REDIMAT
Journal of Research in Mathematics Education

Hipatia Press
www.hipatiapress.com

Instructions for authors, subscriptions and further details:

http://redimat.hipatiapress.com

Students' Misconceptions about Hypothesis Test

Saras Krishnan[1] and Noraini Idris[1]

1) University Malaya, Malaysia

Date of publication: October 24th, 2014
Edition period: October 2014-February 2015

To cite this article: Krishnan, S. & Idris, N. (2014). Students' Misconceptions about Hypothesis Test. *REDIMAT*, *Vol 3*(3), 276-293. doi: 10.4471/redimat.2014.54

To link this article: http://dx.doi.org/10.4471/redimat.2014.54

REDIMAT, Vol. 3 No. 3 October 2014 pp. 276-293

Students' Misconceptions about Hypothesis Test

Saras Krishnan
University Malaya

Noraini Idris
University Malaya

(*Received: 18 June 2014; Accepted: 14 October 2014; Published: 24 October 2014)*

Abstract

Students' misconceptions about hypothesis test have been discussed for decades by many researchers in the developed countries. However, documented studies in the non-developed countries are lacking. The purpose of this study is to fill the gap by identifying misconceptions about hypothesis test made by students in the higher education institutions in a developing country. Descriptive analysis namely percentages and pie charts have been used to analyze students' responses to open-ended items. The misconceptions identified in this study are similar to those discussed in earlier literature implying that students in different educational settings are prone to similar misconceptions about hypothesis test.

Keywords: hypothesis test, inference, misconceptions

2014 Hipatia Press
ISSN: 2014-3621
DOI: 10.4471/redimat.2014.54

Hipatia Press
www.hipatiapress.com

REDIMAT, Vol. 3 No. 3 Octubre 2014 pp. 276-293

Los Errores de los/as Estudiantes sobre el Test de Hipótesis

Saras Krishnan
University Malaya

Noraini Idris
University Malaya

(*Recibido: 18 Junio 2014; Aceptado: 14 Octubre 2014; Publicado: 24 Octubre 2014)*

Resumen

Los errores de los/as estudiantes sobre el test de hipótesis han sido discutidos durante décadas por diferentes investigadores/as en los países desarrollados. A pesar de todo, todavía faltan estudios documentados en países en desarrollo. El propósito de este estudio es cubrir dicho vacío identificando los errores conceptuales sobre el test de hipótesis cometidos por estudiantes de instituciones de educación superior en países en vías de desarrollo. Se ha utilizado análisis descriptivo, en concreto, porcentajes y gráficos de sectores, para analizar las respuestas de los/as estudiantes a los ítems abiertos. Los errores identificados en este estudio son similares a los que han sido discutidos ya en la literatura previa, indicando que los/as estudiantes de diferentes emplazamientos acostumbran a cometer el mismo tipo de errores en el test de hipótesis.

Palabras clave: test de hipótesis, inferencia, errores conceptuales

2014 Hipatia Press
ISSN: 2014-3621
DOI: 10.4471/redimat.2014.54

In the teaching and learning of statistical tests, students' misconceptions about the many statistical concepts involving both the descriptive statistics and the inferential statistics have been observed and researched for more than two decades (e.g., delMas & Liu, 2005; Kadijevich, Kokol-Voljic & Lavicza, 2008; Link, 2002). However, a review of research on students' misconceptions of statistical inference by Sotos, Vanhoof, Noortgate & Onghena (2007) reveal that the documented empirical evidence about students' misconceptions is insufficient and there exists a need for more empirical based studies. This study fills the gap in the sense that students' misconceptions of statistical inference and statistical tests have not been researched much in the developing countries. In particular, this study looks into the misconceptions that students make about the hypothesis test.

Literature Review

Batanero and Diaz (2006) provided two main reasons that explain students' difficulties in understanding inferential statistics. The first reason is that the learning of inferential statistics involves many different concepts such as the null hypothesis and alternate hypothesis, Type I and Type II errors, population and sample, and parameter and statistic that students get confused and misunderstand these concepts. The second reason is the confusion that results from the two different perspectives of statistical tests namely the Fisher (1958) perspective and the Neyman (1950) perspective.

