Self-efficacy on Technological, Pedagogical and Content Knowledge (TPACK) of Biological Science Pre-Service Teachers

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Abstract - *The teachers are the focal figure in education and play vital roles in learning. These roles have served as key point in designing the curriculum and preparing pre-service teachers. Turning students into competent teachers is an interplay of varied factors, one of which is technology. This impact necessitates the utilization of technology in teaching, described as technological pedagogical content knowledge (TPACK).*

The study aimed to investigate TPACK self-efficacies of pre - service biological science teachers who were enrolled in two academic years at the College of Teacher Education in a state university in the Philippines. It also examined whether the responses of the two groups of respondents on TPACK self – efficacy differ and whether these self-efficacies relate to sex, electronic gadget owned and access to internet. It used the descriptive survey method of research employing a questionnaire on TPACK to collect data. The study found out that there is more female than male. Majority have electronic gadgets but have limited access to internet. Findings showed that respondents have good TPACK self – efficacy. The findings showed that the responses of the two groups of participants on TPACK self – efficacies are statistically different . Further, their self – efficacies is very slightly affected by their sex, electronic gadgets owned and access to internet. The study recommends reviewing and improving instructional practices and curriculum of the college to enhance TPACK of respondents.

Keywords: *TPACK, pre-service teachers, pre-service science teachers, pedagogical knowledge, technology integration*

INTRODUCTION

The teachers are the focal figure in education. They have varied and vital roles in the classroom [1]. Various responsibilities, which expand from uncomplicated to intricate and at the same time, exigent and invigorating are inherent to their roles. Every day, they perform these responsibilities as part of their commitment to the teaching job. They must be, therefore, competent and possess the pedagogical knowledge and skills vital in enabling learning among students. These requisites demand teachers to have a mastery of the subject they taught coupled with knowledge of principles and methods of teaching, classroom management, use of instructional materials and assessment. Further, teachers must also consider the nature of the learners and his general development. The teacher should have the ability to recognize individual differences and adjust instructions accordingly.

The myriad responsibilities of teachers have served as key point in designing the curriculum in many teacher education institutions and preparing pre-service teachers for their tasks ahead. Teacher education institution aims at developing competent teachers out of the students they prepare. Turning students into competent teachers is a serious tasks, which is an interplay of varied factors. The process starts with screening and selective admission of incoming students. More importantly, it must be supported by a relevant curriculum, competent faculty members, appropriate instructional materials, strong student support system, effective and efficient assessment system and school administration guided with a vision and mission. There is also a need for experiential learning as this will expose pre-service

teachers to the actual situation of the teaching – learning process. They can get valuable insights essential in developing proper resolve for teaching.

In addition to these factors, the impact of technology is also of paramount concern. Computers, ICT, internet and cell phone are now part of our existence. We are now living in a world whereby technology continuously shapes and affects the way we do and perceive things. Technology has manifested its influence on almost everything we do and its impact on education and learning is steadily growing. We have now a new breed of learners in our classroom whose learning is interwoven with the technology we use in instruction.

These developments have put pressure on academic institutions to improve the curriculum and make it relevant to the needs of the present times. There is an urgent and persisting need for integrating technology in the learning process. This has become an important concern in improving learning among students, so much so in the case of students aspiring and training to become teachers in the very near future. Thus, the preparation of pre – service teachers must include integration of technology to keep them abreast with educational technology innovations and make their preparation relevant to the needs of the students they will be teaching.

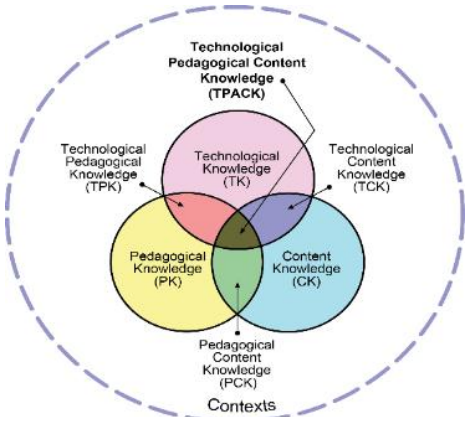

Figure 1. TPACK and its components (Koehler, Mishra, 2008).Used with permission of the publisher, © 2012 by tpack.org.[3]

The integration of technology in classroom teaching is described as technological pedagogical content knowledge (TPACK). As technology has penetrated in almost every aspect of our life, there is an urgent need for new teachers to acquire the ability of incorporating technology in the curriculum for innovative and relevant teaching. Thus, developing TPACK is now essential in the preparation of prospective teachers for teaching effectiveness and is described by Mishra and Koehler [2] in their Technological Pedagogical Content Knowledge framework.

