TECHNOLOGY INTEGRATION IN TEACHING SCIENCE USING TPACK AMONG PRE-SERVICE SCIENCE TEACHERS OF ST. BRIDGET COLLEGE, BATANGAS CITY, PHILIPPINES

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ABSTRACT

Technology is now one of the most influential and important instruments in meeting the demands and coping up with the changes in the field of education. Understanding the implication of Technological Pedagogical Content Knowledge (TPACK) framework in integrating technology in teaching science was help the teachers to facilitate effective science teaching-learning process for the students to acquire all the necessary knowledge and skills from their curriculum. This study used a descriptive method of research which aimed to assess the importance of TPACK Framework as a basis for integrating technology in teaching science of the second year and third year pre-service science teachers of St. Bridget College, Batangas City, Philippines. This became the focus of the survey questionnaire made by the researchers. With regards to the effects of TPACK Framework in Teaching Science relevant to the content, respondents agreed that the TPACK framework makes the content easily understandable. In terms of pedagogy, they agreed that it allows experiential learning experiences, and in terms of technology, respondents agreed that TPACK Framework strengthens the teacher's ability to teach the subjects. Regarding the extent of technology support to 21st century Science Teaching, respondents agreed that in terms of delivery, it arouses students' interest and motivation to learn. In terms of Instructional Materials, they agreed that technology support gives accessible and current information which broadens learning; and in terms of content knowledge, they also agreed that it helps students analyze and understand graphical representation of data easily and clearly. Furthermore, in terms of the use of instructional materials, respondents agreed that the speaker helps in the production of sound in studying science particularly, physics. Based on the findings, a Technological Enhancement Activity using Web quest is proposed as the output of the study which can be used to enhance the science teaching-learning process and enrich science teaching through the use of TPACK Framework. In addition, the responses of the research participants were treated with the use of frequency, weighted mean and ranking. Generally, the researchers recommend the creation of software application to improve science teaching and technological skills of the teachers and the students. In addition to this, future researchers should use a bigger number of respondents to gain more accurate result.

Keywords: Descriptive Method of Research, Learning Process, Pre-service Teachers, Technology Integration, TPACK Framework, Teaching Process, Web Quest, Philippines

INTRODUCTION

To fully cope up with the challenges of the 21st century, the educational system must continue to improve and develop. For this reason, there is a worldwide trend toward producing teachers with high teaching competency specifically in Science Education. To help teachers teaching science to become competent facilitators of learning, the use of technologies in teaching a specific content in the classroom context, the epistemology of Technological Pedagogical Content Knowledge (known as TPCK or TPACK) is used as a basis for designing a particular arrangement of courses for science teacher education programs to help meet the needs of the 21st century teacher education development. The TPACK includes seven constructs that capture the different types of knowledge for effective integration of technology into the teaching of content. These include Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). Content Knowledge (CK) is the knowledge about the actual subject matter that is to be learned or taught. Pedagogical Knowledge (PK) is the knowledge about the processes and practices or methods of teaching and learning and Technological Knowledge (TK) is the knowledge about standard technologies and the skills required to operate particular technologies. Pedagogical Content Knowledge (PCK) is the knowledge about particular teaching practices that are appropriate for the nature of specific subject content. Technological Content Knowledge (TCK) is a particular subject matter that could be manipulated into appropriate representation by the application of standard technologies. Technological Pedagogical Knowledge (TPK) is the knowledge about the existence, components, and capabilities of standard technologies that could be appropriately used to particular support for the processes of teaching and learning; and Technological Pedagogical Content Knowledge (TPACK) is the dynamic transactional relationship between and among the knowledge and content, pedagogy and technology in order to develop appropriate context-specific strategies and representation for better learning or content knowledge. It was explained also by UNESCO the competencies needed for content, technology, pedagogy and profession development required by teachers to develop technological pedagogical content knowledge. Such competencies include the ability to manage information, structure problem tasks, and integrate open-ended software tools. It also involves the ability to integrate subject-specific applications with student-centered teaching methods as well as collaborative projects in support of students' deep understanding of key concepts and their application to solving complex real-world problems. This develops and helps the teacher to be knowledgeable of using technology tools to make teaching-learning process more meaningful. This study wants to emphasize the effects of integrating technology in teaching science through the use of TPACK. This assesses the importance of aligning content and pedagogy with the use of appropriate technology tools in the teaching-learning process. This helps the pre-service teachers, at the same time, the in-service teachers to appropriately support the science teaching using the different technology tools. In addition, this study is far different from other studies because this it promotes awareness and help the teachers and students to acquire all the necessary information and knowledge needed to understand the implication of TPACK in integrating technology in teaching science. This study also helps the different educational institutions in making a way of integrating technology in their curriculum and assess the learners' performance from a technology-based education.