Fisher (1958 as cited in Batanero & Diaz, 2006) argues that statistical tests do not provide inductive inference from sample to population. Instead, he believes that these tests actually result in a deductive inference from a population to the sample. On the other hand, Neyman (1950 as cited in Batanero & Diaz, 2006) believes statistical tests provides a rule for decision making which allows a hypothesis to be accepted or rejected by assuming some risks. The current practice of hypothesis tests combines elements from both perspectives at different stages of the inferential process (Batanero & Diaz, 2006). Regardless of the perspective that dominates the teaching of hypothesis test, students' misconceptions in the learning of hypothesis test are of continual interest and concern.

Link (2002) used students' test papers to investigate their misconceptions about hypothesis test whereby responses to different categories of answers were recorded as percentages. The misconceptions reported by his study concerns statements about the null and alternate hypothesis, making a hypothesis decision, calculation of the test statistic value and writing the probability statement. Rossman and Chance (2004) used open-ended items in investigating students' understanding of misconceptions of statistical inference including the critical value and p-value, and making a conclusion about the statistical significance. Results were reported using percentages. Sotos et al. (2009) used multiple-choice items to investigate students' confidence level of their misconceptions about hypothesis test. Descriptive analysis in the form of percentages was used to provide an overview of the results and further analysis was carried out using non-parametric tests.

According to Sotos et al. (2007) misconceptions about hypothesis test have been discussed for more than twenty years and the two main sources of misconceptions are found to be the textbooks (Brewer, 1985; Gliner, Leech & Morgan, 2002), and the statistics instructors and statisticians (Haller & Krauss, 2002; Mittag & Thompson, 2000). The categories of misconceptions about hypothesis test include approaches to hypotheses testing, definition of hypotheses, the conditional nature of significance levels, interpretation of the numerical value of the p-value, nature of hypotheses tests and evaluation of statistical significance (Sotos et al., 2007).

Methodology

Objective of the Study

The main objective of this study is to investigate the misconceptions students make about hypothesis test, in particular the two-tailed hypothesis test. In specific, this study answers two questions:

1. What misconceptions do students make about the purpose of hypothesis test?
2. What misconceptions do students make about the null hypothesis?

Sample of the Study

Sample of study consists of 150 students from two universities in the central region of Malaysia, a developing country in the South East Asia region. Purposive sampling method has been used to identify students suitable for this study. The composition of students in the sample is shown in Table 1.

Table 1
Composition of students in sample of study

University	Program	Number of students
University A	Program 1	45
	Program 2	43
University B	Program 3	33
	Program 4	29

Instrument

The instruments used in past studies have included questionnaire in the form of multiple-choice items (e.g., Vallecillos, 2002), questionnaire in the form of true/false items (e.g., Vallecillos & Batanero, 1997) and interviews (e.g., Kaplan, 2009). In this study, we have used open-ended questions to be able to gather a multitude of responses from the students. The original instrument contained 21 items and was used in investigating students' statistical literacy. Only the seven items relevant to this study are disclosed in the Appendix. These items assess students' abilities to make hypothesis decision, to infer in the context of the problem and to communicate their understanding of hypothesis test.

Analysis of the Results

Students' responses to the items are segregated into different categories and results are discussed using descriptive analysis presented as percentages and using pie charts.

Ability to Infer in Contexts

The items that are used to investigate students' ability to infer from sample to population are Item 3, Item 4 and Item 6 shown in the Appendix. Table 2 shows the percentage of responses for the different categories of students' responses to these items. Conflicting results are seen whereby most students gave insensible answers for Item 3 (33.33%) and Item 4 (41.33%) but for Item 6 most students have given the correct answer (43.33%). This observation is supported by a correlation analysis that revealed these items have no significant correlations.

