Exploring Technological, Pedagogical, and Content Knowledge (TPACK) and Self Efficacy Belief of Senior High School Biology Teachers in Batangas City

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https://doi.org/10.69721/TPS.J.2018.10.1.03

ABSTRACT

Teachers are considered as one of the key factors in the educational process, especially, in the implementation of a new curriculum. Thus, the introduction and implementation of the new K to 12 curricula, requires monitoring, assessment and evaluation of areas in teaching and learning, in order to ensure that the set goals and objectives were successfully attained. This study aimed to explore two important aspects of teaching such as self-efficacy belief and technological, pedagogical, and content knowledge (TPACK) of private and public senior high school biology teachers from Batangas City for AY 2017-2018. Surveys, focus group discussion and class observation methods were used to gather data. Using mean and standard deviation, the results revealed that biology teachers have moderate self-efficacy belief in both aspects of self-efficacy belief, the personal biology teaching efficacy and biology teaching outcomes expectancy. On the other hand, in TPACK, they were rated as moderately proficient. Furthermore, the study also implies that there is no significant relationship between these two variables when compared using Pearson's *r*, which means that the self-efficacy belief of senior high school (SHS) biology teachers of Batangas City has nothing to do with their TPACK. Designing of a training design framework for faculty development programs and similar studies for physics and chemistry teaching are suggested.

Keywords: Biology Teaching, Content Knowledge, Pedagogical Knowledge, Self-Efficacy Belief, Technological Knowledge, Senior High School

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INTRODUCTION

Having good teachers are very important. Schools and the communities have always sought out the best educators they could get in the belief that their students' success depends on it. Waseka et.al. (2016) emphasized that the most important factor affecting the quality of education is the quality of the individual teacher in the classroom. Tucker and Stronge (2017), on the other hand, stressed that effective teachers not only make students feel good about school and learning, but also, that their work actually results in increased student achievement. As Downes (2011) would say, they are the most important school-based determinant.

Research studies are continuously being conducted to further enhance the quality of educators, ultimately to produce quality graduates. Here in the Philippines, the evolution of the educational system, especially now in the implementation of the K to 12 Program, is really quite challenging. When former president Benigno Aquino signed into law Republic Act 10533 also known as the Enhanced Basic Education Act of 2013, major changes happened. Everybody is on the adjustment phase since it is newly implemented. Inevitably, there are consequences from this shift. Among teachers, there are deep-seated anxieties about the new duties expected of them. To address this issue on teachers, Department of Education (DepEd) conducted mass trainings. However, teachers noted that trainings they have undergone were rushed and not well thought of. France Castro, secretary general of the Alliance of Concerned Teachers (ACT) said the time spent for teachers' training is not enough. He further added that there are lots of new things for teachers to learn in order to implement the new curriculum, thus, one to two months training is not enough (Umil and Viray 2012). Some critics of K to 12 say that the curriculum is "imprecise" and "vague" and the teachers are not ready for their senior high school (SHS) responsibilities. Alliance of Concerned Teachers (ACT) president Antonia Lim said that most teachers are "not prepared" and "competent" enough to teach the SHS subjects after undergoing only five days of training (Quintas 2016). It is on this premise that this study looked into the SHS biology teachers' technological, pedagogical and content knowledge and self-efficacy belief.

Furthermore, the researcher also finds it important to explore these aspects since almost all General Biology teachers are either assigned to a new workplace or transferred from tertiary to SHS or otherwise and facing a new curriculum. It is also the initial stages of having SHS students, it is but relevant to conduct such study to further improve the teaching and learning

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process so as to ensure the realization of the set goals and objectives for the new educational system. It is also worthy to note that this is one of the highlighted topics included in the Philippines' National Integrated Basic Research Agenda (NIBRA) for 2017 – 2022. Therefore, this study was guided by the following research questions:

1. What is the biology teachers' perceived self-efficacy belief in terms of: a) Personal biology teaching efficacy and b) Biology teaching outcomes expectancy?