The three basic knowledge teachers must possess are shown in the framework to be content knowledge, pedagogical knowledge and technology knowledge. Content knowledge refers to teachers' in – depth knowledge on his subject of specialization [4]. Pedagogical knowledge (PK) is described as teachers' in-depth knowledge about the teaching and learning process [4] and pertains to understanding of the dynamics of student learning, including planning, management and assessment of student learning [4]. Technology knowledge (TK) pertains to knowledge about technology, tools and resources. This encompasses using information technology in the work place and in activities in daily life, using technology to accomplish a purpose, and continually adjusting to innovations in information technology [4].

The framework displays pedagogical content knowledge overlapping with pedagogical knowledge to form pedagogical content knowledge, which includes the basics of an effective teaching- learning process, developing the curriculum, implementing assessment and regular reporting to promote learning among student [4].

Next, content knowledge intersects with technology knowledge resulting to the so – called technological content knowledge (TCK). This knowledge can be described as the use of appropriate technology in teaching a subject matter to attain desired learning outcomes and in turn how the subject matter may influence the technology to be employed [4].

Further, technology knowledge forms a link to pedagogical knowledge through the technological pedagogical knowledge (TPK). TPK involves an understanding of how teaching and learning can change when particular technologies are used in particular ways. This includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies [4].

Altogether, these six knowledge domains synthesize to form the technological pedagogical content knowledge (TPACK) and place much

importance on educational technology integration into classroom practices [4]. Additionally, TPACK serves as the foundation of successful teaching using technology. It means taking advantage of technology to facilitate the attainment of learning outcomes among students. It requires a thoughtful consideration of how concepts can be represented and made interesting to learners with the application of technologies. Further, it equates to being able to use pedagogical strategies that incorporate technologies in teaching a subject [4].

As the integration of technology is considered an important preparation for pre-service teachers, there is a need to assess their TPACK. The resulting information can be fed back in enhancing the curriculum and the preparation of prospective teachers. In line with this, this study assessed the TPACK self - efficacies of a sample of pre-service teachers enrolled in the Bachelor in Secondary Education major in Biological Science program at a state university in a region of the Philippines. The study hopes to generate data and information on TPACK of respondents which can be used as the underpinning for enhancing their teacher education preparation and shedding light on what aspects of the curriculum need to be strengthened. The study will also establish whether the use of technology in education is translated into teaching practice by faculty members and this important finding can be fed back to them to spearhead their own professional development initiative.

OBJECTIVES OF THE STUDY

The focal purpose of this study is to investigate self-efficacy on technological, pedagogical and content knowledge (TPACK) of biological science pre-service teachers who were enrolled in two academic years in a state university. In addition, the study examined whether the responses of the two groups of respondents on TPACK self – efficacy differed and whether these self-efficacies relate to sex, electronic gadget owned and access to internet.

METHODS

In this study, the researcher investigates the self-efficacy on technological pedagogical and content knowledge of a sample of pre - service secondary teachers enrolled in the academic year 2014 – 2015 and 2015 - 2016 at the College of Teacher Education, Batangas State University ARASOF Nasugbu, Nasugbu, Batangas, Philippines.

The study used descriptive survey method to gather data needed in the study. It utilized respondents who were students enrolled in the Bachelor of Secondary Education major in Biological Science (BSED) program in the Academic Year (AY) 2014 - 2015 and AY 2015 – 2016 of the aforementioned university. There are only 13 students enrolled in the BSED program AY 2014 - 2015 and 24 in the AY 2015 - 2016. As the researcher is the associate dean of the college and at the same time, one of the instructors of the target respondents handling science major courses and professional teacher education courses, all of them (37) voluntarily participated as respondents of the study.

The student - respondents are about 1/3 of the total number of graduating students enrolled in the Bachelor of Secondary Education programs for each respective academic year with specialization in Biological Science, Mathematics and English. All these students were selected for this study because they are all specializing to become biological science teachers, the focus of this study. As to age profile, all respondents are in the age bracket that can be expected from typical enrolees for this fourth year level of college, that of 20-21 years of age.

