions for interview revolved around the respondent's opinion to the support given by DepED, their issues and concerns and what they want to improve their professional qualifications and pedagogical competencies via google form or face to face interview. Also, a separate questionnaire relevant to the three domains of TPACK namely Technological Knowledge, Pedagogical Knowledge and Content Knowledge was given to the respondents too. Reliability testing of this kind of questionnaire was determined using Cronbach-alpha.

Once the questionnaires have been approved, the researcher wrote a letter to the Superintendent of DCS-Manila informing and seeking approval regarding the researcher's desire to interview the said respondents. The Superintendent was informed that the data gathering will be through google form and/or survey to avoid disruption of classes of the respondents. The data are treated with utmost confidentiality congruent to Data Privacy Act of 2012 (RA 10173).

After gathering all the data, interpretations were done by the researcher especially the TPACK questionnaire via Likert-Scale and statistical analysis was conducted by a reputable and legitimate statistician for intelligent interpretation of the data using appropriate statistical tools. Additionally, in the qualitative part of the study deals mainly with the issues and concerns of the respondents with respect to their pedagogical competencies and professional qualifications, support given by DepED as well as their suggestions and recommendations generally concerning their general well-being both personally and professionally. Their verbatim responses with respect to the different questions were tabulated and keywords of their responses, concepts involve, emerging theme and major theme were interpreted by the researcher and tabulated as well.

## Statistical Treatment of Data

In the analysis of data gathered via Likert-scale, the mean scores of the respondents per question were taken and the overall or composite average results were subjected to interpretation using a scale devised by the

statistician. Other data were analyzed using ANOVA 2 to find out how two independent variables, in combination affect the dependent variable. It is also used when comparing groups on two different categorical variables like age and level of education. This is applied in this study to find out if there exist any significant difference in the professional qualifications and pedagogical competencies of aligned and non-aligned STEM teachers teaching major science subjects in DCS-Manila when grouped according to their profiles such as years of teaching, subjects handled and age.

On the other hand, Spearman's rho test is used to find any correlation between variables or to measure the strength and direction of association between variables. This test is used in this study to find any significant relationship between the professional and pedagogical competencies of aligned and non-aligned STEM teachers handling major science subjects in DCS-Manila.

## RESULTS

This section presents the different data gathered from the results of survey questionnaire and interview. These data are subjected to statistical analysis and the results are subjected to interpretation with corresponding discussions based on the statement of the problem of the study.

When senior high school was opened in 2016, many teachers from junior high school shifted their gear to senior high school due to promotion and availability of new items. This is based on DepEd Order No. 3, s. 2016, HIRING GUIDELINES FOR SENIOR HIGH SCHOOL (SHS) TEACHING POSITIONS which says that "For applicants who are already teaching with the DepEd either in elementary or junior high schools (JHS), DepEd Order No. 66, s. 2007 on the "Revised Guidelines on the Appointment and Promotion of Other Teaching, Related Teaching and Non-Teaching Positions" shall apply." In fact, many teachers in SHS STEM came from Junior High School and they were lured to transfer due to availability of higher items or Salary Grade (SG) tantamount to promotion resulting in better pay.

In addition, as to the range of teaching in years or length of service spanning their careers, 33% or 12 teachers are considered new to the profession who belonged to 1-5 years in service, 8 teachers who have been teaching for 6-10 years represent 22%, 3 teachers or 8% of the respondents have been teaching for 11-15 years, 6 teachers or 17% have been teaching for 16-20 years, 11% or 4 teachers are in the service for 21-25 years, 6% or 2 teachers are in the service for 26-30 years while 1 teacher representing 3% is considered as the most senior having been teaching for 31 years.

A teacher with Biological Science major teaches General Biology 1 and 2 while those with Physical Science major teaches Earth Science, General Chemistry 1 and 2 as well as General Physics 1 and 2. Cross-over teachers are those teaching subjects in both majors. Meaning a Biological Science teacher also teaches physical science subjects while Physical Science major teaches biological science subjects. Therefore, they are teaching "in and out" of their major or specialization in exigency of service. There are 6 teachers or 17% who teach pure biological science subjects, 10 teachers or 28% teach pure physical science and 20 teachers or 56% teach both biological and physical sciences representing 8 cross-over teachers and 12 teachers with general science major.