2. What is the biology teachers' pedagogical content knowledge in terms of: a) Pedagogical knowledge, b) Content knowledge and C) Technological knowledge?

3. Is there a significant relationship between self-efficacy belief and pedagogical content knowledge?

METHODS

This study utilized three data gathering methods: survey, focus group discussion and class observations. A modified Biology Teaching Efficacy Belief Instrument (BTEBI) was used to determine biology teachers' self-efficacy belief based on Savran and Cakiroglu (2001). On the other hand, to evaluate biology teachers' TPACK, researcher self-constructed questionnaire was used. Both questionnaires were validated by four experts in the field and subjected to dry run to selected schools in the province. The data gathered were tabulated and analyzed. Survey questionnaires for both pedagogical content knowledge and self-efficacy were found out to be reliable using Cronbach's alpha.

Class observations were conducted by the researcher and two experts in biology teaching. Fourteen out of 23 teacher-respondents were observed. They were rated using the same instrument used in the TPACK survey. To further substantiate the results, a focus group discussion was also conducted.

After collecting the data, mean and standard deviation were used in the identification of self-efficacy and TPACK, while Pearson's r test of correlation was used for the test of the relationship of self-efficacy belief and TPACK.

RESULTS

In this study, self-efficacy belief of biology teachers have two subscales: personal biology teaching efficacy (PBTE) which is the teachers' belief in their ability to perform biology teaching; and, biology teaching outcome expectancy (BTOE) which reflects their belief that their students can learn biology.

Biology Teachers' Self-Efficacy Belief in terms of Personal Biology Teaching Efficacy (PBTE)

Table 1 shows the biology teachers' self-efficacy belief in terms of personal biology teaching efficacy. It can be gleaned from the table that the statement, *"I cannot effectively monitor my students during experiments because I don't have much experience in handling such activities"* has the lowest mean value of 2.96 followed by the statement *"I am not confident enough that I teach biology effectively because I haven't attended much training in biology teaching"* with mean value of 3.00. The statement, *"I believe I have the necessary skills to teach Biology because my principal and my colleagues say so"* has also a low mean value of 3.13 compared to the rest of the statements. However, these three mentioned indicators of personal biology teaching efficacy have verbal interpretation of moderate self-efficacy belief.

Conversely, the statements *"As much as possible, I don't want my principal to evaluate my teaching because he/she might find my weaknesses as teacher and it's very obvious with my demeanor especially when being observed", "I can continually find better ways to teach Biology through observation of seasoned colleagues", and, "I can identify the steps necessary to teach Biology concepts effectively because I had trainings when I was a pre-service teacher",* have the highest mean values of 3.43, 3.39 and 3.26, respectively, which are all interpreted also as moderate self-efficacy belief.

As a whole, SHS biology teachers were rated as having moderate self-efficacy belief in terms of personal biology teaching efficacy as implied by its composite mean value of 3.20.

Table 1. Respondents' Personal Biology Teaching Efficacy (PBTE)