CONCEPTUAL FRAMEWORK

Recent research indicates that educational

technologies, including digital media, probe ware, modeling tools, computer simulation, and virtual collaborative environments can effectively support teachers' teaching practices in integrating inquiry-based instruction in their science classroom. To be most effective, educational technologies should be situated in a flexible way of knowledge of content, pedagogy, and technology. (Maeng, Mulvey, and Bel l 2013). Due to the demands of educational technologies to support inquiry teaching and learning, teachers' knowledge of content, pedagogy, technology, and their interaction is necessary for successful integration of educational technologies into the science classroom. This research study proposes the great importance of changing the educational system by integrating technology in the classroom through the use of TPACK. As part of it, the constructivist theory is a learning theory which explains how people might acquire knowledge and learn. It has a direct application to education. This theory suggest that humans construct knowledge and meaning from their experiences. This supports the idea of the importance of integrating technology in the classroom by stating that the students are the ones who need to construct their own knowledge based on their current and previous experiences, as well as with the interaction from others. Students can only do that by actually constructing their own knowledge through the use of technology. The use of technology nowadays helps the teachers let the students unlock their own understanding of the things by just following instructions provided on the given technology. On the other hand, inquiry-based learning theory starts by posing questions, problems or scenarios—rather than simply presenting established facts or portraying a smooth path to knowledge. The process is often assisted by a facilitator. This theory supports the needs of integrating technology in the classroom because students should be taught with updated and meaningful lessons in a student-centered way to enable them to respond to real-life problems. The conceptual paradigm followed the IPO or the input- process- output model. It showed the simplified form of this study. The figure below illustrates how the study was conducted. The researchers administered a questionnaire to the respondents in order to identify the effects of technology integration in teaching science through the use of TPACK. Afterward, the researchers came up with the technological enhancement activity as an output of this study.

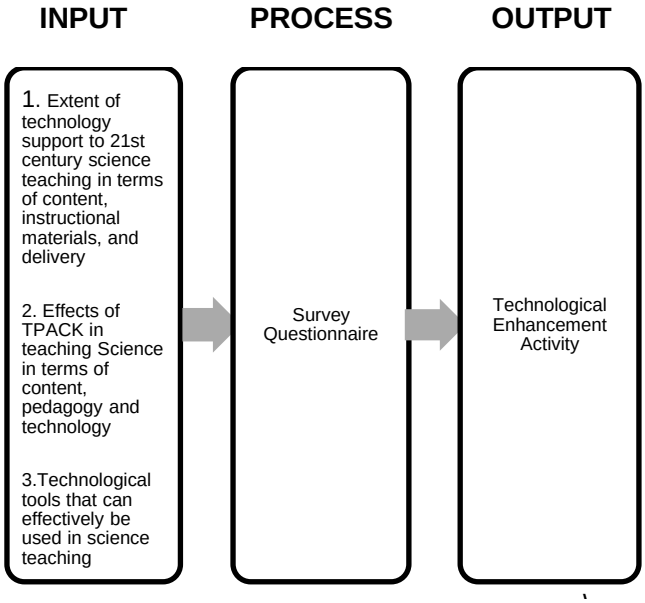

Figure 1. Research Paradigm of Technology Integration in Teaching Science

OBJECTIVES OF THE STUDY

The purpose of this study was to understand the implication of technology integration in teaching science using TPACK among pre-service science teachers of St. Bridget College. Specific aims include the following: (1) to determine the extent of technology support to 21st century science teaching in terms of content, instructional materials, and delivery; (2) to identify the effects of TPACK in teaching science relevant to content, pedagogy, and technology; (3) to identify technological tools that can be used by the pre-service science teachers in their science class; and (4) to develop technological activity can be proposed to enhance the science teaching-learning process.