According to Republic Act 8044, known as The Youth in Nation Building Act declares that the age range of youth is fifteen (15) to thirty (30) years. This is considered as the "onset of adolescence towards the peak of mature, self-reliant and responsible adulthood." Based on the table, the highest percentage of teachers belong to the youth sector representing 14 or 39%, followed by the age bracket of 38-44 representing 9 or 25%, this is closely followed by 45-51 age bracket representing 8 or 22%, then the age brackets of 31-37 and 59-65 age bracket both representing 2 or 6 % and lastly, the 52-58 age bracket represent 1 or 2.77%. In fact, the youngest teacher is 24 (3 teachers) and the oldest is 61 (1 teacher).

These data showed that there is still a vast latitude where these teachers who belong to age 24 up to 51 can be trained, upgrade their professional qualifications, improve their pedagogical competence by acquiring new skills, and can assume greater role in the improvement of STEM education at least here in the City of Manila.

Furthermore, most aligned SHS-STEM teachers have masteral degrees representing 14 or 58%. Of these number 4 teachers are full-fledged masteral graduate (1 graduate with double major) and 10 teachers whose masteral degrees are still in progress. There are 6 teachers or 25% possessed doctoral degrees. Of these number, 1 teacher has a full-fledged PhD in Science Education major in Physics and 1 teacher has a full-fledged EdD major in Education Management. Additionally, in progress in their doctorate degrees are 2 teachers who have a PhD in Science Education, 1 teacher has EdD in Education Management, and 1 teacher has a PhD in Animal Science. Meanwhile, there are 4 teachers (17%).

Among the non-aligned respondents 6 or 50% have masteral degrees. Of this number 1 respondent is a full-fledged masteral graduate while the masteral degree of 5 respondents are still in progress. While the doctoral degree of 4 respondents or 33% are still in progress and 2 respondents or 17% possessed a bachelor's degree. Most of the respondent's highest educational attainment are both in masteral and doctorate degrees, many of which are still in progress.

Many SHS-STEM teachers are aligned representing 67% or 24, while not aligned teachers are 12 representing 33%. Most of the non-aligned teachers are general science majors and there are 10 of them while there are 2 non-aligned teachers who are not LET passers, and both are scholars of the Department of Science and Technology (DOST). The aligned teachers are Biological Science and Physical Science majors.

Meanwhile, thirteen (13) aligned teachers representing 54% have attended/received trainings/seminars and for the aligned teachers who do not have trainings/seminars is 11 or 46%. While seven (7) non-aligned teachers representing 58% have attended/received training/seminars and five (5) non-aligned teachers representing 42% did not receive any.

In addition, with respect to Certifications received, only 3 aligned teachers representing 33% have such, while 21 aligned teachers have none representing 67%. Among the non-aligned teachers only 1 teacher representing 8% has received certification while 11 non-aligned teachers representing 92% have received no certification at all.

Most of the respondents, whether aligned or non-aligned, who received training/certifications are those who have been teaching in SHS for 6-8 years. One factor that can be attributed to those without training/seminars and certification whether aligned or non-aligned teacher is the COVID-19 pandemic from 2020-2022 wherein DepEd did not sponsor seminars and trainings as well as programs with certification.

