CHED - PNU

TPACK STEAM EDUCATION

GRADUATE MENTORING *Handbook* 2018

TPACK in PHILIPPINE STEAM EDUCATION

TPACK in Philippine STEAM Education

GRADUATE MENTORING

HANDBOOK

2018

Philippine Normal University
The National Center for Teacher Education
Taft Ave., Manila

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TPACK-STEAM

Preface

The Graduate Mentoring Handbook seeks to provide volunteer graduate students with a glimpse of how the CHED-funded research, Technological Pedagogical Content Knowledge (TPACK) in Philippine STEAM Education initiated research apprenticeship with STEAM graduate students in select collaborating institutions. The handbook features a brief of the CHED-funded research, briefer of how the research mentoring program started, pedagogical framework used in the conduct of the mentoring program, materials, protocols, guide and instrument for apprenticeship, and reflections by the recipient graduate students. Documentation included in this material affords a snapshot of how the recipients appreciated the program leading to its evolution forming research cells to accommodate more apprentice.

BACK-GROUND OF THE PROJECT

EXECUTIVE

SUMMARY

In the country's journey to improve the quality of life of Filipinos and to establish high economic growth, aspects of science, technology, engineering, agriculture and mathematics (STEAM) may highlight skills to achieve our goals. Apparently, most first world countries adhere to the concept of STEM as the driver of their economy in the 21st century and their powerful tool for individual and economic success (National Governor's Association [NGA], 2011; Donovan, Mateos, Osborne & Bisaccio, 2014; Sahin, 2016). They believe that all aspects of the economy are STEM-influenced, in one way or another. STEM provides a strong human resource or human capital that eventually leads the country to technology-driven state and sustainable growth of resources such as economy-driven biodiversity and ecosystem restoration, enhanced biocapacity and functionality (Donovan, Mateos, Osborne & Bisaccio, 2014); and STEM-triggered research and innovations for improved and probably increased production of goods. In fact, the adherence of the country to STEAM highlights the "AMBISYON NATIN 2040", themed as, "*Matatag, Maginhawa, at Panatag na Buhay* (Philippine Development Plan [PDP], 2017)." The country believed that the 2040 goal may concretized through the three priority areas of the crafted Philippine Development Plan which includes: 1) *malasakit* (enhancing social fabric); 2) *pagbabago* (reducing inequality); and 3) *patuloy na pag-unlad* (increasing growth potential). These three priority areas emphasize among others promotion and awareness of Philippine culture, acceleration of human capital development, promotion of technology, and stimulation of innovation. Apparently, the make-up of the PDP framework puts STEAM as among the cores to achieving the 2040 goals. Thus, necessitates cross-cutting strategies, which may be derived from quality STEAM education for the Filipinos.

The study aims to explore the Technological-Pedagogical- Assessment -Content-Knowledge (TPACK) of Philippine STEAM Educators geared towards STEAM Quality Education. Specifically, the study intends to develop an emerging TPACK Model or Framework customized to Philippine STEAM Educators competencies, skills, and resources. The project intends to provide framework and models on pedagogy for STEAM, assessment, and technology integration, which may dictate lesson exemplars and direct policy makers to attune guidelines and policies related to STEAM Education for quality STEAM manpower of the country. Participants determined through multistage sampling procedure include all STEAM educators from 330 Higher Education Institutions for components 1 and 6 of the study and 33-focused schools for the remaining phases. The study will utilized several research designs with several components for the data collection. Qualitative and quantitative approaches will be used in collecting pertinent data. These varied approaches include descriptive survey, class observations, interviews and focus-group discussion and stakeholders for a varied and matched data analysis will deduce trends and significant data interpretation. The products and outputs of TPACK Model in STEAM education include: 1) indicators of proficient STEAM educators, 2) database of Philippine STEAM educators, 3) TPACK competencies of the Philippine STEAM educators, 4) technology integration model for STEAM education, 5) pedagogical model for STEAM education, 6) assessment tools for STEAM education by looking into the most appropriate forms of assessment for each of the STEAM component, 7) localized TPACK model for Philippine STEAM education, 8) capacity building programs for STEAM education and lesson exemplars, 9)emerging TPACK model for Philippine STEAM education, and 10) policies for Philippine STEAM Education.

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator

MEMORANDUM OF AGREEMENT

KNOW ALL MEN BY THESE PRESENTS:

This Memorandum of Agreement executed by and between:

The COMMISSION ON HIGHER EDUCATION (CHED), an agency of the National Government organized and established under Republic Act No. 7722 otherwise known as the "Higher Education Act of 1994," with office address at HEDC Bldg., C.P. Garcia Ave., U.P. Diliman, Quezon City, represented by its Chairperson, PATRICIA B. LICUANAN, Ph.D., herein referred to as "FIRST PARTY";

-and-

The PHILIPPINE NORMAL UNIVERSITY (PNU), a public Higher Education Institution with principal office at Taft Avenue cor. Ayala Boulevard, Manila, represented herein by its President ESTER B. OGENA, Ph.D., herein referred to as "SECOND PARTY"

WITNESSETH: That,

WHEREAS, the FIRST PARTY is mandated by law to promote affordable, quality and relevant higher education that is accessible to all; ensure academic freedom and promote its exercise and observance for the continuing intellectual growth, advancement of learning and research, development of responsible and effective leadership, education of high-level and middle-level professionals and the enrichment of our historical and cultural heritage in the Philippines;

WHEREAS, the FIRST PARTY recognizes that there is a need to provide additional financial support to the SECOND PARTY in order to upgrade their institutional capability and sustain the development efforts towards meeting the challenges of producing the required manpower resources needed for accelerated national development.

WHEREAS, CHED through Commission en banc (CEB) Resolution No. 245-2011 (Annex "A") approved the creation of the Higher Education Regional Research Center (HERRC), which shall conduct research and capacity building activities , in line with the CHED aim to effectively, efficiently and equitably promote, broaden and provide the research support needed by the HEIs all over the country;

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WHEREAS, PNU thru Commission en banc (CEB) resolution No. 316-2011 (Annex "B") was identified as one of the members of the Higher Regional Research Center (HERRC);

WHEREAS, CHED through CEB Resolution No. _____ (Annex "C") approved the Philippine Normal University RDE project titled: "Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education";

NOW THEREFORE, for and in consideration of the foregoing premises, the parties hereto hereby agree as follows:

I. ROLES AND RESPONSIBILITIES OF THE PARTIES

1. The FIRST PARTY shall:

1.1 Through its Higher Education Development Fund (HEDF) provide funding assistance to the SECOND PARTY in the amount of NINE MILLION PESOS (P9,000,000.00) for the implementation of the project titled: Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education, to be released in full in accordance with the approved Line Item Budget (LIB) (Annex "D"), Work Plan (WP) (Annex "E") and Terms of Reference (TOR) (Annex "F").

1.2 Through its Monitoring and Evaluation Team, see to it that funds provided for to the SECOND PARTY shall be used properly and for the intended purposes specified.

2. The SECOND PARTY shall:

2.1 Properly utilize the funds provided by the FIRST PARTY and shall see to it that these are used for the purpose for which the same are intended, in accordance with the approved WFP and TOR, and subject to the usual accounting and auditing rules and regulations;

2.2 Issue an Official Receipt for every amount received from the CHED;

2.3 Deposit the funds received from the FIRST PARTY with any government authorized depository bank nearest the program site;

2.4 Separately keep and maintain any/all necessary accounting ledgers/ records for the project which shall be voluntarily submitted whenever required and subjected to monitoring and evaluation of the CHED Authorized Representative/s and furnish fully the certified true copies of any/ all required documents;

2.5 Submit accomplishment/ terminal report to the FIRST PARTY within sixty (60) days after the completion of the program;

2.6 Submit a liquidation report to the FIRST PARTY, certified correct by the Accountant and approved by the head of the institution within sixty (60) days after the completion of the program;

2.7 Return to the CHED any/ all unused balance of the program fund, including any/all income/ interest earned/ generated from the same, upon pre-termination or completion of the project within forty-five (45) but not more than sixty (60) calendar days, pursuant to Executive Order No. 338;

2.8 Abide by the provisions of COA Circular No. 2007-001 which is made an integral part hereof and other government laws, rules and regulations directly or indirectly pertaining to projects funded either fully or partly by government agencies;

2.9 In realizing the program, and for the purpose of propriety, transparency and accountability, the SECOND PARTY shall faithfully observe the provisions of RA 9184 and its Implementing Rules and Regulations;

2.10 Adhere to the prescribed accounting entries for booking up property/ equipment purchased out of Program funds.

II. OWNERSHIP OF PURCHASED EQUIPMENT AND FACILITIES

In the event that the research grant shall include provision for equipment and facilities, the FIRST PARTY reserves the right to ownership over the purchased equipment and facilities subject of the grant until full liquidation by the SECOND PARTY is completed.

Transfer of ownership of the said equipment and facilities in favor of the SECOND PARTY shall ensue upon issuance of Invoice Receipt of property by the FIRST PARTY, or completion of any other required accounting and audit procedure for the purpose.

III. OWNERSHIP OF RESEARCH OUTPUTS

The FIRST PARTY and SECOND PARTY hereby agree and understand that intellectual property rights, ownership and enjoyment thereof arising from this project shall be governed by the applicable provisions of RA 10055 *(An Act Providing the Framework and Support System for the Ownership, Management, Use, and Commercialization of Intellectual Property Generated from Research and Development funded by Government and for other purposes)*, RA 8439 *(An Act Providing a Magna Carta for Scientists, Engineers, Researchers and other Science and Technology Personnel in Government)*, and RA 8293 *(An Act Prescribing the Intellectual Property Code and Establishing the Intellectual Property Office, Providing for Its Powers and Functions, and for Other Purposes)* including their respective Implementing Rules and Regulations, as well as existing and future policies of the FIRST PARTY on Intellectual Property Rights such as but not limited to the following:

1. Any publication arising from the activities undertaken by virtue of and pursuant to this MOA shall clearly establish and identify the Parties as the source of the output and grant, respectively.

2. All reports arising from activities undertaken by virtue of and pursuant to this MOA shall be made in the name of the Parties, as source of the output and grant, respectively. The names of the principal authors, researchers and/or Program Leaders/Project Leaders shall be identified, recognized and included in the report.

3. The FIRST PARTY shall have the right to freely use all data and findings by virtue of and pursuant to this Contract for any of the purposes within its legal mandate. The SECOND PARTY, acknowledged as the principal authors, researchers and/or Program Leaders/Project Leaders identified, recognized and included in the report, shall provide the FIRST PARTY written updates on the use of any of the data or information contained in the report and the purposes thereof, to ensure that government-funded researches are utilized, continuously supported, and properly documented for the widest dissemination and use by the general public, and to encourage further scientific studies and researches.

4. The SECOND PARTY shall ensure that the research conducted and its outcome would not violate the intellectual property rights of any third party.

IV. RESEARCH DEALING WITH INDIGENOUS PEOPLE'S PROPERTIES, RESOURCES, KNOWLEDGE AND/OR HERITAGE

In case the research project would utilize any property, knowledge, heritage, culture, tradition, institution and/or any other resource that belong to any indigenous community, the SECOND PARTY has the responsibility of securing the indigenous community's free prior informed consent and subject itself to the provisions and requirements relative to researchers and research outcomes provided in *RA 8371 (An Act to Recognize, Protect and Promote the Rights of Indigenous Cultural Communities/Indigenous People, Creating a National Commission of Indigenous People, Establishing Implementing Mechanisms, Appropriating Funds Therefor, and for Other Purposes)* and its Implementing Rules and Regulations, to protect and respect the community intellectual property rights of the concerned indigenous community.

For any violation of the provisions of the above law, with no valid cause to justify the same, the FIRST PARTY may exercise the option of rescinding the research grant, through written notice given to the SECOND PARTY citing the particular violation found, and the SECOND PARTY may be required to return any and all funds subject of this research project.

V. ETHICAL CONDUCT OF RESEARCH

The SECOND PARTY has the responsibility of ensuring that the conduct of the research is in accordance with ethical research standards. The same sanction cited in the next preceding Section shall apply to violations found under this provision of the Contract.

VI. SEPARABILITY CLAUSE

In the event that one or more provisions contained herein shall be held invalid, illegal or unenforceable in any respect and for any reason, the remaining provisions shall remain valid, legal and enforceable.

VII. DOCUMENTS COMPRISING THIS AGREEMENT

All appendices hereto attached are hereby expressly made an integral part of this agreement by reference, excluding inconsistencies with any/all part, terms, and conditions contained in this Memorandum of Agreement.

VIII. EFFECTIVITY OF THE AGREEMENT

This Agreement shall take effect upon the release of funds to the concerned HEI for the project implementation and shall be in effect for a period of two (2) years from execution hereof, unless further extension is requested in writing for valid cause by the SECOND PARTY, and written approval is issued by the FIRST PARTY prior to the expiration of the original contract period. After a first extension granted, no further extensions shall be allowed by the FIRST PARTY.

IN WITNESS WHEREOF, the parties hereunto have affixed their respective signatures this 20 day of JAN 2017 2016 at MANILA, Philippines.

COMMISSION ON HIGHER EDUCATION
FIRST PARTY

By:

PATRICIA B. LICUANAN, Ph.D.
Chairperson

PHILIPPINE NORMAL UNIVERSITY
SECOND PARTY

By:

ESTER B. OGENA, Ph.D.,
President

Signed in the presence of:

NAPOLEON K. JUANILLO, JR., Ph.D
Director IV, OPRKM
Commission on Higher Education

WILMA S. REYES, Ph.D.
Principal Investigator
Philippine Normal University

CERTIFIED AS TO AVAILABILITY OF FUNDS

₱9,000,000.-

CHIEF ACCOUNTANT, CHED

DV# 02 3141 2017 01 0032
1/19/17

ACKNOWLEDGMENT

REPULIC OF THE PHILIPPINES)
City of MANILA)S. S.

BEFORE ME, a Notary Public, for and in the City of MANILA, this 26 day of JAN 2016, personally appeared:

	ID No.	Issued on/ Issued at
PATRICIA B. LICUANAN, Ph.D.	CO-0291	September 14, 2012 Quezon City
ESTER B. OGENA, Ph.D.,	PPT [illegible]	[illegible] Pasay City

Known to me and to me known to be the same person(s) who executed the foregoing instrument and who acknowledged to me that the same is their free and voluntary act and deed, and that of the institutions respectively represented.

The foregoing instrument refers to a Memorandum of Agreement (MOA) consisting of seven (7) pages, including the page in which this Acknowledgement is written, signed by the parties, including their instrumental witnesses on each and every page thereof and sealed with my notarial seal.

WITNESS MY HAND AND SEAL, on the date and place above written.

NOTARY PUBLIC

Doc. No. 234
Page No. 48
Book No. I
Series of 2016

NOTICE TO Proceed

Republic of the Philippines
OFFICE OF THE PRESIDENT
COMMISSION ON HIGHER EDUCATION

NOTICE TO PROCEED

8 August 2017

ESTER B. OGENA, Ph.D.
President
Philippine Normal University
Taft Avenue, Manila

ATTENTION: **MARIE PAZ E. MORALES, Ph.D.**
Principal Investigator

Dear **Dr. Ogena:**

The attached Memorandum of Agreement having been signed, notice is hereby issued so that the implementation and conduct of the program titled ***"Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education",*** by your institution, may commence not later than 7 days after the receipt of this notice.

The Program shall be undertaken consistent with the terms and conditions as stipulated in the Agreement. Thus, as the lead institution, you shall be shall be responsible for ensuring the completion of the program in accordance with the approved Work and Financial Plan.

Please acknowledge receipt and acceptance of this NOTICE by signing both copies in the space provided below. Keep one copy and return the other to the Commission on Higher Education, Office of Policy, Planning, Research and Information, Higher Education Development Center Bldg., Ground Floor, C.P. Garcia Ave., UP-Diliman, Quezon City.

Very truly yours,

KAROL MARK R. YEE
Executive Director IV

Conforme:

ESTER B. OGENA, Ph.D.
President

PROJECT *Proposal*

RPAG Form 1

RESEARCH PROPOSALS APPLICATION FORM

I. Research Title: **Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education**

II. Name of Principal Investigator: Dr. MARIE PAZ E. MORALES
Designation: Director
Department: Philippine Normal University-Publication Office
Principal Investigator's Contact Details: (02) 3171768 loc. 515
Name of Institution: Philippine Normal University
Address: Taft Avenue, Manila
Institution's Contact Details: (02) 3171768
Name of the Head of the Institution: Dr. ESTER B. OGENA

Name(s) and Designation of Co-Investigators and Members:

Name(s)	Role	Contact Details	HEI Name & Address
Dr. Marie Paz E. Morales	Principal Investigator	(02) 3171768 loc. 515 reyes.ws@pnu.edu.ph	Philippine Normal University Taft Avenue, Manila 1000
Dr. Edna Luz R. Abulon	Co-Investigator (Components 1, 2, 5, 6, 7)	(02) 3171768 loc. 751 morales.mpe@pnu.edu.ph	Philippine Normal University Taft Avenue, Manila 1000
Prof. Ruel Avilla	Co-Investigator (Component 3)	(02) 3171768 loc. 744 avilla.ra@pnu.edu.ph	Philippine Normal University Taft Avenue, Manila 1000
Dr. Rosie Lopez-Conde	Co-Investigator (Component 4)	(02) 3171768 local 751 c/o eprdc@pnu.edu.ph	Philippine Normal University Taft Avenue, Manila 1000
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Dr. Jinky Bornales	Member	0998-9824671 Jbornales@gmail.com	Mindanao State University-Iligan Institute of Technology
Dr. Emil Alcantara	Member	09228047702 alcantara_emil0204@yahoo.com	Batangas State University, Batangas

III. Curriculum Vitae of Principal Investigator, Co-Investigators, and Members of Research Team: (*Please place as Attachment A*) – Submitted

IV. **RDE Grant Proposal**

1. ***Abstract*** *(maximum of 250 words)*

The study aims to explore the Technological-Pedagogical-Assessment-Content Knowledge (TPACK) of Philippine STEAM Educators geared towards STEAM Quality Education. Specifically, the study intends to develop an emerging TPACK Model or Framework customized to Philippine STEAM Educators competencies, skills, and resources It will provide frameworks and models on pedagogy for STEAM, assessment, and technology integration which may dictate lesson exemplars and direct policy makers to attune guidelines and policies related to STEAM Education for quality STEAM manpower of the country. Participants determined through multistage sampling procedure include all STEAM educators from 330 Higher Education Institutions for components1 and 6 of the study and 33 focused schools for the remaining phases. The study will utilize several research designs with several components for the data collection. Qualitative and quantitative approaches will be used in collecting pertinent data. Varied and matched data analysis will deduce trends and significant data interpretation. The products and outputs of TPACK Model in STEAM education include: 1) indicators of proficient STEAM educators, 2) database of Philippine STEAM educators, 3) TPACK competencies of the Philippine STEAM educators, 4) model technology integration in STEAM education, 5) Innovative pedagogical approach for STEAM Education, 6) assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component, 7) localized TPACK model for Philippine STEAM education. 8) capacity building programs for STEAM education; 9) lesson exemplars featuring TPACK Model for STEAM educators, 10) emerging TPACK model for Philippine STEAM education, and 11) craft policies for Philippine STEAM Education.

2. ***Background***

In the country's journey to improve the quality of life of Filipinos and to establish high economic growth, aspects of science, technology, engineering, agriculture and mathematics (STEAM) may highlight skills to achieve our goals. Apparently, most first world countries adhere to the concept of STEM as the driver of their economy in the 21st century and their powerful tool for individual and economic success ((National Governor's Association [NGA], 2011; Donovan, Mateos, Osborne & Bisaccio, 2014; Sahin, 2016). They believe that all aspects of the economy are STEM-influenced, in one way or another. STEM provides a strong human resource or human capital that eventually leads the country to technology-driven state and sustainable growth of resources such as economy-driven biodiversity and ecosystem restoration, enhanced biocapacity and functionality (Donovan, Mateos, Osborne & Bisaccio, 2014); and STEM-triggered research and innovations for improved and probably

increased production of goods. In fact, the adherence of the country to STEAM highlights the "AMBISYONNATIN2040", themed as, "*Matatag, Maginhawa, at Panatag na Buhay* (Philippine Development Plan [PDP], 2017)." The country believed that the 2040 goal may be concretized through the three priority areas of the crafted Philippine Development Plan which includes: 1) *malasakit* (enhancing social fabric); 2) *pagbabago* (reducing inequality); and 3) *patuloy na pagunlad* (increasing growth potential). These three priority areas emphasize among others promotion and awareness of Philippine culture, acceleration of human capital development, promotion of technology, and stimulation of innovation. Apparently, the make-up of the PDP framework puts STEAM as among the cores to achieving the 2040 goals. Thus, necessitates cross-cutting strategies, which may be derived from quality STEAM education for the Filipinos.

In this realm, UNESCO (2014) defined ***good-quality education*** as the focus of the vision where the featured process is equipping people with the skills, knowledge and attitudes to: obtain decent work; live together as active citizens nationally and globally; understand and prepare for a world in which environmental degradation and climate change present a threat to sustainable living and livelihoods; and understand their rights as individuals and citizens of a country. Thus, post-2015 education highlights **productive participation in society achieved through "high quality education for all**." Accordingly, the Philippine Normal University (PNU) as the National Center for Teacher Education (NCTE) is envisioned to be known nationally and internationally as the primary center of excellence in teacher education and educational leadership in the Philippines and in the ASEAN Region. As the established producer of knowledge workers in the field of education, PNU shall be the pioneer in promoting principles of reciprocity, cooperation and commitment through collaborative projects both in academic and in research that will enhance partnerships and foster greater co-operation and understanding among Philippine Universities and ASEAN nations through education. With the proposed study on Technological-Pedagogical-Assessment-Content Knowledge (TPACK Model) for STEAM Education, PNU takes major part in the following CHED priorities:

- building research collaborations among researchers, scientists or investigators from small and big, old and new, and private and public HEI's;
- supporting multidisciplinary research;
- promoting gender-sensitivity and gender balance in research undertakings and teaching and learning processes; and providing opportunities for young researchers;
- improving competitiveness and comparative advantage of Philippine HEIs through education.

