The Use of PSPP Software in Learning Statistics

Minerva Sto.-Tomas
University of Saint Louis, PHILIPPINES

Darin Jan Tindowen*
University of Saint Louis, PHILIPPINES

Marie Jean Mendezabal
University of Saint Louis, PHILIPPINES

Pyrene Quilang
University of Saint Louis, PHILIPPINES

Erovita Teresita Agustin
University of Saint Louis, PHILIPPINES

Abstract: This descriptive and correlational study investigated the effects of using PSPP in learning Statistics on students' attitudes and performance. The respondents of the study were 200 Grade 11 Senior High School students who were enrolled in Probability and Statistics subject during the Second Semester of School Year 2018-2019. The respondents were randomly selected from those classes across the different academic strands that used PSPP in their Probability and Statistics subject through stratified random sampling. The results revealed that the students have favorable attitudes towards learning Statistics with the use of the PSPP software. The students became more interested and engaged in their learning of statistics which resulted to an improved academic performance.

Keywords: *Probability and statistics, attitude, PSPP software, academic performance, technology.*

Introduction

The rapid development of technology has brought remarkable changes in the modern society and in all aspects of life such as in politics, trade and commerce, and education. Today, technological advancement serves as an important basis in the development of societies and countries. With these, the rise of information and communications technology also brought a drastic change in the 21st century educational landscape. Teaching and learning are now becoming more engaging and innovative through technology-aided instruction (Mendezabal & Tindowen, 2017). Integration of technology is really perceived by educators as a very important tool for effective delivery of teaching for all levels of education.

The use of technology as an aid in teaching plays a very important role in the present educational landscape. This is also true to mathematics and statistics education. Previous studies had been conducted stressing the vital function of the use of technology in teaching statistics and mathematics courses (Mendezabal & Tindowen, 2017; Pierce, Stacey, & Barkatsas, 2005; Tabachnick, 2007; Chick & Pierce, 2008). However, despite the emergence of technology in teaching mathematics, it has been revealed that studies on the effect of integration of technology in teaching mathematics is only limited to calculus, algebra, solid mensuration, and trigonometry which are mostly conceptual and procedural in nature (Hohenwarter, Hohenwarter, Kreis, & Lavicza, 2008; Mendezabal & Tindowen, 2017; Ferrara, Pratt, & Robutti, 2006; Thomas & Holton, 2003). However, limited studies had been conducted looking into the effects of the utilization of educational soft wares and applications in teaching statistics especially in developing countries such as the Philippines (Orleans, 2007; Pratt, Davies, & Connor, 2011). Furthermore, although technology is finally being integrated into education, its use for teaching and learning still remains a challenge. Despite the fact that many colleges and universities today are privileged to fast internet connection, trained teachers to use educational technology, and a positive policy school-environment, the use of technology in the classroom is still low.

* **Corresponding author:**

Darin Jan Tindowen, Center for Social Innovation, Local Knowledge and Educational Research, University of Saint Louis, Tuguegarao City, Philippines. ✉ djtindowen2015@gmail.com

Probability and Statistics serves as a general overview to descriptive and inferential statistics. In traditional classroom-based statistics courses, strategies used by teachers are plainly using the prescribed textbook, using lectures and doing chalk and board drills regularly. Recent technological developments, however, offer teachers an innovative way to teach statistics course that is relevant and adaptive to the demands of the 21st century educational landscape. The use of technology in the classroom continues to increase, eventually offering several advantages. Some of the benefits of using technology in the classroom include promotion of active learning, enhancement of collaborative learning, development of student's independence and emphasis on task-based instruction. However, despite these initiatives and movements, still nowadays Statistics is always regarded as a subject which is boring, burdensome, and scary. Students tend to memorize the necessary formulae and steps in order to obtain good results in examination. Moreover, memorizing formulae without understanding is regarded as low level of learning (Mendezabal & Tindowen, 2017).