**TPACK Knowledge**

I. Technological Knowledge

*Mean Distributions of the Respondents on the Technology Knowledge*

TECHNOLOGY KNOWLEDGE	ALIGNED		NON- ALIGNED	
	Mean	Interpretation	Mean	Interpretation
During lesson/grade preparation, I can solve my own technical problem	4.208	High Competence	4.00	High Competence
I am a fast learner whenever I encounter new technology	3.916	High Competence	3.82	High Competence
I make myself updated in the latest technology/application related to teaching and learning	3.708	High Competence	4.18	High Competence
I always use technology/application in most of my teaching	3.708	High Competence	4.00	High Competence

I am familiar with different technology/application related to teaching and learning	3.65	High Competence	4.00	High Competence
I possess technical skills that I can apply in my teaching and in evaluating my students	3.75	High Competence	3.91	High Competence
I possess technical certifications that allow me to interact to different technology/application	3.541	High Competence	3.91	High Competence
<b>WEIGHTED MEAN</b>	<b>3.78</b>	<b>High Competence</b>	<b>3.97</b>	<b>High Competence</b>

The Technological Knowledge of teachers includes their ability to integrate ICT in the teaching and learning process in and out of the classroom. They understand how to use technological tools, utilize different learning platforms both in lecture and laboratory sessions and also, they are capable of creating a complete technologically driven activities and lesson plan.

Teaching with technology is a complicated matter filled with challenges (Khoeler and Mishra, 2009). Examples of challenges include the availability of funds, strong internet connections, learning concerns of teachers (especially the anxiety of senior ones) as they transition to newer technologies, inadequacy of gadgets among students and the like. Surprisingly, based on the results all SHS-STEM teachers, whether aligned or non-aligned show High Competence with respect to their Technological Knowledge. The composite average of non-aligned teachers is slightly higher than aligned teachers. Their verbal interpretation is similar because most of the teachers belong to adult or middle adulthood and they seemed to be fast learners, adept in technology, seasoned in their craft and have explored many avenues of learning such as trainings or seminars as well as peer tutoring, In-Service Training (INSET) and Learning Action Cell (LAC) sessions.

Learning, improving or even enhancing one’s technological knowledge is a challenge. In fact, among the three domains of TPACK, integrating technology is the last among the domains that is learned and developed (Morales, et al., 2022).

The technological skills attune to the demands of 21<sup>st</sup> century learning include online interactive learning, simulation, augmented and virtual reality, and digital gaming. Both teachers and students must be adept in these skills in order to create and facilitate a more robust teaching and learning process. While the students nowadays are digital natives, the challenges lie more on the teachers especially those who have anxiety in learning these skills. Vahidy (2019) believes that learning these skills can help develop a deeper knowledge and understanding or learning of subjects under STEM.

## II. Pedagogical Knowledge

### *Mean Distributions of the Respondents on the Pedagogical Knowledge*

PEDAGOGICAL KNOWLEDGE	ALIGNED		NON- ALIGNED	
	Mean	Verbal Interpretation	Mean	Verbal Interpretation
I am confident and knowledgeable in assessing the different performances of my students inside the classroom	4.13	High Competence	4.36	High Competence
I am flexible in adapting different teaching styles and strategies based on the level of understanding of my students on certain science concepts or topics	4.17	High Competence	4.55	Very High Competence

I can easily adjust my teaching styles and strategies both in homogeneous and heterogeneous classes	4.13	High Competence	4.55	Very High Competence
I have variety of ways or means of verifying the level of student learning or understanding on certain science concepts or topics	4.17	High Competence	4.36	High Competence
I can easily identify students who are having difficulty/misconception regarding specific science concepts or topics	4.17	High Competence	4.36	High Competence
I am confident with my knowledge, approaches, and strategies in classroom management	4.21	High Competence	4.36	High Competence
<b>WEIGHTED MEAN</b>	<b>4.16</b>	<b>High Competence</b>	<b>4.42</b>	<b>High Competence</b>

This table revealed that non-aligned teachers demonstrated Very High Competence in flexibility in adapting to different teaching styles and strategies based on the level of understanding of the students on certain science concepts and topics and in adjusting their teaching styles and strategies both in homogeneous and heterogeneous classes.