The study employed a survey questionnaire to collect data needed to achieve the objectives of the study. It used in particular the Technological Pedagogical Content Knowledge questionnaire by Schmidt, Baran, Thompson, Koehler, Mishra, and Shin [6] to collect data needed. The researcher emailed the authors of the questionnaire to obtain their permission to use and adapt the said scale for this study. When the researcher received the permission, she analyzed the content and deleted some items as they were deemed not applicable for pre – service secondary biological science teachers. All in all, only 37 questions from the original questionnaire were used. The instrument's content validity and reliability were tested previously by Schmidt, Baran, Thompson, Koehler, Mishra, and Shin [6], so it was not tested again for this study.

Student observations and interviews were also conducted to substantiate the findings of the study. Observation included those what has been seen happening in the respondents' classroom. Informal interviews were conducted before, during, and after classes.

The instrument was distributed to pre-service teachers to collect required data. Afterwards, the data were tallied, analysed and interpreted. Weighted mean, percentage, frequency and ranking were used to describe the typicality of responses. The levels that are used to interpret verbally weighted mean are as follows: "strongly disagree" for average values between "1.00–1.50"; "disagree" for average values between ranges of "1.51–2.50"; "neutral" for average values between ranges of "2.51– 3.50"; "agree" for average values between ranges of "3.51–4.50", and "strongly agree" for values between ranges of "4.51–5.00".

To identify if the responses on TPACK self – efficacy differ, t- test of independent samples was used. To determine if a relationship between sex and TPACK, electronic gadget owned and TPACK and access to internet and TPACK, Pearson r was used.

RESULTS AND DISCUSSION

The respondents' sex, electronic gadgets owned and access to internet

For the first group of respondents, 2 are male and 11are female while for the second group of respondents, 8 are male and 16 are female indicating the preponderance of female in this type of program of study.

This research involved a survey of technology, ICT and internet applications used by pre –service teachers to acquire knowledge and learn as well as in their pre-service teaching experiences. This may shed light on the objective of finding how they improve on their knowledge regarding technology.

All respondents have their own cell phone with access to internet although for many of them, this access is limited. Majority own smart cell phones. Mostly, they use the cell phone for personal communication to send messages to their family and friends (via social media and cell phone lines), and for academic purposes to inquire about school projects and activities. They use the internet connections to send emails, for research, that is, whenever they want answers to questions they themselves cannot answer and as a consequence, it becomes instrumental in knowledge acquisition and learning.

Most have their computer/laptop unit and are all, therefore, are computer literate. They use computer for doing a lot things, from completing and doing course requirements to personal and social communication with people. For the minor few who do not have their own computer unit, they use computers whenever they have the opportunity – when friends allow them to use their computers, in school when there are available units or in computer café when they strongly felt the need to use a computer to accomplish school and course requirements. Since all are computer literate, all take advantage of power point presentation and other kinds of presentation for class activities.

In addition, a few has smart TV, tablets and even educational soft wares, which they use to further their learning and for their personal enjoyment.

Pre-service biological teachers' CK, PK and TK

For respondents' self – efficacy about science content knowledge (CK), the data revealed that respondents have confidence in the level of their science knowledge. Under this category are three items to which respondents give a rating of 4.1, 4.3 and 4.4 respectively. Considering their answers in items in other categories, these self – efficacy ratings are relatively high, emphasizing their belief that they have good science knowledge. This is an imperative in the field of teaching. Having good content knowledge in the course you are to teach is a prerequisite for effective teaching.

In particular, respondents agree they have diverse ways and approaches of expanding their understanding of science and these are through personal research, reading of books, magazines and internet sources and also through television shows. Close observation found out these students have initiatives of improving their learning and expanding their knowledge. They ask questions and search answers to questions. Additionally, respondents agree that they have sufficient knowledge about science owing to their curriculum, which they said is adequate in providing them the needed content knowledge in science. To this, they also agree they can use a scientific way of thinking, this as an application of science in decision making and everyday life.

For respondents' self – efficacy in terms of pedagogical knowledge, data collected show respondents are confident of having good knowledge in terms of classroom assessment, using a variety of teaching approaches and adapting teaching style, student understanding and misconceptions, and classroom management. The respondents answer agree to all seven items under this category and the

weighted mean ranges from 3.9 - 4.2, which can be noted to be slightly lower to the mean ranges obtained in content knowledge self – efficacy. Nevertheless, these values reflect their faith in their curriculum as well as the institution preparing them adequately to perform pedagogical functions. In the study of Horzum, Demirbaş, and Bayrakci [7],pre – service teachers reported that they were provided with adequate education on technology and pedagogy at university.