Statements	Mean	Standard Deviation	Verbal Interpretation
Mastery Experiences			
I can identify the steps necessary to teach Biology concepts effectively because I had trainings when I was a pre-service teacher.	3.26	0.62	Moderate
I cannot effectively monitor my students' during experiments because I don't have much experience in handling such activities.	2.96	0.64	Moderate
I am not confident enough that I teach biology effectively because I haven't attended much training in biology teaching.	3.00	0.80	Moderate
I can teach the subject effectively because I understand Biology concepts well enough from my undergraduate/graduate degrees.	3.22	0.50	Moderate
I can typically answer my students' questions in Biology with confidence because I know biology well enough since I constantly study the course.	3.22	0.50	Moderate
I usually welcome questions from students because I am confident that I can answer any question in Biology since I always update myself with the trends and topics related to it.	3.17	0.49	Moderate
Vicarious Experiences			
I can continually find better ways to teach Biology through observation of seasoned colleagues.	3.39	0.50	Moderate
When my students have difficulty understanding a biology concept, I can help the students understand it better because I learned variety of strategies from my mentors.	3.17	0.49	Moderate
Verbal Persuasion			
I believe I have the necessary skills to teach Biology because my principal and my colleagues say so.	3.13	0.50	Moderate
Somatic and Emotional States			
I can hardly explain to students why Biology experiments work because I am naturally not so good in explaining especially when I am depressed or has personal problems.	3.22	0.60	Moderate
As much as possible, I don't want my principal to evaluate my teaching because he/she might find my weaknesses as teacher and it's very obvious with my demeanor especially when being observed.	3.43	0.51	Moderate
Even I exert much efforts, I cannot turn my students to like Biology maybe because it's quite obvious with how I speak that I am still a newbie.	3.17	0.72	Moderate
Composite Mean	**3.20**	**0.59**	**Moderate**

Biology Teachers' Self-Efficacy Belief in terms of Biology Teaching Outcomes Expectancy (BTOE)

Table 2 shows the self-efficacy belief of SHS biology teachers in terms of biology teaching outcomes expectancy. It is apparent from the table that teachers have moderate self-efficacy with a mean value of 2.35 in the statement, *"If my students are underachieving in Biology, it is most likely due to my shortcomings in teaching them because I, myself, am still learning since this is a new preparation for me"*.

Moderate self-efficacy, with a mean value of 2.77 is also noted with the statement, *"If parents comment that their child is showing more interest in biology at school, I am sure it is due to my performance as his/her teacher because I get the same comments with my colleagues and principal"*. On the other hand, teacher respondents are confident enough of their effectiveness in teaching as reflected on the mean value of 2.91 on the statement, *"I am confident enough of my effectiveness as a teacher, thus low achievement of my students should not be blamed on me because I know I am good and has performed well according to my principal"*.

Different trends can be noted from the following statements on biology teaching outcomes expectancy: *"I can find more effective teaching approach to improve my students' grades in Biology by attending in-service training"; "I can improve the performance of my students in Biology if I exert extra effort in teaching the subject by observing other teachers and learning techniques from them"; "I can help my students overcome their inadequacy in Biology background through exerting extra time and effort in teaching them as what I have observed being practiced by my senior colleagues"; and, " I can make my students achieve high grades in Biology since I am good at motivation. They can see how enthusiastic and passionate I am when I explain and do lectures during our classes"*. They have higher mean values of 3.61, 3.43, 3.43 and 3.26 with standard deviation values of 0.05, 0.51, 0.50 and 0.45, respectively.

In general, respondents' biology teaching outcomes expectancy has a composite mean of 2.99 with a standard deviation value of 0.75 which falls on the category moderate self-efficacy belief. Same factors were revealed that would probably affect the moderate self-efficacy belief of teachers, these are mastery experiences and verbal persuasion. It could be noted that the teacher respondents are unsure that they can make positive influence on their students because the subject is a new preparation.

Table 2. Respondents' Biology Teaching Outcomes Expectancy (BTOE)

