

Improving the Performance of Pre-service Teachers in Genetics through an Interactive Software

Maria Cristina B. Bandarlippe, Ph.D.

ABSTRACT-This research aimed to improve the performance of pre-service teachers in Genetics and develop their TPACK confidence level using an interactive software. One-group pretest-posttest experimental design was used to examine the Pre-service teachers' TPACK and to test the effectiveness of a validated interactive software in the perspective of the pre-service teachers. Twenty-seven pre-service teachers served as the respondents for the study. The quantitative data was collected using the two instruments as pre and posttests, namely the TPACK in Science Survey and a validated 30 – item pretest/posttest on Genetics concepts. Based on the findings of the study, there was significant improvement between pre and post scores on all of the TPACK constructs and results indicate a significant increase for all constructs. Likewise, there was a significant increase in the scores in posttest and pretest. It implies that the interactive software is effective in improving the performance of the preservice teachers in Genetics. Based on the findings, it is recommended that pre-service teachers be trained more on Genetics concepts and the use of computer in teaching the subject. Also, the interactive lesson can be utilized to increase the TPACK confidence level and performance of pre-service teachers.

Keywords: interactive, software, Genetics, TPACK, pre-service teachers

1 INTRODUCTION

According to the study of Tasar et.al (2010) at the University of Turkey, the turn of the 21st century marked the beginning of a much common and widespread use of computer technologies in science classrooms. This is due to the fact that personal computer hardware became affordable to larger populations and applications with enhanced visual characteristics were created with lesser effort not only by computer experts but also by science educators. Not to mention the availability of other gadgets not only the desktop personal computers. However, using technology in science classes requires teacher competence in technology. Teachers need to have a coherent knowledge about content, pedagogy and technology. Pre-service and in-service science teachers need to develop technological pedagogical content knowledge of the most effective ways to teach various science concepts, principles, and now how to create a technology rich environment.

Chi-Yan Tsui and David F. Treagust (2002) explored teachers' pedagogical content knowledge (PCK) through the story of Linda, a preservice science teacher, who participated in this study while she taught Genetics in a Year 10 classroom during her practice teaching. Although Linda did not have a strong content knowledge of Genetics, she was able to expand it in response to students' learning demands. She also improved her pedagogical knowledge through reflection upon her teaching practice despite difficulties she encountered.

On the other hand, a number of researchers worked on developing instructional materials for most of the topics in Biology such as Ecosystem, Cells, Organ System, Life Energy and Biodiversity but less for the concepts in Genetics. Over the past two decades, researchers in Australia, New Zealand, the UK and the USA have unanimously found that Genetics

remains linguistically and conceptually difficult to teach and learn in secondary schools (Tsui and Treagust 2002). As such, new teachers are likely to find Genetics even more difficult to teach. It is considered to be one of the most difficult subjects for students in both schools and higher learning institutions. Based on observations, most textbooks place Genetics as the last topic in Biology. Moreover, in the new K to12 Curriculum, the Learners' Material for Grade 8 Science, Biology is the last module in the 4th quarter. This module focuses on Mendelian Inheritance which lay the foundation in learning Genetics and Heredity. For this reason, teachers often would not have enough time to tackle Genetics and some would deem this as the most difficult topic to teach. These concepts need to be simplified in activities where students may enjoy. The present study aimed to produce competitive students who are equipped with scientific concepts and applications of Genetics which will pave way towards excellent performance of Science Education in the country. The results of the study can be used by future researchers and graduate students as basis for verification or replication of the study for future endeavors. After the development of an interactive software in Genetics, the researcher aims to help pre-service teachers to be conceptually and linguistically ready to teach the subject as they also develop their TPACK confidence level. The researcher would also like to test the effectiveness of the validated interactive software in the perspective of the pre-service teachers, thus, this study.

1.1 STATEMENT OF THE PROBLEM

The study aimed at assessing the technological pedagogical and content knowledge of Pre-service Science teachers and to test the effectiveness of an interactive lessons software in Genetics. Specifically, it answered the following questions: (1). What is the perceived confidence level of pre-service

Science teachers' related to the four TPACK constructs before and after exposure to the interactive software (i.e., TK, TPK, TCK, TPCK)?; (2). Are there significance differences on the pretest and posttest mean values of the teachers' confidence level related to the four TPACK constructs?; (3). What is the performance of the group exposed to the interactive resource material in terms of the pretest mean scores and the posttest mean scores?; and, (4). Is there is a significant difference between the groups' pretest mean scores and posttest mean scores?