Since most non-aligned teachers have been in the service longer (more than 5 years) than most aligned teachers and shifted from JHS and SHS as well as teaching both physical and biological science subjects for years, therefore, based on their perceptions (probably shaped by their experience) they were able to acquire mastery (very high competence) of the pedagogical knowledge stated herein. Pedagogical knowledge is basically a specialized knowledge of teachers acquired through the years of their service responsible for the creation of conducive or less threatening environment for teaching and learning for all students. The study of Graham, et al. (2020) showed evidence of an association between experience and teaching quality and this research has resulted in mixed findings.

However, Ogodu (2024) said that aside from content expertise and the promotion of pedagogy or social context as approaches for translating STEM contents to the students, teachers must also be culturally knowledgeable to respond to students' diversity effectively in 21<sup>st</sup> century classroom. This approach, which is beyond content expertise and teaching is practical and holistic and is useful for STEM teachers' preparation as well as for their growth and development. This will lead the way towards more meaningful and inclusive learning for all students.

### III. Content Knowledge

#### *Mean Distributions of the Respondents on the Content Knowledge*

CONTENT KNOWLEDGE	ALIGNED		NOT ALIGNED	
	Mean	Verbal Interpretation	Mean	Verbal Interpretation
I know how to use different ways and strategies that guide me to my understanding of different science concepts in the subject/s I am teaching.	3.88	High Competence	4.18	High Competence
I always exercise or display scientific attitude and thinking whenever I conduct my science classes.	4.08	High Competence	4.55	Very High Competence

I possess respectable or enough mastery of knowledge in the science subject/s I am teaching.	3.90	High Competence	4.36	High Competence
I always conduct laboratory classes to relate to my specific science lesson.	3.38	Moderate Competence	4.00	High Competence
I am familiar with different laboratory instruments and equipment during experiment	3.92	High Competence	4.00	High Competence
I am knowledgeable in different experiments related to my lecture topics in science.	3.96	High Competence	3.91	High Competence
I know how to prepare solutions, make innovations or improvisations on my science experiments.	3.92	High Competence	3.82	High Competence
I am familiar in calibrating certain instruments in the laboratory	3.79	High Competence	3.82	High Competence
I am aware on what to do in cases of any untoward incidents in the laboratory	3.83	High Competence	3.91	High Competence
<b>WEIGHTED MEAN</b>	<b>3.85</b>	<b>High Competence</b>	<b>4.06</b>	<b>High Competence</b>

Content Knowledge (CK) refers to the teacher’s knowledge regarding subject matter that needs to be taught and learned by the students. The SHS-STEM teachers are required to exhibit mastery of the subject matter especially the learning standards and competencies as stipulated in the Minimum Expected Learning Competencies or MELCS. Both aligned and non-aligned teachers exhibit high competence in the overall CK, while the non-aligned teachers exhibit Very High Competence in the area related to the display of scientific attitude in the conduct of their science classes. This is perhaps since most non-aligned teachers have been in the service longer than most aligned teachers. This is the area where experience and longevity reign supreme in that specific area of CK. With respect to the conduct of laboratory classes, aligned STEM teachers showed moderate competence. This is because some schools lack laboratory infrastructures, many lack equipment and materials like laboratory manuals, glassware and the like as well as laboratory supplies like topic-specific reagents or chemicals. Also, all STEM-oriented schools have no full-time laboratory technician.

While the rest of the contents of CK are Highly competent, overall, the composite average of both aligned and non-aligned teachers are Highly Competent. Moreover, in the literature review conducted by Mientus, et al. (2022) in the Pedagogical Content Knowledge (PCK) in the framework of Refined Consensus Model (RCM), they found out that there is a need to systematize the existing science education research on PCK through RCM of PCK.

The understanding of the socio-cultural perspective on the importance or relevance of Pedagogical Content Knowledge (PCK) and Subject Matter Content Knowledge (SMCK) in teaching and learning of STEM subjects with mastery and flexibility can indeed help the learners improve their cognitive abilities, connect ideas across different disciplines and to their everyday life. This was emphasized on the study of Mafa-Theledi, (2024) and she further stated that the process of becoming effective teachers and effective teaching involves the application of social constructivism, and this will enhance the teacher’s knowledge about their students and their socio-economic backgrounds. The findings of the study revealed that PCK and SMCK can enhance STEM educator’s professionalism and can improve the quality of teaching and learning outcomes, including motivational levels of both teacher and learners inside the classroom. Thus, she believes that the enhancement of PCK and SMCK must be integrated in the training programs of teachers.