METHODOLOGY

The researchers used the descriptive method of research involving the collection, analysis, and interpretation of data concerning the importance of TPACK as a basis for integrating technology in teaching science. The researchers made use of a questionnaire covering the effects of TPACK relevant to content, pedagogy and technology, the extent of technology support in teaching science in terms of content, instructional materials and delivery, technology tools that can be used to effectively teach the science subject, and the technological activity that can be proposed to enhance the teaching-learning process. The researchers chose the 28 respondents coming from the second year and third year pre-service science teachers of St. Bridget College as the main respondents of the study. The respondents are chosen to help the researchers assess the importance of using TPACK as a basis for integrating technology in teaching science. This study assessed the importance of TPACK in integrating technology in teaching science. This uses a survey questionnaire that is composed of 3 parts. The researchers asked the help of the chosen respondents to answer the given questionnaire to find out the relevance of this study. The data gathered were computed to get the result of this study interpreted by the researchers. The findings of this study were contributed to the improvement of the educational system of the institution.

RESULTS AND DISCUSSION

1. The Extent of Technology Support to 21st Century Science Teaching in terms of Delivery, Instructional Materials, and Content

1.1 in terms of Delivery

As presented in Table 1, most of the respondents agreed that the extent of technology in terms of delivery arouses students' interest and motivation. It obtained a weighted mean of 3.71, ranked first and was strongly agreed. The item increases teachers' confidence in teaching the subject matter had 3.57 as its weighted mean, ranked second and was strongly agreed by the respondents.

Table 1. The Extent of Technology Support to 21st Century Science Teaching in terms of Delivery

A. Delivery	WM	VI
1. Arouses students' interest and motivation	3.71	SA
2. Increases teacher's confidence in teaching the subject matter	3.57	SA
3. Meets students' expectation of the subject matter	3.43	SA
4. Motivates students to participate actively	3.43	SA
5. Makes the student understand complex area clearly	3.36	SA

This category stated technology in terms of delivery. On the other hand, some of the respondents agreed that in terms of delivery, technology meets the students' expectation of the subject matter and it motivates students' to participate actively. These two items have the same rank and with the weighted mean of 3.43, with verbal interpretation strongly agreed In addition, the respondents agreed that technology makes the student understood a complex area clearly. It obtained 3.36, ranked fifth and was strongly agreed by the respondents. The result of the table is related to the study of the of Ryan and Cowie (2009) claimed that technology can foster independent as well as collaborative learning while Osborne and Hennessy (2011) asserted that ICT has the ability to enhance investigative learning in science.

1.2 In terms of Instructional Materials

As presented in Table 2, among the 28 respondents they agreed that the extension of technology to instructional material gives accessible and current information which broadens learning. It obtained an average of 3.64 as weighted mean and ranked first. The next item engages the students to participate in the teaching-learning process gained a weighted mean of 3.61 and ranked 2nd. It was followed by the item, increases students' interest and motivation which has 3.57 weighted mean that ranked third.

Table 2. The Extent of Technology Support to 21st Century Science Teaching in terms of Instructional Materials

B. Instructional Materials	WM	VI
1. Gives a piece of accessible and current information which broadens learning	3.64	SA
2. Engages the students to participate in the teaching-learning process	3.61	SA
3. Increases students' interest and motivation	3.57	SA
4. Promotes a conducive learning environment	3.50	SA
5. Provides options for tailoring optimal pace of learning	3.36	SA

The second to the last item provides a conducive learning environment gained 3.50 as its weighted mean. Few of the respondents agreed that technology support to instructional material provides an option for tailoring optimal pace of learning, having a weighted mean of 3.36 that ranked fifth for this category. The verbal interpretation for this category is strongly agreed. The results above support the study of Beyerbach et.al (2008) who further argued for technology integration in teacher education to provide pre-service teachers with hands-on experiences, exploring computer technologies and their applications in teaching and learning. These items were evident from the study conducted by McCrory (2008) which stated that having adequate pedagogical knowledge allows teachers to teach effectively a particular science concept to a particular group of students. It is evidently shown on the second item wherein the integration of technology and pedagogical knowledge consider the affordance of learning to both pre-service teachers and students.