Several studies had been conducted looking into factors that may influence students' performance in statistics courses (Higazi, 2002; Lee and Hollebrands, 2011). Among these factors, attitude is one important factor that has been consistently studied (Farooq, 2008; Mohamed & Waheed, 2011). Attitude is concerned with an individual's way of thinking, acting and behaving. This may have critical implications for students, teachers, and the whole educational system (Anastasiadou, 2011). Attitudes are formed as a result of some kind of learning experiences students go through. Recent developments also reveal that attitude towards learning a specific subject may positively affect students' academic performance especially if proper intervention and action will be done by teachers such as utilization of technology-aided instruction (Mendezabal & Tindowen, 2017; Higazi, 2002). Thus, this study was conducted to describe the attitude of senior high school students towards learning probability and statistics with technology specifically, the use of PSPP software. PSPP is a free mathematical and statistical software application for analysis of data, intended as a substitute for IBM SPSS Statistics. This software provides a comprehensive set of capabilities including frequencies and descriptives, measures of central tendency; mean comparison such as both Independent and Dependent Sample T-Tests and One Way and Two Way Analysis of Variance, test of relationships, linear and logistic regression, reliability tests, non-parametric tests, factorial analysis, chi-square analysis and other statistical tests (Pfaff, Darrignton, Stover, Satman & Beckman, 2007).

Conceptual Framework

This study is anchored on the study of Anastasiadou (2011) on the importance of teaching Statistics with the use of technology to students. It was then stressed that technology provides avenues for teachers to explore possibilities in coming up with innovative ways of teaching statistics subject that may lead to the enhancement of learning through cognitive, metacognitive and affective aspects. Learning statistics with technology in the form of certain computer soft wares, calculators, graphic calculators, Geogebra, Microsoft Mathematics, SPSS, Stata, and PSPP can help students develop critical thinking and problem solving skills, help teachers and instructors teach the subject in a creative and innovative manner, and may also eradicate students' negative notion towards the subject which is purely procedural and conceptual (Pierce, Stacey & Barkatsas, 2005).

Furthermore, one important aspect that can be considered with the shift of the new technological aided landscape in teaching statistics from the traditional method of teaching is on the attitudes of students. In this study, attitudes of students towards the learning p[probability and statistics with the use of PSPP include both cognitive and affective aspects about doing and learning statistics. The general attitudes of students towards learning probability and statistics with the use of PSPP are divided into the following dimensions:

a. *Statistics Cognitive Competence.* This refers to the positive and negative attitudes concerning a student's knowledge and skills as applied to statistics.

b. *Technology Cognitive Competence.* This refers to the positive and negative attitudes concerning a student's knowledge and skills as applied to technology and computers.

c. *Learning Statistics with Technology.* This refers to the positive and negative attitudes concerning a student's attitudes to learning statistics with the aid of technology.

d. *Value.* This refers to the positive and negative attitudes to the worth and usefulness of statistics in students' personal and professional life.

e. *Affect.* This refers to the positive and negative emotions concerning statistics.

Research Objective/Questions

This study was conducted to determine the use of the PSPP software in learning statistics among Grade 11 Senior High School Students. Specifically, it tried to answer the following questions:

1. What is the profile of the respondents along the following:
   a. Gender
   b. Academic Strand

      c. Academic Performance in Probability and Statistics subject
2.   What is the attitude of respondents towards learning statistics using PSPP along the following:
      a. Statistics Cognitive Competence
      b. Technology Cognitive Competence
      c. Learning Statistics with Technology
      d. Value
      e. Affect
3.   Is there a significant difference on the attitude of respondents towards learning statistics using PSPP when grouped according to gender and academic strand?
4.   Is there a significant relationship between the attitude of respondents towards learning statistics using PSPP and their academic performance?

Methodology

Research Design

This study utilized the descriptive and correlational research design to determine students' attitudes and performance in Statistics using PSPP software. PSPP is a free software under the GNU project sponsored by Free Software Foundation.

Sample and Data Collection

The respondents of the study were 200 Grade 11 Senior High School students who were enrolled in Probability and Statistics subject during the Second Semester of School Year 2018-2019. The respondents were randomly selected from those classes across the different academic strands that used PSPP in their Probability and Statistics subject through stratified random sampling.