The professional qualifications of aligned STEM teachers such as the highest educational attainment vs. subjects handle and age and STEM-related training vs. years of teaching and age as well as the highest educational attainment of non-aligned respondents when compared to age showed significant difference that led to the rejection of the null hypothesis. This means that there must be practical importance or relevance of the two variables (subject handled and age) when paired to highest educational attainment and the other two variables (years of teaching and age) when paired to STEM-related training as well the certifications received by the respondents when compared to subjects handled. Probably, this provides a meaningful distinction between the variables concerned that are being compared. The rejection of the null hypothesis means that there is a statistical significance between the concerned variables because their p-values are less than the critical value of 0.05. Additionally, the alignment of degree program when compared to the profiles of the respondent showed its non-applicability when subjected to two-way ANOVA because of lack of variance among the ranking of both aligned and non-aligned respondents.

Meanwhile, the highest educational attainment and STEM-related training when paired with subjects handled and certifications received compared to years of teaching and age among aligned and non-aligned respondents showed no significant difference that led to the acceptance of the null hypothesis because their p-value is greater than 0.05. Among the non-aligned respondents, the highest educational attainment and STEM-related training when compared to years of teaching and age as well as the certification received when compared to subjects handled all showed no significant difference. The variables being compared are not significantly different probably because the sample size is small. It appears that there is no statistical evidence that the differences among the means of the variables being compared is not due to chance.

Furthermore, the results stated in the table would appear that teacher qualifications, expertise, experience and advanced degrees either in math or science gained through the years of teaching showed significant association with student’s gaining higher education degrees. It is the subject-matter expertise appears to be greatest predictor of the student’s ability to obtain higher education degrees (Lee and Lee, 2020). Therefore, the results of such table and their ability to predict student performance and academic achievement need further exploration.

The profiles of both aligned and non-aligned respondents showed no significant difference. This means that the null hypothesis is accepted because their respective p-values are greater than the significance level of 0.05. Therefore, the results are not statistically significant. This revealed that there is no statistical evidence that would support the differences of means between variables are not due to chance or have no statistical connotations. This means that the different ages of the respondents have no influence on their pedagogical competencies aligned to TPACK. The individual studies of He (2013) and Wang (2014) as mentioned in the study of Zeng et.al (2022) showed that all dimensions of teacher’s TPACK have nothing to do with teachers’ age. In contrast to the results in the table, Kumala, et al. (2022) found out that teaching experience and their TPACK knowledge is proportional to their length of teaching. The researchers also revealed that the age category of 40 years old and younger have better technological skills compared to their older colleagues. Additionally, Mohamad, (2021) and Akun and Mohamad (2020) reported that teachers who are longer in the profession or with more extensive teaching experience showed higher confidence with their TPACK as compared to their novice counterparts.

*Pedagogical Competencies and Professional Qualifications of Aligned and Non-Aligned STEM Teachers*

Pedagogical Competencies	Aligned			Non-Aligned		
	p-value	Interpretation	Decision (Ho)	p-value	Interpretation	Decision (Ho)
Technological Knowledge vs Highest Educational Attainment	0.276	No Significant Relationship	Accept	0.253	No Significant Relationship	Accept