Additionally, this research project will enable the University to concretely realize the mandates and strategic directions as the premier and leader in Philippine Teacher Education. As the lead research institution for this study, the University will be able to foster more research collaborations with partner institutions; strengthen affiliations and alliances with private universities and other government agencies; and promote quality assurance, branding, internationalization, and human capital management through research mentoring and optimizing STEAM graduate programs eventually providing the much needed contribution to the realization of PDP 2022.

The major purpose of the study is to craft an Emerging Technological-Pedagogical-Assessment-Content Knowledge (TPACK) Model for Philippine STEAM Education and to provide inputs to policies for Philippine STEAM Education. Specifically, the objectives are as follows:

1. Determine the TPACK competencies of the Philippine STEAM Educators;
2. Model Technology integration in STEAM Education;
3. Develop innovative pedagogical approach for STEAM Education;

4. Develop assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component;
5. Localize TPACK Model for Philippine STEAM Education.
6. Provide capacity building programs for STEAM Education;
7. Design and develop lesson exemplars featuring TPACK Model for STEAM Educators; and
8. Create emerging TPACK Model for Philippine STEAM Education and craft policies for Philippine STEAM Education.

Literature Survey

Technological-Pedagogical-Assessment-Content Knowledge (TPACK) of STEAM educators is foreseen to be the leading edge in facing the 21st century education. As envisioned, TPACK in Science Education may provide a strong base for STEAM Education in the country with the confluence of the following frameworks and theories: 1) TPACK competencies; 2) pedagogical frameworks, assessment and content; and 3) standards, competencies, capacity building, and quality assurance.

Philexport (2014) reports that the Philippines need to vastly improve its R & D innovation system to transition from efficiency-driven stage, which the country begins to develop more efficient production processes and increase product quality to its ultimate goal to reach innovation-driven stage in which a country sustains higher wages and standard of living by enabling businesses to compete in creating new or unique products. The current economic and R & D state of the country reported in the World Economic Forum's Global Competitiveness (2012-2013) calls for better R & D which may be addressed by quality STEAM manpower through quality STEAM Education.

TPACK Competencies

Quality STEAM Education may be greatly propelled by quality STEAM educators. Consequently, Robinson, Plake, and Knowles (2001) believed that quality teachers are: 1) committed to their students and student learning; 2) possess deep subject matter knowledge; 3) manage and monitors student learning; 4) use varied instructional strategies to meet the individual needs of the students; 5) carefully evaluates whether the set of learning objectives have been attained; 6) reflective of their own teaching; 7) make continual adjustments to attain the desired student progress. These characteristics of a quality teacher are in consonance with teacher's PCK attributes as Shulman (1986) defined. Accordingly, Shulman acknowledged that merely understanding the subject matter is not sufficient to teach a subject. It is the teacher's PCK that makes quality and effective teaching (Karaman, 2012; Park & Oliver, 2007; Shulman, 1987). Researchers identified several factors that may influence teacher's PCK: 1) attendance to workshops and trainings (Clermont, Borko & Krajcick, 1994); 2) content knowledge (Aydin et al., 2009; Kaya, 2009; Usak, 2005; Villaluz, 2005); 3) knowledge of student conception and learning difficulties (Geddis, 1998; Van Driel et al., 1998); and 4) curriculum knowledge and knowledge on instructional strategies and assessment (Magnusson et al., 1999; Usak, 2005).

Guided by the dramatic technology revolution in the 21st century, Clark (2010) claimed that integrating technology in the curriculum and instruction will bring about significant student achievement leading to deep understanding of concepts. As defined by Clark (2010) "meaningful

integration" of technology refers to the process of matching the most effective tool with the most appropriate pedagogy to achieve the learning goals of a particular lesson. A match on this desire are the goals of Mishra and Koehler (2006) of injecting technology on Shulman's (1986) concept of pedagogical content knowledge (PCK) to address the growing prominence of digital technologies in instructional settings. Geared towards tapping the transformative benefits and potentials of introducing technologies in instructional setting, Mishra and Koehler (2006) described the integration of technology into the teaching and learning system as Technological Pedagogical Content Knowledge (TPCK). Adhering to the belief that TPCK formed an integrated whole, the framework was later renamed as TPACK for Total PACKage (Thompson & Mishra, 2008). As a framework, TPACK focuses on the complex interactions between teacher's knowledge of the content (CK), pedagogy (PK), and technology (TK). Mishra and Koehler (2006) further claimed that a teacher who can navigate between these interrelations act as an expert who is different than a lone subject matter, pedagogy, or technology expert. With this framework, technology education has become an integral part of teacher education.

Assessing the effectiveness of technology education in the development of teachers' TPACK has been the trend in TPACK researches (Angeli & Valanides, 2009; Niess, 2008; Schmidt et al., 2009). Park, Jang, Chen and Jung (2011) assessed teachers' level of TPACK using a rubric based on observations of teaching practices and pre/post observation interviews. PCK rubric was also developed by Gardner and GessNewsome (2011) using video tapes of teachers' classroom instructions, interviews and written reflections. Probable categories and profiling of STEAM educators through their TPACK competencies may provide better capacity building.

Pedagogical frameworks, assessment and content

Pedagogy for STEAM teaching ranges from straight lecturing to interactive teaching (Mazur, 1997, 2009; Powell, 2003). Some researchers (Handelsman et al., 2006) boldly identified specific teaching frameworks specific to STEAM field (teachers teach like scientists, methodically and strategically). Wiggin and McTighe (1998) specified "Background Design" as a framework for scientific teaching features. Finally, Postner and Roessner (2006) advocated the research-based knowledge absorption. Assessment in STEAM (Wiggin & McTighe, 1998) focus on alternative and authentic rather than the traditional schemes. Additionally, the International Center for Leadership and Innovation (ICLI, 2015) identified problem-based learning and assessment as the focus assessment style in STEAM education.

However, common pedagogy and assessment frameworks may not exist or may not apply across STEAM fields (will include A-Agriculture). Accordingly, research in multiple STEAM disciplines (Borrego et al., 2010; Fryod, Borrego, Cutter, Henderson & Prince, 2013) suggests that strategies currently used by change agents have been relatively successful at creating awareness and interest, but have not been as successful at supporting faculty during the final stage. Even Baldwin (2009) accounted for many factors for the slow, sporadic space reform in STEAM Education.

Standards, Competencies and Capacity Building, and Quality Assurance

For STEAM education to be considered as the most important enabling instrument towards reaching the country's goals, there is a need for quality assurance in this field. Quality

assurance, according to Church (1988) is not about specifying the standards or specifications against which to measure or control quality. Quality assurance is about ensuring that there are mechanisms, procedures and processes in place to ensure that the desired quality, however defined and measured, is delivered. Furthermore, the UNESCO Regional Report of Asia and the Pacific describes quality assurance in higher education as the systematic management and assessment procedures to monitor performance of higher education institutions. Quality, considers all aspects of education—from teaching and academic study programs, research and scholarship, staffing, students, infrastructure and facilities, to services to the community and the academic environment. In 2003, the ASEAN Economic Community (AEC) established regional initiatives for quality assurance with core elements that included free flow of services and free flow of skilled labor. In the Philippines, efforts to attune the country to the regional and global contour led to the establishment of the Philippine Qualification Framework (PQF, 2012). Objectives of this framework include 1) to adopt national standards and level for outcomes of education; 2) to support the development and maintenance of pathways and equivalencies which provide access to qualifications and assist people to move easily and readily between the different education and training sectors and between these sectors and the labor market; and 3) to align the PQF with international qualifications framework to support the national and international mobility of workers through increased recognition of the value and comparability of Philippine qualification. With PQF, all education sectors are tasked to make detailed descriptors for each qualification level based on learning standards in basic education, competency standards of training regulations, and the policies and standards of higher education academic programs. Guided by the vision, mission and goals of PQF, the Philippine higher education system is mandated to contribute to building a quality nation capable of transcending the social, political, economic, cultural and ethical issues that constrain the country's human development, productivity and global competitiveness. Specifically, Philippine universities and colleges are tasked to produce graduates with high levels of academic, thinking, behavioral, and technical skills to be productive members and citizens and provide a pool of quality human resource, who are globally competent to raise the Philippine international ranking.

Accordingly, in this digital and technological age, strong workforce are important for many jobs created in the booming fields of medicine, computer and IT industries worldwide. This scenario directs countries including the Philippines to demand STEAM growth through quality STEAM Education which are envisioned to be provided by Higher Education Institutions (STEM Education Grows in Developing Countries, 2015). With quality STEAM education, skilled citizens may bring about tremendous growth to the nations' economy. In fact, Obama (2015) strongly believed that in a world that is becoming increasingly complex, and success is not only driven by what you know, but what you can do with what you know, it is vital that the people are equipped with the knowledge and skills to solve tough problems, gather and evaluate evidences and make sense of information—skills and competencies learned through STEAM Education.

Competencies and standards are basically needed in all frameworks. Mind Tools (2015) considered competencies as a complete way of bridging individual performance with the country's goals. These competencies are the integrated knowledge, skills, judgment, and attributes that the citizens need to achieve. Furthermore, defining which competencies are necessary for success in the organization can help do the following:

- Ensure that people demonstrate sufficient expertise.
- Recruit and select new staff more effectively.
- Evaluate performance more effectively.

- Identify skill and competency gaps more efficiently.
- Provide more customized training and professional development.
- Plan sufficiently for succession.
- Make change management processes work more efficiently.

The above mentioned frameworks, content area standards and competencies allied with assessment frameworks, innovative pedagogical practices and technology integration model serve as valuable inputs to each of the STEAM components, science, technology, engineering, agriculture and mathematics.

Guidelines, concepts and principles from the inputs (Innovative pedagogical approach, content area standard and competencies, assessment framework) specific to each of the STEAM components: science, technology, engineering, agriculture and mathematics – are combined to form themes and concepts for the general TPACK for STEAM Education and its specifics for all STEAM components. These general TPACK principles and concepts of STEAM education and its specifics for all the components, consequently support the entire STEAM Education in Higher Education.

This project aims to achieve the designed Quality Tertiary Education consequently aligned to the Philippine and Asian quality standards for quality assurance; and to the themes of "AMBISYONNATIN2040:" "*Matatag, Maginhawa, at Panatag na Buhay* (Philippine Development Plan [PDP], 2017)." The country believed that the 2040 goal may be concretized through the three priority areas of the crafted Philippine Development Plan which includes: 1) *malasakit* (enhancing social fabric); 2) *pagbabago* (reducing inequality); and 3) *patuloy na pagunlad* (increasing growth potential). These three priority areas emphasize among others promotion and awareness of Philippine culture, acceleration of human capital development, promotion of technology, and stimulation of innovation. Apparently, the make-up of the PDP framework puts STEAM as among the cores to achieving the 2040 goals. Thus, necessitates cross-cutting strategies, which may be derived from quality STEAM education for the Filipinos. Figure 1 provides a visual counterpart of the conceptual framework of the study.

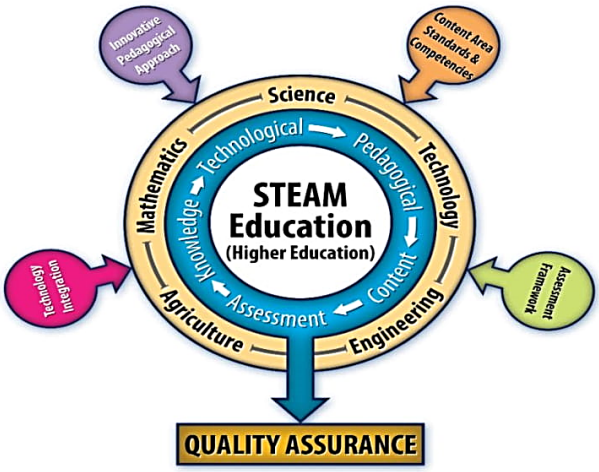

Figure 1: Conceptual Framework

Quality assurance fuels the impetus to develop an emerging TPACK Model customized for the Philippine STEAM Education. This desire for quality STEAM Education is grounded on providing concrete, multi-faceted and interdisciplinary solutions to complex issues and problems the country usually face brought about by man-made and natural factors. A well-thought of STEAM Education should include all facets of learning defined by the TPACK Model which includes: Technology integration, innovative pedagogical approaches, appropriate assessment tools, and content standards and competencies. These existing frameworks may have reached the realms of the Philippine Higher Education, yet, concrete implementation of schemes to translate these frameworks to concrete outputs may be nil. Thus, this study focus on developing an emerging TPACK Model for Philippine STEAM Education anchored on the TPACK Framework but customized to Philippine STEAM Education to identify the TPACK competencies of STEAM educators; identify the most innovative and appropriate pedagogical approaches for Filipino learners; to specify the useful assessment tools to formative development and assessment of learning; to model technology integration and identify content standards and competencies of STEAM Education unique to Filipino STEAM learners but have global significance to bring them to better competitive stance. This study, thus, provides directions, pathways, and way forward in the field of STEAM education for better management of learning, developing quality STEAM human resources, STEAM literacy to enhance life management, resources management, risk reduction and sustainability of knowledge and resources for quality living.

Statement of Desired Outcomes:

Consequently, the study intends to provide the following deliverables and expected outputs:

1. TPACK competencies of the Philippine STEAM Educators;
2. Model Technology integration in STEAM Education;
3. Innovative pedagogical approach for STEAM Education;
4. Assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component;
5. Localized TPACK Model for Philippine STEAM Education.
6. Capacity building programs for STEAM Education;

7. Lesson exemplars featuring TPACK Model for STEAM Educators; and
8. Emerging TPACK Model for Philippine STEAM Education and craft policies for Philippine STEAM Education.

Significance of the Research

Pointedly, quality STEAM Education may engage larger population of learners in the STEAM track, which may attract the best minds to go into STEAM and be part of our Science and Technology human resource which the Department of Science and Technology and other government agencies need and hope for if the country needs to move forward to being a first world. Quality tertiary STEAM Education that will be provided by our capacitated STEAM Educators through our study (TPACK in STEAM Education) may stimulate the ripple of quality assurance providing the best education and developing best professionals who can also lead the K – 12 senior high school STEAM track to better training and attract good students to engage in STEAM.

TPACK in Steam education engages in developing scientific literacy warriors which may lead campaigns to develop STEAM literacy to the entire populace. STEAM literacy points to the desired STEAM education outcomes rooted strongly on the idea that critical knowledge in STEAM is important in every young person's education. This idea will position STEAM at the base of a country's hierarchy of needs which directs schools to make science and technology an obligatory part of their curriculum. This scenario highlights the attainment of STEAM literacy to remain as the universal goal and significant challenge for science education and for many countries as well (Tan 2004). In the Philippines, Gregorio et al. (2011) highlighted the crucial need to be scientifically, technologically, mathematically literate citizenry with the annual occurrence of risks and natural disaster, economic lows, and agricultural problems brought about by climate change.

In a more specific stance, providing quality teachers for STEAM Education through the TPACK in Steam Education may lead to the following:

- High level of Filipino STEAM competencies for Quality Assurance;
- Globally competitive and internationally competent STEAM graduates;
- Highlight STEAM Literacy for social welfare and development of low and middle income families for better life management, resources management, risk reduction and sustainability of knowledge and resources for quality living.

Finally, the STEAM curricular framework anchored on the TPACK Model to be proposed in the study could provide a seamless effort to put it into practice both at the senior high school level and at the HEI. The innovativeness of the TPACK may provide the STEAM educators better grasp of the current needs in terms of pedagogical approach for STEAM Education to make all HEI programs achieve quality standards.

3. **Description of method or approach**

The proposed study will be implemented in seven components. **Component 1** will determine the TPACK competencies of the Philippine HEI STEAM Educators. **Component 2** will showcase technology integration in STEAM education as linked to enhancing pedagogy. **Component 3** will deduce innovative and appropriate pedagogical approaches for STEAM Education. **Component 4** will center on extracting exemplar assessment tools and further developing assessment tools for STEAM education by looking into the most appropriate forms of assessment for each of the STEAM component. **Component 5** will localize TPACK Model for

Philippine STEAM Education. **Component 6** will emphasize capacity building for STEAM educators dictated by the developed TPACK framework to help build a community of STEAM educators and STEAM lessons exemplars designer. All outputs from all phases will provide inputs for planning and crafting of an emerging TPACK for Philippine STEAM Education and provide policies inputs for Philippine STEAM Education (**Component 7**).

The Participants

With set confidence level of 95% and from CHED data on the total population of Philippine HEI (2299), 330 schools will be randomly selected from 17 regions. Based on percentage representation, 235 (71%) private schools and 95 (29%) public HEI will comprise the sample for these phases. Specifically, public HEI included complete enumeration (50) of Levels 1 or 2 SUC and random sampling of LUCs (45). The private HEI's included sectarian schools (50) and non-sectarian schools (185) identified through proportionate sampling. Complete enumeration of STEAM educators in the identified schools are the focus participants for component 1.

About 33 (10%) schools of the identified sample in component 1 will be involved in components 2, 3, and 4. Primarily, purposive sampling will determine the 33 focus schools for the aforementioned components. Selection criteria includes school inclusion of the most number of STEAM programs, low level of as evaluated by CHED or other accrediting agencies, most number of STEAM educators, location and security.

Research Design Phase

Combination of several research designs will achieve the objectives of the study. For all the identified phases, survey and descriptive research will gather data on STEAM educators': 1) TPACK competencies; 2) pedagogical skills inclusive of technological integration; and 3) assessment skills. Developmental research style featuring both quantitative and qualitative approaches will also extract important data.

Please refer to attached Matrix

4. ***Description of the competence, qualifications and experience of the investigators, project team and collaborators*** *(if applicable)-CVs Submitted*

The members of the research team are experts in the areas of research and STEAM Education. Most of them are head of science education department, directors of research, directors of publication, and vice presidents of the research domains of their respective institutions. Several of them are in the STEAM Education field who are into research and publication of science education issues and themes. They are also practicing teachers of STEAM courses in their respective institutions, thus they are expert in the areas identified in this study.

5. ***Description of relevant institutional resources***

The Philippine Normal University has established solid research infrastructure in terms of facilities and manpower to lead funded research activities and facilitate the conduct of research. The collaborating universities have similar thrusts in terms of the research function of being universities.

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7. ***Proposed project personnel arrangements and other manpower requirements*** *(Please compute number of man-days for the proposed duration of the project for each project personnel)*

The undertaking of this proposed project shall be over and above the regular functions of the investigators and members. Other manpower requirements will be the availment of the services of student assistants on "per month" basis based on the maximum number of hours allowed by lead university (PNU) and Field Researchers from the sampled schools.

V. Sustainability and Capacity Building

Would the proposed RDE be part of an existing collaboration between the partner institutions? If so, please give details. Yes, since the lead proponent (PNU) and the collaborators in the NCR are members of two educational consortia with signed memorandum of agreement to undertake collaborative research projects for mutual cooperation and benefits.	
Please give a description of how you and your group/department/institution plan to continue the collaboration after the end of the activity. Please provide information about potential funding sources that might support this research collaboration after the end of this RDE. The HEIs involved in the study will continue to collaborate to implement the TPACK, the lesson exemplars and the capability building program. Proposals for the roll out of implementation at the Department of Education on Capability Building and the TPACK STEAM track for the K-12Program and to CHED for the TPACK STEAM programs will be prepared collaboratively so that the research outputs will be continuously utilized, monitored and evaluated for usefulness and relevance to the needs of time.	

How will the collaboration contribute to the capacity building of the wider research and innovation landscape in the Philippines? The STEAM curricular framework to be proposed in the study anchored on the TPACK Model could provide a seamless effort to put it into practice both at the senior high school level and at the HEI. The innovativeness of the TPACK may provide the STEAM educators better grasp of the current needs in terms of pedagogical approach for STEAM Education to make all HEI programs achieve quality standards.	

VI. **Relevance to Economic Development, Inclusive Growth and Social Welfare**

Does the research/innovation addressed by your collaboration support areas relevant to the economic development and social welfare of low- and middle-income families, etc., benefitting poor and vulnerable populations in the country? Providing quality teachers for STEAM Education through the TPACK in Steam Education may lead to the following: • High level of Filipino STEAM competencies for Quality Assurance • Globally competitive and internationally competent STEAM graduates • Highlight STEAM Literacy for social welfare and development of low and middle income families for better life management, resources management, risk reduction and sustainability of knowledge and resources for quality living.	
Please indicate a plausible pathway of how the research may contribute to the economic development and social welfare of the partner applicant and lead to positive impact on the lives of people on low income within a reasonable time frame (3-15 years). Quality STEAM Education may engage larger population of learners in the STEAM track. We may be able to attract the best minds to go into STEAM and be part of our Science and Technology human resource which the Department of Science and Technology and other government agencies need and hope for if the country needs to move forward to being a first world. Quality tertiary STEAM Education provided by our capacitated STEAM Educators through our study (TPACK in STEAM Education) may stimulate the ripple of quality assurance providing the best education and developing best professionals who can also lead the K – 12 senior high school STEM track to better training and attract good students to engage in STEM. TPACK in Steam education engages in developing scientific literacy warriors which may lead campaigns to develop STEAM literacy to the entire populace. STEAM literacy points to the desired STEAM education outcomes rooted strongly on the idea that critical knowledge in STEAM is important in every young person's education. This idea positioned STEAM at the base of a country's hierarchy of needs which directs schools to make science and technology an obligatory part of their curriculum. This scenario highlights the attainment of STEAM to remain as the universal goal and significant challenge for science education and for many countries as well (Tan 2004). In the Philippines, Gregorio et al. (2011) highlighted the crucial need to be scientifically, technologically, mathematically literate citizenry with the annual occurrence of risks and natural disaster, economic lows, and agricultural problems brought about by climate change.	