Table 1. Distribution of the Respondents of the Study

Academic Strand	Frequency	Percentage
Science, Technology, Engineering and Mathematics - Non Health (STEM-Non Health)	60	30.00
Science, Technology, Engineering and Mathematics – Health (STEM-Health)	70	35.00
Accountancy, Business and Management (ABM)	50	25.00
Humanities and Social Sciences (HUMSS)	20	10.00
TOTAL	200	100.00

Research Instruments

Students' Attitudes towards Learning Statistics with Technology

The attitude of students towards learning statistics using PSPP was measured using the Students Attitudes toward Statistics and Technology Scale (SASTSc) developed by Anastasiadou (2011). The tool consisted of 28 items distributed to five different attitude subscales which are Statistics Cognitive Competence (6 items), Technology Cognitive Competence (4 items), Learning Statistics with Technology (6 items), Value (6 items) and Affect (6 items). Each item of the instrument used a 5-point Likert Scale that ranged from 1 – Strongly Disagree to 5 – Strongly Agree. The result of the reliability test revealed a Cronbach's Alpha coefficient f .900 which means the tool is reliable.

Data Source for Students' Academic Performance in Statistics

The academic performance of students in statistics was measured using their Final Grade during the Second Semester of School Year 2018 -2019 in Probability and Statistics subject.

The Final Grade of the respondents in Probability and Statistics subject during the Second Semester of School Year 2018 -2019 were considered as the data for the academic performance of students in Statistics..

Analyzing of Data

The data gathered in the study were analyzed using the following statistical tools:

Frequency Counts and Percentage. These were used to describe the profile of the respondents along gender, academic strands, and academic performance in Probability and Statistics subject.

Weighted Mean. This was used to determine students' attitudes towards learning Statistics with PSPP. The attitudes of the students were interpreted using the following Scale:

Range	Qualitative Description
4.50 – 5.00	Very Favorable
3.50 – 4.49	Favorable
2.50 – 3.49	Moderately Favorable
1.50 – 2.49	Slightly Favorable
1.00 – 1.49	Not Favorable

Independent Sample T-Test. This was used to determine significant difference on the attitude of students towards learning statistics using PSPP when grouped according to gender.

One-Way Analysis of Variance. This was used to determine significant difference on the attitude of students towards learning statistics using PSPP when grouped according to academic strands.

Pearson-R Product Correlation. This was used to determine significant relationship between the attitude of students towards learning statistics using PSPP and their academic performance in Statistics and Probability Subject.

Findings / Results

Table 1. Profile of the Respondents

Profile	Frequency (N= 200)	Percentage (100.00)
Gender		
Male	99	49.50
Female	101	50.50
Academic Strand		
Accountancy, Business and Management (ABM)	60	30.00
Science, Technology, Engineering and Mathematics (STEM) – Health	70	35.00
Science, Technology, Engineering and Mathematics (STEM) – Non Health	50	25.00
Humanities and Social Sciences (HUMSS)	20	10.00
Academic Performance in Probability and Statistics Subject		
95-100	5	2.50
90-94	30	15.00
85-89	75	37.50
80-84	58	29.00
75-79	32	16.00
General Average	85.00	

Table 1 presents the profile of the respondents. It can be shown from the table that there are more female respondents than male respondents in the study. In terms of their academic strands, many of the students enrolled in the Senior High School are under the Science, Technology, Engineering and Mathematics Program. And finally in terms of their academic performance in Probability and Statistics subject, a substantial number of senior high school students attained a grade from 85-89. This means that most of the students in the senior school achieved an average academic performance in Statistics.

Table 2. Attitude of Students towards Learning Statistics using PSPP Software

Attitudes	Mean	Qualitative Description
Statistics Cognitive Competence	3.33	Moderately Favorable
Technology Cognitive Competence	3.89	Favorable
Learning Statistics with Technology	4.36	Favorable
Value	4.23	Favorable
Affect	4.38	Favorable
OVERALL MEAN	4.03	Favorable

Table 2 presents the attitudes of students towards learning statistics with the aid of PSPP software. It can be shown from the table that students have a favorable attitude towards learning statistics using the PSPP software. This means that the use of technology in teaching a certain subject such as in statistics promotes positive and favorable attitudes to

the learners. Specifically, students have favorable attitudes along technology cognitive competence, learning statistics with technology, value and affect. Meanwhile, students have a moderately favorable attitude towards learning statistics with the aid of PSPP software along statistics cognitive competence.