	Aligned			Non-Aligned		
Pedagogical Competencies	p-value	Interpretation	Decision (Ho)	p-value	Interpretation	Decision (Ho)
Pedagogical Knowledge vs Highest Educational Attainment	0.062	No Significant Relationship	Accept	0.737	No Significant Relationship	Accept
Content Knowledge vs Highest Educational Attainment	0.193	No Significant Relationship	Accept	0.468	No Significant Relationship	Accept
Technological Knowledge vs Alignment of Degree Program	NaN	Significant Large Negative Relationship	Accept	NaN	Significant Large Negative Relationship	Accept
Pedagogical Knowledge vs Alignment of Degree Program	NaN	Significant Large Negative Relationship	Accept	NaN	Significant Large Negative Relationship	Accept
Content Knowledge vs Alignment of Degree Program	NaN	Significant Large Negative Relationship	Accept	NaN	Significant Large Negative Relationship	Accept
Technological Knowledge vs STEM-related Training	0.363	No Significant Relationship	Accept	0.001	Significant Relationship	Reject
Pedagogical Knowledge vs STEM-related Training	0.072	No Significant Relationship	Accept	0.013	Significant Relationship	Reject
Content Knowledge vs STEM-related Training	0.085	No Significant Relationship	Accept	0.027	Significant Relationship	Reject
Technological Knowledge vs Certification	0.139	No Significant Relationship	Accept	0.153	No Significant Relationship	Accept
Pedagogical Knowledge vs Certification	0.828	No Significant Relationship	Accept	0.247	No Significant Relationship	Accept
Content Knowledge vs Certification	0.467	No Significant Relationship	Accept	0.110	No Significant Relationship	Accept

Significance Level  $p=0.05$

This table shows that across all variables; their means have no significant relationship. The pairing of the concerned variable showed that they are independent and thus, no correlation exists between them. Probably this is due to a small sample size because there is not enough data that would conclude that the relationship between the variables is not due to a chance. Moreover, the relationship between the 3 domains of TPACK and alignment of degree program showed a significantly large negative relationship. This means that this negative correlation with respect to these two variables appear to move in opposite direction or has an inverse relationship.

In contrast to the study of Colon, et al. (2023), that the training of the respondents has a significant relationship to their pedagogical competencies. This means that training can effectively increase or significantly influence the pedagogical competencies of the respondents. Therefore, the TPACK model can significantly contribute to teacher’s training in their educational work. In addition, Paidi, et al. (2021) believed that the evidenced they have gathered in their study, the mastery of TPACK is most likely influenced by the biology

teacher's academic background, educational level. And teacher certification status. The study of Morales, et al. (2022), used TPACK to determine the experiences and practice of STEM teachers. They develop one knowledge construct of TPACK at a time, the last is the integration of technology. They developed a model of STEM teacher's experiences and practice to enhance their skills relevant to the demands of 21<sup>st</sup> century skills.

Moreover, the pedagogical competencies of teachers in general affect their well-being because their teaching and diagnostic skills are fundamental to the success of their students both in practical and theoretical aspects of learning. In the case of STEM teachers, they lament the lack or inadequate laboratory infrastructures, equipment and materials, laboratory manuals and other resources. The teachers feel overburdened like they teach subjects beyond their major or lack expertise on certain topics, lack of time to finish the experiment, high teacher to student ratio and the like. In effect, these scenarios affect their well-being as a teacher. These can ultimately lead to a lack of self-care and ultimately cause burn out in the long run. According to Murphy, et al. (2021), the Teacher Pedagogical Well-Being (TPWB) relates to the teacher's sense of self-care where support from management, colleagues and students form the foundations of TPWB. The study of Yamtinah, et al. (2022) opined that availability of different kinds of support for science teachers are considered a challenge. This gives teachers the difficulty of helping their students meet the Minimum Competency Assessment (MCA). The issues and challenges being experienced have striking similarities to the STEM teachers of Malaysia that is based on the study of Ismail, et al. (2019). According to the researchers, lack of exposure to training, facilities, budget and support from the administration, heavy workloads and time constraints affect the science teacher's motivation, level of stress and job satisfaction when teaching the students.