VII. **Research Governance and Ethics**

Please describe how will you ensure that the activity will be carried out to the highest standards of ethics and research integrity? Since the Philippine Normal University has already instituted the Research Ethics Review Committee, the ethical issues in the undertaking of this research have been subjected for ethics review. The core ethical standards of respect, beneficence and justice shall be adhered to in every step of the conduct of this research.	
Please describe how potential ethical health and safety issues arising as part of this collaboration have been considered and how they will be addressed. The data gathering procedure proposed in the study will not in any way place the respondents nor the field researchers in health or psychological hazards. The respective schools chosen in the sampling procedure will be the research locale of the study to ensure safety and security of the respondents. Sampled respondents will sign an informed consent form to ensure that any ethical issues (e.g. voluntary participation, confidentiality) shall be addressed. On the part of the field researchers from collaborating institutions, procurement of insurance for the period of data gathering shall be observed to provide security measures. Authority to travel among the field researchers shall be secured also prior to their departure to the research sites.	
Will the proposed RDE involve research on animals, human participants, human tissue or patient/participant data? The proposed study involves human participants who are HEI STEAM educators. The ethical standards of respect, beneficence and justice shall be observed at any stage of this undertaking.	
Has the proposed RDE been reviewed by the respective research boards of the participating institutions? It has been reviewed by the PNU Research Ethics Committee and the Research and Extension Coordinating Committee.	

VII. **Proposed Budget** (This includes counterparts and source/s of funds).

Professional Services = Php 3,077,800.00 MOOE = Php 4,969,819.05 Capital Outlay = Php 550,000.00 Administrative Cost (5%) = Php 402,380.95 **TOTAL = Php 9,000,000.00**	
Please indicate the total amount provided as in-kind contribution by Principal Investigator and Associated Partners • Estimated equivalent amounts to about 3,000,000.00.	
Please provide a description of in-kind contribution provided by the Principal Investigators'	

institutions and Associated Partners. • The use of equipment and school facilities (e.g. journal access, internet access), including utilities and available office supplies. • Model processes instituted by the Principal Investigators' Institution and Associated Partners.	
Please provide justifications for these costs, including value for money and confirmation that a fair procurement process will be carried out. • All purchases and procurement has undergone the prescribed and standard purchase and procurement process as directed by the approved procurement plan of the University.	

VIII. **Expected Outputs and Deliverables** (This refers to the products of the investigation which would contribute and increase the stock of knowledge.)

The products and outputs of TPACK in STEAM Education in all STEAM components: Science, Technology, Engineering, Agriculture and Fisheries, and Mathematics include:

- TPACK competencies of the Philippine HEI STEAM Educators;
- Model Technology integration in STEAM Education;
- Innovative pedagogical approach for STEAM Education;
- Assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component;
- Localized TPACK Model for Philippine STEAM Education.
- Capacity building programs for STEAM Education; and
- Lesson exemplars featuring TPACK Model for STEAM Educators;
- Emerging TPACK Model for Philippine STEAM Education and craft policies for Philippine STEAM Education.

IX. **Mentoring Plan:** Describe the supports/mentoring activities that will be provided for MS/Doctoral Students.)

Mentoring MS/Doctoral students would include the following:

- Orienting graduate students on the different qualitative and quantitative research methodologies related to the study.
- Familiarizing graduate students to different data gathering techniques, qualitative and quantitative analyses of data.
- Training graduate students to conceptualize large bodies of knowledge such as building frameworks and programs for better knowledge creation.
- Guiding students to build good relationships with researchers, content experts and others.
- Helping STEAM mentors to provide the best apprenticeship possible to STEAM students.

X. **Target Beneficiaries of Research Results:** (who and how many are the direct / indirect beneficiaries of the study, what are the benefits that are likely to accrue in the short or long term)

Target Beneficiaries	Total
1. Doctoral and Masteral students	More than 100

2. Higher Education institution	330 (sample) to 2299
3. Researchers in Education (Member researchers of the project, field researchers of the project, STEAM Educators in the country)	354
4. Government Agencies (CHED, DEPED, DOST-SEI, LGU)	4

XI. **Dissemination Plan:** (what is the plan for sharing / communicating research results to different stakeholders / possible beneficiaries; please mention specific activities)

Activities	Strategy
1. Capacity Building	Training, workshop and symposia
2. Knowledge creation and sharing	Paper presentation in national and international conferences Research publications in CHED-accredited journals, international-refereed journals.
3. Lesson exemplars, curricular framework design, literacy tests	Copyright, research publication, book publication

SUBMITTED BY:

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator

APPROVED AND ENDORSED BY:

ESTER B. OGENA, Ph.D.
Head, University Research Board
Head of Institution

TERMS OF REFERENCE (TOR)

Research Title:	**Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education**
Principal Investigator:	**DR. MARIE PAZ E. MORALES**
Implementing Institution:	**Philippine Normal University**
Collaborating Institutions:	**DELA SALLE UNIVERSITY, MANUEL ENVERGA UNIVERSITY, BATANGAS STATE UNIVERSITY, POLYTECHNIC UNIVERSITY OF THE PHILIPPINES, EARIST, WEST VISAYAS STATE UNIVERSITY, RIZAL TECHNOLOGICAL UNIVERSITY, MINDANAO STATE UNIVERSITY-ILIGAN INSTITUTE OF TECHNOLOGY, BATANGAS STATE UNIVERSITY, UP LOS BANOS, WEST VISAYAS STATE UNIVERSITY**
Period Covered	**24 months**
Total Project Cost	**9,000,000.00**

Objectives:

The major goal of the proposed study is to explore the Technological-Pedagogical-Assessment-Content Knowledge (TPACK) of STEAM Educators aimed towards STEAM quality education. It envisions providing frameworks and models on pedagogy for STEAM, assessment, and technology integration which may dictate lesson exemplars and direct policy makers to attune guidelines and policies related to STEAM Education for quality STEAM manpower of the country.

The major purpose of the study is to craft Technological-Pedagogical-Assessment-Content Knowledge (TPACK) Model for STEAM Education. Specifically, the objectives are as follows:

1. Determine the TPACK competencies of the Philippine HEI STEAM Educators;
2. Model Technology integration in STEAM Education;
3. Develop innovative pedagogical approach for STEAM Education;
4. Develop assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component;
5. Localize TPACK Model for Philippine STEAM Education.
6. Provide capacity building programs for STEAM Education;
7. Design and develop lesson exemplars featuring TPACK Model for STEAM Educators; AND
8. Create emerging TPACK Model for Philippine STEAM Education and craft policies for Philippine STEAM Education.

Scope:

STEAM Track for tertiary education

Research Method (Sampling, Research Design and Data Treatment):

With set confidence level of 95% and from CHED data on the total population of Philippine HEI (2299), 330 schools will be randomly selected from 17 regions. Based on percentage representation, 235 (71%) private schools and 95 (29%) public HEI will comprise the sample for these phases. Specifically, public HEI included complete enumeration (50) of Levels 1 or 2 SUC and random sampling of LUCs (45). The private HEI's included sectarian schools (50) and non-sectarian schools (185) identified through proportionate sampling. Complete enumeration of STEAM educators in the identified schools are the focus participants for component 1.

About 33 (10%) schools of the identified sample in component 1 will be involved in components 2, 3, and 4. Primarily, purposive sampling will determine the 33 focus schools for the aforementioned components. Selection criteria includes school inclusion of the most number of STEAM programs, low level of as evaluated by CHED or other accrediting agencies, most number of STEAM educators, location and security.

Activities:

Activities	Months																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Component 1. Assessment of STEAM Educators' TPACK: (Technology, Pedagogy, Assessment, Content) to determine the TPACK competencies of Philippine STEAM Educators																								
Components 2, 3, 4 1. Deducing and developing innovative pedagogical approach for Philippine STEAM Education 2. Modeling Technology Integration in Philippine STEAM Education 3. Deducing and developing assessment tools for Philippine STEAM Education by looking into the most appropriate forms of assessment for each STEAM component																								
Component 5 Localizing TPACK Model for Philippine STEAM Education																								
Component 6 1. Providing capacity																								

building programs for Philippine STEAM Education 2. Designing and developing lesson exemplars																								
Component 7 1. Creating an emerging TPACK for Philippine STEAM Education 2. Crafting policy inputs for Philippine STEAM Education																								

Personnel Requirements/Team Composition & Modus Operandi (including delineation of assignments, coordination/networking arrangements):

Activities	Person Involved/ Institutional Affiliation	Responsibility
Component 1 Assessment of STEAM Educators' TPACK: (Technology, Pedagogy, Assessment, Content) to determine the TPACK competencies of Philippine STEAM Educators	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators (DLSU, MEU, BSU, UP-LB, PUP, EARIST, RTU, WVSU and MSU-IIT)	**Principal Investigator** • Prepares research proposal for the intended project • Identifies, assigns, and monitors people in the institution and collaborators involved in the project. • Gives directions/instructions to the people involved in the project. • Oversees the entire research implementation. • Identifies and leads the development of instruments needed in the project. • Acts as the financial manager of the entire project. • Determines the content, scope, and sequence of the work • Calls meetings with the members • Strategizes the course of action to be done to accomplish the desired output; • Assigns the unit of work to each member • Ensures that the research standards were met. • Sets deadlines for the submission of the output • Checks on the amount of work accomplished by each member • Ensures the completion of the project and accountable for meeting research standard of the work- content, methodologies, instruments, data analysis and correctness of results. • Spearheads the writing and submission of the technical report as well as in the writing of the article per component of the project. • Writes assigned part of the research output/technical report/research articles • Ensures submission of deliverables to CHED • Ensures publication of the research article per component. **Co-investigators** • Assists in the preparation of the proposal • Prepares the line item budget • Manages the project in terms of the funding provided • Communicates with the members of the teams for their field work assignment • Reports the financial status of the research. • Preparation of the scope of work of the researchers, field researchers and administrative support staff • Ensures the on time completion of the tasks of the research team members • Assures the completeness of the quantitative from surveys conducted. • Assures the completeness of the criteria and record for the selection of the participants for the interview and FGD. • Oversees the conduct of the interview and FGD in the respective school. • Coordinates with the Project Leader and the researchers for the conduct of the class observation, FGD and interviews. • Prepares the templates of the report to be submitted by the members of the team. • Assists in the consolidation of report in each component • Writes assigned part of the research output/technical report/research articles **Researchers (Lead HEI, PNU)** • Coordinates all assigned research activities (on assigned key area e.g. pedagogy, technology integration and assessment) • Reports to the project leader the progress of data collection and report preparation on the assigned key area; • Serves as the lead facilitator in assigned key area during the conduct of document analysis, survey, framework development, test development, pilot testing and validation processes; • Prepares report on the class observation, FGD, and interviews conducted in the assigned key area; • Consolidates the reports on all components on assigned key area; • Takes part/portion in the writing of the research report and research articles (e.g. literature review, data analysis and interpretation, article writing) **Researchers from Collaborating HEIS** • Spearheads the conduct of observations, interviews and FGD's done in the region/school assigned. • Coordinates with the Field Researchers for the conduct of the data gathering • Spearheads the implementing the Capacity Building program by serving as Resource Persons/Facilitators (Component 6) • Provides significant assistance to the project leader in writing the research output (e.g. analysis of results and article writing in Component 2,3 and 4) **Technical Staff** • Serves as the over-all coordinator for the technical, financial and administrative legwork of the project. • Conducts literature review (e.g. Professional Standards and Guidelines, Philippine Professional Standards and Guidelines, Indicators of Proficient K-12 Science Teacher • Prepares communications/correspondence.
Components 2, 3, 4 • Deducing and developing innovative pedagogical approach for Philippine STEAM Education • Modeling Technology Integration in Philippine STEAM Education • Deducing and developing assessment tools for Philippine STEAM Education by looking into the most appropriate forms of assessment for each STEAM component	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators	
Component 5. Localizing TPACK Model for Philippine STEAM Education	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators (DLSU, MEU, UP-NISMET, UP-LB, PUP, EARIST, RTU, WVSU and MSU-IIT)	
Component 6 • Providing capacity building programs for Philippine STEAM Education • Designing and developing lesson	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators (DLSU, MEU, BSU, UP-LB,	

Personnel Requirements/Team Composition & Modus Operandi (including delineation of assignments, coordination/networking arrangements):

Activities	Person Involved/ Institutional Affiliation	Responsibility
Component 1 Assessment of STEAM Educators' TPACK: (Technology, Pedagogy, Assessment, Content) to determine the TPACK competencies of Philippine STEAM Educators	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators (DLSU, MEU, BSU, UP-LB, PUP, EARIST, RTU, WVSU and MSU-IIT)	**Principal Investigator** • Prepares research proposal for the intended project • Identifies, assigns, and monitors people in the institution and collaborators involved in the project. • Gives directions/instructions to the people involved in the project. • Oversees the entire research implementation. • Identifies and leads the development of instruments needed in the project. • Acts as the financial manager of the entire project. • Determines the content, scope, and sequence of the work • Calls meetings with the members • Strategizes the course of action to be done to accomplish the desired output; • Assigns the unit of work to each member • Ensures that the research standards were met. • Sets deadlines for the submission of the output • Checks on the amount of work accomplished by each member • Ensures the completion of the project and accountable for meeting research standard of the work- content, methodologies, instruments, data analysis and correctness of results. • Spearheads the writing and submission of the technical report as well as in the writing of the article per component of the project. • Writes assigned part of the research output/technical report/research articles • Ensures submission of deliverables to CHED • Ensures publication of the research article per component. **Co-investigators** • Assists in the preparation of the proposal • Prepares the line item budget • Manages the project in terms of the funding provided • Communicates with the members of the teams for their field work assignment • Reports the financial status of the research. • Preparation of the scope of work of the researchers, field researchers and administrative support staff • Ensures the on time completion of the tasks of the research team members • Assures the completeness of the quantitative from surveys conducted. • Assures the completeness of the criteria and record for the selection of the participants for the interview and FGD. • Oversees the conduct of the interview and FGD in the respective school. • Coordinates with the Project Leader and the researchers for the conduct of the class observation, FGD and interviews. • Prepares the templates of the report to be submitted by the members of the team. • Assists in the consolidation of report in each component • Writes assigned part of the research output/technical report/research articles **Researchers (Lead HEI, PNU)** • Coordinates all assigned research activities (on assigned key area e.g. pedagogy, technology integration and assessment) • Reports to the project leader the progress of data collection and report preparation on the assigned key area; • Serves as the lead facilitator in assigned key area during the conduct of document analysis, survey, framework development, test development, pilot testing and validation processes; • Prepares report on the class observation, FGD, and interviews conducted in the assigned key area; • Consolidates the reports on all components on assigned key area; • Takes part/portion in the writing of the research report and research articles (e.g. literature review, data analysis and interpretation, article writing) **Researchers from Collaborating HEIS** • Spearheads the conduct of observations, interviews and FGD's done in the region/school assigned. • Coordinates with the Field Researchers for the conduct of the data gathering • Spearheads the implementing the Capacity Building program by serving as Resource Persons/Facilitators (Component 6) • Provides significant assistance to the project leader in writing the research output (e.g. analysis of results and article writing in Component 2,3 and 4) **Technical Staff** • Serves as the over-all coordinator for the technical, financial and administrative legwork of the project. • Conducts literature review (e.g. Professional Standards and Guidelines, Philippine Professional Standards and Guidelines, Indicators of Proficient K-12 Science Teacher • Prepares communications/correspondence.
Components 2, 3, 4 • Deducing and developing innovative pedagogical approach for Philippine STEAM Education • Modeling Technology Integration in Philippine STEAM Education • Deducing and developing assessment tools for Philippine STEAM Education by looking into the most appropriate forms of assessment for each STEAM component	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators	
Component 5. Localizing TPACK Model for Philippine STEAM Education	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators (DLSU, MEU, UP-NISMET, UP-LB, PUP, EARIST, RTU, WVSU and MSU-IIT)	
Component 6 • Providing capacity building programs for Philippine STEAM Education • Designing and developing lesson	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff Researchers from Collaborators (DLSU, MEU, BSU, UP-LB,	

exemplars	PUP, EARIST, RTU, WVSUand MSU-IIT)	

Component 7. Providing inputs for planning and crafting of policies	Principal Investigator Co-investigators Field Researchers Technical and Admin Staff **Researchers from Collaborators** (DLSU, MEU, BSU, UP-LB, PUP, EARIST, RTU, WVSU, and MSU-IIT)	• **Prepares templates for the travel report / data collection report** • Prepares monthly status on the financial aspect of the project • Ensures the upkeep of the cash advance records and receipts • Procures the supplies and equipment needed for the project • Coordinates with the researchers / institutional researchers for their workload and submission of deliverables. • Issues needed equipment and supplies to the research team • Coordinates with institutional researchers for the schedule of the data gathering • Distributes the workload of the encoders, transcribers and student assistants **Administrative Staff** • Provides necessary administrative assistance to the research team. • Arranges the food and venue during workshops and meetings. • **Prepares all the materials needed for each fieldwork (forms, recorders, payroll etc.)** • Helps in encoding and preparing all the needs in the conduct and publication of research and development projects. • **Prepares routine templates, forms, payroll, communication needed for the project.** • Assists researchers, coordinators and project leader in administrative work. • Communicates with the field researchers/researchers for the updates on the data gathering and for the submission of outputs • Keeps the financial records and receipts of all transactions. • In-charge of the booking of transportation/airfare for the data gathering. • **In-charge of the filing of all the raw data and documents of the project** **Field Researchers (Lead HEI, PNU)** • Administers survey instruments and evaluation instruments to the participants. • Conducts cognitive interviews and FGDs. • Gathers references needed for document analysis, assessment design and framework design. • Conducts observation in assigned school • Submits all raw data / proceedings to the assigned Researcher • **Facilitates the signing of payroll for meals and transportation allowances** **Field Researcher (Sampled HEI)** • Arranges for the venue, schedule of the field work in their HEI; • Invites the participants for the FGD as per schedule; • Facilitates the distribution of meals and allowances; • Facilitates the accommodation of the Field Researchers from PNU. **Encoders/Transcribers** • Encodes and transcribe all video and audio-taped observations and FGD sessions; • Performs inter-coder process; • Codes student answers in the pilot testing process; • Codes student answers in the literacy assessment proper; • Helps in encoding and preparing all the needs in the conduct and publication of research and development projects; • Helps in encoding and preparing all the needed requirements in the conduct and publication of research and development projects; • Helps in the reproduction of forms and documents **Technical Experts (Research, Academic and Finance)** • Provides technical guidance in the implementation of the project in terms of scientific soundness and ethical standards; • Provides advice/technical inputs on the academic component of the project; • Oversees the implementation of the budgeting, financial management, liquidation, release of cash advance in relation on the project and ensures the compliance to existing accounting and auditing rules. **Statistician** • Helps in the conceptualization of pilot testing and sampling processes; • Conducts appropriate statistical tests to the data gathered in each of the **components;** • Processes data via appropriate software; • Organizes data into tables **Qualitative Data Organizer** • In charge of the thematic analysis of the encoded qualitative data ; • Processes and analyzes qualitative data; • Organizes data into tables **Language Editor** • Provides content and language editing services until publication phase; • Provides technical assistance and other assistance to the research team. **Student Assistants** • Serves food/does errands during meetings and orientation; • Assists in the sorting of accomplished checklists and forms and documents; • In-charge of the reproduction of forms and documents

SUBMITTED BY:

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator

REVIEWED AND ENDORSED BY:

ESTER B. OGENA, Ph.D.
President

APPROVED BY:

NAPOLEON K. JUANILLO, JR., Ph.D.
Director IV, OPRKM

LIB Form 2

LINE ITEM BUDGET (LIB)

Research Title:	**Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education**
Principal Investigator:	**DR. MARIE PAZ E. MORALES**
Implementing Institution:	**Philippine Normal University**
Collaborating Institutions:	**DELA SALLE UNIVERSITY, MANUEL ENVERGA UNIVERSITY, BATANGAS STATE UNIVERSITY, POLYTECHNIC UNIVERSITY OF THE PHILIPPINES, EARIST, WEST VISAYAS STATE UNIVERSITY, RIZAL TECHNOLOGICAL UNIVERSITY, MINDANAO STATE UNIVERSITY-ILIGAN INSTITUTE OF TECHNOLOGY, UP LOS BANOS, WEST VISAYAS STATE UNIVERSITY**
Period Covered	**24 months**
Total Project Cost	**9,000,000.00**

ITEMS/PARTICULARS	AMOUNT
Maintenance and Other Operating Expenses	4,969,819.05
I. Travel/Transportation Expenses (including per diem, on site expenses, data gathering, monitoring, FGD, observation)	3,702,000.00
II. Supplies/Materials (including reproduction of questionnaires and printing & binding of reports and research outputs/results)	397,819.05
III. Communication Expenses (mails, internets, mobile cards, etc.)	170,000.00
IV. Meals and Venue (including research team orientation, meetings, trainings, report writing, presentation of report for critiquing)	700,000.00
V. Others	
Personal Services	3,077,800.00
Sub-Total (MOOE)	**4,969,819.05**
Sub-Total (PS)	**3,077,800.00**
Administrative Costs (5%)	**402,380.95**
Capital Outlay	**550,000.00**
GRAND TOTAL	**9,000,000.00**

SUBMITTED BY:

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator

REVIEWED AND ENDORSED BY:

ESTER B. OGENA, Ph.D.
President

APPROVED BY:

NAPOLEON K. JUANILLO, JR., Ph.D.
Director IV, OPRKM

WORK PLAN

Research Title:	**Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education**
Principal Investigator:	**DR. MARIE PAZ E. MORALES**
Implementing Institution:	**Philippine Normal University**
Collaborating Institutions:	**DELA SALLE UNIVERSITY, MANUEL ENVERGA UNIVERSITY, BATANGAS STATE UNIVERSITY, POLYTECHNIC UNIVERSITY OF THE PHILIPPINES, EARIST, WEST VISAYAS STATE UNIVERSITY, RIZAL TECHNOLOGICAL UNIVERSITY, MINDANAO STATE UNIVERSITY-ILIGAN INSTITUTE OF TECHNOLOGY, UP LOS BANOS, WEST VISAYAS STATE UNIVERSITY**
Period Covered	**24 months**
Total Project Cost	**9,000,000.00**