Statements	Mean	Standard Deviation	Verbal Interpretation
Mastery Experiences			
I can find more effective teaching approach to improve my students' grades in Biology by attending in-service training.	3.61	0.05	High
If my students are underachieving in Biology, it is most likely due to my shortcomings in teaching them because I, myself, still learning since this is a new preparation for me.	2.35	0.70	Moderate
Even if I exert more effort in teaching Biology, I cannot improve their achievement because I have limited knowledge with different teaching pedagogies.	3.13	0.50	Moderate
I can make my students succeed or fail in Biology since I apply different approaches I learned from my professors in college.	3.05	0.60	Moderate
Vicarious Experiences			
I can improve the performance of my students in Biology if I exert extra effort in teaching the subject by observing other teachers and learning techniques from them.	3.43	0.51	Moderate
I can help my students overcome their inadequacy in Biology background through exerting extra time and effort in teaching them as what I have observed being practiced by my senior colleagues.	3.43	0.50	Moderate
Verbal Persuasion			
I am confident enough of my effectiveness as a teacher, thus low achievement of my students should not be blamed on me because I know I am good and has performed well according to my principal.	2.91	0.70	Moderate
If parents comment that their child is showing more interest in biology at school, I am sure it is due to my performance as his/her teacher because I get the same comments with my colleagues and principal.	2.77	0.61	Moderate
Somatic and Emotional States			
I can make low-achieving students progress in biology because I know how to motivate them to do good through my confident demeanor during classes.	3.17	0.39	Moderate
I can make my students achieve high grades in Biology since I am good at motivation. They can see how enthusiastic and passionate I am when I explain and do lectures during our classes.	3.26	0.45	Moderate
Composite Mean	**2.99**	**0.75**	**Moderate**

Technological Knowledge

In terms of technological knowledge, it is shown on Table 3 that the level of technological knowledge of biology teachers' evaluation vary among group of raters. Similar trend can be seen on the students' and teachers' self-evaluation with 3.04 and 3.28 mean values, respectively, equivalent to moderate proficiency. Conversely, with the rating from class observation, the value of mean, 2.38 which is equivalent to slight proficiency is significantly lower with that of the other two groups of evaluators.

This is probably because there are two specific statements regarding technological knowledge that were rated as "low proficiency". Teachers were rated low in the statements, *"I make use of laboratory equipment with ease"* with mean value of 1.40 and, *"I apply certain techniques when using laboratory instruments"* with mean value of 1.48.

Table 3. Biology Teachers' Technological Knowledge

Statements	*Students' Evaluation*	*Teachers' Self-Evaluation*	*Class Observation Evaluation*
1. I use projector and laptop in the class.	3.38 Moderate	3.70 High	3.24 Moderate
2. I know how to solve simple technical glitches.	3.09 Moderate	3.35 Moderate	2.76 Moderate
3. I use downloaded animations and videos in support to our lesson in biology.	3.14 Moderate	3.61 High	2.88 Moderate
4. I reach out to my students regarding our lesson thru online messaging.	3.08 Moderate	3.22 Moderate	2.64 Moderate
5. I create online group account for our class intended for sharing files and other learning materials relevant to our topics in biology.	2.94 Moderate	3.09 Moderate	2.48 Slight
6. I include multimedia platforms like Facebook, YouTube, in some of our activities.	2.80 Moderate	3.00 Moderate	2.60 Moderate
7. I mention during classes jargons which are somewhat "techie" in nature.	2.78 Moderate	3.05 Moderate	2.50 Moderate
8. I give activities that involve use of technology.	3.12 Moderate	3.30 Moderate	1.79 Slight
9. I make use of laboratory equipment with ease.	3.06 Moderate	3.27 Moderate	1.40 Low
10. I apply certain techniques when using laboratory instruments.	2.98 Moderate	3.18 Moderate	1.48 Low
Composite Mean	**3.04 Moderate Proficiency**	**3.28 Moderate Proficiency**	**2.38 Slight Proficiency**

The use of multimedia platforms like Facebook and YouTube, as well as the use of jargons which are somewhat "techie" has low mean values of 2.60 and 2.50, respectively. On the other hand, different trend is exhibited when it comes to the use of projector and laptop in class. This statement has the

highest mean value in all groups of evaluators. These quantitative results were confirmed by the researcher during class observations. More than half of the population of the teacher respondents were observed.

Pedagogical Knowledge

Table 4 presents the respondents' pedagogical knowledge or the knowledge of the SHS biology teachers to deliver, thru different strategies and approaches, the lessons in biology to their students.