The assessment of respondents' technological knowledge self – efficacies revealed that they answer *agree* to all items, which can be taken to mean that they believe they have good technological knowledge. There are seven items in this category and the weighted means fall within 3.6 – 4.1. This interpretation is supported by respondents' agreement that they can learn technology easily (WM=4.1). This response coincides with the researcher's personal observation of these students' ability and initiative to keep themselves updated with latest technology through the internet, asking to be taught by friends who are knowledgeable in the said technology and through self – learning.

Another response accentuating good technological knowledge of respondents relate to their admission that they possess the technical skills needed to apply technology and they can keep abreast with relevant new technologies (WM = 3.9). These admissions implied that they grab available opportunity to use these technologies so that they will learn more about them and they can keep themselves abreast with the latest technology.

The responses to the remaining items of agree also synthesize to the interpretation of good technological knowledge. Respondents disclosed that they believe they are capable of solving their own problems about using technology. They reported having adequate exposure to different technologies. They believe they can become skilled at technology without so much difficulty. In addition, they divulge that they have frequent opportunities to play around with technology and they can identify with a variety of technologies. These statements clearly indicate respondents' self – efficacy at the level of agree for technological knowledge.

Accordingly, it can be concluded that these pre-service teachers regard themselves as highly sufficient in terms of CK, PK and TK.

Pre-Service Biological Teachers' Pedagogical Content Knowledge, Technological Content Knowledge, Technological Pedagogical Knowledge

With reference to pedagogical content knowledge, the respondents' self – efficacy was at the level of "agree. They indicated that they are competent enough in identifying effective teaching approaches to facilitate students' cognitive process and learning in science. Teaching approaches are some of the major topics in the courses Principles of Teaching 1 and 2 which are part of their program curriculum. The response implies respondents' confidence to have a solid background on different teaching approaches hence they are have the capability to select effective teaching to promote higher order thinking skills in science.

For the self-efficacy in technological content knowledge, there is only one item and the respondents gave their view as "agree'. They disclosed that they are familiar with many technologies that they can take advantage of for learning and doing science. When interviewed how they become knowledgeable about the said technologies, they unanimously responded that these were integrated in the different courses they took up. The integration of ICT's and internet applications may contribute to teacher's TPACK development [8]. Additionally, they were also pressured to study these technologies and internet applications because they need them to answer projects and assignment.).

Under the category of technological pedagogical knowledge with 5 items, the respondents perceived a self-efficacy at the level of "agree" with weighted means values of 4.0 - 4.1. They reported that they are capable of identifing the kind of technologies that will improve the teaching methods for a science lesson and that also enhance students' science learning. Furthermore, they agree that their preparation in teacher education has instilled in them to be analytic and at the same time, critical of the technology they will be using in teaching and in the classroom for effective learning of students. This means that they can identify its advantages and disadvantages on the teaching approaches they will use in the classroom and whether the technology will improve student engagement or not in the learning process. They also unveil that they are satisfied with their capability of adapting the utilization of the technologies they are familiar with to suit their different teaching activities.

Pre-Service Biological Teachers' TPACK

Generally, the respondents professed self – efficacies at the level of agree to all five items in this category of TPACK with weighted mean ranges of 3.8 – 4.5. Among the different knowledge in the TPACK framework, it can be noted that respondents reported the highest level of self - efficacy of 4.5 in this area and this is for the item on offering leadership or guidance in assisting others to maximize the benefits of integrating content, technologies and teaching strategies. This statement asserts respondents' leadership potential and level of confidence in using technology, which can be considered an outcome of their learning experiences in the college and their enthusiasm in learning technology.

The lowest rating of 3.8 for employing teaching strategies that integrate content, technologies and teaching approaches they learned in their course implies a slight decline in the respondents' level of self – confidence with respect to technology integration. However, it can be noted that this value is still high considering their responses in other area.

Other items in between the highest and the lowest values emphasize the high level of self – efficacy of respondents. The respondents revealed that can identify technologies that will appropriately enrich content of a science lesson (4.1). In similar manner, respondents affirm that they can choose technologies for utilization in their classroom (4.0) that will enrich what they teach, improve how they teach and what students can learn.

Pre-Service biological science teachers' perceptions of TPACK modelling by their faculty

How and whether teachers integrate technology in teaching may inspire students to use it too. As teachers' practices may have an overriding impact on students learning, this study also included a survey of the respondents' perceptions of the TPACK modelling by their faculty.