Activities	Deliverables/Outputs	Due Date
Determine the TPACK competencies of Philippine HEI STEAM Educators	• Indicators of Proficient STEAM Educator • Data base of Philippine STEAM Educators • Level of Competencies of Philippine STEAM Educators	7th month
Develop innovative pedagogical approach for STEAM Education	• An array of best pedagogical approaches for STEAM Education • Pedagogical Model/Framework for Philippine STEAM Education	
Model Technology Integration in STEAM Education	• Technology Integration Model for Philippine STEAM Education	13th month
Develop assessment tools for SEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component	• Assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component	
Localize TPACK Model for Philippine STEAM Education	• Localized TPACK Model for Philippine STEAM Education	16th month
Provide capacity building programs for STEAM Educators	• Capacity Building Program for STEAM Educators	22nd month
Design and develop lesson exemplars	• Lesson Exemplars	
Create Emerging TPACK Model for Philippine STEAM Education and Crafting of Policies for STEAM Education	• Emerging TPACK Model for Philippine STEAM Education and • Policy inputs for Philippine STEAM Education	24th month

SUBMITTED BY:

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator

REVIEWED AND ENDORSED BY:

ESTER B. OGENA, Ph.D.
President

APPROVED BY:

NAPOLEON K. JUANILLO, JR., Ph.D.
Director IV, OPRKM

Form 5

LOGFRAME

Research Title:	**Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education**
Principal Investigator:	**DR. MARIE PAZ E. MORALES**
Implementing Institution:	**Philippine Normal University**
Collaborating Institutions:	**DELA SALLE UNIVERSITY, MANUEL ENVERGA UNIVERSITY, BATANGAS STATE UNIVERSITY, POLYTECHNIC UNIVERSITY OF THE PHILIPPINES, EARIST, WEST VISAYAS STATE UNIVERSITY, RIZAL TECHNOLOGICAL UNIVERSITY, MINDANAO STATE UNIVERSITY-ILIGAN INSTITUTE OF TECHNOLOGY, UP LOS BANOS, WEST VISAYAS STATE UNIVERSITY**
Period Covered	**24 months**
Total Project Cost	**9,000,000.00**

PROJECT SUMMARY	INDICATORS	MEANS OF VERIFICATIONS	ASSUMPTIONS
GOAL: The country's economic growth may highly depend on a STEAM-literate and competent human capital. Economic growth that encompasses the country's wealth in all aspects including biocapacity and environment functionality, biodiversity and ecosystem restoration may be achieved through quality Philippine STEAM Education. This thrust necessitates developing quality STEAM teachers to implement an emerging TPACK Model particularly customized to the Filipino learners.	• Emerging TPACK Model for Philippine STEAM Education • Policy inputs for STEAM Education	• Evaluation of the TPACK Model • Coherence to Philippine Development Plan 2017-2022 framework • Adherence to sustainability goals	Acceptable and sound evaluation by stakeholders
OUTCOME(S): The envisioned outcomes of the study include skilled and competent STEAM Educators who are able to competently implement the localized TPACK model for Philippine STEAM Education. STEAM-influenced Filipino citizens who exhibit authentic awareness of the country's resources for sustainable living	• Capacitated STEAM Educators • Skilled and competent STEAM Educators • Development of Lesson Exemplars	• Evaluation of Capacity Building Program • Level of competence of STEAM Educators • Evaluation of Lesson Exemplars	• At least 85% of the participants rated the Capacity Building program as exemplar • Acceptable validation and reliability indices of STEAM competency indicators • Acceptable validation and reliability indices of evaluation instrument for lesson exemplars. • Availability of experts to validate lesson exemplars
OUTPUT(S): The intended outputs of the study include concrete deliverables in each of the identified study components. All these outputs collectively form the unique outcomes	Indicators of Proficient STEAM Educators	Evaluation of Indicators of Proficient STEAM Educators	Acceptable validation and reliability indices of STEAM competency indicators
	Database of Philippine STEAM Educators	Completeness of database (by region, with representative sample for each category-SUC (L1/L2), LUC, Private-Non-sec, and Private-sec)	Each school participant provided complete enumeration of their STEAM Educators. At least 90% participated in the conduct of the study

leading to the goal of the study.	Identified Level of Competencies of Philippine STEAM Educators	STEAM Educator categories based on Competencies	Each participating school have a STEAM program and credentials of their respective STEAM educators are easily categorized based on the indicators
	Identified innovative and appropriate pedagogical approach for STEAM Education Pedagogical Model/Framework for Philippine STEAM Education	Listing of innovative and appropriate pedagogical practices for STEAM Education and their specific feature Evaluation of the Pedagogical Model/Framework by stakeholders	Participating STEAM Educators are able show multiple, innovative and appropriate pedagogical approaches. Participating STEAM Educators and other stakeholders conduct sound and appropriate evaluation on the pedagogical model/framework
	Technology Integration Model for Philippine STEAM Education	Evaluation of Technology Integration Model for STEAM Education	Participating STEAM Educators are able showcase technology integration in their teaching
	Assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM components	Evaluation of Assessment Tools for STEAM Education by Stakeholders	Participating STEAM Educators are able to provide varied assessment schemes for STEAM Education
	Localized TPACK Model for Philippine STEAM Education	Evaluation of the Localized TPACK Model for Philippine STEAM Education	Acceptable and sound evaluation by stakeholders Complete participation by stakeholders
	Capacity Building Program for STEAM Education	Evaluation of Capacity Building Program for STEAM Education by Stakeholders	At least 85% of the participants rated the Capacity Building program as exemplar
	Lesson Exemplars in STEAM Education	Evaluation of Lesson Exemplars by Experts and End-users	Acceptable validation and reliability indices of STEAM competency indicators Acceptable validation and reliability indices of evaluation instrument for lesson exemplars. Availability of experts to validate lesson exemplars

PROJECT SUMMARY	INDICATORS	MEANS OF VERIFICATIONS	ASSUMPTIONS
ACTIVITIES: The activities provided herewith included a wide array of research methods, approaches and strategies to be able to attain all intended outcomes and to achieve the end goal of the study- developing an emerging TPACK Model for Philippine STEAM Education	Instrument Development • Initial indicators • Validation of "indicators" (using observation and interviews) • Checklist for validation of indicators	• Consistency of inputs (literature review, Professionals Guidelines, Indicators of a Proficient K-12 Science Teacher) • Evaluation by content experts	Experts in Line of TPACK may include content/subject experts as well.
	Survey to develop the database for Philippine STEAM Educators	• Indicators of a Proficient STEAM Educator • Retrieved data sets from accomplished Google forms. • Coded and consolidated data sets	• 100% release of forms (Google forms) for survey • Participants' provides accuracy and authentic responses • 85-90% retrieval of forms
	Determining the level of competencies of Philippine STEAM Educators	Coring framework/design for proficiency of STEAM Educators	
	Identification of best pedagogical practices and development of Pedagogical Model/Framework for Philippine STEAM Educators	• List of best practices of pedagogy and teaching strategies • Evaluation of experts of the Pedagogical Model	90% cooperation by STEAM Educators of participating schools and at least 80% retrieval of survey documents
	Model Technology Integration in STEAM Education	• List of technology integration approaches • Evaluation of experts of the Technology Integration Model	Participating STEAM Educators are able to showcase technology integration in their teaching and are able to provide varied assessment schemes for STEAM Education
	Design and developing assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component	• List of assessment tools • Evaluation of experts of the Assessment Framework or Model	Participating STEAM Educators are able to showcase varied assessment schemes for STEAM Education
	Localizing TPACK Model for Philippine STEAM Educators	Evaluation by Content Experts/Stakeholders	Acceptable evaluation by stakeholders and concrete and accurate suggestions and recommendations by experts
	Capacity Building Program for STEAM Education	Evaluation of Capacity Building Program by Experts and STakeholders	Acceptable evaluation by stakeholders and concrete and accurate suggestions and recommendations by experts
	Developing Lesson Exemplars for STEAM Education	Evaluation of Lesson Exemplars by Experts and End-users	• Acceptable validation and reliability indices of STEAM competency indicators • Acceptable validation and reliability indices of evaluation instrument for lesson exemplars. • Availability of experts to validate lesson exemplars
	• Emerging TPACK Model for Philippine STEAM Education • Policy inputs for STEAM Education	• Evaluation of the TPACK Model • Coherence to Philippine Development Plan 2017-2022 framework • Adherence to sustainability goals	Acceptable and sound evaluation by stakeholders

SUBMITTED BY:

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator

REVIEWED AND ENDORSED BY:

ESTER B. OGENA, Ph.D.
President

APPROVED BY:

NAPOLEON K. JUANILLO, JR., Ph.D.
Director IV, UPRKM

Workplan

Program Title:

Project Title: **Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education**

Total Duration (in months): 24 months Planned Start: Month: June Year: 2017 Planned End: Month: May Year: 2019

			Year 1												Year 2											
Objectives	**Expected Output**	**Activities or Workplan**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Component 1 Assessment of STEAM Educators' TPACK: (Technology, Pedagogy, Assessment, Content) to determine the TPACK competencies of Philippine STEAM Educators	• Indicators of Proficient STEAM Educator • Level of Competencies of Philippine STEAM Educators • Data base of Philippine STEAM Educators	• Determine the TPACK competencies of Philippine HEI STEAM Educators • Develop innovative pedagogical approach for STEAM Education																								
Components 2, 3, 4 1. Deducing and developing innovative pedagogical approach for Philippine STEAM Education 2. Modeling Technology Integration in Philippine STEAM Education 3. Deducing and developing assessment tools for Philippine STEAM Education by looking into the most appropriate forms of assessment for each STEAM component	• An array of best pedagogical approaches for STEAM Education • Pedagogical Model/Framework for Philippine STEAM Education • Technology Integration Model for Philippine STEAM Education • Assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component	• Model Technology Integration in STEAM Education • Develop assessment tools for SEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component																								
Component 5 Localizing TPACK Model for Philippine STEAM Education	• Localized TPACK Model for Philippine STEAM Education	• Localized TPACK Model for Philippine STEAM Education																								
Component 6 1. Providing capacity building programs for Philippine STEAM Education 2. Designing and developing lesson exemplars	• Capacity Building Program for STEAM Educators	• Capacity Building Program for STEAM Educators																								
Component 7 1. Creating an emerging TPACK for Philippine STEAM Education 2. Crafting policy inputs for Philippine STEAM Education	• Emerging TPACK Model for Philippine STEAM Education and Policy inputs for Philippine STEAM Education	• Lesson Exemplars • Emerging TPACK Model for Philippine STEAM Education and • Policy inputs for Philippine STEAM Education																								

Prepared by:

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator
Philippine Normal University

Endorsed by:

ESTER B. OGENA, Ph.D.
President
Philippine Normal University

Approved by:

NAPOLEON M. JUANILLO, JR., Ph.D.
Director IV, OPRKM

LOGICAL FRAMEWORK

Project Title: Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in STEAM Education

Agency: Philippine Normal University

Project Leader: Marie Paz E. Morales

Budget Requested: 9,000,000.00

Narrative Summary	Project Targets - Objectively Verifiable Indicators	Means of Verification	Assumptions
Goal: The major goal of the proposed study is to explore the Technological-Pedagogical-Assessment-Content Knowledge (TPACK) of STEAM Educators aimed towards STEAM quality education. It envisions providing frameworks and models on pedagogy for STEAM, assessment, and technology integration which may dictate lesson exemplars and direct policy makers to attune guidelines and policies related to STEAM Education for quality STEAM manpower of the country.	Emerging TPACK Model for Philippine STEAM Education Policy inputs for STEAM Education	Evaluation of the TPACK Model Coherence to Philippine Development Plan 2017-2022 framework Adherence to sustainability goals	Acceptable and sound evaluation by stakeholders
Purpose: The major purpose of the study is to craft Technological-Pedagogical-Assessment-Content Knowledge (TPACK) Model for STEAM Education	Capacitated STEAM Educators Skilled and competent STEAM Educators Lesson Exemplars	Evaluation of Capacity Building Program Level of competence of STEAM Educators Evaluation of Lesson Exemplars	At least 85% of the participants rated the Capacity Building program as exemplar Acceptable validation and reliability indices of STEAM competency indicators Acceptable validation and reliability indices of evaluation instrument for lesson exemplars. Availability of experts to validate lesson exemplars
Project Outputs:			
Component 1 Assessment of STEAM Educators' TPACK: (Technology, Pedagogy, Assessment, Content) to determine the TPACK competencies of Philippine STEAM Educators	Indicators of Proficient STEAM Educator Level of Competencies of Philippine STEAM Educators Data base of Philippine STEAM Educators	Evaluation of Indicators of Proficient STEAM Educators STEAM Educator categories based on Competencies Completeness of database (by region, with representative sample for each category-SUC (L1/L2), LUC, Private-Non-sec, and Private-sec)	Acceptable validation and reliability indices of STEAM competency indicators Each participating school have a STEAM program and credentials of their respective STEAM educators are easily categorized based on the indicators Each school participant provided complete enumeration of their STEAM Educators. At least 90% participated in the conduct of the study

Components 2, 3, 4 Deducing and developing innovative pedagogical approach for Philippine STEAM Education Modeling Technology Integration in Philippine STEAM Education Deducing and developing assessment tools for Philippine STEAM Education by looking into the most appropriate forms of assessment for each STEAM component	An array of best pedagogical approaches for STEAM Education Pedagogical Model/Framework for Philippine STEAM Education Technology Integration Model for Philippine STEAM Education Assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component	Listing of innovative and appropriate pedagogical practices for STEAM Education and their specific feature Evaluation of the Pedagogical Model/Framework by stakeholders Evaluation of Technology Integration Model for STEAM Education Evaluation of Assessment Tools for STEAM Education by Stakeholders	Participating STEAM Educators are able show multiple, innovative and appropriate pedagogical approaches. Participating STEAM Educators and other stakeholders conduct sound and appropriate evaluation on the pedagogical model/framework Participating STEAM Educators are able showcase technology integration in their teaching Participating STEAM Educators are able to provide varied assessment schemes for STEAM Education
Component 5. Localizing TPACK Model for Philippine STEAM Education	Localized TPACK Model for Philippine STEAM Education	Evaluation of the Localized TPACK Model for Philippine STEAM Education	Acceptable and sound evaluation by stakeholders Complete participation by stakeholders
Component 6 Providing capacity building programs for Philippine STEAM Education Designing and developing lesson exemplars	Capacity Building Program for STEAM Educators	Evaluation of Capacity Building Program for STEAM Education by Stakeholders	At least 85% of the participants rated the Capacity Building program as exemplar
Component 7. Providing inputs for planning and crafting of policies	Emerging TPACK Model for Philippine STEAM Education and Policy inputs for Philippine STEAM Education	Evaluation of the Emerging TPACK Model for Philipine STEAM Education and Policy Inputs for Philippine STEAM Education	At least 85% of the participants rated the Model and Inputs are exemplar
Activities:	**Inputs:**		
Instrument Development	Literature Review Evaluation by Content Experts		
Assessment of STEAM Educators' TPACK to determine the TPACK Level of continuum of Philippine STEAM Educators	Survey results deduced from assessment of TPACK Levels		
Identification of best pedagogical practices and model for technology integration	List of best practices and technology integration approaches Ranking of those in the list		
Design and developing assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM component	Evaluation by Content Experts/Stakeholders forum		
Designing TPACK model, policies, guidelines and framework	Evaluation by Content Experts/Stakeholders forum		
Conducting capacity Building Program for STEAM Education and developing Lesson Exemplars for STEAM Education	Evaluation of Capacity Building Program Development of Lesson Exemplars		
Developing Emerging TPACK Model for Philippine STEAM Education and Policy inputs for Philippine STEAM Education	Emerging TPACK Model for Philippine STEAM Education and Policy inputs for Philippine STEAM Education		

Submitted by:

MARIE PAZ E. MORALES, Ph.D.
Principal Investigator
Philippine Normal University

Approved by:

NAPOLEON K. JUANILLO, JR., Ph.D.
Director IV, OPRKM

THE GRADUATE MENTORING PROGRAM

INVITATION TO THE *Program*

CHED-PNU
TPACK
STEAM EDUCATION

TPACK IN PHILIPPINE STEAM EDUCATION

WANT TO BE PART OF OUR TEAM?

WE'RE LOOKING FOR:

PNU Graduate Students

Preferably doctoral students taking Science Education or Mathematics Education degrees who will be part of our team and be recipients of TPACK research mentoring program. We also accept Master's Students in all areas.

For interested students, please register to Ms. Nica Casilla at PNU Publication Office, Rm.202, Orata Bldg. For further inquiries you may call at 317-1768 local 530 or 09063719733

SCREENING *Criteria*

For Graduate Student Volunteer

1. Preferably **a doctoral student** taking Science Education or Mathematics Education.
2. Is on his or her dissertation writing or **enrolled in a research class.**
3. Has a **good standing** in his or her graduate studies program
4. Willing to **conduct data collection** in places outside the metropolis.
5. Able to **articulate his or herself** in front of university or school officials.
6. For students taking their master's degree:
    a. Preferably specializing in any of the **STEAM disciplines**
    b. Has a **good standing** in his or her graduate studies program.
    c. May be currently **enrolled in a research class** or in his or her **thesis writing stage**
    d. Willing to work as **research assistant** of senior graduate students

TECHNOLOGICAL PEDAGOGICAL ASSESSMENT CONTENT KNOWLEDGE (TPACK) IN PHILIPPINE STEAM EDUCATION
(02) 317-1768 local 530
0906-3719733 / 0923-9324884 (Nica A. Casilla, Technical Staff)
steam@pnu.edu.ph
https://www.facebook.com/TPACK.CHED/

_____, 2018

NAME
Regional Director
DEPED Region _____

Thru: **NAME**
Superintendent
Division of _____

NAME
School Head/Principal
School

Dear Dr. _____,

Greetings!

Our Commission on Higher Education (CHED)-commissioned research titled, ***"Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education,"*** officially commenced this August 2017 (please refer to attached Notice to Proceed). The project intends to map STEAM Education competencies and design the emerging TPACK framework unique to the Philippine Higher Education system. The major deliverables of this project are our contribution to the country's knowledge-based economy. Our core research team has already developed the Philippine STEAM Proficiency Indicators. In all the seven components of the entire project, the research team needs to intensively communicate with 330 Higher Education Institutions (HEIs) for a four-stage survey. Additionally, quantitative data collection through survey coupled with qualitative data collection through interviews, focus-group-discussions, and classroom observations (inclusive of video and audio recording) will be conducted with the 33 focus HEIs.

Furthermore, the project intends to serve as platform for Research Mentoring Program for our graduate students to strengthen their research skills and be contributory to the country's knowledge economy. Relative thereto, we request that you allow ____**(Name of Graduate Student)**____, a MAEd/PhD student of ___**(School Affiliation)**__ to join our TEAM in the conduct of class observations and interviews, which has already commenced this February 2018.

We anticipate your acceptance and we look forward to this research pursuit with much fervor. Kindly email the COLLABORATING AGENCY'S ACCEPTANCE FORM if you accept this invitation, to the Principal Investigator, Dr. Marie Paz E. Morales at *morales.mpe@pnu.edu.ph* or *steam@pnu.edu.ph*. Herewith also is the executive summary of the research study, for your perusal.

Thank you and we hope for more collaborative research projects with you.

Very truly yours,

DR. MA. ANTOINETTE C. MONTEALEGRE
OIC, Office of the President

COLLABORATING INSTITUTION'S/ AGENCY'S ACCEPTANCE FORM

This is to express that the _____ whose
Institution/ Agency
Representative/Field Researcher is _____ hereby accepts
Graduate Student
the invitation to be part of the research project titled ,***"Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education"*** commissioned by the CHED to the Philippine Normal University.

_____
Institution/ Agency

_____
DepEd Region ____, Director

_____
Division of _____, Superintendent

_____
School Head/Principal

_____
Graduate Student

_____
Date Accomplished

_____
Contact Numbers and Email Address of
the Graduate Student

TPACK in Philippine STEAM Education
PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education
Manila

Commitment Form

This **Commitment Form (the "Agreement")** is made and effective on _____ at the Philippine Normal University, Taft Avenue Manila, Philippines.

BETWEEN: _____ (a "Graduate Student" for Research Mentoring Program of TPACK), a volunteer researcher of TPACK in Philippine STEAM Education, with its affiliation, _____ located at:

_____

_____

AND: **Philippine Normal University – Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education**, a CHED-funded Research Project which has commenced on August 2017, with its office located at:

Room 202, Pedro T. Orata Hall
Taft Avenue, Manila, 1000 Philippines

WHEREAS, the parties agree to certain terms on services to be performed by the Graduate Student for the abovementioned project;

THEREFORE, for and in consideration of the foregoing and the stipulations herein set forth, the parties hereby agree on the following:

I. TERMS:

The **Commitment Form** is to serve as Graduate Student's written authorization to perform services for the research project titled, ***Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education***. Author's signature also indicates understanding of terms and liability to the research project for said services.

II. DESCRIPTION OF SERVICES:

1. The **Graduate Student(s)** is/are voluntarily participating in this project, thus services he/she will be rendering are not subject to honorarium.
2. The **Graduate Student(s)** is/are expected to actively participate in this project from _____ to _____
3. The **Graduate Student(s)** is/are expected to conduct data gathering (i.e., classroom observations and interview sessions) in the remaining HEIs out of the 33 target HEIs subject to data collection.
4. The **Graduate Student(s)** is/are expected to do and complete the required tasks for this mentoring program such as, but not limited to accomplishing travel report, transcribing, coding, analyzing set of data, and attending meetings and workshops if required.

5. Submit complete liquidation report of the expenses that will be incurred in the future data gathering.
6. In the event the **Graduate Student(s)** fail(s) to complete the required tasks within the approved timeframe as a result of circumstances beyond his/her control, an extension is only allowed upon the approval of the Principal Investigator.

III. THE PROJECT

1. Provides assistance in terms of materials and equipment.
2. Conducts applicable trainings.
3. Shoulders all expenses that will incur in the identified travel for this project's data gathering.
4. Provides expert assistance for matters related to personal & academic endeavour of the recipient.
5. Provides opportunities for research collaboration.

IN WITNESS WHEREOF, the parties hereto have signed this Contract this _____ 2018 in the City of Manila.