Table 3. Significant Difference on the Attitude of Students towards Learning Probability and Statistics with PSPP when grouped According to Gender and Academic Strand

Profile	t-value/F-value	P-Value	Decision
Gender	-1.674	.096	Accept Ho
Academic Strand	3.253	.023	Reject Ho

Table 3 presents the significant difference on the attitude of students towards learning statistics with the use of PSPP when grouped according to gender and academic strand. It can be shown from the results that there is no significant difference on the attitude of students towards learning statistics with the use of PSPP when grouped according to gender. Hence, the null hypothesis is accepted. This means that the attitudes of senior high school students do not vary regardless of their gender.

Meanwhile, the table further shows that there is a significant difference on the attitude of students towards learning probability and statistics with the use of PSPP when grouped according academic strand. Hence, the null hypothesis is rejected. This means that the attitude of senior high school towards statistics with the aid of PSPP software varies regardless of their academic strand.

Table 4. Post-hoc Test Analysis on the Significant Difference on the Attitude of Students towards Learning Statistics with Technology when grouped According Academic Strand

Academic Strand	Mean	ABM	STEM-H	STEM-NH	HUMSS
ABM	3.94	1			
STEM-H	4.08	.012	1		
STEM-NH	4.10	.008	.717	1	
HUMSS	3.98	.652	.198	.137	1

Table 4 presents the post-hoc test analysis on the significant difference on the attitude of students towards learning statistics with PSPP when grouped according to academic strand. The results reveal that there is a significant difference on the attitude of students towards learning statistics with technology among STEM-Health students, Non-Health students and ABM students.

Table 5. Significant Relationship between Attitude of Students towards Learning Statistics with PSPP and their Academic Performance in Probability and Statistics Subject

Variables	Pearson-R	P-Value	Decision
Attitude of Students towards Learning Statistics with Technology Academic Performance in Probability and Statistics Subject	.656	.006	Reject Ho

Table 5 shows the significant relationship between attitude of students towards learning statistics with the aid of PSPP and their academic performance in statistics subject. The finding reveals that there is a positive correlation between the attitude of students towards learning statistics with the aid of PSPP and their academic performance in probability and statistics subject. Hence, the null hypothesis is rejected.

Discussion

This study was conducted to determine the use of PSPP software in learning statistics among Grade 11 Senior High School Students along their attitudes and academic performance towards Statistics. The results reveal that the attitude of senior high school students in statistics along cognitive competence is moderately favorable. This means that attitude towards the subject with the use of PSPP is in the moderate extent. Despite the use of mathematical software in teaching statistics, still students believed that their proficiency and understanding towards the subject is neither that high nor low. This may be attributed to the difficulty of the subject and their conception that the subject is purely procedural and conceptual in nature in which there is really a need to study statistics carefully. They still find difficulty in learning the subject despite the fact that there is a technology that aids their learning. However, the findings reveal that the use of technology also helps students understand statistics easily. The findings conform to the results of previous studies that students have a negative attitude towards mathematics and statistics if the lessons will be delivered in a traditional way, but there is an increase in the interests of the students and their attitudes are becoming

positive if there is an integration of technology in the classroom (Pierce, Stacey & Barkatsas, 2007; Tseng, Chang, Lou, & Chen, 2013).

Meanwhile, in terms of their attitude along technology cognitive competence, students have a favorable attitude towards learning statistics with the aid of PSPP. This can be attributed to the fact that students nowadays are considered as digital natives. Digital Natives are considered as products of the recent technological revolution where they are spending their entire lives in using computers, cell phones, social media, and all other tools and applications of the digital age (Prensky, 2001). Hence, it is an easy task for these students to use computers in their daily tasks such as in learning. Studies have shown that students in the today's educational landscape possessed ICT skills which are core skills in the 21st century (Thompson, 2013; Kolikant, 2010; Bennett & Maton, 2010; Helsper & Eynon, 2010). More specifically, senior high school students are good at computers and do not have problems using software since they can also fix many hardware problems in computers. This affirms the results of previous studies that students have high competencies in terms of technology cognitive competence (Sampson & Fytros, 2008; Suanpang, Petcz, & Kalceff, 2004; Mills, 2004). Furthermore, the study also reveals that students can easily run PSPP. Due to their ICT skills, students can easily run computer applications and soft wares such as educational soft wares which is the PSPP. In this manner, students can be more engaged in studying statistics because learning the subject is easier since their mode of learning is ICT-based.