1.2 In terms of Contents

As indicated in Table 3 on the extent of technology support to content knowledge, the item, helps students analyze and understand graphical representation of data easily and clearly and the item helps demonstrate concepts in a more effective and understandable way ranked first with a weighted mean of 3.71. Some of them agreed that the extent of technology support to content knowledge helps students understand the lesson well with its weighted mean of 3.39.

Table 3. The Extent of Technology Support to 21st Century Science Teaching in terms of Content

C. Content	WM	VI
1. Help students analyze and understand graphical representation of data easily and clearly	3.71	SA
2. Helps demonstrate concepts in a more effective and understandable way	3.57	SA
3. Help students analyze and understand graphical representation of data easily and clearly	3.71	SA
4. Provides connection with real-world application and Experience	3.39	SA
5. Supports interdisciplinary learning of the subject matter	3.32	SA

The item which ranked fourth stated that associating technology to content provides a connection with a real-world application and experience. It gained 3.39 as weighted mean. The last item supports interdisciplinary learning of the subject matter has a weighted mean of 3.32 and ranked fifth. Strongly agree was the result of the verbal interpretation for this category. As presented in the table can be related to the study conducted by UNESCO (2008a), which indicates that TPACK has the ability to integrate subject-specific applications with student-centered teaching methods as well as collaborative projects in support of students' deep understanding of key concepts and their application to solving complex, real-world problems. This statement relates to the first and fourth items wherein technological support to content knowledge helps the students to analyze and understand data because there is a highlight for real-life applications. Technology gives powerful springboards for learning and useful goals of science instructions. It leads to a variety of constructivist and student-learning approaches.

2. The Effects of TPACK in Teaching Science Relevant to Content, Pedagogy, and Technology

2.1 The Effects of TPACK in Teaching Science Relevant to Content

As presented in table 4, the item which states that TPACK is relevant to content because it provides opportunities to perceive the knowledge clearly obtained a weighted mean of 3.54 and ranked first. The item that ranked second with 3.50 as the weighted mean, tells us that it makes scientific knowledge more accessible. Respondents agreed that TPACK increases the intellectual capability of the teachers to teach the topic well with 3.46 as weighted mean and ranked third.

Table 4. The Effects of TPACK in Teaching Science Relevant to Content

A. Content	WM	VI
1. Provides opportunities to perceive the knowledge clearly	3.54	SA
2. Makes scientific knowledge more accessible	3.50	SA
3. Increases intellectual capability of the teachers to teach the topic well	3.46	SA
4. Makes the content easily understood	3.41	SA
5. Strives to capture some of the essential knowledge	3.36	SA

The item that ranked fourth with 3.41 as its weighted mean, explains that TPACK makes the content easily understood. The last item with 3.36 tells that it strives to capture some of the essential knowledge. It ranked fifth. The items under this category have a verbal interpretation of strongly agree. According to McCrory (2008) investigated science teachers' TPACK, pointing out that four knowledge bases are vital to science teachers' development of TPACK such as content, students, technology, and pedagogy. According to him, science teachers need to possess adequate knowledge of science to help students develop understandings of various science concepts.

2.2 The Effects of TPACK in Teaching Science Relevant to Pedagogy

As stated in Table 5, TPACK is relevant to pedagogy as it allows experiential learning experiences which ranked first with a weighted mean of 3.64.

Table 5. The Effects of TPACK in Teaching Science Relevant to Pedagogy

B. Pedagogy	WM	VI
1. Allows experiential learning experience	3.64	SA
2. Creates a student-centered learning environment	3.57	SA
3. Allows the teacher to teach a particular science concept effectively	3.46	SA
4. Creates a well-designed lesson plan for effective teaching	3.46	SA
5. Employs effective teaching strategies	3.43	SA

Most of the respondents agreed that it creates a student-centered learning environment having a weighted mean of 3.57 as and ranked second. This was followed by the item stating that it allows the teacher to teach a particular science concept effectively and creates a well-designed lesson plan for effective teaching with a weighted mean of 3.46 in the same rank. The last item that stated that TPACK is relevant to pedagogy as it employs effective teaching strategies with a weighted mean of 3.43. The verbal interpretation of all the items is strongly agreed.