_____	**MARIE PAZ E. MORALES, Ph.D.**
Graduate Student	Principal Investigator
_____	_____
Date	Date

Mentoring PAR-APRROACH

Participatory Action Research

Participatory Action Research directed the Graduate Mentoring Program of the CHED-funded research titled, TPACK in Philippine Education. It seeks to perpetuate the concept of collaborative practice and collaborative action to mentor graduate students on research through apprenticeship. Apprenticeship with several capability building defined the mentoring processes exuded by the core research team to train the first set of eight volunteer graduate students on the following research processes: protocols of class observation and interview, government processes related to financial liquidation, transcription of interview and observation and coding mechanisms and systems. Though the project's intentions are novel and with promising results, the core team may not be able to repeat the same mentoring process to as much graduate students as possible, resulting to advocacy to the collaborative aspect of apprenticeship. The aim is to reach out to as many graduate students as possible, and be able to inculcate the culture of research and the concept of reflective practice. As such, Action Research (AR) principles sneaked in to perpetuate developing teacher-researchers.

In the Philippines, the education system perpetuates action research to help teachers make decisions about their classes; improve classroom or school practice making them reflective practitioners; encourage teachers to see themselves as producers of knowledge; and allow them to clarify, elaborate, and modify theories that inform them (Mills, 2011, p.19).

These AR characteristics codified how research may inform and improve teaching and learning practice and how practice may inform research that highlights systematic inquiry based on ongoing reflection. Classroom-based and practical action research may well document these reflections and insights on theory-driven action and action-driven theory. AR in a collaborative perspective, better known as PAR, may bring about significant changes to important education domains, such as school policies, curricular reform, and education in general. Participatory Action Research is seen my many researchers to benefit the education field by fostering collaborative perspective characteristics of action research. PAR "seeks to bring together action and reflection, theory and practice, in participation with others, in pursuit of practical solutions to issues of pressing concerns to people, and more generally the flourishing of the individual and their communities (Reason & Bradbury, 2001, p.1).

PAR features such equitable participation, empowerment, co-learning for capacity building and system change, and has a commitment to promote sustainability through long-term collaboration (Blair & Minkle, 2009; Israel, Schulz, Parker, Becker, Allen, & Guzman, 2008; Minkler, 2005) significantly provided the guiding framework in a collaborative apprenticeship for the graduate research mentoring program. Each of the first eight graduate volunteers who were trained on the aforementioned research processes was assigned certain number of new recruits of graduate students for the mentoring program. The first set of eight refers to the senior batch and the next trainor for their specific research cell. In a way, these eight seniors will be able to transfer all their knowledge gained in the mentoring program and be able to successfully provide the new recruits with sufficient knowledge on research culture creating them researchers and reflective practitioners as well—the main goal of the mentoring program.

TPACK Instruments

- Classroom Observation Protocol
- Classroom Observation Rating Scale
- Classroom Observation Notes
- Interview Guides
- Pre-Observation Questions
- Lesson or Session Guide
- Technology & Assessment Checklist

CLASSROOM OBSERVATION PROTOCOL FOR STEAM

Philippine Normal University

_____

Name of Teacher Observed

_____

Subject/Course

In the country's journey to improve the quality of life of Filipinos and to establish high economic growth, aspects of science, technology, engineering, agriculture and mathematics (STEAM) may highlight skills to achieve our goals. In fact, the adherence of the country to STEAM highlights the "AMBISYONNATIN 2040," themed as, "*Matatag, Maginhawa, at Panatag na Buhay* (Philippine Development Plan [PDP], 2017)." The country believed that the 2040 goal may be concretized through the three priority areas of the crafted Philippine Development Plan which includes: 1) *malasakit* (enhancing social fabric); 2) *pagbabago* (reducing inequality); and 3) *patuloy na pagunlad* (increasing growth potential). These three priority areas emphasize among others promotion and awareness of Philippine culture, acceleration of human capital development, promotion of technology, and stimulation of innovation. Apparently, the make-up of the PDP framework puts STEAM as among the cores to achieving the 2040 goals. Thus, necessitates cross-cutting strategies, which may be derived from quality STEAM education for the Filipinos. Relative thereto, our study aims to craft an Emerging Technological-Pedagogical-Assessment-Content Knowledge (TPACK) Model for Philippine STEAM Education and to provide inputs to policies for Philippine STEAM Education.

The **STEAM Classroom Observation Protocol** is a tool designed to help educators and researchers derive or deduce important information from STEAM educators significant to inform practices and policies in Philippine STEAM Education.

The Protocol contains the following instruments:

STEAM Classroom Observation Rating Scale – This instrument is a 6-point Likert scale sectioned into basic descriptive information and instruction. The rating scale determines the extent of visibility of the identified traits, characteristics, processes and products relative to content, knowledge and pedagogy; the learning pedagogy; and the diversity of learners. It is not recommended that this worksheet be used by teachers to rate classroom practice of their peers or for use by administrators to evaluate teacher performance. The worksheet is intended to be used in conjunction with the other instruments and protocol included in this set.

Classroom Observation Notes – This instrument includes questions clustered into the dimensions of TPACK. The observation notes is designed for use by researchers who would want to collect qualitative data on STEAM Education anchored to the TPACK framework It is not recommended that this worksheet be used by teachers to rate classroom practice of their peers or for use by administrators to evaluate teacher performance.

TPACK Interview Protocol—This instrument includes sets of questions intended to guide the researcher or evaluator in the collection of qualitative observations and extrapolation of meanings and explanations that will be used augment all areas of concern not completely provided by the two other instruments. Themes highlighted in this interview guide include: Teacher's scientific attitude and pedagogical reputation, inquiry-based learning and teaching, inclusive and relevant STEAM education, classroom management, attainment of learning outcomes, knowledge of STEAM and STEAM related fields.

Technology Integration Checklist – This checklist can be used to document the nature of the teacher and the student's use of technology in the classroom.

Assessment Checklist- This instrument includes items on various techniques a STEAM educator utilizes to assess the performance of the student.

Possible Uses

The table below describes several possible uses of this tool. It also identifies which forms are most appropriate for each use:

Possible Use	STEAM Classroom Observation Rating Scale	Classroom Observation Notes	TPACK Interview Protocol	Technology Integration Checklist	Assessment Checklist
In-service Professional Development: In this case the tools are used by teachers or administrators to collect data on the knowledge and practice of in-service teachers regarding STEAM Education. Data collected can serve as baseline for analysis and development of framework leading to In-service trainings to enhance Philippine STEAM Education.	✔	✔	✔	✔	✔
Pre-service Professional Development: Teacher preparation programs would find the tool useful to help pre-service teachers to understand how to enact quality STEAM Education. What different traits and aspects of classroom such as pedagogy, assessment and classroom management are needed to practice quality STEAM Education?	✔	✔	✔	✔	✔
Data Collection for Research of Evaluation: Researchers or evaluators would use the tool to formally collect data. In this case the tool would need to be used under more rigorous standards by observers who have been trained on the use of the tool and who have a deep understanding of STEAM instructional practice.	✔	✔	✔	✔	✔

Some Tips in Classroom Observation

Below are several tips to take into consideration when collecting classroom observation data.

- Stick on to all normal protocol when observing classes that relate to your role. This may include obtaining permission from the administrator and teacher, signing in when you visit the school, obtaining certificate of appearance if you are from a government school.

- Meet briefly with the teacher of the class you plan to observe prior to observation and ask the pre-observation questions (checklist) provided on the instrument pack in order to gather information about the lesson and the classroom context.

- It is important that the lesson observed be a typical lesson. Therefore, do not indicate to the teacher what it is that you are looking for because then the teacher will feel obligated to show you that and will adjust their lesson accordingly. Do not share any of the worksheets or protocols with the teacher.

- You must be able to observe at least several classes of the teacher to get a feel of the lesson and the education quality particularly on pedagogy, assessment, technology integration and content knowledge of the teacher.

- During each observation, take notes on separate paper. Avoid interactions with students and do not become a teaching assistant by helping students with the activity. It may be necessary to quietly ask a few students a question or two to check their understanding. Focus your observation on what the students are doing and saying looking and on the teacher.

- After the lesson is finished, ask the teacher the post-observations questions on the worksheet to get a better understanding of the lesson from the teacher's perspective.

- Ask also for some students for the student interview or focus-group-discussion (if necessary).

- In using the ***STEAM Observation Rating Scale*** check the number which you think is the appropriate rating during observation. The "don't know" is usually intended for items which you are not really familiar with regards the teacher concern or have no way of finding out. The "N/A" is chosen for items not connected or related to the class being observed.

STEAM Classroom Observation Rating Scale

Observation Date: _____ Time Start: _____ Time End: _____

School:_____ Address: _____

Teacher: _____

PART ONE: THE LESSON

SECTION A. BASIC DESCRIPTIVE INFORMATION

1. Teacher Gender: _____:Male _____:Female
2. Subject Observed:_____
3. Level: _____
4. Program:_____
5. Course Title (if applicable): _____
6. Class Period (if applicable): _____
7. Number of Students: _____:Male _____:Female

SECTION B: INSTRUCTION

D1. Content, Knowledge and Pedagogy	N/A	Not at all				To a great extent
	(0)	(1)	(2)	(3)	(4)	(5)
1. Possesses content knowledge on STEAM (Science, Technology, Engineering, Agriculture, and Mathematics).						
2. Demonstrates content knowledge on core STEAM courses.						
3. Demonstrates content knowledge on STEAM-related fields (i.e., research, language and communication).						

4. Demonstrates STEAM-related laboratory/clinical skills.						
5. Possesses knowledge on related industry/community as service providers.						
6. Exhibits knowledge on STEAM fields (content and skills) responsive to national goals and global concerns.						
7. Plans, conducts, and disseminates STEAM-related research.						
8. Designs, improves, innovates, and supervises basic to advance systems and/or procedures as solutions to local and global problems within realistic constraints.						
9. Utilizes research outputs to enhance professional practice and to address national and global concerns.						
10. Develops /Improvises new technology (software, laboratory equipment, and teaching materials) using locally available resources to advance effective and efficient practice of the profession.						
11. Uses modern statistical and computing techniques and tools in predicting future trends and processes of STEAM.						
12. Familiarizes with database relevant to the STEAM profession.						
13. Uses advanced and research-based techniques and tools in teaching STEAM content knowledge.						
14. Develops models of STEAM knowledge and processes.						
15. Communicates effectively across multiple platforms, both oral and written, especially in the English language.						
16. Seeks out information on subject related research, e.g., via journals or by attending conferences.						
17. Facilitates development of reflective and critical thinking among students.						
18. Promotes inquiry attitude through questioning.						
19. Facilitates active classroom discussion using inquiry learning strategies (project-based, problem-based, and product-based).						
20. Allows flexible channels of communication to get across students of different abilities and comprehension skills and even allows occasional use of mother tongue to help express themselves or their answers better (then translate them to a common language for everyone to appreciate and learn from).						
D2. Learning Environment						
21. Ensures a safe STEAM learning environment (free from fire hazards, safe electrical wiring, conforms to building code).						
22. Observes precautionary measures in the laboratory rooms and classrooms (fire extinguishers, fire force) alarm systems, and campus security.						
23. Facilitates ethical use of online resources.						
24. Promotes working effectively in multidisciplinary and multi-cultural teams.						

25. Exhibits capability to facilitate large classes.						
26. Manages proper and fair implementation of Problem/Project-based Learning activities.						
27. Promotes proper care and handling of laboratory instruments, tools, equipment, online systems, virtual laboratories, and software.						
28. Promotes seamless transition of topics and establishes relevant relationship of concepts.						
29. Provides students with activities and classroom situations where they can implement independent individual or collaborative group work when suitable.						
30. Promotes student engagement and quality performance in class activities such as during group work, projects, and other activities.						
31. Utilizes teaching strategies suited to diverse learners.						
32. Monitors each student by establishing eye contact, walking around the area, being aware of what's happening in the class during sessions, site visits, field trips, tours, and other supervised visits.						
33. Models various scientific attitudes and STEAM professional traits.						
34. Promotes the concept of voluntary service by making students carry out classroom-related duties (e.g., monitoring cleanliness and orderliness in the classroom).						
35. Promotes proactive classroom management and exhibits capability of handling untoward behavior with fairness and prudence.						
D3. Diversity of Learners						
36. Develops instructional plan appropriate to the identified learners.						
37. Facilitates lessons and activities that are suited to the students' interests and individual differences and do not discriminate any cultural groups and are sensitive to students' needs.						
38. Arranges opportunities for students to learn by allowing them to form varied group structures (solo, pair, groups, and teams).						
39. Develops gender-sensitive instructional materials.						
40. Takes into consideration the cultural, social, and emotional differences among students.						
41. Prepares materials and lessons appropriate to specific learning capability.						
42. Offers additional classroom-based sessions (within official hours) to improve learning.						
43. Designs, plans, and implements working and support groups to provide help to learners in difficult circumstances.						
44. Facilitates peer learning to support other students cognitively and affectively.						

45. Is open to invitations for team teaching to provide supplemental learning from each member of the team for more holistic student learning.						
46. Listens skillfully, reasonably, and patiently to his or her students during consultation.						
47. Develops different learning paths to respond to the student differences brought about by culture and ethnicity.						
48. Being aware of norms, cultures, and traditions so as not to cause discrimination in the delivery of lessons.						

TPACK Classroom Observation Notes

This instrument includes questions clustered into the dimensions of TPACK. The observation notes is designed for use by researchers who would want to collect qualitative data on STEAM Education anchored to the TPACK framework It is not recommended that this worksheet be used by teachers to rate classroom practice of their peers or for use by administrators to evaluate teacher performance.

Dimensions	Items	Observer's Field Notes
CK	What content/topic does the teacher intend to teach?	Does the teacher possess sufficient understanding of the topic being discussed? **1. enumerate indicators of mastery of subject matter (see examples below)** ☐ Uses Department's Scope and Sequence documents as appropriate ☐ Uses relevant curriculum documents specific to year/subject level ☐ Keeps abreast of new ideas and techniques through professional reading ☐ Integrates knowledge and skills in content area **(Observer may enumerate as many indicators as possible)** **2. provide details of observed teacher's misconceptions (if any)** **3. take note of the provided real-life examples (if there are any) that are inappropriate to the concept being advanced**

PK	**Intended Strategy (Based on the Session Plan)**	**Is the teacher skillful in implementing the teaching strategy/ies used?** 1. describe the teaching strategy/ies used 2. provide indicators of effective (or ineffective) use of specific strategy (e.g. student engagement, student participation, productive work of students, smooth flow of laboratory work)
TK	**Intended tools for teaching and learning (based on session plan)**	**Is the teacher adept in using learning tools?** 1. enumerate/describe the teaching materials/tools used (e.g. specific softwares, equipment, gadgets, improvised material, laboratory materials)

☐	CB	(Chalkboard/whiteboard/SMART board)
☐	OP	(Overhead Projector/Opaque Projector)
☐	PP	(PowerPoint or other digital slides)
☐	CL	(Clicker Response System)
☐	D	(Demonstration Equipment, e.g. could include Chemistry demonstrations of reactions, physics demonstrations of motion or any other material being used for the demonstration of a process or phenomenon)
☐	DT	(Digital Tablet or any technology where the instructor can actively write on a document cameras as well as software on a laptop that allows for writing on PDF files)
☐	M	(Movie, documentary, video clips, or YouTube videos)
☐	Si	(Simulations that can be digital applets or web-based simulations and animations)
☐	WEB	(Website which includes instructor interaction with course website or other online resource other than YouTube videos. This can also include using website for student responses to questions in lieu of clickers)
☐	LDEM	(Use of equipment (e.g. lab equipment, computer simulation to convey course content)
☐	IAE	(Improvised apparatus or equipment)
☐	LA	(Learning applications, e.g. Kahoot)

		2. provide indicators of effective (or ineffective) use of learning tools
PCK	1. Did the teacher implement the lesson using the intended pedagogy? 2. Does the teacher manifest deep understanding of both the content and the strategy during the session? 3. Did the teacher fluently and fluidly conduct the lesson using the intended strategy? 4. Did the teacher resort to "on the spot" changes in the intended strategy to accommodate students' needs? 5. Did the teacher	**Is the strategy used appropriate to the topic being discussed?** 1. List down indicators where the teaching strategy used promotes students' understanding of the subject matter ☐ Introductory part of the lesson ☐ Activity proper ☐ Lecture proper ☐ Discussion Proper **(Provide additional list if necessary)**

	extract high student engagement during the session?	
TCK	**Did the teacher use digital tools in class?**	**Are the teaching tools used appropriate to the topic being discussed?** 1. List down indicators where the teaching tools used promotes students' understanding of the subject matter
TPK	**How did the teacher use the intended technology to extract the desired learning outcomes and experiences?**	**Are the teaching tools used appropriate to the teaching strategy/ies** employed? 1. List down indicators where the teaching tools used enhance the effectiveness of the teaching strategy
TPACK	**Assessment of TPACK Integration**	
	Session Plan	Actual Session

Interview Questions

Theme: Teacher's Scientific Attitude and Pedagogical Reputation		
Main Question	***(For STEAM Teachers)*** *What scientific characteristics do you possess that you want to model to your learners?* ***(For STEAM Teacher Education only)*** *What scientific and pedagogical characteristics do you possess that you want to model to your learners?*	***(For School Heads, College Deans, and Other Officials)*** *How would you assess the scientific and pedagogical characteristics that your STEAM faculty model to STEAM learners?*
Probing Points	***(Please customize the questions to the discipline of the interviewee)*** 1. How do you emphasize in your learning and teaching processes that STEAM should benefit the society (e.g. school, community)? 2. How do you exhibit dedication and commitment to the realization of the goals of the STEAM discipline? 3. How do you promote academic integrity in teaching STEAM? a. ethical conduct as a professional such as but not limited to the ethical treatment of shared information and knowledge (e.g. online resources) b. ethical use of assessment results and student data 4. How do you establish (or maintain) a reputation as a "good STEAM teacher"? 5. Describe your research activities in the past five years (in terms of): a. efforts to familiarize with sources of information regarding STEAM b. researches conducted c. research results that were utilized for policies and decisions and predicting trends in STEAM and STEAM education d. technologies developed from one's research results	1. What are your indicators that your STEAM faculty emphasize in their teaching processes that STEAM should benefit the society (e.g. school, community)? 2. How do you assess the dedication and commitment of your STEM Faculty in the realization of the goals of the STEAM discipline? 3. How do you guide your STEAM faculty in maintaining a reputation as a "good STEAM teacher and promoting academic integrity in teaching STEAM? c. ethical conduct as a professional such as but not limited to the ethical treatment of shared information and knowledge (e.g. online resources) d. ethical use of assessment results and student data 4. As an administrator, how do you manage negative feedback of students to your STEAM teachers? 5. Describe the research activities you facilitate in the past five years (in terms of): a. efforts to familiarize with sources of information regarding STEAM b. researches conducted c. research results that were utilized for policies and decisions and predicting trends in STEAM and STEAM education technologies developed from one's research results

Theme: Inquiry-Based Learning and Teaching		
Main Question	***(For STEAM Teachers)*** *Do you believe that inquiry-based learning and teaching approach is appropriate in the teaching of STEAM?* ***(Please customize the questions to the discipline of the interviewee)***	***(For School Heads, College Deans, and Other Officials)*** *Do you believe and encourage your faculty to advocate inquiry-based learning and teaching approach is appropriate in the teaching of STEAM?*
Probing Points	1. How do you promote critical and reflective thinking in class? 2. How do you structure your questions during class discussion to maximize learning? 3. How do you promote active and collaborative learning? 4. How do you promote seamless transition of lessons and establish connection of concepts?	1. What are your ways and means to help your STEAM faculty promote critical and reflective thinking in class? 2. Do you encourage your faculty to attend trainings on assessment of learning, active and collaborative learning and contextual learning? In what way do you extent support? Do you allow all request for trainings, seminars and attendance to conferences? Why or Why not? 3. If your school sponsored the STEAM faculty in conferences and seminars, how do you facilitate successful knowledge sharing?
Theme: Inclusive and Relevant STEAM Education		
Main Question	***(For STEAM Teachers)*** *How do you ensure the relevance of STEAM to the learners?* ***(Please customize the questions to the discipline of the interviewee)***	***(For School Heads, College Deans, and Other Officials)*** *How do you ensure that your STEAM faculty discuss and integrate the relevance of STEAM in their lessons?*
Probing Points	1. How do you maintain the relevance of STEAM content and processes to the learners and the community? a. relevance to local needs (issues and problems) and contexts b. relevance to global needs (issues and problems) and contexts 2. Do you think a teacher should put into consideration the different types and backgrounds of learners in his learning plans (i.e. teaching strategies, language, gender, culture)? Why? Any relevant example/situation from your experience? 3. Do you utilize the appropriate tools/technology in teaching STEAM concepts? How do you integrate these tools in the lesson delivery?	1. What management styles do you practice to sustain STEAM faculty's integration of relevance of STEAM content and processes to the learners and the community? a. relevance to local needs (issues and problems) and contexts b. relevance to global needs (issues and problems) and contexts 2. What administrative support do you extend to your STEAM faculty for them to be able to utilize the appropriate tools/technology in teaching STEAM concepts? 3. What are the strengths and weaknesses of the planned and implemented support to your STEAM faculty?
Theme: Classroom Management		
Main Question	***(For STEAM Teachers)*** *How do you promote safe learning environment?*	***(For School Heads, College Deans, and Other Officials)*** *How do you ensure safe learning environment?*

Probing Points	1. How do you ensure safety in STEAM activities and processes such as laboratory works? 2. How do you monitor student activities and engagement during your class? 3. Do you think student consultation is helpful? Why? Any relevant experience/situation? 4. How do you assign and monitor student responsibilities?	1. How do you ensure safety in STEAM activities and processes such as laboratory works? 2. How do you monitor STEAM classes and their activities? 3. Do you require your STEAM teachers to conduct student consultation? Do you think this is helpful? Why?
Theme: Attainment of Learning Outcomes		
Main Question	***(For STEAM Teachers)*** *How you promote awareness and attainment of learning outcomes?*	***(For School Heads, College Deans, and Other Officials)*** *How you promote awareness and attainment of learning outcomes?*
Probing Points	1. How do you ensure that your learning outcomes are clear to your learners? 2. How do you keep your learning outcomes apparent in your teaching strategies? 3. Do you think it is helpful to engage your learner in formulating your learning outcomes? 4. How do results of your assessment help you plan for your classes? 5. How do you sustain the knowledge in the prescribed curriculum and competencies? 6. How do you select your assessment tools? Do you follow a criteria in the selection of what technology to integrate in a lesson?	1. How do you ensure that the learning outcomes are clearly communicated by your STEAM faculty to the learners? 2. What are the major indicators that you use to determine if STEAM teachers visibly include the learning outcomes in their teaching strategies? 3. Do you advocate involving STEAM learners in the process of formulating the learning outcomes? 4. What scheme (departmental, or school-based) do you implement in using assessment and feedback system to inform improvement of practice and curriculum? What do you think are the probable strengths and weaknesses of this scheme? 5. Do you extend help to your STEAM teachers in selecting your assessment tools?
Theme: Knowledge of STEAM and STEAM related fields		
Main Question	***(For STEAM Teachers)*** *On a scale of 1 to 10 (10 being the highest and 1 being the lowest), how do you rate your content knowledge on STEAM?*	***(For School Heads, College Deans, and Other Officials)*** *On a scale of 1 to 10 (10 being the highest and 1 being the lowest), how do you rate your STEAM teachers' content knowledge on STEAM?*
Probing Points	1. Do you think you have sufficient preparations (in terms of content) to teach STEAM courses? 2. What other fields do you think are necessary in learning and teaching STEAM? How do you rate your content knowledge in each of these fields?	1. Do you think your STEAM teachers have sufficient preparations (in terms of content) to teach STEAM courses? 2. What other fields do you think are necessary in learning and teaching STEAM? How do you rate your STEAM teachers' content knowledge in each of these fields?