As shown in the table, students evaluated their teacher as moderately proficient with a mean value of 2.99. Same trend can be seen with biology teachers' self-evaluation as well as the result of class observations with mean values of 3.45 and 2.65, respectively. It is worthy to note that evaluation of biology teachers' pedagogical knowledge is the same in all group of evaluators which means they all agree that there is still aspects on the use of appropriate biology teaching methodologies that should be addressed to achieve highest proficiency.

It is important also to mention, however, that the statements, *"I use variety of strategies in presenting topics in biology", "I try another strategy when my students are having difficulty understanding the lesson"* and, *"I provide activities that can help students cope with the subject"* were rated as slightly proficient by class observers. And, it is quite obvious that the ratings from class observations are somewhat different with that the students' and teachers' self-evaluation as indicated in its mean value although it is also verbally interpreted as moderate proficiency.

Content Knowledge

Table 5 shows the SHS biology teachers' content knowledge. It can be gleaned from the table that SHS biology teachers of Batangas City perceived their content knowledge as moderately proficient with a mean value of 3.33. However, the evaluation from students and classroom observation say otherwise. Mean values of 2.48 and 2.14 are lower which indicate slight proficiency.

It can be seen from the table that the statement, *"I use non-traditional authentic assessment techniques like concept mapping, debates and practical exam"* has the lowest mean value of 1.40 with a verbal interpretation of slight proficiency. Other statements with low mean values include: *"I give simple yet innovative laboratory activities"*, *"I provide updates related to our topic"*, *"I can discuss lessons in my own language and do not rely much on the book"*, *"I explain difficult topics as if it is easy, thus, my students understand them better", and "I relate biology topics to other subject areas"*. These aspects of

biology teachers' content knowledge were all rated as slightly proficient by both students and class observers, which is obviously, different from teachers' self-evaluation. This suggests that even the students recognize that their biology teachers are not well-versed in general biology course based on the indicators mentioned in the table, and their assessment is strengthened by class observers' evaluation who know more about the nature of the subject.

Table 4. Biology Teachers' Pedagogical Knowledge

Statements	*Students' Evaluation*	*Teachers' Self-Evaluation*	*Class Observations Evaluation*
1. I use variety of strategies in presenting topics in biology.	2.85 Moderate	3.43 Moderate	2.36 Slight
2. I know how to assess students' performance in the classroom.	3.12 Moderate	3.39 Moderate	2.50 Moderate
3. I show fairness in dealing with students.	3.11 Moderate	3.70 High	3.24 Moderate
4. I try another strategy when my students are having difficulty understanding the lesson.	2.89 Moderate	3.39 Moderate	2.49 Slight
5. I correct students' misconceptions about certain topic.	3.16 Moderate	3.48 Moderate	2.67 Moderate
6. I adapt my teaching style based on the level of understanding of my students.	2.98 Moderate	3.57 High	2.69 Moderate
7. I adjust teaching method when some of my students are having difficulty in understanding the lesson.	2.89 Moderate	3.39 Moderate	2.64 Moderate
8. I know how to manage and organize our classroom.	3.05 Moderate	3.39 Moderate	2.74 Moderate
9. I provide activities that can help students cope with the subject.	2.81 Moderate	3.43 Moderate	2.36 Slight
10. I know the pace of lessons appropriate to the needs and difficulties of my students.	2.98 Moderate	3.35 Moderate	2.86 Moderate
Composite Mean	**2.99** **Moderate** **Proficiency**	**3.45** **Moderate** **Proficiency**	**2.65** **Moderate** **Proficiency**