Furthermore, in terms of the attitude of students towards learning statistics with PSPP software along learning statistics with technology, they have a favorable attitude. This means that the attitude of senior high school students regarding the use of PSPP in learning statistics is positive and as a result, they became more interested in the subject and became more engaged in the classroom discussion. The findings affirm the result of previous studies that student have a more positive attitude towards learning when technology is being used as an aid in the instruction such as in statistics (Spinelli, 2001; Pratt, Davies & Connor, 2011; Basturk, 2006; Wit, 2003). Specifically, students believed that technology makes the learning of statistics fun, interactive, and easy to understand. With the use of technology such as the PSPP, the classroom is being transformed into a learner-centered classroom because students are provided with avenue to explore statistical problems and concepts on their own. Furthermore, previous literature also stressed how technology brings an important shift in the education process especially along mathematics and statistics education in which negative attitudes of students and their disengagement in the class towards the subject transformed into a more positive attitude due to the use of technology-aid strategies (Basturk, 2006; Gattuso & Pannone, 2002; Llyod & Robertson, 2012).

Along value, students have a favorable attitude towards learning statistics with the use of PSPP. This means that students imbibed the value of the subject true the help of using technology in teaching the subject such as the PSPP. The results of the study reveal that one of the effects of using technology in learning statistics is that it only enhances procedural and conceptual skills among students, but more importantly on the application of the concepts in real life situations. The findings affirm the results of previous studies that students have a more positive attitude towards learning mathematics with the use of technology and as a result, will appreciate more the value of the subject in their personal and professional lives (Libman, 2010; Pierce & Chick, 2011). More specifically, students perceived that statistics is valuable and is also part of their daily lives. In real life applications, statistics is widely used in all professions and in all fields both in natural and social sciences. Statistical methods and procedures are also used in decision making activities for making accurate inferences from a collated body of data and in the face of uncertainty. The use of mathematical and statistical softwares such as the PSPP has expedited complex and difficult statistical computations into a more convenient and easier way of computations (Dorofeev & Grant, 2006; Reid & Petocz, 2002).

Finally, with regard to the attitude of students towards learning statistics with the aid of PSPP along affect, senior high school students have a positive and favorable emotion towards the subject when using technology such as the PSPP in learning statistics. Specifically, they already enjoy learning statistics because they are learning the subject with the use of technology which most of the students prefer. Also, because of the use of technology, students now like learning statistics and they perceive the subject as an interesting and not a frustrating one. This coincides with the results of previous studies that the use of technology especially in teaching mathematics and statistics reduces students' conception of the subject as boring, not interesting, and purely procedural (Tabachnick, 2007; Chick & Pierce, 2008).

In general, students have a favorable attitude towards learning statistics with the use of PSPP software. The findings imply that attitudes really play an important role in teaching a certain subject such as statistics. Students have favorable attitudes towards the subject because of the integration of technology in the lesson. The findings affirm the results of previous studies that technology integration is a very important tool for effective delivery of teaching for all levels of education, and such really has an effect on students'' attitudes towards the subject (Mendezabal & Tindowen, 2017; Martin & Ertzberger, 2013; Masrom, 2007; Libman, 2010; Kolikant, 2010; Thompson, 2010).

The findings affirm the results of previous studies that gender does not have any attribute to the attitude of students in teaching statistics with the use of technology (Ursuni & Snachez, 2008; Stout, Dasgupta, Hunsinger & McManus, 2011; Shin, Sutherland, Norris, & Soloway, 2012). The analysis of the current study suggests that both male and female

students have a favorable attitude towards the use of statistics with the aid of technology such as the use of PSPP software.