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PRE-OBSERVATION QUESTIONS

Observation Date: _____ Time Start: _____ Time End: _____

School:_____

Teacher: _____

Subject to be Observed: _____

Level: _____

Course Title (if applicable): _____

In the pre-observation session, the researcher-observer should obtain information from the pre-identified STEAM Educator concerning his or her class goals, students, and particular teaching style. An interview schedule provides a brief, structured way of obtaining such information and includes the following questions:

1. Briefly, what will be happening in the class I will observe?

2. What is your goal for the class? What do you hope students will gain from this session?

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3. What do you expect students to be doing in class to reach stated goals?

4. What can I expect you to be doing in class? What role will you take? What teaching methods will you use?

5. What have students been asked to do to prepare for this class?

6. What was done in earlier classes to lead up to this one?

7. Will this class be generally typical of your teaching? If not, what will be different?

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8. Is there anything in particular that you would like me to focus on during the class?

Details such as the date for the classroom observation, use of a particular observation form or method, and seating arrangement for the colleague observer should also be decided by mutual agreement at this session.

***

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Subject: _____ **Date of Observation:** _____
No. of Students: _____ **Time of Observation:** _____

Session Guide	
Learning Goals/Objectives	*(Please list all learning objectives for the session observation)*
Subject Matter	**Lesson** *(Please list the topic(s) for the session observation)*:
	Concepts *(Please list all concepts that you intend your students to learn for the session observation)*:
	Skills *(Please list all skills that you intend your students to learn for the session observation)*:
	Values *(Please list all values that you intend your students to learn for the session observation)*:
	Materials/Tools *(Please list all tools and materials that you plan to use for the session observation)*:
	References:

Learning Activities	**Major Teaching Strategies** *(Please list all teaching strategies that you plan to use for the session observation):*
	Routine Activities:
	Lesson Proper: *(Please sequence in bullet or number format how you will deliver your lesson)*
Evaluation	*Please indicate here (in numbered or bullet form) how will you gauge if your students learned all intended concepts for the session:*

Prepared by:

_____

(Signature over printed name)

_____

(Date)

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Dear STEAM Teacher,

This Technology Integration Checklist can be used to document the nature of you and your students' use of technology in the classroom. We request that you take time in identifying which among the identified list you use in teaching STEAM courses.

Thank you very much.

The PNU Research TEAM

TECHNOLOGY INTEGRATION CHECKLIST

Name: _____

Date: _____

Specific Area (Please check): ☐ Science ☐ Technology ☐ Engineering ☐ Agriculture ☐ Math

Directions: Please put a check mark on the technology you are integrating or you have integrated in your lessons.

☐	CB	(Chalkboard/whiteboard/SMART board)
☐	OP	(Overhead Projector/Opaque Projector)
☐	PP	(PowerPoint or other digital slides)
☐	CL	(Clicker Response System)
☐	D	(Demonstration Equipment, e.g. could include Chemistry demonstrations of reactions, physics demonstrations of motion or any other material being used for the demonstration of a process or phenomenon)
☐	DT	(Digital Tablet or any technology where the instructor can actively write on a document cameras as well as software on a laptop that allows for writing on PDF files)
☐	M	(Movie, documentary, video clips, or YouTube videos)
☐	Si	(Simulations that can be digital applets or web-based simulations and animations)
☐	WEB	(Website which includes instructor interaction with course website or other online resource other than YouTube videos. This can also include using website for student responses to questions in lieu of clickers)
☐	LDEM	(Use of equipment (e.g. lab equipment, computer simulation to convey course content)
☐	IAE	(Improvised apparatus or equipment)
☐	LA	(Learning applications, e.g. Kahoot)

Questions:

1. What are your basic intentions of using or integrating these technologies?

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2. What were your major considerations in choosing or integrating these technologies?

3. When and what part of the lesson do you use these identified technologies?

Specific Technology	Lesson

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Dear STEAM Teacher,

This checklist is aimed at determining the various techniques a STEAM Educator utilizes to assess the performance of the students. We request that you take time in identifying which among in the list you use in teaching STEAM courses.

Thank you very much.

The PNU Research TEAM

ASSESSMENT CHECKLIST

Name: _____

Date: _____

Specific Area (Please check): ☐ Science ☐ Technology ☐ Engineering ☐ Agriculture ☐ Math

Directions: Please put a check mark in the box ☐ which corresponds to the technique/s you are using to assess performance of your students.

- ☐ Quizzes (print/online)
- ☐ Long Test (e.g. Mid-term, Final examination)
- ☐ Course Homework
- ☐ Class Seatwork
- ☐ Class Discussion Participation/Recitation
- ☐ Research Project
- ☐ Case Study Analysis
- ☐ Observation of Field work
- ☐ Practical Test (e.g. actual demonstration, actual assembly)
- ☐ Portfolios (working, documentary, showcase)
- ☐ Products
- ☐ Journal (e.g. reflective)
- ☐ Assessment tools which are not in the list

_____ _____ _____

_____ _____ _____

_____ _____ _____

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The National Center for Teacher Education
Manila

Guidelines on the Implementation of Components 2 to 4

Components 2 to 4 of our CHED-Funded project focus on the development of pedagogical and technology integration models, and exemplar assessment tools applicable for Philippine STEAM education. Our major deliverables include: 1) an array of best pedagogical approaches for STEAM Education; 2) pedagogical model/framework for Philippine STEAM education; 3) technology integration model for Philippine STEAM education; and 4) assessment tools for STEAM Education by looking into the most appropriate forms of assessment for each of the STEAM components. Below is our general guide in the conduct of the aforecited components:

1. Components 2 to 4 will commence on the last week of February and will run for six months (February to August 2018).

2. Each Research collaborator is assigned to at most 4 HEIs for the conduct of components 2 to 4.

3. **Research collaborators** will be accompanied by a **volunteer graduate student/research staff** from the Lead University.

4. Prior to the scheduled conduct of the processes for components 2 to 4, the Lead University will send the following documents:
    a. General Guide for the conduct of component 2 to 4
    b. Terms of Reference of Research Collaborators for Components 2 to 4
    c. Terms of Reference of HEI representatives for Components 2 to 4
    d. Informed Consent
    e. Accomplished Reply Slip
    f. Instruments (Classroom Observation Protocol, Interview Guides)
    g. Certificate of Appearance
    h. Line-Item-Budget for the assigned HEIs
    i. Acknowledgement receipts
    j. Attendance sheets
    k. Airline tickets

5. **Research Collaborators** should seek their respective travel authority from their respective institutions (PNU to provide a copy of MOA with CHED and MOA with collaborating institution)

6. Travel authority by the members of the core research team will be processed by the administrative staffs (Malou and Bel) and technical staff (Nica).

7. Prior communications to representatives of the HEIs will be done by our technical staff (Nica).

8. Nica will also endorse all contact information of the HEI representative (Field Researcher) to the Research Collaborators and the members of the Core Research group.

9. **Research Collaborators** shall facilitate and preside formal meetings with the Field Researcher for the smooth conduct of classroom observations and interviews with the Dean, Associate Dean/Department Chair and selected STEAM faculty members (may be the one observed or may be not observed) of the participating HEIs.
    a. Agenda for the formal meeting
        i. ***Retrieval of survey forms and Lesson/ Session Guide(pre-visit survey)***
        ii. ***Confirmation of schedules as reflected in the submitted accomplished reply slip***
        iii. ***Finalization of schedules including courtesy calls, snack or meals with interviewees***
        iv. ***Introduction of volunteer graduate student/research staff to the Field Researcher***
        v. ***Delineation of the tasks of the Field Researcher during the school visit and the task of the volunteer graduate student/research staff***

10. All classroom observations are videotaped and all interviews are audio- or video-taped. Research Collaborators/Members of the Core Research Group advise their volunteer graduate student/research staff to facilitate recording of the sessions. All equipment for the conduct of the classroom observations and interviews will be provided by the Research Collaborator (as per MOA).

11. Interview with the selected STEAM teachers may serve as post-conference after class observations to provide time for clarifications.

12. A formal meeting with the Field Researcher may be done after completing all the processes for components 2 to 4 to formally conclude the school visit.

13. Please note that conduct of school visit may be done in 2 to 3 days depending on the provided schedule and financial equivalent as reflected in the Line-Item-Budget (LIB).

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Guidelines for Classroom Observation

In the country's journey to improve the quality of life of Filipinos and to establish high economic growth, aspects of science, technology, engineering, agriculture and mathematics (STEAM) may highlight skills to achieve our goals. In fact, the adherence of the country to STEAM highlights the "AMBISYONNATIN 2040," themed as, "Matatag, Maginhawa, at Panatag na Buhay (Philippine Development Plan [PDP], 2017)." The country believed that the 2040 goal may be concretized through the three priority areas of the crafted Philippine Development Plan which includes: 1) malasakit (enhancing social fabric); 2) pagbabago (reducing inequality); and 3) patuloy na pagunlad (increasing growth potential). These three priority areas emphasize among others promotion and awareness of Philippine culture, acceleration of human capital development, promotion of technology, and stimulation of innovation. Apparently, the make-up of the PDP framework puts STEAM as among the cores to achieving the 2040 goals. Thus, necessitates cross-cutting strategies, which may be derived from quality STEAM education for the Filipinos. Relative thereto, our study aims to craft an Emerging Technological-Pedagogical-Assessment-Content Knowledge (TPACK) Model for Philippine STEAM Education and to provide inputs to policies for Philippine STEAM Education.

The following procedures for developing a STEAM Educator visitation program are drawn from experiences of successful classroom visitation programs borne out of researches. Classroom observation models emphasize a three-step consultation process which includes a pre-observation conference, classroom observation, and a post-observation conference.

Pre-Observation Conference

In the pre-observation session, the researcher-observer should obtain information from the pre-identified STEAM Educator concerning his or her class goals, students, and particular teaching style. An interview schedule provides a brief, structured way of obtaining such information and includes the following questions:

1. Briefly, what will be happening in the class I will observe?
2. What is your goal for the class? What do you hope students will gain from this session?
3. What do you expect students to be doing in class to reach stated goals?

4. What can I expect you to be doing in class? What role will you take? What teaching methods will you use?
5. What have students been asked to do to prepare for this class?
6. What was done in earlier classes to lead up to this one?
7. Will this class be generally typical of your teaching? If not, what will be different?
8. Is there anything in particular that you would like me to focus on during the class?

Details such as the date for the classroom observation, use of a particular observation form or method, and seating arrangement for the colleague observer should also be decided by mutual agreement at this session.

Classroom Observation

To explore the Technological-Pedagogical-Assessment-Content Knowledge (TPACK) of Philippine STEAM Educators geared towards STEAM Quality Education, the Research Team developed several instruments for Classroom Observation that may be able to source facets of learning in terms of TPACK Model which includes: Technology integration from which to design technology integration model for STEAM Education, innovative pedagogical approaches from which to draw a pedagogical model for STEAM education, appropriate assessment tools, and content standards and competencies. Below are the definitions of TPACK dimensions and corresponding examples which may be evident in the classroom session of identified STEAM Educators.

Table 1. Summary of TPACK Dimensions

TPACK Constructs	Definition	Example
TK	Knowledge about how to use ICT hardware and software and associated peripherals	Knowledge about how to use Web 2.0 tools (e.g., Wiki, Blogs, Facebook)
PK	Knowledge about the students' learning, instructional methods, different educational theories, and learning assessment to teach a subject matter without references towards content	Knowledge about how to use problem based learning (PBL) in teaching
CK	Knowledge of the subject matter without consideration about teaching the subject matter	Knowledge about Science or Mathematics subjects
PCK	Knowledge of representing content knowledge and adopting pedagogical strategies to make the specific content/topic more understandable for the learners	Knowledge of using analogies to teach electricity (see Shulman, 1986)
TPK	Knowledge of the existence and specifications of various technologies to enable teaching approaches without	The notion of Webquest, KBC, using ICT as cognitive tools, computer

	reference towards subject matter	supported collaborative learning
TCK	Knowledge about how to use technology to represent/research and create the content in different ways without consideration about teaching	Knowledge about online dictionary, SPSS, subject specific ICT tools e.g. Geometer's Sketchpad, topic specific simulation
TPACK	Knowledge of using various technologies to teach and/represent and/ facilitate knowledge creation of specific subject content	Knowledge about how to use Wiki as an communication tool to enhance collaborative learning in social science

Source: Chai, C.-S., Koh, J. H.-L., & Tsai, C.-C. (2013). A Review of Technological Pedagogical Content Knowledge. Educational Technology & Society, 16 (2), 31–51.

The Instruments

The **Classroom Observation Protocol for STEAM Education** a tool designed to help educators and researchers derive or deduce important information from STEAM educators significant to inform practices and policies in Philippine STEAM Education.

The Protocol contains the following instruments:

STEAM Classroom Observation Rating Scale – This instrument is a 6-point Likert scale sectioned into basic descriptive information and instruction. The rating scale determines the extent of visibility of the identified traits, characteristics, processes and products relative to content, knowledge and pedagogy; the learning pedagogy; and the diversity of learners.

The 6-point Likert scale runs from 0-N/A (not applicable) to 5-To a great extent. Ratings ranging from 1 – 6 corresponds to the extent of the observed trait, characteristic or behaviour. A rating of 1 corresponding to "Not at All," may mean that the item is not observable in the current session but may be observed in other sessions. In cases as such, the observation may be highlighted in the **Classroom Observation Notes**. Furthermore, these not observable items in the current session may also be highlighted in the Post Observation Conference or Interview using the **TPACK Interview Protocol.**

The other instruments in this tool pack are meant to provide in-depth data collection for triangulation, clarification and justifications to all observed and not observed traits, characteristics, processes and items identified in the STEAM **Classroom Observation Rating Scale**.

Classroom Observation Notes – This instrument includes questions clustered into the dimensions of TPACK. The observation notes is designed for use by researchers who would want to collect qualitative data on STEAM Education anchored to the TPACK framework. Specific examples are provided per item

to provide easier account of the teaching process. Observer is requested, though, to narrate all observation related to each item. It is not recommended that this worksheet be used by teachers to rate classroom practice of their peers or for use by administrators to evaluate teacher performance.

It is not recommended that this worksheet be used by teachers to rate classroom practice of their peers or for use by administrators to evaluate teacher performance. The worksheet is intended to be used in conjunction with the other instruments and protocol included in this set.

Post-Observation Conference

The post-observation conference is most useful if it occurs within while the activities are still fresh in the minds of the teacher and the observer. Below are general questions which the observer may ask the interviewee (STEAM Educator) to initiate the Post Observation Conference:

1. In general, how did you feel the class went?
2. How did you feel about your teaching during the class?
3. Did students accomplish the goals you had planned for this class?
4. Is there anything that worked well for you in class today that you particularly liked? Does that usually go well?
5. Is there anything that did not work well-that you disliked about the way the class went? Is that typically a problem area for you?.
6. What were your teaching strengths? Did you notice anything you improved on or any personal goals you met?
7. What were your teaching problems- areas that still need improvement?
8. Do you have any suggestions or strategies for improvement?

As observers/interviewers, you may choose several of the aforementioned questions to initiate this section. For in-depth narration of the session in terms of TPACK dimensions, the observer will use the TPACK Interview Protocol. You also need to ask the teacher to complete the Technology Integration Checklist and the Assessment Checklist.

TPACK Interview Protocol—This instrument includes sets of questions intended to guide the researcher or evaluator in the collection of qualitative observations and extrapolation of meanings and explanations that will be used augment all areas of concern not completely provided by the two other instruments. Themes highlighted in this interview guide include: Teacher's scientific attitude and pedagogical reputation, inquiry-based learning and teaching, inclusive and relevant STEAM education, classroom management, attainment of learning outcomes, knowledge of STEAM and STEAM related

fields. The interview protocol provides a sequentially designed probing points which may be used to extract other details to clarify or confirm listed items in the field notes and rated items in the Classroom Observation Rating Scale.

Technology Integration Checklist – This checklist can be used to document the nature of the teacher and the student's use of technology in the classroom. While the other aforementioned tools deduce listing of technology used by the STEAM Educator in the observed session, this instrument may help the observer identify other technology used by the STEAM Educator in other classes or sessions (not observed in the current session).

Assessment Checklist- This instrument includes items on various techniques a STEAM educator utilizes to assess the performance of the student. While the other aforementioned tools deduce listing of assessment tools and strategies used by the STEAM Educator in the observed session, this instrument may help the observer identify other assessment tools and strategies used by the STEAM Educator in other classes or sessions (not observed in the current session).

An analysis and interpretation of the classroom visit, as well as of the post-observation conference, should go to the instructor. It is important that the results of observations be shared with the faculty member being evaluated. It is also important that any colleague observation program emphasize the positive, constructive feature of the observation process - the improvement of instruction.

RECORDINGS *and* TRANSCRIPTIONS

Digital Recordings and Transcriptions

Digital recordings and transcriptions are two relevant data sources in qualitative research. Digital recordings enable the field researcher to gather actual relevant interview proceedings and to use as basis of transcription writing. The recordings help the transcriber efficiently create transcripts essential for data analyses. It may sometimes be challenging to understand recordings due to factors related to volume, overlapping speech or sometimes noise or due to interference.

Transcription tries to capture an interpretive act through repeated careful listening. It is a challenging endeavor since the transcriber needs to make judgment to shape the meaning of the written words. Basically, both processes require patience, quality, and sufficient time to successfully accomplish the tasks. Below are practical tips to follow in order to do successful interview recordings and transcriptions.

For Recording Field Research Interviews

1. **Conducive Location**. The key step to consider is to control background noise and interruptions so as to ensure successful conduct of the interview.

2. **Digital Voice Recorder Condition**. Check the condition of the digital recorder prior to its use. Be sure that it is functional (with power source and proper audio quality). Do not forget to turn the **POWER** and **RECORDING** buttons "ON" right after seeking permission from the interviewee to conduct the interview. From time to time, check if the recorder is properly functioning. After the interview, press the "STOP" button to save the recorded interview proceedings.

3. **Interviewee Condition.** During the interview, ensure that the interviewee is found near the digital voice recorder. Be sure that the device is placed in the right proximity to the respondent's location to capture his/her responses clearly. Give the interviewee time to talk. Do not interrupt. Observe non-verbal actions such as - a nod, a smile, or raising eyebrows and the like. Let the interviewee finish answering before raising a probing question or before proceeding to the next question. Thank the interviewee to signal the end of the interviewee.

For Writing Transcriptions

1. Before transcription, prepare the template for the transcript, as follows:
    - Name of interviewee
    - School or Institution
    - Department/ Subject being taught/ topic
    - Date and Time of Interview
2. Listen to the recording once or twice to observe familiarity of voices and to understand content.
3. Be attentive. As you listen to the recording the second time, write down what you hear. Copy the words exactly/verbatim and make notes of non-verbal communication like sighs, laughs or by simply considering the inclusion of descriptions in brackets.

4. When done transcribing, listen to the audio recording again while reading through your transcripts to check for possible error or discrepancy of data.

PROCESS of LIQUIDATION

The **liquidation of expenses** is necessary process of a funded research project. This process provides the researching institute all the proofs of outlays and serves as a legal document that protects the entire investigating team. Below are specific details of the liquidation process as performed by the team for the implementation of field research for the funded-research.

Understanding the Budget Allocation for Field Research

Interview sessions and class observations to different Higher Education Institutes (HEIs) entail corresponding budget. The budget is allocated as accommodation, intercity allowance, meals allowances of the participants and the field researchers, and contingency. Both hotel accommodation and the meal allowances require official receipts. The intercity allowance, which refers to all the transportation expenses in the research site require Reimbursement Expense Reports (RER). The meal allowance allotted for the (HEIs) is endorsed to the representative for the meals of the participants and the researchers while in the campus. The HEI representative must be reminded that the amount can be fully consumed as long as official receipts are in order. Lastly, the contingency allocation can be utilized during emergency cases or wherever there are untoward incidents. To note, field researchers must initially ask if the establishments where researchers intending to transact with during the field research (e.g., hotel, restaurant, ticket fare booth and stores) issue an Official Receipt. Receipts indicating other than the above mentioned allocations **won't be recognized** as they are not part of Line Item Budget (LIB).

Safekeeping and Proper compilation of ALL the Receipts, Boarding Pass, and Fare Tickets

The field researchers must be responsible in keeping all the fare tickets and boarding passes as these documents are included in the travel reports. These include round trip boarding passes and fare tickets like Ferry Boat, Buses. Grab, Taxi rides.

Preparing the Financial Report

One of the field researchers must take charge in preparing the financial report of the group. He or she must accomplish the liquidation form and submit this report together with the compiled receipts, fare tickets and boarding passes.