Table 5. Biology Teachers' Content Knowledge

Statements	*Students' Evaluation*	*Teachers' Self-Evaluation*	*Class Observations' Evaluation*
1. I discuss biology lesson clearly.	2.60 Moderate	3.35 Moderate	2.57 Moderate
2. I encourage my students to ask questions even practical ones.	2.65 Moderate	3.61 High	2.24 Slight
3. I relate biology topics to other subject areas.	2.49 Slight	3.43 Moderate	2.05 Slight
4. I set lesson objectives within the experiences and capabilities of my students.	2.57 Moderate	3.43 Moderate	2.31 Slight
5. I show confidence in delivering the lesson.	2.72 Moderate	3.43 Moderate	2.71 Moderate
6. I can discuss lessons in my own language and do not rely much on the book.	2.39 Slight	3.13 Moderate	2.26 Slight
7. I provide updates related to our topic.	2.41 Slight	3.26 Moderate	2.05 Slight
8. I give simple yet innovative laboratory activity.	2.39 Slight	3.09 Moderate	1.69 Slight
9. I use non-traditional authentic assessment techniques like concept mapping, debates and practical exam.	2.12 Slight	3.26 Moderate	1.40 Low
10. I explain difficult topics as if it is easy, thus, my students understand them better.	2.49 Slight	3.26 Moderate	2.14 Slight
Composite Mean	**2.48 Slight Proficiency**	**3.33 Moderate Proficiency**	**2.14 Slight Proficiency**

Self-Efficacy Belief and TPACK

Pearson correlation was computed to determine the relationship of the SHS biology teachers' self-efficacy belief and their technological, pedagogical and content knowledge. As shown in the Table 6, the computed Pearson's *r* of 0.401 with p-value of 0.058 implies that there is no significant relationship between these two variables.

Table 6. Biology Teachers' Self-Efficacy Belief and their TPACK

	Pearson's *r*	***p*-value**	**Interpretation**
Self-efficacy Belief VS TPACK	0.401	0.058	No Significant Relationship

DISCUSSION

Biology Teachers' Self-Efficacy Belief in terms of Personal Biology Teaching Efficacy

In terms of PBTE, the results revealed that they have moderate self-efficacy belief which suggests that most of the SHS biology teachers believed they can deliver lessons to their students well but there is still room for doubt. This feeling of non-absolute answer is expected from teachers who are newly hired, transferred into a new workplace or even to those who are exposed to new subject preparations, most especially to those who did not attend trainings on this particular subject area, more so if the teacher's educational background is non-science or graduate of other disciplines, which is actually the case of the SHS biology teachers of Batangas City. Focus group discussion revealed that some of them are not well versed in doing usual biology experiments especially some are graduates of other courses like Computer Engineering and Food Technology which do not require similar laboratory activities in general biology course. In addition, most of them are first timers in handling the subject and were not able to attend trainings on biology teaching.

In this context, the results confirm Lekhu's (2013) idea that mastery experience is one of the identified factors that greatly influences teachers' efficacy belief. Francis (2016) on the other hand, mentioned that strong mastery experiences support teachers' attitudes and desired professional goals result into high levels of self-efficacy belief. Hence, SHS biology teachers of Batangas City are not so confident that they can teach the subject based on their background.

Ravikumar (2013) however, focused on how influential people in the teachers' lives like that of their principal and colleagues strengthen their

beliefs through persuasion and giving positive comments about their teaching. It can be assumed then that teacher-respondents rarely received these encouraging feedbacks.

It could be noted from the findings that mastery experiences and verbal persuasions are two factors that cover the statements with the lowest mean values, therefore, SHS biology teachers of Batangas City need some boost in these aspects influencing their self-efficacy belief, attendance to training workshops, specifically with activities that require development of laboratory skills and conducting experiments. Abaan et al. (2012) also suggested collaborative planning sessions, team meetings, peer observations and mentoring relationships should be included because these provide opportunities to enhance self-efficacy belied through verbal persuasions.

Biology Teachers' Self-Efficacy Belief in terms of Biology Teaching Outcomes Expectancy

Based on their self-assessment, teachers concluded that they have moderate self-efficacy belief. Mastery experiences and verbal persuasions are also the two factors that need to be addressed to be able to improve on this aspect. This is probably because the subject is a new preparation under a new curriculum.