2 METHODOLOGY

This study focused on the use of descriptive and experimental research designs. The descriptive research method was used in order to determine pre-service Science teachers' TPACK confidence level and their pre-assessed Genetics concepts knowledge using a survey questionnaire and Genetics test. One-group pretest-posttest experimental design was also used to examine if there is an improvement on the pre-service teachers' performance and TPACK confidence level after the class was taught using an interactive resource material in Genetics. There were 27 Pre-service teachers who served as the respondents for the TPACK confidence level assessment and the same group was given the pretest and posttest for the Genetics concepts. The quantitative data was collected using the "TPACK in Science Survey (TPACKSS)" developed by Graham, Burgoyne, Cantrell, Smith, Clair and Harris (2009). It was administered to the 27 pre-service teachers as pre and posttests. A validated 30 - item pretest/posttest on Genetics concepts was used which was evaluated by proficient educators in the fields of Science

The class experienced the interactive lessons in Genetics after the administration of the TPACKSS and Genetics concepts pretests. The topics were limited to the Mendelian and Non-Mendelian Inheritance and the Central Dogma of Molecular Biology topics which are also the topics included in Grades 8, 9 and 10 Biology modules in the K to 12 Curriculum.

The data gathered were subjected to statistical treatments. The TPACKSS survey consists of thirty-one items along the areas of technological knowledge (TK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPCK) and the scale for answering consisted of 6 points level of confidence. For each of the survey items descriptive statistics including means and standard deviations was calculated. The mean differences were obtained through the pre mean minus post mean for each item. Pre and post means values were calculated for four TPACK constructs using t-test to determine if there is a significant increase for all constructs.

To determine if there exist significant differences between the means of the pretest and posttest of the group, the t-test was also employed at 0.05 level of significance.

3 FINDINGS

3.1 The TPACK Confidence Level of the Pre-service Teachers

Using the TPACKSS instrument to assess the pre-service teachers' confidence level along the four TPACK constructs namely Technological Knowledge (TK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and Technological, Pedagogical, Content Knowledge (TPCK), results showed that there was an increase in the pre and post mean values for each item as shown by the mean difference-pre mean minus post mean. Their TPACK confidence level was low before they were taught using the interactive software and increased after using the software. This implies that pre-service teachers TPACK confidence level was elevated positively after using the interactive lessons software. TPACK can be described as how teachers understand educational technologies and it is the complex interaction among content, pedagogy and technology. Tasar (2010) mentioned Niess (2005) who proposed that teachers exhibit TPCK when they demonstrate an overarching concept of what it means to teach a particular subject in which technology is integrated into learning; knowledge of instructional strategies and representations for teaching specific topics with technology; knowledge of students' understandings, thinking, and learning with technology in a particular subject; and knowledge of curricula and curriculum materials that integrate technology with learning in specific subject area (Niess, 2005)

The same increase is evident with the other three constructs. Among the four, TK increased the greatest followed by TPK, TPCK and TCK. Previous studies also show that technological knowledge (TK) increased the greatest since this is the foundational knowledge of TPACK framework (Graham, 2009; Tasar, 2010). The eleven items under TK are basic operations in using the computer. This implies that the pre-service teachers are knowledgeable on these basic skills. Among these items, saving images from the internet to a hard drive (TK 1) obtained the highest mean increase and the least is creating their own website (TK 11). According to Koehler and Mishra (2006), TK is associated with the ability to use technological tools but also the knowledge behind this technology. This finding reinforces the idea that confidence in TK is foundational to developing confidence in the other three forms of knowledge measured. This makes sense if one believes that some basic technical awareness and skills are a prerequisite to being able to meaningfully integrate technology into teaching.

TCK, on the other hand, was the second highest that mean that the pre-service teachers after being taught using the interactive software improved on knowing how to incorporate content and technology. Quantitative data of Tasar's (2010) study showed that pre-service teachers asserted that they do not know how to incorporate technology with content.

Following TCK was TPK which means that the pre-service teachers already have knowledge on incorporating

technology and pedagogy as well for the topics in Genetics. Though it is the lowest in score, TPACK increased also as the pre-service teachers gained knowledge of the complex interactions among content, pedagogy and technology which is primarily achieved when the teacher knows how technological tools transform pedagogical strategies and content representations for teaching particular topics, and how technology tools and representations impact's a student's understanding of the topic.

Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012) found that teachers' attitudes towards technology play an important role in their integration efforts. According to Ertmer, Conklin, and Lewandowski (2001), pre-service teachers' beliefs about technology will be shaped by educators who help them increase their competence in technology integration, and TPACK is believed to assist in improving technological confidence (Mishra & Koehler, 2006). Positive first hand experiences of pre-service teachers may affect their future applications of information technologies (Bhattacharjee & Premkumar, 2004).

TABLE 1. PAIRED-SAMPLE T-TEST FOR THE PRE AND POST TPACK CONSTRUCTS

	Mean	t	p
Pre TPACK	4.43	2.36	8.16E-07*
Post TPACK	5.58		
Pre TPK	4.61	2.45	1.25E-05*
Post TPK	5.63		
Pre TCK	4.15	2.78	4.58E-05*
Post TCK	5.66		
Pre TK	4.69	2.23	6.39E-05*
Post TK	5.72		

*-significant at 0.05 level

Paired-sample t-Test was used to determine significant difference between the four TPACK constructs. The computed t-value for the difference between the means of the pretest and posttest among the four constructs were significant at $p < 0.05$. There was a significant increase in the scores in posttest and pretest. This means that the pre-service teachers' TPACK confidence improved as compared to the initial pre-test.