The study of Fakhrutdinova, et al. (2020) concluded that, *"A high school teacher should be able to: apply in the educational process the knowledge of historical basis, modern developments, modernization trends in the scientific field, its integration with other sciences; - present the teaching material in direct connection with the disciplines in the curriculum; - use the knowledge of culture and art as a means of students' education."*

Meanwhile, the issues and concerns as well as the challenges that affect the pedagogical competence of STEM teachers are also directly related or linked to their professional qualifications. Issues on teacher's specialization, lack of professional development programs/seminars and trainings related to research, technology integration, technical skills improvement and lack of support from education leaders to provide scholarship grants as well as stringent qualifications for promotion affect the professional growth and development of STEM teachers. These concerns are intimately related to the issues and challenges being experienced by STEM teachers of Malaysia (Ismail, 2019).

One way to improve the professional qualifications of science teachers, they must possess specific specialization either in physical science or biological science. According to Sancassani (2023), teacher subject-specific science qualifications can increase the student's science test score by 35%. When teachers possess subject-specific qualifications, their confidence to teach can increase by 20%. The study of Okeke and Iwara (2020) revealed that the professional qualifications and educational attainment of teachers have significant effect on and relationship with the student's academic achievement.

Since the theme of the issues and concerns as well as challenges confronting STEM teachers is focused on their well-being is actually part of the ambition of the Organization for Economic Cooperation and Development (OECD) Teacher Well-being and Quality Teaching Project. According to Viac and Fraser (2020), this project proposes a comprehensive conceptual framework to analyze the teacher's occupational well-being and social well-being. The core concept of this framework is to define a teacher's well-being around four (4) key components namely: physical and mental well-being, cognitive well-being, subjective well-being and social well-being. While the respondents acknowledge the support being given by DepEd, still they view such support as inadequate or lacking. The respondents yearn for more training in science both in theory and practice, collaboration and networking opportunities, allocation of funds to procure more chemicals, equipment, materials and construction of laboratory rooms. Teachers also need updated manuals, modules and books.

Furthermore, the respondent's suggestions mainly focus on the improvement or elevation of their professional qualifications and pedagogical competencies. Exposure to more training of all science teachers (not being selective) will help improve both their theoretical and practical knowledge and skills or their content and

pedagogy. Target-specific professional development programs will boost their subject-specific expertise and strategies. They also believe that less clerical work, optimal teacher-student ratio, no overloading and availability of updated learning materials will immensely contribute to the maximization of their teaching and evaluation skills. Provision of scholarship and research grants will help the teachers improve their professional qualifications and research skills. Over-all, the respondents want DepEd to provide more funds for professional development programs, invest in research, construct well-equipped laboratory rooms, minimal “off-teaching” duties and alignment of both theoretical and practical parts of teaching to MELCS. In short, they want INCLUSIVITY as well as an EQUAL OPPORTUNITY FOR ALL that will benefit not only them but more importantly their students.

## CONCLUSION

The result of the present study shows that the respondents can either teach pure biological science subjects, physical science subjects or both. They are mostly young as to age, many shifted from JHS to SHS and thus, have been teaching for so long. Many STEM teachers pursued post graduate studies either full-fledged or in progress both in the masteral and doctoral levels. Their knowledge on the 3 domains of TPACK based on composite means is considered highly competent. Many of the professional qualifications of aligned and non-aligned respondents with respect to their profiles accepted the null hypothesis or have no significant difference as compared to other profiles that rejected the null hypothesis indicating significant difference. While that of pedagogical competencies vs. the profiles of the respondents all showed no significant difference or the null hypothesis is accepted.

Across all domains of TPACK when analyzed for significant relationship, except for the item alignment of degree program, showed no significant relationship. Such absence of correlation among the variables suggests that they are independent, and this could be due to small sample size. While the TPACK vs alignment of degree program exhibits an inverse relationship.

The respondent’s remarks in relation to the issues and concern affecting the pedagogical competencies and professional qualifications mostly focus on provision of training, learning materials, laboratory infrastructure including materials and equipment, scholarship/financial assistance, and conducive learning environment. The respondents deemed that the support given by DepEd is inadequate. The major theme is centered on the promotion of the overall well-being of teachers that is more inclusive, and they need to be accorded by equality of opportunity for all.

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