Table 2
Descriptive analysis for ability to infer in contexts

	Item 3	Item 4	Item 6
Omitted	18 (12%)	22 (14.67%)	4 (2.67%)
Wrong inequality	3 (2%)	0 (0.0%)	4 (2.67%)
Referred to sample	0 (0.0%)	6 (4%)	16 (10.67%)
Explain procedure	39 (26%)	16 (10.67%)	3 (2%)
Claim is true/false	0 (0.0%)	0 (0.0%)	6 (4%)
Problem context	5 (3.33%)	19 (12.67%)	13 (8.67%)
Insensible answer	50 (33.33%)	62 (41.33%)	39 (26%)
Correct answer	35 (23.33%)	25 (16.67%)	65 (43.33%)
Total	150 (99.99%)	150 (100.01%)	150 (100.01%)

The pie chart in Figure 1 displays the average percentages for categories of responses for Item 3, Item 4 and Item 6. The pie chart shows that the largest percentage of responses is for insensible answers (33.55%). However, this is followed by the percentage of correct responses (27.78%). Further, 12.89% of the students explained the hypothesis testing procedure instead of making an inference, 8.22% failed to infer in the context of the problem, 4.89% referred to the sample instead of the population, 1.56% used the wrong inequality statement in their inference and 1.33% just stated whether the claim is true or false.

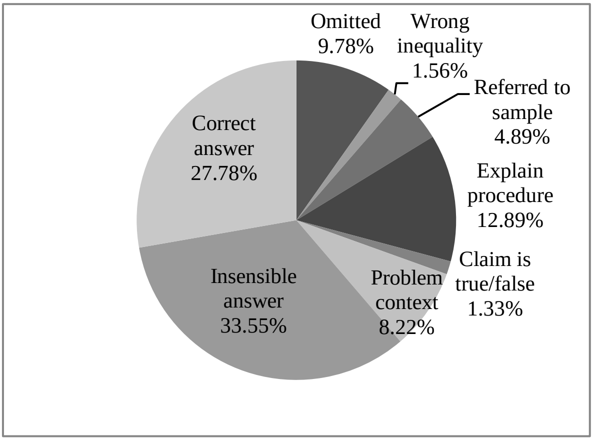

Figure 1. Pie chart for ability to infer in contexts

Communication of Understanding

The items used to investigate students' ability to communicate their understanding of hypothesis test are Item 5 and Item 7. These items assessed students' communication skills in explaining the hypothesis testing procedure and process. As shown in Table 3, many of the students provided the correct answers for both the items. In detail, 47.33% and 30.67% of the students answered correctly Item 5 and Item 7 respectively.

Table 3
Descriptive analysis for communication of understanding

	Item 5	Item 7
Omitted	18 (12%)	25 (16.67%)
Whether H_0 is true or not	9 (6%)	29 (19.33%)
To reject H_0	3 (2%)	6 (4%)
Referred to sample	12 (8%)	18 (12%)
Insensible answer	37 (24.67%)	26 (17.33%)
Correct answer	71 (47.33%)	46 (30.67%)
Total	150 (100%)	150 (100%)

The pie chart in Figure 2 shows that more students made the mistake of thinking that the hypothesis test is conducted to test if the null hypothesis is true or false (12.67%) as opposed to those who said that the hypothesis test is conducted with the purpose of rejecting the null hypothesis (3%). Further, 10% of the students referred to the sample statistic instead of the population parameter in their answers.

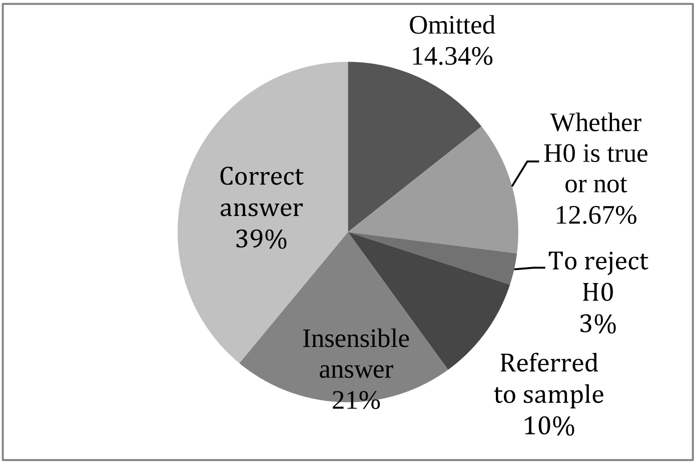

Figure 2. Pie chart for communication of understanding

Complete Knowledge of Decision Making

The two items that are concerned with hypothesis decision making are Item 1 and Item 2. The correct hypothesis decision for Item 1 is "*reject H_0 and accept H_a*" while the correct decision for Item 2 is "*do not reject H_0*". Shown in Table 4, most students gave the incomplete answer "*reject H_0*" for Item 1. Meanwhile, the answer that most students gave for Item 2 is to accept the null hypothesis which is actually statistically incorrect.