Meanwhile, it was also revealed that there is no significant difference on the on the attitude of students towards learning statistics with the use of PSPP when grouped according to gender. The findings affirm the results of previous studies that gender does not have any attribute to the attitude of students in teaching statistics with the use of technology (Ursuni & Snachez, 2008; Stout, Dasgupta, Hunsinger & McManus, 2011; Shin, Sutherland, Norris, & Soloway, 2012). The analysis of the current study suggests that both male and female students have a favorable attitude towards the use of statistics with the aid of technology such as the use of PSPP software. Furthermore, there is a significant difference on the attitude of students towards learning statistics with the use of PSPP when grouped according academic strand. STEM Health and Non-Health Students have a more favorable attitude towards learning statistics with the aid of PSPP than ABM students. Many studies stressed the need for health practitioners and engineers to really focus on the statistics since in most cases, probability study is very important especially for these two professions (Romeu, 2006; Davies, 2001; Gigerenzer, et. al., 2007; Veney, Kros, & Rosenthal, 2009).

Finally, there is a significant relationship between the attitudes of students in learning statistics with the use of PSPP software and their academic performance. This means that the favorable attitude of senior high school students in the use of technology such as the PSPP software in learning statistics may lead to a positive and higher academic performance. Thus, this current study shows that attitude towards learning statistics with technology is significantly and positively correlated with academic achievement. The findings also conforms to the results of previous literatures and studies that the use of technology in teaching mathematics such as statistics may increase students' positive attitude towards the subject, and at the end will lead to better academic performance towards the subject (Mushtaq & Khan, 2012; Basturk, 2005; Zhang, et. al., 2012; Mendezabal & Tindowen, 2018; Mata, Monteiro & Peixoto, 2012).

Conclusion and Suggestions

This study concludes that the use of computer-aided instruction in teaching Probability and Statistics such as the PSPP among Senior High School students leads to a positive and favorable attitude towards the subject. More importantly, their favorable attitude towards the subjects leads to an improved academic performance.

Mathematics and Statistics teachers should continue the utilization of technology-driven strategies such as the PSPP in teaching the Probability and Statistics subject among senior high school students since it was found out that they have positive attitude towards the use of technology and at the same time resulted to higher academic achievement in the subject.

The use of technology in learning probability and statistics leads to a favorable attitude towards the subject. In view, mathematics teachers are encouraged to integrate and to use different types of technology and computer aided strategies in teaching statistics and mathematics subjects.

A possible extension of this study is to look into other technology and computer aided instructional strategies and activities that will also enhance students' attitude and academic performance in Statistics and other mathematics subjects.

Future researchers may also dwell into exploring and looking into other important factors that contribute to the academic performance of students in statistics and other mathematics subjects. Furthermore, other factors may also be considered such as technical skills, procedural skills, and other factors in order to shed light into how technology really affects mathematics and statistics learning.

Acknowledgements

References

Anastasiadou, S. D. (2011). Reliability and validity testing of a new scale for measuring attitudes toward learning statistics with technology. *Acta Didactica Napocensia*, *4*(1), 1-10.

Barkatsas, A. (2005). A new scale for monitoring students' attitudes to learning mathematics with technology (MTAS). *Building connections: Theory, research and practice*, *1(1)*, 129-137.

Basturk, R. (2005). The effectiveness of computer-assisted instruction in teaching introductory statistics. *Journal of Educational Technology & Society*, *8*(2), 170-178.

Bennett, S., & Maton, K. (2010). Beyond the 'digital natives' debate: Towards a more nuanced understanding of students' technology experiences. *Journal of computer assisted learning*, *26*(5), 321-331.

Chick, H. L., & Pierce, R. (2008). Chick, H. L., & Pierce, R. (2008). Teaching statistics at the primary school level: Beliefs, affordances and pedagogical content knowledge. *In ICMI study 18 and 2008 IASE round table conference* (Vol. 1, pp. 1-6).

Davies, N. (2001). A new way to teach statistics to engineers. *MSOR Connections*, *1*(2), 7-9.

Dorofeev, S., & Grant, P. (2006). *Statistics for real-life sample surveys: Non-simple-random samples and weighted data*. Cambridge, England: Cambridge University Press.

Farooq, M. S., & Shah, S. Z. U. (2008). Students 'attitude towards mathematics. *Pakistan Economic and Social Review*, *46(1),* 75-83.