3.2 Performance of the Pre-service teachers in Genetics

Table 2 shows the performance of the two groups in the Pretest and Posttest. It can be gleaned from this table that there was an increase in the average mean score of the group in the posttest after being taught using the interactive lessons software.

TABLE 2. DESCRIPTIVE STATISTICS FOR THE PRETEST AND POSTTEST MEAN SCORES ON GENETICS

	N	Min	Max	Mean	Std. Deviation
Pretest	27	6	14	10.48	2.455
Posttest	27	17	28	21.37	2.830

The posttest scores ranged from 17 to 28 points out of the 30-item Genetics test. This denotes that the performance of the pre-service teachers improved with the use of the software in Genetics.

Table 3 confirms that the performances of the two groups are significantly different in terms of the average means in the pretest and posttest.

TABLE 3. PAIRED SAMPLE T-TEST RESULTS FOR THE PRETEST AND POSTTEST MEAN SCORES.

	Mean	t	df	Sig. (2-tailed)
Posttest-Pretest	10.889	17.938	26	.000*

*-significant at 0.05 level

As shown in Table 3, based on the computed p-value, there exist significant difference between the pretest and posttest mean scores of the group. It also implies that the use of the interactive lessons is effective in improving the performance of the preservice teachers' in Genetics. The findings confirm the assertion of Heinrich et al (1985) that students can do activities on their own pace and can go back to previous lessons using programmed instruction. This not only leads to higher scores, but also indicates that students enjoy the experience more than those in conventional classes. Moreover, Huppert (1998) found out when he used computer simulations in high school microbiology courses to supplement instruction in cell growth and division students performed better on post-tests than students in the traditional labs.

4 CONCLUSION

From the realities revealed in this study, the following conclusions were drawn: (1). The TPACK framework consisting of four constructs can be used to assess the TPACK confidence level of pre-service teachers in teaching Science particularly the use of the TPAKSS instrument. In this study, there was an improvement in the four TPACK constructs which indicate that interactive lessons can help pre-service teachers develop their confidence level along the TPACK framework that would aid them in teaching Genetics which is noted to be conceptually and linguistically difficult to teach; and, (2). A significant difference was established in the performance of the pre-service teachers in

the pretest and posttest. Therefore, the interactive lessons aided in improving their performance and can be used to help them teach Genetics as future educators in the field of Science.

5 RECOMMENDATIONS

Based on the foregoing findings and conclusions, the researcher humbly advance the following viable recommendations: (1). Teacher education institutions should provide science teacher preparation programs that would guide pre-service teachers to develop their competence in using technology and to combine it with appropriate pedagogy in the delivery of the content and become an effective teacher in the field; (2). It is suggested that science teachers in HEIs may design and plan suitable technology rich environments and resources to address the development of pre-service teachers' knowledge along the four constructs of the TPACK framework; (3). Available interactive resources can be used to effectively enhance TPACK confidence and performance of pre-service teachers such as the interactive lessons software in Genetics used in this study; and, (4). Further researches can be conducted aside from measuring TPACK confidence but also to develop other TPACK performance assessment to directly measure the TPACK constructs.

6 REFERENCES

- [1] Bhattacharjee, A., G. Premkumar. 2004. Understanding changes in belief and attitude toward information technology usage: A theoretical model and longitudinal test. *MIS Quart*, 28(2) 351-370.
- [2] Chi-Yan Tsui and David F. Treagust. A 2002. Preservice Science Teacher's Pedagogical Content Knowledge (PCK): The Story of Linda. Curtin University of Technology Queensland, Australia.
- [3] Ertmer, P. A., Conklin, D., & Lewandowski, J. (2001). Increasing preservice teachers' capacity for technology integration through use of electronic models. Presented at the Annual Meeting of National Convention of the Association for Educational Communications and Technology, Atlanta, GA.
- [4] Ertmer, P., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers and Education*, 59(2), 423-435.
- [5] Graham, C.R., Burgoyne, N., Cantrell, P., Smith, L., St Calir, L., & Harris R. (2009). TPACK Development in Science Teaching: Measuring the TPACK Confidence of Inservice Science Teachers. *TechTrends*, 53(5), 70-79.
- [6] Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054. doi:10.1111/j.1467-9620.2006.00684.x
- [7] Niess, M.L. (2005). Preparing teachers to teach science and mathematics with technology; Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, 21(5), 509-523. Doi: 10.1016/j.tate.2005.03.006
- [8] Schmidt, D., Baran, E., Thompson, A., Koehler, M.J., Mishra, P., & Shin, T. (2009). Examining preservice teachers' development of technological pedagogical content knowledge in an introductory instructional technology course. Paper presented at the 2009 International Conference of the Society for the Information and Technology & Teacher Education. March 2-6, Charleston, SC.
- [9] Taşar, M. F., & Timur, B. (2010). Developing Preservice Science Teachers' Technological Pedagogical Content Knowledge through Microteaching Lesson Study by Utilizing Inquiry Based Interactive Computer Animations, GIREP-ICPE-MPTL Conference, 22-29 August 2010, Reims, France.