CODING System

CODING – a process of qualitative data analysis that involves:

- Extraction of the important concepts from raw qualitative data sourced from
    1. Interviews/discussions
    2. Observations
    3. Pertinent documents
- Filtration of ideas describing a phenomenon leading to a new figure of experiences, practices, etc.
- Dissection of experiences connecting and relating the essential statements resulting to a new context.

CODING TIPS

- ✓ Transcribe the interview session by yourself.
- ✓ Read the transcription to make yourself effectively immersed in the phenomenon being investigated.
- ✓ Do not delete any statement in the interview (even sounds ah, eh, ih, oh, uh)
- ✓ Start coding using the interview with rich expression of experiences or phenomenon.
- ✓ Do not be in hurry. But finish the interview you started coding.
- ✓ Generate codes as many as you can.
- ✓ From time to time, classify the generated codes according to the pre-determined or emerging themes.
- ✓ When you are done coding all the interviews, retrieve the all the segments that are within a specific code. Describe the code according to the participants. (Memo)

Research	Targeted Skills
Data Collection	• Conducting interviews • Conducting observations • Note taking • Summarizing • Documentation

Data Analysis	• Transcribing
	• Enhanced memory skills
	• Writing skills
	• Ability to be reflexive
	• Critical thinking skills
	• Creativity and judgment to make sense of and transform massive amounts of data/text into theory by:
	  ○ Reducing the volume of raw information;
	  ○ Sifting trivia from significance;
	  ○ Identifying significant themes;
	  ○ Constructing a conceptual framework.
	• Ability to go beyond description. Link elements.
	• Weave a 'story'.
	• Ability to start analyzing and interpreting data whilst still collecting it
	• Ability to strike a balance between focused exploration on one hand and (attempted) open-mindedness on the other.

Others	• Interpersonal skill

REFLECTIONS

FORMS & SAMPLES

GRADUATE REFLECTION FOR *Data Gathering*

TECHNOLOGICAL PEDAGOGICAL ASSESSMENT CONTENT KNOWLEDGE (TPACK) IN PHILIPPINE STEAM EDUCATION

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Graduate Student Reflection

Project Title: *Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in Philippine STEAM Education*	**Research Collaborator/Researcher from Lead University:**

Travel Details:

- Visited HEI: _____ Date(s) of Visit: _____
- Officials Interviewed: _____
- STEAM Teachers Observed: _____
- Subjects Observed: _____

Details of Reflection

(Please narrate your entire experience during the school visit underscoring all insights gained and learnings from your involvement in the project through all conducted activities)

Interview with School officials	
Pre-Interview with STEAM Teachers	
Classroom Observation	
Post-Interview with STEAM Teachers	

Graduate Student Evaluation

(*Graduate Students will be asked to reflect on the whole process of their professional learning, guided by a series of reflective questions.*)	
What have I learned from this research project involvement?	
How my students and my school could benefit for this involvement?	
What were the challenges I experienced during the conduct of all activities relative to the research project?	
What aspects of my involvement in this project which I would like to keep?	
What aspects of my involvement in this project which I think I need to improve?	
What learning experiences which I consider have enhanced my research skills as a graduate student?	
Where to from here?	

(02) 317-1768 local 530
0906-3719733 / 0923-9324884 (Nica A. Casilla, Technical Staff)
steam@pnu.edu.ph
https://www.facebook.com/TPACK.CHED/

Comments/Suggestions

Submitted by:

_____

Graduate Student Research Volunteer
(Signature over printed name)

_____

Date

GRADUATE REFLECTION FOR *Workshop*

TECHNOLOGICAL PEDAGOGICAL ASSESSMENT CONTENT KNOWLEDGE (TPACK) IN PHILIPPINE STEAM EDUCATION

(02) 317-1768 local 530
0906-3719733 / 0923-9324884 (Nica A. Casilla, Technical Staff)
steam@pnu.edu.ph
https://www.facebook.com/TPACK.CHED/

Graduate Student Reflection

Project Title: *Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in Philippine STEAM Education*	**Senior Graduate Student Mentor:**
Group/Research Cell Description	

Details of Reflection

(Please narrate your entire experience during the mentoring process)

Workshop with the entire Research Team (Researchers and Senior Graduate Students)	
Topics included in the Workshop	

Graduate Student Evaluation

(*Graduate Students will be asked to reflect on the whole process of their professional learning, guided by a series of reflective questions.*)

What have I learned from this workshop?	

How my students and my school could benefit for this involvement?	
What were the challenges I experienced during the mentoring process?	
What aspects of the mentoring process helped me as an intending researcher?	
What aspects **o**f my involvement in this project which I think I need to improve?	

What learning experiences have enhanced my research skills as a graduate student?	
Where to from here?	
Comments/Suggestions:	

Submitted by:

_____

Graduate Student Research Volunteer
(Signature over printed name)

_____

Date

GRADUATE REFLECTION FOR *Data Gathering*

SAMPLE ACCOMPLISHED FORM

Philippine Normal University
The National Center for Teacher Education
EDUCATIONAL POLICY RESEARCH AND DEVELOPMENT CENTER
Taft Avenue, Manila 1000, Philippines
Tel/Fax: (632) 527-0366; 317-1768, Loc. 711 e-mail: eprdc@pnu.edu.ph

Graduate Student Reflection

Project Title	Research Collaborator/Researcher from Lead University:
Technological Pedagogical Assessment Content Knowledge (TPACK) in Phil. STEAM EDUCATION	Dr. Paulo Pagkalinawan JONATHAN PICHO

Travel Details:

- Visited HEI: Sta Isabel College Date(s) of Visit: February 27, 2018
- Officials Interviewed: _____
- STEAM Teachers Observed: NA - Observation was cancelled
- Subjects Observed: NA

Details of Reflection

(Please narrate your entire experience during the school visit underscoring all insights gained and learnings from your involvement in the project through all conducted activities)

Interview with School officials	Interview session was meaningful. The school officials were very honest in airing their views and feelings about their school roles & responsibilities. However, just inferred that some of the officials where not that expert in delivering their functions. ~~& the~~
Pre-Interview with STEAM Teachers	- The teachers were performing multiple functions due to limited faculty (to teach a specific discipline) Hence, resulted to difficulty in delivering the instruction and in improving student learning outcomes.
Classroom Observation	NA - Cancelled
Post-Interview with STEAM Teachers	NA - Cancelled

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Taft Avenue, Manila 1000, Philippines
Tel/Fax: (632) 527-0366; 317-1768, Loc. 711 e-mail: eprdc@pnu.edu.ph

EPRDC

Graduate Student Evaluation	
(*Graduate Students will be asked to reflect on the whole process of their professional learning, guided by a series of reflective questions.*)	
What have I learned from this research project involvement?	Though the observation phase was not implemented, I found my involvement essential on the delivery of the project's purpose. On a personal note, my skills as a qualitative researcher was honed.
How my students and my school could benefit for this involvement?	• Since I am handling research class in my home school, the skills & knowledge I got/acquired will be beneficial in teaching the subject and in doing researches.
What were the challenges I experienced during the conduct of all activities relative to the research project?	- With the interview phase, I had difficulty in communicating the questions to the respondents since they have a different perspective or frame of reference, that is why I had to simplify the questions and add probing questions.
What aspects of my involvement in this project which I would like to keep?	- In the conduct of this research, I had the chance of meeting colleagues in the profession whom I consider fortune human resources and gave me the chance as well to go places & serve my country through the research objectives.
What aspects of my involvement in this project which I think I need to improve?	→ To overcome my being disorganized & forgetful in delivering the expected outcomes like the accomplishment of the forms / documents.
What learning experiences which I consider have enhanced my research skills as a graduate student?	→ As a graduate student, I was given the chance to apply the theoretical skills/ knowledge I acquired during the program. I was able to see the real picture, challenges & problems of conducting qualitative study.

Philippine Normal University
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EDUCATIONAL POLICY RESEARCH AND DEVELOPMENT CENTER
Taft Avenue, Manila 1000, Philippines
Tel/Fax: (632) 527-0366; 317-1768, Loc. 711 e-mail: eprdc@pnu.edu.ph

Where to from here?	With the knowledge and skills I acquired, I am looking forward to a more productive research engagements with my learning institution is to deliver quality research services to my future students.
Comments/Suggestions	→ For other field researcher who has no experience in conducting qualitative research to be provided mentoring session most especially on quality research protocol so as to observe smooth research conduct.

Submitted by:

RAQUEL A. GONZALES
Graduate Student Research Volunteer
(Signature over printed name)

March 1, 2018
Date

GRADUATE REFLECTION FOR *Workshop*

SAMPLE ACCOMPLISHED FORM

TECHNOLOGICAL PEDAGOGICAL ASSESSMENT CONTENT KNOWLEDGE (TPACK) IN PHILIPPINE STEAM EDUCATION
(02) 317-1768 local 530
0906-3719733 / 0923-9324884 (Nica A. Casilla, Technical Staff)
steam@pnu.edu.ph
https://www.facebook.com/TPACK.CHED/

Graduate Student Reflection

Project Title: *Technological-Pedagogical-Assessment-Content-Knowledge (TPACK) in Philippine STEAM Education*	**Senior Graduate Student Mentor:** RAQUEL A. GONZALES

Group/Research Cell Description
TPACK STEAM EDUCATION
Workshop on Qualitative Data Analysis
July 13, 2018 1:00PM to 5:00PM

Details of Reflection

(Please narrate your entire experience during the mentoring process)

Workshop with the entire Research Team (Researchers and Senior Graduate Students)	The senior graduate student-researchers are very generous in providing inputs and tips on the future research tasks of the junior student-researcher.
Topics included in the Workshop	I enjoyed listening on the lecture about recording and transcriptions and coding system because I found qualitative research "easy but taskful" However, I am very willing to know and learn the technical know-how of qualitative research and to be a contributor in this CHED national funded research.

Graduate Student Evaluation

(Graduate Students will be asked to reflect on the whole process of their professional learning, guided by a series of reflective questions.)

What have I learned from this workshop?	I have learned that doing qualitative research is easy but as a researcher, I must be deligent in conducting it for me to be effective and efficient during the recording, transcribing, coding, and liquidating process.

How my students and my school could benefit for this involvement?	My students and my school could benefit for this involvement by introducing the technical know-how of conducting qualitative research and processing or coding the data which could help them conduct their own research for their own benefit, for the benefit of the school, and for the betterment of the educational system.
What were the challenges I experienced during the mentoring process?	The challenge I experienced during the mentoring process is the access to observations and interview instruments during the workshop because I do not have the copy, I was not able to follow the hints discussed by Sir Milano. Another is the unavailability of the MAXQDA software in preparation of the coding system. I do not have a copy of it and I do not know how to use it.
What aspects of the mentoring process helped me as an intending researcher?	As an intending research, I was motivated to conduct my thesis benchmarking the use of qualitative research for the methodology of my study. The workshop also gave me an idea to generate topics based on the components of the TPACK STEAM Education.
What aspects of my involvement in this project which I think I need to improve?	The love for reading. According to Sir Milano (2018), it is better to further read and read the observation and interview tools for easy and fast conference/interview with the interviewee. Also, it challenges me to love reading and read further about the components of TPACK and qualitative research so that I would have ideas during the interview (for good questions which are relavant) and for the coding part of research.

TECHNOLOGICAL PEDAGOGICAL ASSESSMENT CONTENT KNOWLEDGE (TPACK) IN PHILIPPINE STEAM EDUCATION

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steam@pnu.edu.ph
https://www.facebook.com/TPACK.CHED/

What learning experiences have enhanced my research skills as a graduate student?	My motivation to love and conduct my thesis relevant to qualitative research. It also enhanced my knowledge and skills in recording and strategies in transcribing.
Where to from here?	From this workshop, I am planning and thinking of ways and topic in Science Education for my thesis with the use of qualitative research as the methodology. Also, from here, I will start reading the observation and interview tools many times.

Comments/Suggestions:

1.) Congratulations to all the people behind this research project. This project is a great way to multiply knowledge and skills in research for students like me.

2.) For the mentor-mentees group collaboration/training, hope there will be a memorandum and set date, enough time and place for it. So that all researchers will be excused from our respective schools and all researchers will attend the training. In order for us to have enough time and proper focus on the training or mentoring program. Thank you! ☺

Submitted by:

LEAH R. BURBOS

Graduate Student Research Volunteer
(Signature over printed name)

JULY 13, 2018
Date

DOCUMENTATION

Research Mentoring Program

INVITATION TO THE *Program*

CHED - PNU
TPACK
STEAM EDUCATION

TPACK IN PHILIPPINE STEAM EDUCATION

WANT TO BE PART OF OUR TEAM?

WE'RE LOOKING FOR:

PNU Graduate Students

Preferably doctoral students taking Science Education or Mathematics Education degrees who will be part of our team and be recipients of TPACK research mentoring program. We also accept Master's Students in all areas.

For interested students, please register to Ms. Nica Casilla at PNU Publication Office, Rm.202, Orata Bldg. For further inquiries you may call at 317-1768 local 530 or 09063719733

SAMPLE

REPUBLIKA NG PILIPINAS
Republic of the Philippines
PAMANTASANG NORMAL NG PILIPINAS
Philippine Normal University
ANG PAMBANSANG SENTRO SA EDUKASYONG PANGGURO
The National Center for Teacher Education
Maynila
Manila

June 28, 2018

DR. GREGORIO A. ANDAMAN, JR.
President
St. Dominic College of Asia
Bacoor City, Cavite, 4102

Thru: **DR. NILDA W. BALSICAS**
Vice President for Academics and Research
St. Dominic College of Asia

Dear Dr. Andaman,

Greetings!

Our Commission on Higher Education (CHED)-commissioned research titled, ***"Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education,"*** officially commenced this August 2017 (please refer to attached Notice to Proceed). The project intends to map STEAM Education competencies and design the emerging TPACK framework unique to the Philippine Higher Education system. The major deliverables of this project are our contribution to the country's knowledge-based economy. Our core research team has already developed the Philippine STEAM Proficiency Indicators. In all the seven components of the entire project, the research team needs to intensively communicate with 330 Higher Education Institutions (HEIs) for a four-stage survey. Additionally, quantitative data collection through survey coupled with qualitative data collection through interviews, focus-group-discussions, and classroom observations (inclusive of video and audio recording) will be conducted with the 33 focus HEIs.

Furthermore, the project intends to serve as platform for Research Mentoring Program for our graduate students to strengthen their research skills and be contributory to the country's knowledge economy. Relative thereto, we request that you allow **MS. BELINDA ABDON-LIWANAG**, a PhD Science Education student to join our TEAM in the conduct of class observations and interviews, which has already commenced this February 2018.

We anticipate your acceptance and we look forward to this research pursuit with much fervor. Kindly email the COLLABORATING AGENCY'S ACCEPTANCE FORM if you accept this invitation, to the Principal Investigator, Dr. Marie Paz E. Morales at *morales.mpe@pnu.edu.ph* or *steam@pnu.edu.ph*. Herewith also is the executive summary of the research study, for your perusal.

Thank you and we hope for more collaborative research projects with you.

Very truly yours,

Montealegre

DR. MA. ANTOINETTE C. MONTEALEGRE
OIC, Office of the President

Telefax No.: 527-0375 E-mail: president@pnu.edu.ph Website: www.pnu.edu.ph

COLLABORATING INSTITUTION'S/ AGENCY'S ACCEPTANCE FORM

This is to express that the St. Dominic College of Asia (Institution/ Agency) whose Representative/Field Researcher is BELINDA A. LIWANAG (Graduate Student) hereby accepts the invitation to be part of the research project titled, ***"Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education"*** commissioned by the CHED to the Philippine Normal University.

ST. DOMINIC COLLEGE OF ASIA
Institution/ Agency

DR. GREGORIO A. ANDAMAN, JR.
President

DR. NILDA W. BALSICAS
Vice President for Academic Research

MS. BELINDA A. LIWANAG
Graduate Student

7-6-18
Date Accomplished

0927 777 0882 belindaliwanag@gmail.com
Contact Numbers and Email Address of the Graduate Student

Commitment FORM

SAMPLE ACCOMPLISHED FORM

TPACK in Philippine STEAM Education
PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education
Manila

Commitment Form

This **Commitment Form (the "Agreement")** is made and effective on JUNE 23, 2018 at the Philippine Normal University, Taft Avenue Manila, Philippines.

BETWEEN: LEAH R. BURBOS (a "Graduate Student" for Research Mentoring Program of TPACK), a volunteer researcher of TPACK in Philippine STEAM Education, with its affiliation, PHILIPPINE NORMAL UNIVERSITY located at: TAFT AVENUE, MANILA AND DEPED ANTIPOLO CITY NATIONAL SCIENCE AND TECHNOLOGY HIGH SCHOOL ANTIPOLO CITY

AND: **Philippine Normal University – Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education**, a CHED-funded Research Project which has commenced on August 2017, with its office located at:

Room 202, Pedro T. Orata Hall
Taft Avenue, Manila, 1000 Philippines

WHEREAS, the parties agree to certain terms on services to be performed by the Graduate Student for the abovementioned project;

THEREFORE, for and in consideration of the foregoing and the stipulations herein set forth, the parties hereby agree on the following:

I. TERMS:

The **Commitment Form** is to serve as Graduate Student's written authorization to perform services for the research project titled, ***Technological Pedagogical Assessment Content Knowledge (TPACK) in Philippine STEAM Education***. Author's signature also indicates understanding of terms and liability to the research project for said services.

II. DESCRIPTION OF SERVICES:

1. The **Graduate Student(s)** is/are voluntarily participating in this project, thus services he/she will be rendering are not subject to honorarium.
2. The **Graduate Student(s)** is/are expected to actively participate in this project from _____ to _____
3. The **Graduate Student(s)** is/are expected to conduct data gathering (i.e., classroom observations and interview sessions) in the remaining HEIs out of the 33 target HEIs subject to data collection.
4. The **Graduate Student(s)** is/are expected to do and complete the required tasks for this mentoring program such as, but not limited to accomplishing travel report, transcribing, coding, analyzing set of data, and attending meetings and workshops if required.

5. Submit complete liquidation report of the expenses that will be incurred in the future data gathering.
6. In the event the **Graduate Student(s)** fail(s) to complete the required tasks within the approved timeframe as a result of circumstances beyond his/her control, an extension is only allowed upon the approval of the Principal Investigator.

III. THE PROJECT

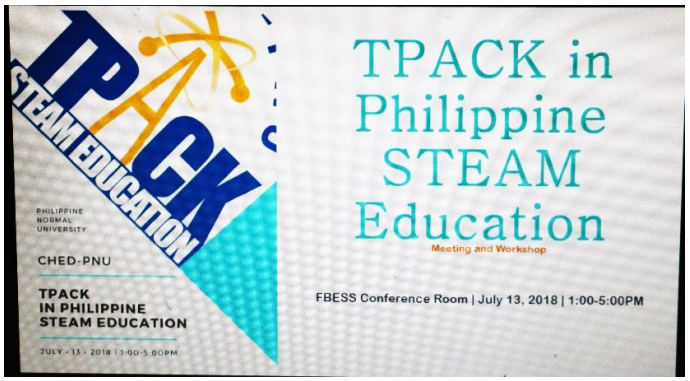
1. Provides assistance in terms of materials and equipment.
2. Conducts applicable trainings.
3. Shoulders all expenses that will incur in the identified travel for this project's data gathering.
4. Provides expert assistance for matters related to personal & academic endeavour of the recipient.
5. Provides opportunities for research collaboration.

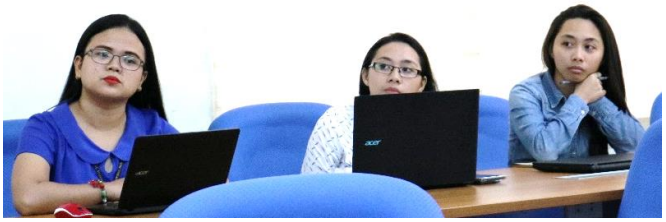
IN WITNESS WHEREOF, the parties hereto have signed this Contract this JUNE 23, 2018 in the City of Manila.