Ferrara, F., Pratt, D., & Robutti, O. (2006). The role and uses of technologies for the teaching of algebra and calculus: Ideas discussed at PME over the last 30 years. In A. Gutierrez & Boero, P. (Eds.), *Handbook of research on the psychology of mathematics education* (pp. 237-273). Boston, MA: Sense Publishers.

Gal, I., Ginsburg, L., & Schau, C. (1997). Monitoring attitudes and beliefs in statistics education. *The assessment challenge in statistics education*, *12(1)*, 37-51.

Gattuso, L., & Pannone, M. A. (2002). Teachers' training in a statistic teaching experimentation. In B. Phillips (Ed.), *Proceedings of the Sixth International Conference on Teaching Statistics* (pp. 1-6). Town, South Africa: International Statistical Institute and International Association.

Gigerenzer, G., Gaissmaier, W., Kurz-Milcke, E., Schwartz, L. M., & Woloshin, S. (2007). Helping doctors and patients make sense of health statistics. *Psychological science in the public interest*, *8*(2), 53-96.

Helsper, E. J., & Eynon, R. (2010). Digital natives: where is the evidence? *British educational research journal*, *36*(3), 503-520.

Higazi, S. M. (2002). *Teaching statistics using technology*. Paper presented at the International Conference in Teaching Statestics, Cape Town, South Africa.

Hohenwarter, M., Hohenwarter, J., Kreis, Y., & Lavicza, Z. (2008). *Teaching and learning calculus with free dynamic mathematics software GeoGebra*. Paper presented at the 11th International Congress on Mathematical Education. Monterrey, Nuevo Leon, Mexico.

Kennedy, G. E., Judd, T. S., Churchward, A., Gray, K., & Krause, K. L. (2008). First year students' experiences with technology: Are they really digital natives? *Australasian Journal of Educational Technology*, *24(1),* 108-122.

Kolikant, Y. B. D. (2010). Digital natives, better learners? Students' beliefs about how the Internet influenced their ability to learn. *Computers in Human Behavior*, *26*(6), 1384-1391.

Lee, H. S., & Hollebrands, K. F. (2011). Characterising and developing teachers' knowledge for teaching statistics with technology. In C. Batanero, Burril, G., & Reading, C. (Eds.), *Teaching statistics in school mathematics-challenges for teaching and teacher education* (pp. 359-369). New York, NY: Springer Publishing.

Libman, Z. (2010). Integrating real-life data analysis in teaching descriptive statistics: A constructivist approach. *Journal of Statistics Education*, *18*(1), 1-23.

Lloyd, S. A., & Robertson, C. L. (2012). Screencast tutorials enhance student learning of statistics. *Teaching of Psychology*, *39*(1), 67-71.

Martin, F., & Ertzberger, J. (2013). Here and now mobile learning: An experimental study on the use of mobile technology. *Computers & Education*, *68(1)*, 76-85.

Masrom, M. (2007). Technology acceptance model and e-learning. *Technology*, *21*(24), 81.

Mata, M. D. L., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research, 2012,* 1-10.

Mendezabal, M. J. N., & Tindowen, D. J. C. (2018). Improving students' attitude, conceptual understanding and procedural skills in differential calculus through Microsoft mathematics. *Journal of Technology and Science Education, 8*(4), 385-397.

Mills, J. D. (2004). Students 'attitudes toward statistics: Implications for the future. *College Student Journal*, *38*(3), 349-361.

Mills, J. D., & Raju, D. (2011). Teaching statistics online: A decade's review of the literature about what works. *Journal of Statistics Education*, *19*(2), 1-28.

Mohamed, L., & Waheed, H. (2011). Secondary students' attitude towards mathematics in a selected school of Maldives. *International Journal of Humanities and Social Science, 1*(15), 277-281.

Mushtaq, I., & Khan, S. N. (2012). Factors affecting students' academic performance. *Global journal of management and business research*, *12(9),* 1-7.

Orleans, A. V. (2007). The condition of secondary school physics education in the Philippines: Recent developments and remaining challenges for substantive improvements. *The Australian Educational Researcher*, *34*(1), 33-54.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International journal of science education*, *25*(9), 1049-1079.