Table 4
Descriptive analysis for complete knowledge of decision making

	Item 1	Item 2
Omitted	25 (16.67%)	21 (14%)
Incomplete	61 (40.67%)	0 (0.0%)
Accept H_0	0 (0.0%)	71 (47.33%)
Insensible answer	37 (24.67%)	26 (17.33%)
Correct answer	27 (18%)	32 (21.33%)
Total	150 (100.01%)	150 (99.99%)

The pie chart in Figure 3 shows that on average more students made the mistake of accepting a null hypothesis (23.67%) compared to the percentage of incomplete answers (20.34%). However, due to the nature of the questions and subsequently the answers, we can see from Table 4 that these two categories of responses are mutually exclusive.

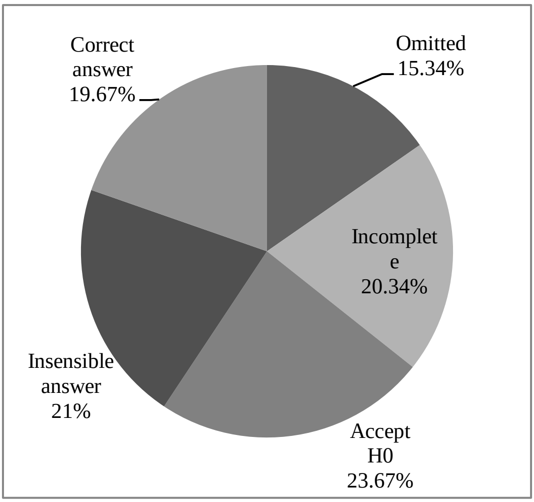

Figure 3. Pie chart for complete knowledge of decision making

Students' Misconceptions about Hypothesis Test

Misconceptions about the Purpose of Hypothesis Test

The two misconceptions associated with the purpose of hypothesis test identified in this study are hypothesis test is carried out to establish the sample statistic and hypothesis test is carried out to decide if the null hypothesis is true or false.

Hypothesis test is carried out to establish the sample statistic

Students who make this misconception do not have the fundamental idea of inferential statistics which essentially is to make an inference about a population parameter. Instead, these students have the misconception that the inferential procedure is carried out to determine the value of a sample statistic which is the sample mean in this case. Examples of students' responses to Item 5 are shown in Figure 4 and Figure 5.

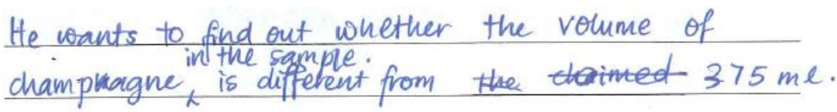

Figure 4. Sample answer from respondent A039

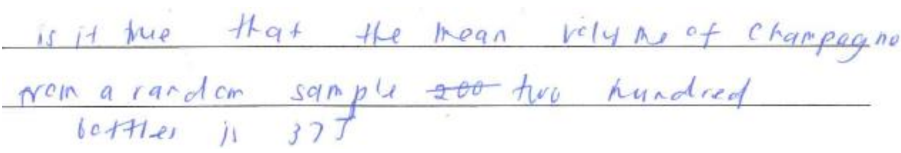

Figure 5. Sample answer from respondent M031

This misconception has been reported in earlier literature such as Link (2002), and Vallecillos and Batanero (1997). Further, the study by Jala and Reston (2010) found that students incorrectly validated a generalization that was made about a population based on sample data. This mistake revealed that students lack understanding of the role of probabilistic chance and uncertainty in making generalizations about a population, and the relationships between variables in a sample. In other words, students do not know the logic or the reason for conducting an inferential procedure. Likewise, Haller and Krauss (2002) had earlier found that literature suggests students merely mastered the calculations but did not grasp the meaning of the underlying idea of hypothesis test. Worse, it was found that besides the students, the statistics instructors too have misconceptions associated with the purpose of conducting hypothesis tests.

Hypothesis test is carried out to decide if the null hypothesis is true or false

This misconception reveals that students view inferential procedures to be deterministic just like a mathematical proof (Sotos et al., 2009). In practicality, a hypothesis testing procedure is carried out to investigate the claim made about a population parameter and while it is possible to decide on the probability of the null hypothesis being true based on certain level of significance α, it is not possible to actually conclude that the null hypothesis is true. This is because it is statistically incorrect to make a decision to accept the null hypothesis.