The findings clearly show then that the teacher preparation program is very important. Since teacher efficacy plays an important role in promoting students' learning achievement and their self-efficacy development in the classroom. Mastery experience was found to be the main predictor for academic achievements (Choy and Loo 2013). Hence, teacher educators must provide better teacher preparation programs for efficacy development (Chang 2015; Incikabi 2013).

In addition, verbal persuasion is also a factor because they believed that encouraging words and praises from colleagues and immediate supervisor like their principal uplift their self-efficacy belief (Ravikumar 2013). Thus, it can be deduced that they did not receive those compliments. Validation coming from the parents with their children performing well, showing interest in biology and getting high grades are affirmations that they are doing the right thing in teaching the subject. Absence of these lessen self-efficacy belief which in effect will also affect student outcomes. These mentioned areas are needed to be considered in planning and drafting of any kind of development programs for SHS biology teachers of Batangas City.

Technological Knowledge

It can be noted from the results that weaknesses of the SHS biology teachers of Batangas City on this aspect are mostly on the knowledge on how to come up with activities that involve technology, manipulation laboratory equipment and laboratory techniques.

It was mentioned during the focus group discussion that most of the respondents are having a hard time coming up with laboratory activities. One teacher even commented, which everybody agreed, that if ever there are training plans, a sort of compilation of laboratory activities which is simple and easy to do that can be provided and photocopied would be helpful. This statement is a clear indication that they do not have enough knowledge on these matters, hence, cannot come up with their own good laboratory activities. These findings are similar with the findings on the study of Tibyehabwa et al. (2017) wherein in-service teachers' lab-based training was suggested to address this problem. Furthermore, experience could be a factor because most of them are less than five years in teaching. The proposition of Tondeur et al. (2012) that technological knowledge is the most critical area for "novice" teachers because they have not participated in many learning experiences that were enriched by technology must be true then.

In addition, numerous studies concluded that technology, by their very nature are tools that encourage and support independent learning (Lowther et al. 2012). Thus, teachers' technological knowledge is very important to educate millennial learners. The technological knowledge consists of having an understanding of the standard technologies as books and chalk and more advanced technologies such as the internet and soft wares. Teachers need this kind of knowledge so that they know how lessons have been planned or designed to integrate technology into their classroom activities (Agyie and Voogt 2012). It could then be assumed that technological knowledge of the respondents need enhancement based on the findings.

Pedagogical Knowledge

It is apparent from the results that the teachers are using the same teaching strategies as they deliver the lesson, however, this should not be the case in biology teaching. Tanner (2018) emphasized the importance of using various strategies in teaching because if a teacher chooses a singular approach – always lecturing or always concept-mapping, regardless of the nature of approach – it could result in the alienation and exclusion from learning of a subpopulation of students. The biology teacher should then know how to utilize different teaching strategies.

In the case of the respondents, it was mentioned that some of them are non-science education graduates, hence, it is probably the reason why this particular aspect of pedagogical knowledge was only rated as moderately proficient. Van Driel et al. (2014) mentioned that a higher level of subject matter knowledge, which cannot be expected from teachers who are graduates of other disciplines, is typically associated with more confidence and more interactive and adventurous ways of teaching. Moreover, general biology is under the new K to 12 curriculum, most of the teachers are young and new in the teaching profession and everything is on its initial stages, these could probable the reasons.

Content Knowledge

Results implied that SHS biology teachers of Batangas City are not inclined much on giving updates on the subject and providing relevant activities as shown in the ranking of their mean values. It is also very evident that among the three categories of TPACK, content knowledge has the lowest rating which should not be the case. Biology is science and teachers should know the latest information from different sources like journal articles. They are lifelong learners who continue to keep current with the latest news, discoveries and research findings (Silver undated)

Teachers with high content knowledge can discuss the lesson spontaneously and use their own words and explain difficult topics as if they are easy. This clearly reflects the mastery of the teacher with the subject matter. Teachers who depend much in the book or references during discussions show lack of comprehensive knowledge. Relying solely on the book restricts the ideas that teachers can share to their students (Ball et al. 2008).