Pan, W. S. (2003). The challenges of teaching statistics in the current technology environment. *Journal of American Academy of Business, Cambridge*, *3*(1-2), 351-351.

Pfaff, B., Darrington, J., Stover, J., Satman, M. H., & Beckmann, F. (2007). *GNU PSPP Statistical Analysis Software: Release 0.9.* Boston, MA: Free Software Foundation.

Pierce, R., & Chick, H. (2011). Teachers' beliefs about statistics education. In C. Batanero, Burrill, G., & Reading, C. *Teaching statistics in school mathematics-Challenges for teaching and teacher education* (pp. 151-162). New York, NY: Springer Publishing.

Pratt, D., Davies, N., & Connor, D. (2011). The role of technology in teaching and learning statistics. In C. Batanero, Burrill, G., & Reading, C. *Teaching statistics in school mathematics-Challenges for teaching and teacher education* (pp. 97-107). New York, NY: Springer Publishing.

Prenksy, M. (2001). Digital Natives, Digital Immigrants. *On the Horizon, 9*(5), 1-6.

Reid, A., & Petocz, P. (2002). Students' conceptions of statistics: A phenomenographic study. *Journal of Statistics Education*, *10*(2), 1-18. doi:10.1080/10691898.2002.11910662

Romeu, J. L. (2006, July). *Teaching engineering statistics to practicing engineers*. Paper presented at the 7th International Conference on Teaching Statistics, Kuala Lumpur, Malaysia.

Sampson, D., & Fytros, D. (2008). Competence models in technology-enhanced competence-based learning. In *Handbook on information technologies for education and training* (pp. 155-177). Berlin, Germany: Springer.

Shin, N., Sutherland, L. M., Norris, C. A., & Soloway, E. (2012). Effects of game technology on elementary student learning in mathematics. *British journal of educational technology*, *43*(4), 540-560.

Spinelli, M. A. (2001). The use of technology in teaching business statistics. *Journal of Education for Business*, *77*(1), 41-44.

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of personality and social psychology*, *100*(2), 255-270.

Suanpang, P., Petocz, P., & Kalceff, W. (2004). Student attitudes to learning business statistics: Comparison of online and traditional methods. *Educational Technology & Society*, *7*(3), 9-20.

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). *Using multivariate statistics* (Vol. 5). Boston, MA: Pearson.

Tabunda, A. (2006). Some aspects of the teaching of statistics in the Philippines. *The Philippine Statistician*, *55*(3-4), 43-54.

Thomas, M. O., & Holton, D. (2003). Technology as a tool for teaching undergraduate mathematics. . In C. Batanero, Burrill, G., & Reading, C. *Teaching statistics in school mathematics-Challenges for teaching and teacher education* (pp. 351-394). New York, NY: Springer Publishing.

Thompson, P. (2013). The digital natives as learners: Technology use patterns and approaches to learning. *Computers & Education*, *65(1)*, 12-33.

Tseng, K. H., Chang, C. C., Lou, S. J., & Chen, W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PJBL) environment. *International Journal of Technology and Design Education*, *23*(1), 87-102.

Ursini, S., & Sánchez, G. (2008). Gender, technology and attitude towards mathematics: a comparative longitudinal study with Mexican students. *ZDM*, *40*(4), 559-577.

Vannatta, R. A., & Nancy, F. (2004). Teacher dispositions as predictors of classroom technology use. *Journal of Research on Technology in Education*, *36*(3), 253-271.

Veney, J. E., Kros, J. F., & Rosenthal, D. A. (2009). *Statistics for health care professionals: working with Excel* (Vol. 9). Hoboken, NJ: John Wiley & Sons.

Volk, K., Yip, W. M., & Lo, T. K. (2003). Hong Kong pupils' attitudes toward technology: The impact of design and technology programs. *Journal of technology education*, *15*(1), 48-63.

Wit, E. (2003). Who wants to be... The use of a personal response system in statistics teaching. *MSOR connections*, *3*(2), 14-20.

Zhang, Y., Shang, L., Wang, R., Zhao, Q., Li, C., Xu, Y., & Su, H. (2012). Attitudes toward statistics in medical postgraduates: measuring, evaluating and monitoring. *BMC Medical Education*, *12*(1), 117-125.