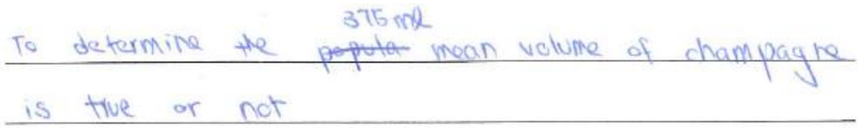

Figure 6. Sample answer from respondent A004

Figure 7. Sample answer from respondent A019

Sample responses for Item 5 from respondent A004 and respondent A019 are shown in Figure 6 and Figure 7 respectively. Such answers suggest that students view hypothesis test as a mathematical proof instead of as a probabilistic proof (Sotos et al., 2007). The misconception that the purpose of hypothesis test is to decide if the null hypothesis is true or false is related to the misconception associated with hypothesis decision making discussed next whereby students believe that the null hypothesis can be accepted.

Misconceptions about the Null Hypothesis

Over the years, strong objections towards the null hypothesis significance testing have been voiced out by many (Gliner et al., 2002; Nickerson, 2000) on the basis that the procedure is futile because the null hypothesis is always false (Kirk, 1996 as cited in Gliner et al., 2002). Another reason is that many misconceptions associated with the null hypothesis statistical testing result in unjustifiable conclusions (Nickerson, 2000). Suggestions to overcome the imperfections of the null hypothesis significance testing are to provide the effect size estimate when reporting p-value (Wilkinson & the APA Task Force on Statistical Inference, 1999 as cited in Gliner et al., 2002) and the use of confidence intervals either as a substitute for hypothesis test (Cumming, Williams & Fidler, 2004) or as a complement to hypothesis test (Reichardt & Gollob, 1997 as cited in Sotos et al., 2007). The two misconceptions associated with null hypothesis identified in this study are null hypothesis must be rejected and null hypothesis can be accepted.

Null hypothesis must be rejected

This misconception is different from the second misconception discussed for the misconceptions about the purpose of hypothesis test. In the former, students believe that a set of inferential procedures can be used to determine whether the null hypothesis is true or false. On the other hand, here students believe that the null hypothesis is wrong and their work is to use the inferential procedures to prove this. In this particular instant, students believe inferential procedures provide a pre-determined result (Sotos et al., 2007) that is one that will tell us that the mean value given in the null hypothesis is wrong. Examples of students' responses to Item 5 are shown in Figure 8 and Figure 9 below.

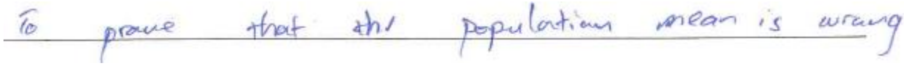

Figure 8. Sample answer from respondent A027

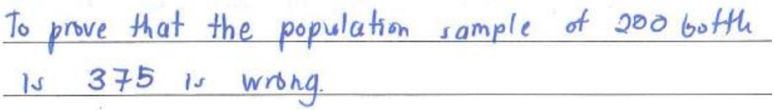

Figure 9. Sample answer from respondent M002

Null hypothesis can be accepted

The second misconception about the null hypothesis observed in this study is that the null hypothesis can be accepted. This misconception has been reported previously by researchers such as Nickerson (2000), and Vallecillos and Batanero (1997, as cited in Sotos et al., 2007). Sample responses for Item 2 extracted from respondent I011 and respondent I014 are shown in Figure 10 and Figure 11 respectively.

Figure 10. Sample answer from respondent I011

Figure 11. Sample answer from respondent I014

Further, Nickerson (2000) found that this misconception is not only made by students but by researchers too. He cited Harcum (1990) and Schmidt (1996) as some of the examples. As a matter of fact, one of the teachers teaching students involved in this study admitted that she tells the students that failure to reject the null hypothesis means that the null hypothesis is true since "*it is easier to teach that way*". However, this teacher had failed to educate the students on the various reasons why the null hypothesis is not rejected such as faulty experimental design and the effect of extraneous variable (Nickerson, 2000). As suggested by Haller and Krauss (2002), and

Mittag and Thompson (2000), the fact that the teachers themselves are prone to making misconceptions is one of the reasons for students to have many misconceptions about hypothesis tests.