Self-Efficacy Belief and TPACK

Senior high school biology teachers of Batangas City have moderate proficiency in both aspects of self-efficacy belief: personal biology teaching efficacy (PBTE) and biology teachers' outcomes expectancy (BTOE). Mastery experiences and verbal persuasions were found to be the factors that should be looked into and addressed.

On the other hand, teachers, in general, have moderate proficiency in TPACK, however, it is important to mention that there are indicators on each category which varies based on the group of evaluators that need to be noted: knowledge on the manipulation of laboratory equipment and integration of technology in laboratory activities; the use of various teaching strategies; and, use of non-traditional assessment techniques like concept mapping, debates, and practical exam, constant subject matter updating and contextualization

are aspects that ought to be strengthened. Furthermore, since SHS is new, all biology teachers can be treated as "novice" regardless of their technological, pedagogical and content knowledge proficiency, hence, there is no relationship with their self-efficacy belief.

When it comes to the correlation of self-efficacy belief and TPACK, respondents perceived that there is no significant relationship between these two variables. This means that the respondents do not think that the teachers' conviction to teach the subject as well as the belief that they can produce positive student outcomes have something to do with their technological, pedagogical and content knowledge. Which means that their moderate proficiency in terms of TPACK has nothing to do with their self-efficacy belief, and their moderate self-efficacy does not result into their moderate proficiency in TPACK.

Results challenge the theoretical assumptions about the positive relationship of self-efficacy belief and TPACK of Joseph (2010) and Rohaan et al. (2012). The findings are quite different from most studies which demonstrated the connection between the two variables. It could then be assumed that since SHS is in its initial stages, all teachers can be considered as "novice" regardless of their technological know-how, the level of their subject matter knowledge and expertise on the use of different teaching strategies. All of them are on the new academic setting and teaching environment with new challenges and expectations so no matter what TPACK proficiency they have, it has nothing to do with their self-efficacy belief. The feeling of anxiety and being uncertain and doubtful of their capabilities are expected. However, Abbitt (2011) explained the changing nature of the relationship between TPACK and self-efficacy belief, thus, when everything is settled and in place, the relationship between these two variables might change.

The relationship properties of TPACK-self-efficacy belief can be referenced in the framework of training for pre-service and in-service science teachers (Eny Hartadiyati and Sutikno 2015). As emphasized by Joseph (2010), science educators should have a clearer understanding of their combined impacts one could expect an effective teacher to have well-structured pedagogical content knowledge and consequently, a higher sense of teaching efficacy.

Luft and Hewson (2014) pointed out that professional development can occur before a teacher ever begins teaching in the classroom and may continue until the end of the teaching career. It is then highly recommended for the SHS teachers of Batangas City to attend such trainings, especially, everything in the SHS is in its transition and adjustment period. However, a training design framework can be drafted to serve as ground principle of

future training design plans since this present study provided baseline data. It will ensure that the trainings to be implemented are tailored to the needs of SHS biology teachers of Batangas City. It is also suggested to conduct similar study on other science disciplines like physics and chemistry in order to assess science teaching in totality.

ACKNOWLEDGEMENTS

This research would not be possible without the financial support of the Commission on Higher Education (CHED) under K to 12 Transition Program through the dissertation grant provided to the researcher. Sincere gratitude is also extended to Batangas State University family for their support. Likewise, the researcher will be forever grateful to Dr. Rebecca C. Nueva España for the guidance and inspiration all throughout the challenging research writing journey. To the Department of Education – Division of Batangas City headed by Dr. Donato Bueno and to all school administrators of private senior high schools for the assistance and cooperation during data collection. The researcher is also grateful to the anonymous external reviewers for their valuable inputs in the improvement of this paper.

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ARTICLE INFO

Received: 31 January 2018
Revised: 19 March 2018
Accepted: 20 March 2018