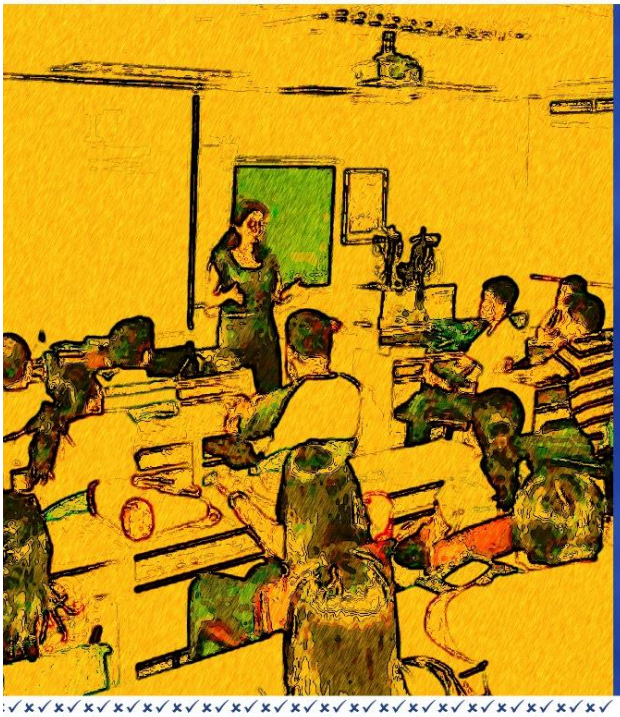
LEAH R. BURBOS	**MARIE PAZ E. MORALES, Ph.D.**
Graduate Student	Principal Investigator
JUNE 23, 2018	7-23-18
Date	Date

Mentoring PAR-APRROACH

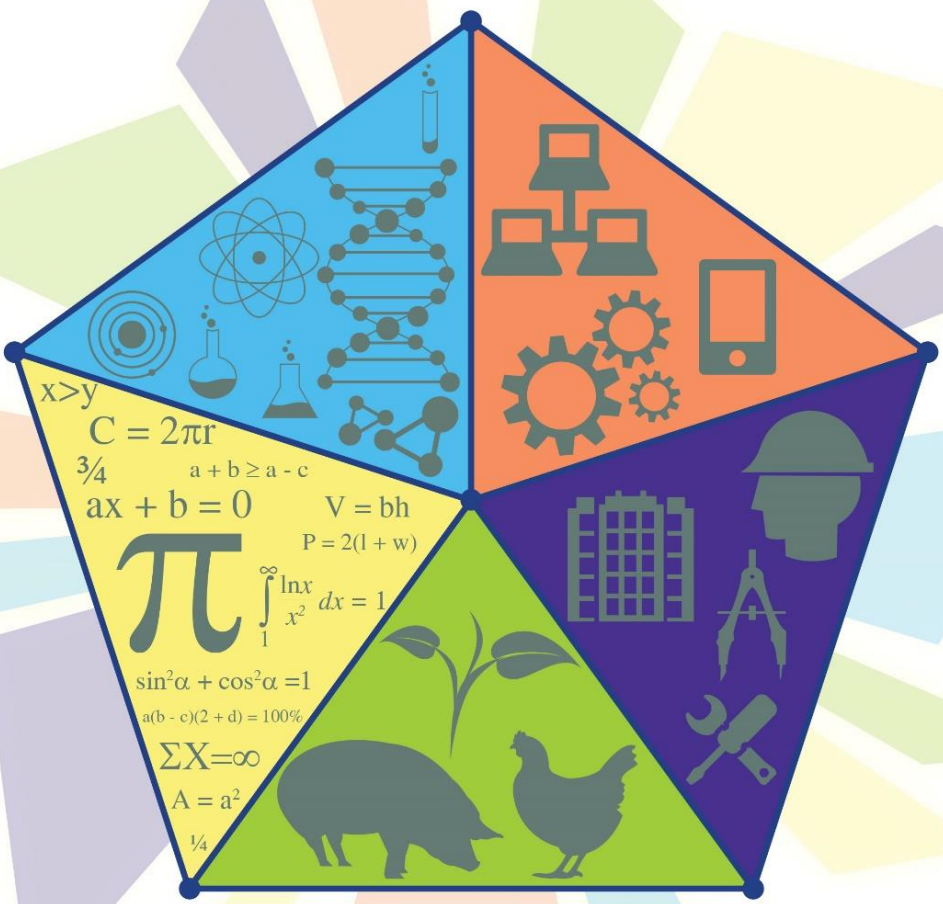
PHOTOS DURING ORIENTATION ON DATA GATHERING AND DATA CODING & ANALYSIS
JULY 13, 2108







STEAM CLASSROOM OBSERVATION PROTOCOL



STEAM Educators Proficiency Indicators

SAMPLE (EXCERPT ONLY

Interviewer: **MS. RAQUEL GONZALES (Graduate Student)**
Interviewee: **MR. LANTORIA**
Mater Dei College –Bohol
TE 409- System Integration

Theme: Teacher's Scientific Attitude and Pedagogical Reputation

Main Question: What scientific characteristics do you possess that you want to model to your learners?

Participant: The most important thing characteristic that I possess that I would like to important to my student would be the interest in the new technologies..ahhh it starts with interest and ahh. Then from there.. they can become passion ..Most of the things that the students in my profession in this career needs to learn can be taken even without studying formal education .. by having that amount of interest and …uhhmmm ..executing the interest by studying on their own.. that they can get tutorials from the internet , many resources that can help them learn the craft. If and that is actually I have been doing for the past years.. ahh if that would be the characteristic I want my students to have.

Interviewer: How do you emphasize in your learning and teaching processes that STEAM should benefit the society (e.g. school, community)?

Participant: Ahh.. the process that I usually do in teaching them .. especially, letting them grow in terms of interest ahhh. that is, that I teach them how I learn these things so all the things that I did in order to learn these concepts that what I teach them // say getting the relevant ah resources over the internet. Usually almost coming from the internet because books for technology are very rare even if it's available it's also very expensive so it's going to be mostly online . Ahh getting the resources. How to read documentations most especially for technical matters especially when we are talking about software development. Documentation is a very important thing. Most people do not know how to read documentations and so they do not understand what documentation tells about the technology then ahhh since the documentation in software development is very unusual. Its not like dictionary or any other book. It's not written that way, so ahh the process would be exactly the way I learned it. I will teach them the way How I learned it.

Interviewer: How do you exhibit dedication and commitment to the realization of the goals of the STEAM discipline?

Participant: So with regard to that.. my personal time has always been used for the purposes of achieving new skills and lessons.. and concepts or things that I still lack ahh on a daily basis in fact so I tend to ahh accept ahh freelance jobs to develop myself since its only now that I develop my own industry.. experience ,,,There are available platforms on the internet that provides freelance like me or professionals skilled people to perform specific jobs for foreign or even local clientele with a fee of course . Performing actual software development and design ahh outside of the school of course for people even in other countries .. I have been doing that as part of growing up

Interviewer: How do you promote academic integrity in teaching STEAM?

a. Ethical conduct as a professional such as but not limited to the ethical treatment of shared information and knowledge (e.g. online resources)

Participant: Ah in this school.. ethics has been always part of the culture. In every aspect that necessitates the idea on ethical matter in evaluating the students for example in specific course .. not for security for example. Wherein they will be able to learn how to penetrate system and there is that very high rate of unethical possibilities and so what are the things they need to do ethically also I made them.. ahh even promise not to do unethical thing. Next Monday we have en election of officers for student body, There was a time wherein students hack the results of the election.. even up to now still we do not pinpoint. Who that is. we don't know who was it or who did it. To resolve the issue we actually squash the election and mended it the next sem for the next school year. Since our election happen during the next sem. That time we really found out that the information was hacked so we have to redo the election during the next semester after that incident and we have increased our security protocols for that purposes.

b. Ethical use of assessment result and student data

Participant: Well just like what you have observed our students here are generally very good people.. the assessment results are not use. In my personal experience.. in any way are not tampered by them. Their scores however can be or their test ,, they sometimes cheat.. We experience this incidence and if that happens. If a student is found out to be cheating on an exam,,, the examination in invalidated.. we invalidate the examination then we let them take special examination on their own. So that;s how we take the assessment.

Interviewer: How do you establish (or maintain) a reputation as a "good STEAM teacher"?

PROCESS of LIQUIDATION

SAMPLE LIQUIDATION REPORT

LIQUIDATION REPORT
For St. Michael's College, Iligan City
Conduct of Components 2-4 of the TPACK in Philippine STEAM Education
March 6-8, 2018

Accommodation and Food (PhP12,000.00)		
Date	**Particulars**	**Amount**
March 6, 2018	Accommodation (Plaza Alemania Hotel)	5,300.00
March 6, 2018	Meals	714.00
March 6, 2018	Meals	621.50
March 6, 2018	Meals	400.00
March 6, 2018	Meals	~~60.00~~
March 7, 2018	Meals	59.35 96.35
March 7, 2018	Meals	274.00
March 7, 2018	Meals	238.00
March 7, 2018	Meals	480.00
March 8, 2018	Meals	267.00
March 8, 2018	Meals	80.00
March 8, 2018	Meals	140.00
March 8, 2018	Meals	425.00
Total Expenses for Accommodation and Meals		**PhP9,095.85**
Balance		**PhP2,904.15**

8,998.85

Intercity Allowance (PhP1,000.00)		
March 6, 2018	Laguindingan Airport to Iligan Bus Terminal	390.00
March 6, 2018	Iligan Bus Terminal to Plaza Alemania Hotel	200.00
March 8, 2018	Plaza Alemania Hotel to Iligan Bus Terminal	200.00
March 8, 2018	Iligan to Laguindingan Airport	200.00
Total Expenses for Intercity Allowance		**PhP990.00**
Balance		**10.00**

Interview and Collaboration Meals (PhP7,000.00)		
March 7, 2018	Meals	4,050.00
March 8, 2018	Meals	3,022.00
Total Expenses for Interview and Collaboration Meal		**PhP7,072.00**
Debit		**PhP72.00**

Contingency (PhP,000.00)		
March 5, 2018	Transportation (PNU-PUP)	110.00
March 6, 2018	Transportation (Bus c/o Sir Milan)	79.00
March 6, 2018	Transportation (Parañaque-Terminal 3)	270.00
March 6, 2018	Transportation	180.00
March 6, 2018	Transportation	250.00
March 6, 2018	Toll Fee	~~70.00~~
March 8, 2018	Toll Fee	35 ~~75.00~~
Total Expenses less to Contingency		**PhP1,034.00**
Balance		**PhP8,966.00**

105

994

Total Expenses for Accommodation and Meals	PhP9,095.85
Total Expenses for Intercity Allowance	PhP990.00
Total Expenses for Interview and Observation Meals	PhP7,072.00
Total Expenses less to Contingency	PhP1,034.00
c/o Sir Milan	PhP2,000.00
Total Expenses	**PhP20,191.85**
PhP30,000.00-PhP20,191.85	**PhP9,808.15**

Prepared by

Assoc. Prof. RANDY D. SAGUN
PUP Research Collaborator

Note: This summary of expenses must always have corresponding receipts

CODING System

SAMPLE CODED DATA USING MAXQDA

Summaries with Coded Segments - TPACK.mx18

Code	Coded segments	Summary
STEAM and its required fields	So you need to be ano, mentally equipped and also skills, dapat may skills ka you know how to communicate... Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 185 - 185 (0) So you have to teach them how to communicate well, for patient counselling Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 187 - 187 (0)	
STEAM and its required fields\Collaborative academic partnership	I have a research collaboration with IIT Interview with Officials\180212_002: 43 - 43 (0)	
STEAM and its required fields\Internship program	I think one of this outcome-based is the practicum, this is the practicum based I make to say because they have their learning checklist activities that they have to follow. Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 261 - 261 (0) like pag nag inter-practicum sila sa hospital I make to see na, I have to talk to them na ano, saan na kayo, anong nalalaman ninyo, anong gamot ito ganyan ganyan. So, I can measure them na they are doing their assignment o ano ba ito. Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 313 - 313 (0)	
	So actually we invite industry partners and we also collaborate with other institutions for us to really check. Our OJT we have them OJT journal for daily fill in and do some remarks with our OJT. And we also have evaluation form for the supervisors to really evaluate our OJTs and we also conduct some community trainings. Interview with Officials\180212_002: 33 - 33 (0)	
STEAM and its required fields\Counselling	So you have to teach them how to communicate well, for patient counselling Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 187 - 187 (0) But in the bigger hospital where I came from we do counselling. We have to make sure na alam ng pasyente kung ano yung, paano niya itetake ang medicine niya, kung anong oras at kung anong unang dapat niyang inumin. Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 189 - 189 (0)	
STEAM and its required fields\Communication	So you need to be ano, mentally equipped and also skills, dapat may skills ka you know how to communicate... Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 185 - 185 (0) So you have to teach them how to communicate well, for patient counselling Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City): 187 - 187 (0) I encourage them to talk, I encourage them to do, that's why kung meron man silang responsibility I keep pushing them, para akong nanay, nagsasalita sa kanila na ganito ganyan. Kasi dapat idikdik kayo para matuto kayo ganun...so parang broken record ka na rin (both laugh) Interview with Teachers\UDZ_Taslima T. Manupat (Pagadian City):	

Code System	Memo	#
Code System		466
STEAM and its required fields	STEAM and its required fields This code refers to what the teacher's reflection as to an important areas or field to STEAM 1. Communication: "So you need to be ano, mentally equipped and also skills, dapat may skills ka you know how to communicate…" 2. Conselling 3. Internship programs 4. Collaborative academic partnership	2
Collaborative academic partnership	Collaborative academic partnership	1
Internship program	Internship program	3
Counselling	Counselling	2
Communication	Communication	7
Miscellaneous	Miscellaneous memo collates other emerging codes which, to the ability of the researcher, cannot be grouped to 7 domains, as far as the current understanding of the domains is concerned. This included the following: 1. Unpopular science (pharmacy) profession (Lack of popularity and recognition of pharmacy profession) "nowadays pharmacist are not much very ahhh, ecognize… you know this is one thing that we have…" 2. Popularizing science programs (e.g. BS Pharmacy) "may mga outreach programs outside medical outreach programs if we don't insist ourselves di man masyado kaming nakikilala so nowadays…" 3. Client-focused/patient-focused science programs 4. The teacher practitioner Miscellanous memo may be expanded as co-curricular and/or extra-curricular to teaching activities.	0
The teacher-practitioner	The teacher-practitioners refer to teachers (not a professional teacher) of STEAM disciplines like pharmacy and medical technology but aside from professional work they are engaged in the teaching of profession. Note: Part-time faculty is basically involved in teaching the discipline and there is limited participation to engage in research. The research participation is limited to thesis advising and as member of defense panel. 1. External engagement and exposure relative to the profession	11

			External engagement and exposure relative to the profession	External engagement and exposure relative to the profession 1. Research	13
				Research	1
		Client-focused/patient-focused science programs	Client-focused/patient-focused science programs		2
		Popularizing science programs (e.g. BS Pharmacy)	Popularizing science programs (e.g. BS Pharmacy)		9
		Unpopular science (pharmacy) profession	Unpopular science (pharmacy) profession		4
	Pedagogical Content Knowledge		Pedagogical Content Knowledge. This code generally pertains to the ability of STEAM teachers to apply/employ teaching strategies appropriate to the content. Specifically, this code pertains to (1) strategies employed by teachers in order to attain the objectives of the subject/topic, (2) the process of - 1. Ability to create meaningful learning 2. Ability to interpolate 3. Ability to find nexus between values and science (STEM) 4. Institutionally-formulated PCK		35
		Institutionally-formulated PCK	Institutionally-formulated PCK. In case of Religous of the Virgin Mary (RVM) schools, there is a pedagogy developed to deliver instruction called RVM pedagogy. RVM pedagogy is drawn by inculcating values formation in various discipline.		4
		Ability to find nexus between values and science (STEM)	Ability to fuse values and science (STEM) 1. “We also have to, aside from the benefits of science, it has enable…ahm… had given man, it is also important that we need to integrate the values also. Working hand in hand let say for example, the teaching as ahhmm, genetics and the importance of genetics and the moral and ethical implications of genetics. Or genetic engineering”		10
		Ability to interpolate	Ability to interpolate - in some cases, it is the teacher who organizes everything due to the limited “learning experiences” that can be provided by any learning resource such as books. The teacher does the “in-between”. This is regarded as the “process” of the teacher “to interpolate”. 1. There are instances where teacher feels the need for constant updating.		13
		Ability to create meaningful learning	Ability to create meaningful learning 1. Ability to present meaningful visual formats of the topic 2. Ability to state HOTS questions 3. Ability to understand learner and learning situation Line 168: “Kadaghan” seems not a Tagalog word		19
			Ability to understand learner and learning situation	Ability to understand learner and learning situation	12

			Ability to present meaningful visual formats of the topic	Ability to present meaningful visual formats of the topic 1. “Okay so, yan kung may question pa tayo we will explain, so let the experience let them the real plot of the…because mas madali maintindihan kung may graph tayo, may graph tsaka yung table, table” 2. “Kung table table lang parang hindi yata maappreciate. Kung maipapakita mo yung, kung graph yun, ahh madali lang ohh”	7
			Ability to state HOTS questions	Ability to state HOTS questions 1. “or example ahhh…magbibigay ako ng circuit, sasabihin ko ahh… mag question ako. What if I will change the value of this component here, kasi I will change the value of the resistor, what will be its effect on the current flowing on this, or what will be the effect on the voltage.” 2. “…mag interpret na, magcompute na, mag derive ng equation, so magchechange na sila ng connector. So what happen, kunyari increase natin ano ang mangyayari, idecrease natin ano ang mangyayari okay. Yan ito yan so I plot natin, so iplot because…because that plotting we will easily understand what will happen if we have the plotinput and output. So kapag inincrease natin ahh ito pala, pag ganito pala decrease so, ma pipicture nila ano? So if we have a real number ahhh… a clear picture or understanding of that body. So, yun lang what if ah… I change ko ito ang value nito ay ganito, what if inincrease pa natin. Okay so, yan kung may question pa tayo we will explain, so let the experience let them the real plot of the…because mas madali maintindihan kung may graph tayo, may graph tsaka yung table, table”	7
	Technological Pedagogical Knowledge		Technological Pedagogical Knowledge. This code generally pertains to the ability of STEAM teachers to apply/employ technology appropriate to the strategies. Specifically, this code pertains to (1) technological employed by teachers in order to attain the objectives of the subject/topic, (2) the process of -		6
	Technological Content Knowledge		Technological Content Knowledge This code generally pertains to the ability of STEAM teachers to select technology appropriate to the content.		8
	Content Knowledge		Content Knowledge This refers to the knowledge of the teacher about the subject matter. 1. Imparting analytical skills was renamed as SKILLS OF TEACHER 2. Innate qualities of teacher which means exercising ingenuity in solving problems renamed as INNATE QUALITIES OF TEACHER 3. Research quality of a teacher (3. Ability to state HOTS questions => was placed as an umbrella ability of creating meaningful learning) 4. Inquirer of discipline		25

		Inquirer of discipline	Inquirer of discipline 1. (a) yes the content of ecology will not change but, application or…practice application is could be variede…depending on the, the students, the set of students, like HRM…application let say, how do you…(b) engineering like cleaning the technology or with, with, with HRM like how do you do about your thing yours, your, your serving. How do you do it with your Styrofoam and your straws. How do you do it, at the same time kwan,		4
		Research quality of a teacher	Research quality of a teacher		4
		Skills of teacher	Skills of teacher 1. "I have to impart to the students, especially ahm ahh…yung ahhh problem solving and analytical" 2. "if we are going to apply that in the plant the shortest time you are able to solve the problem in a meteoric consideration malaking ano yan (clear throat)…malaking pera yan (clear throat)…" 3. Research skills: "Teacher conducting research: "I have conducted research here but I haven't yet…pinopropose pa lang ano…pero may ginagawa na ako"		13
		Innate qualities of teacher	This refers to teacher's discipline-borne characteristics. A. Strict teacher 1. Apparent teacher's initiative to learn: "ahm… self, learning self so dapat ahhm, nag reresearch na ako no" 2. "after that makikita ko yung ano, so kung ano yung ahhh… part dun na kami ang kumokonsumo ng ahhh…kuryente, so tapos gagawan ko yan ng Sistema. So I want to create a system, that will ahhh…minimize the power consumption or not even a system, a system could be a policy or a hardware or a software." 3. Honesty: "I also, do not pretend to know everything most especially in the field of science." 4. Teacher's patience: "yung, yung may mga fast learner talaga, tapos yung isang grupo lang ng estudyante talagang, medyo talagang kwan…" "oo, parang ikaw lang yung interested…" "ikaw lang ang interested and then, parang ganun lang…" "usually sir, in general education, the usual thing I do is yun lang talagang, I, I," B. Team-spirited teacher		28
			Team spirited	Team-spirited teacher	2
			Strict/conventional teacher	Strict/conventional teacher	5

	Pedagogical Knowledge	Pedagogical Knowledge. This pertains to strategies used by teachers. 1. Teaching collaboration 2. Doing teacher's clinical tasks: "hm… self, learning self so dapat ahhm, nag reresearch na ako no" 3. Mentoring students: "you have to change lang the idea and then express yourself express you ownself not just the idea and then develop it using your own words" Pedagogical knowledge makes: 1. the coach teacher 2. the considerate teacher 3. the reflective techer 4. the visionary teacher 5. the pragmatic teacher 6. The social catalyst 7. The motivation builder 4. On collaborative strategy: "collaborative learning, yes sir, like giving them activities,"; "usually sir, the most common thing I do is to group them into, into 5 or 6 or 7 or by table, and then…"; "yes sir, usually in the laboratories, and it's also, it's okay that laboratories should not exceeding in 30 like, so it's easy for them. But it is hard, it is pretty hard on the 40's and above ano, because their quiet…"; "but usually sir the most common way that I do to encourage collaborative learning is to, group them, give them activities, or set of questions where they need to answer and later need to present in the class. This will serve as a class recitation, I don't know, I really what else can be? Question and answer? Ahm… field work…";		28
	The motivation builder	The motivation builder		10
	The social catalyst	The social catalyst - the teacher as community extension worker 1. Teacher as extension worker		14
		Teacher as extension worker	Teacher as extension worker	5
	The pragmatic teacher	The pragmatic teacher		26
	The visionary teacher	The visionary teacher		8
	The reflective teacher	The reflective teacher		54
	The coach teacher	The coach teacher 1. kasi kahit na hindi ko estudyante, lalapit sa akin para to… bigyan lang ng mga inputs lang so ganito gawin niyo ganyan, for example sa mga calculus, ahhmmm…they find it difficult to alam nila na medyo may…ano tayo sa calculus, may ano tayo so…nag aask sila. 2. sinasabi ko nga kasi tayo magboboard exam tayo tapos sa board exam kailangan mabilis yan kasi may time yan so kailangan ito ginagamit ko noon so mabilis na yung mga techniques na short method to solve the problem pwede rin yung mataas		23

	The considerate teacher	Teacher's consideration 1. “if the project is ahhh… so expensive, we need to have because konti lang yung ano…engineering ehhh konti lang yun number siguro mga lima or pito, lima anim (sir: in a class) in a class.So, mahal yung project nila for example yung project namin yung sa systems yung airplane, so mahal yun, so mag resist kayo diyan so ito yan ito yung system natin ito yung study niyo tapos mag research kayo. Tapos, yung mga problema ahhh ask me some questions that I will provide some ahhh…ahhh…information yun ang ginagawa nila…ayun. Because engineering is project driven so dapat para ahhh out of the wisdom tayo, so yung output is yung project nila. So idivide nila yun…sila na yung bahala dun mag ano mag collaborate but they have some questions usually papatulong yan sa akin ehhh, sir hindi lilipad yung ano naming sir, paano yung ano naming, ano yung gagawin. (both laugh) dalhin niyo yung project niyo so nakita ko, yung legate niyo, ay yung wheel, so yung wheel niyo, parang wala yatang ano…lubrications so, ilubricate niyo masyado para walang friction, para maka, makatakbo na sir okay na, pero bakit. O sige ganito I adjust niyo yung ano, yung gain ng ampere”	21
Technological Knowledge		Technological Knowledge. This refers to teacher’s knowledge on the use of technology in education. -This knowledge provides teacher an awareness to keep abreast of the current educational technology 1. TK Limitations and challenges	19
	TK Limitations and challenges	Limitations and challenges	1