Conclusion

This article has identified four misconceptions about hypothesis test by analysing students' responses to open-ended items. The misconceptions are: (1) hypothesis test is carried out to establish the sample statistic, (2) hypothesis test is carried out to decide if the null hypothesis is true or false, (3) null hypothesis must be rejected, and (4) null hypothesis can be accepted. Although there have been a number of studies in the past concerning students' misconceptions about inferential statistics in general and students' misconceptions about hypothesis test in particular, these studies mainly involve researchers and students from the developed countries. Hence, the importance of this study is to fill the gap since studies about students' misconceptions of inferential statistics are limited in the developing countries. The main outcome of this study is that the students' misconceptions about hypothesis test are similar to the misconceptions identified in the earlier studies. However, considering the fact that studies on students' misconceptions about hypothesis test are scarce in the developing countries, we would like to see more studies that can complement or contradict the findings of this study to emerge in future.

References

Batanero, C. & Diaz, C. (2006). Methodological and Didactical Controversies around Statistical Inference. *Actes des 38-iemes Journees de Statstique*, CD-ROM, Paris: Societé Française de Statistique.

Brewer, J.K. (1985). Behavioral statistics textbooks: Source of myths and misconceptions? *Journal of Educational Statistics*, *10*(3), 252-268. doi: 10.3102/10769986010003252

Cumming, G., Williams, J. & Fidler, F. (2004). Replication, and researchers' understanding of confidence intervals and standard error bars. *Understanding Statistics*, *3*(4), 199-311. doi: 10.1207/s15328031us0304_5 delMas, R.C. & Liu, Y. (2005). Exploring students' conceptions of the standard deviation. *Statistics Education Research Journal*, *4*(1), 55-82.

Fisher, R.A. (1958). *Statistical methods for research workers*. New York: Hafner.

Gliner, J.A., Leech, N.L. & Morgan, G.A. (2002). Problems with null hypothesis significance testing (NHST): What do the textbooks say? *The Journal of Experimental Education*, *71*(1), 83-92. doi: 10.1080/00220970209602058

Haller, H. & Krauss, S. (2002). Misinterpretations of significance : A problem students share with their teachers? *Methods of Psychological Research*, *7*(1), 1-20.

Harcum, E.T. (1990). Methodological vs. empirical literature: Two views on causal acceptance of the null hypothesis. *American Psychologist*, *45*, 404-405. doi: 10.1037/0003-066X.45.3.404

Jala, L.L. & Reston, E. (2010). Assessment of Graduate Students' Conception of Statistical Inference: Philippine Perspective. In C. Reading (Ed.), *Data and Context in Statistics Education: Towards an evidence-based society*. *Proceedings of the 8th International Conference on Teaching Statistics (ICOTS8)*. Voorburg, The Netherlands: International Statistical Institute.

Kadijevich, D., Kokol-Voljic, V. & Lavicza, Z. (2008). Towards a Suitably Designed Instruction on Statistical Reasoning: Understanding Sampling Distribution with Technology. In C. Batanero, G. Burrill, C. Reading & A. Rossman (Eds.), *Joint ICMI/IASE Study: Teaching Statistics in School Mathematics. Challenges for Teaching and Teacher Education. Proceedings of the ICMI Study 18 and 2008 IASE Round Table Conference*. Retrieved from: https://www.stat.auckland.ac.nz/~iase/publications/rt08/T4P9_Kadijevich.pdf

Kaplan, J.J. (2009). Effect of Belief Bias on the Development of Undergraduate Students' Reasoning about Inference. *Journal of Statistics Education*, *17*(1). Retrieved from: http://www.amstat.org/publications/jse/v17n1/kaplan.html

Kirk, R.E. (1996). Practical significance: A concept whose time has come. *Educational and Psychological Measurement*, *56*, 746-759. doi: 10.1177/0013164496056005002

Link, W.C. (2002). An Examination of Student Mistakes in Setting Up Hypothesis Testing Problems. *Louisiana-Mississippi Section of the Mathematical Association of America*.