2.3 The Effects of TPACK in Teaching Science Relevant to Technology

Table 6. The Effects of TPACK in Teaching Science Relevant to Technology

C. Technology	WM	VI
1. Strengthens the teacher's ability to teach the subject	3.64	SA
2. Organizes the teaching-learning process	3.64	SA
3. Enhances teacher's capability to teach the content	3.57	SA
4. Builds teacher's confidence in teaching complex area of subject matter	3.54	SA
5. Meets the expected students' needs	3.29	SA

As can be seen in Table 6, most respondents agreed that TPACK is relevant to technology as it strengthens the teacher's ability to teach the subjects and it organizes well the teaching-learning process. The items obtained a weighted mean of 3.64 with the same verbal interpretation strongly agree, The item which has

3.57 as its weighted mean ranked 3rd explaining that technology enhances teachers' capability to teach the content. Most of the respondents also agreed that technology "builds teachers' confidence in teaching complex area of the subject matter having 3.54 as its weighted mean and ranked 4th for this category. Other respondents agreed that technology meets the students' needs having 3.29 as its weighted mean and ranked 5th. The verbal interpretation for this category is strongly agreed. The result in this table is connected to the idea of Maeng, et al., (2013), who conducted a study stating that educational technologies including digital media probe ware, modeling tools computer simulation and virtual collaborative environments can effectively support teachers' teaching practices in integrating inquiry-based instruction in their science classroom.

3. The Technology Tools that Can Be Used in Teaching Science

Table 7. The Technology Tools that Can Be Used in Teaching Science

III. Technology Tools	WM	VI
1. Speaker helps in the production of sound in studying science particularly physics	3.82	SA
2. Computer/Laptop serves as an instrument of presenting concepts and facts	3.79	SA
3. Web quest makes lesson fun and interesting	3.71	SA
4. LCD Projector helps the students visualize the information clearly	3.64	SA
5. PowerPoint Presentation helps teachers present the lesson in a dynamic way	3.64	SA
6. E-Book/Tablet serves as alternative resource material in discussing science	3.57	SA
7. Cell phone serves as one of the sources of information and communicative way of disseminating information	3.50	SA
8. Smart TV presents information in an organized way and connects to the internet easily	3.36	SA
9. Compact Discs (CD) provide readily available resources about a certain topic	3.29	SA
10. OHP presents science information and facts	3.21	A

As can be seen in table 7, the technology tool that ranked first is the use of speaker, used for the production of sound in studying science, has 3.82 as its weighted mean followed by the use of laptop/computer which has 3.79 of its average weighted mean, which can usually be used as an instrument of presenting facts and concepts. On the other hand, the technology tool that ranked 10 is the use of OHP (Over Head Projector) which presents information and facts. All the items for this category obtained the verbal interpretation of strongly agree. According to Maeng (2013), digital technology can provide students the opportunity to engage in virtual reality.

5. A Proposed Action Plan to enhance the science teaching-learning process

Based on the findings of the study, the researchers created web quests for different grade levels. This was a good aid to make the science teaching-learning more meaningful and capable of developing scientific competencies among the pre-service teachers and students.

CONCLUSIONS

Based on the findings of the study, the following conclusions were drawn:

1. The extent of technology support to the 21st-century science teaching in terms of delivery arouses student's interest and motivation; in terms of instructional materials gives accessible and current information which broaden learning; in terms of content helps student analyze and understand graphical representation of data easily and clearly.
2. The effects of TPACK in teaching science relevant to content include providing opportunities to perceive the knowledge clearly. In terms of pedagogy it allows experiential learning experiences and in terms of technology, it strengthens the teacher's ability to teach the subject and organizes the teaching-learning process.
3. The technology tool that can be used in teaching science is the speaker which helps in

the production of sound in studying science, particularly physics. It is followed by the use of a computer or laptop which serves as an instrument in presenting concepts and facts.

RECOMMENDATIONS

In light of the findings and conclusions from this study, it was recommended that the researchers should focus on a wider scope of the study and should consider a bigger number of respondents; there should have an assessment of whether the technology tools are really helpful or can really improve the science teaching to have a more accurate result.

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