The respondents gave their perceptions of the faculty members handling science specialization courses, professional education courses and general education courses and this is disclosed in Table 1.In general, they agreed that all their teachers appropriately model combining content, technologies and teaching approaches in their teaching with weighted mean ranging from 4.0 – 4.2. Faculty members handling general education were rated with the lowest mean of 4.0 for this area but can be considered high considering their responses in other knowledge areas. The other groups of teachers all received a rating of 4.1. These findings can be taken to mean that respondents were exposed to technologies in their learning as students. This response can also be interpreted that they perceived their teachers as skilled in using different technologies in teaching and that they favour the use of technology in teaching.

Likewise, the respondents turned in favourable perception towards their cooperating teachers as evidenced by a weighted mean of 4.2. They perceived that their cooperating teachers were also appropriately modelling combining content, technologies and teaching approaches in their teaching.

Table 1. Pre-Service Biological Science Teachers' Perceptions of TPACK Modelling by Their Faculty

Models of TPACK (Faculty)	WM	VI	Rank
1. My instructors handling science major courses appropriately model combining content, technologies and teaching approaches in their teaching.	4.1	Agree	3.5
2. My instructors handling professional teacher education courses appropriately model combining content, technologies and teaching approaches in their teaching.	4.1	Agree	3.5
3. My instructors handling general education courses appropriately model combining content, technologies and teaching approaches in their teaching.	4.0	Agree	1.5
4. My cooperating teachers/resource teachers appropriately model combining content, technologies and teaching approaches in their teaching.	4.2	Agree	1.5
Composite Mean	4.1	Agree	

Comparison of TPACK of Two groups of Respondents

For the comparison of TPACK self – efficacy of the two groups of respondents, the researcher applied a t-test of independent samples. The T-value obtained is 2.740589 while the p-value is 0.00397, which means that the responses on the TPACK self – efficacy of the two groups of participants are not statistically the same. This means that one group perceives their TPACK to be different from the other group. As the weighted mean of the first group of respondents is higher than that of the second group, it could be that the first group of respondents believed that they have a better TPACK self – efficacy since

they are less in number and they are very motivated and interested in learning about technology.

Pre-service biological teachers' TPACK and sex, electronic gadget owned and to internet.

Many studies attempt at exploring how TPACK may be developed among pre-service secondary science teachers using different methods and strategies. These include the enhancement of TPACK through exposure to ICT course [5], field experiences [9], problem posing [10] and microteaching lesson study [11]. For this study, the TPACK is correlated with sex, electronic gadget owned and to internet.

The data were statistically treated using Pearson r and the results show that there is a weak relationship between respondents' TPACK and sex; TPACK and number of electronic gadget owned; and TPACK and access to internet. The data seem to imply that the development of TPACK of these pre – service secondary science teachers is very weakly influenced by their sex nor by the number of electronic gadget they own and whether they have unlimited access to internet or not. These findings point out that the respondents of the study are very eager in using technology for their learning. They know and accept the relevance of technology in their preparation as pre – service teachers hence they take advantage of every opportunity to learn and apply it. They would not let the circumstances of being a male or female, the gadgets they own and their access to internet to hinder using technology in their learning and their journey to become good teachers.

CONCLUSION

The study investigated the self – efficacy of a sample of pre – service teachers on TPACK. It also examined how the responses on self – efficacy on TPACK of the two groups of responses compare. It also investigated the relationship of TPACK and sex, number of electronic gadget owned and access to internet. The findings of the study result to the following conclusions. The profile of the respondents showed greater number of female over female. Majority have electronic gadgets that they use whenever possible. Their access to internet is limited. Findings on TPACK self – efficacy point out that biological science pre-service teachers have good TPACK self – efficacy. They assessed that their teachers have good TPACK modelling also. The two groups of respondents have reported different TPACK self – efficacies. Further, their self – efficacies on TPACK is very slightly affected by their sex, number of electronic gadgets owned and access to internet.

RECOMMENDATION

One finding that the researcher feels noteworthy for making recommendation is that there is a significant difference in the TPACK self – efficacy among the two groups of respondents. This finding can be used as basis in reviewing the curriculum and instructional practices in the college. Faculty members should be encouraged to enhance technology integration in providing learning experiences among the students to enhance TPACK of pre-service biological science teachers. The college may also organize seminars and workshops on the use of technology in teaching and improving the curriculum for both pre-service teachers and faculty members themselves. This effort should be complimented with the procurement of equipment needed to improve technology integration in the curriculum. In as much as the study focussed only on the TPACK of pre-service biological science teachers, the TPACK of other pre-service teachers should also be explored to obtain a clearer picture of the extent of TPACK of these students, the findings of which should also be subjected to test of significant difference and the reasons for the difference be accounted for.

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