Mittag, K.C. & Thompson, B. (2000). A national survey of AERA members' perception of statistical significance tests and other statistical issues. *Educational Researcher*, *29*(4), 14-20.

Neyman, J. (1950). *First course in probability and statistics*. New York: Henry Holt.

Nickerson, R.S. (2000). Null Hypothesis Significance Testing: A Review of an Old and Continuing Controversy. *Psychological Methods*, *5(2)*, 241-301. doi: 10.1037/1082-989X.5.2.241

Reichardt, C.S. & Gollob, H.F. (1997). When confidence intervals should be used instead of statistical tests, and vice versa. In L.L. Harlow, S.A. Mulaik & J.H. Steiger (Eds.), *What if there were no significant tests?* (pp. 259-284). London: Lawrence Erlbaum Associates, Publishers.

Rossman, A.J. & Chance, B. (2004). Anticipating and addressing student misconceptions. In *ARTIST Conference on assessment in Statistics, Lawrence University*. August, 1-4.

Schmidt, F.L. (1996). Statistical significance testing and cumulative knowledge in psychology: Implications for training of researchers. *Psychological Methods*, *1*, 115-129. doi: 10.1037/1082-989X.1.2.115

Sotos, C., Vanhoof, S., Noortgate, W. & Onghena, P. (2007). Students' misconceptions of statistical inference: A review of the empirical evidence from research on statistics education. *Educational Research Review*, *2*(2), 98-113. doi: 10.1016/j.edurev.2007.04.001

Sotos, C., Vanhoof, S., Noortgate, W. & Onghena, P. (2009). How confident are students in their Misconceptions about Hypothesis Tests? *Journal of Statistics Education*, *17*(2). Retrieved from: http://www.amstat.org/publications/jse/v17n2/castrosotos.pdf

Vallecillos, A. (2002). Empirical evidence about understanding of the level of significance concept in hypothesis testing by university students. *Themes in Education*, *3*(2), 183-198.

Vallecillos, A. & Batanero, C. (1997). Activated concepts in the statistical hypotheses contrast and their understanding by university students. *Recherches en Didactique des Mathematiques*, *17*, 29-48.

Wilkinson, L. & the APA Task Force on Statistical Inference. (1999). Statistical methods in psychology journals: Guidelines and explanations. *American Psychologist*, *54*, 594-604. doi: 10.1037/0003-066X.54.8.594

Saras Krishnan is postgraduate student, in the Department of Mathematics and Science Education, University Malaya, Malaysia.
Noraini Idris is professor, in the Department of Mathematics and Science Education, University Malaya, Malaysia.

Contact Address: Direct correspondence concerning this article, should be addressed to the author. Postal address: Department of Mathematics and Science Education, Faculty of Education Building, University of Malaya, 50603 Kuala Lumpur, Malaysia. **Email**: noridris@um.edu.my

Appendix

Consider the hypothesis statements $H_0: \mu = 32, H_a: \mu \neq 32$.

Item 1

What hypothesis decision will you make based on a *z*-score of 2.05?

Item 1

The mean monthly allowance for clothes for female students studying in City Q is assumed to be 200 dollars. Consider the hypothesis statements:

$$H_0: \mu = 200, H_a: \mu \neq 200.$$

Item 2

Diana's sample generated a P-value of $P = 0.652$. What decision on the null hypothesis will Diana take?

Item 3

Jason conducted a hypothesis test and made the decision to reject the null hypothesis. Interpret Jason's decision.

Item 2 and Item 3

Best Sugar packets sugar in polystyrene bags using newly imported machines. The quality control inspector will instruct the machines to be adjusted if the mean weight of $\mu = 1010$ grams is not met.

Let the mean weight of a random sample of seventy bags be 1015 grams.

Item 4

Consider the hypothesis statements: $H_0: \mu = 1010, H_a: \mu \neq 1010$. Interpret the decision "*reject* H_0 *and accept* H_a".

Item 4

In a winery in Spain, the actual volume filled into the champagne bottles varies slightly from bottle to bottle. Pepillo found that the mean volume of champagne from a random sample of two hundred bottles is 371 ml.

Consider the hypothesis statements: $H_0: \mu = 375, H_a: \mu \neq 375.$

Item 5

Explain what Pepillo wants to find out by conducting this hypothesis test.

Item 6

Say that Pepillo's hypothesis testing results in the decision "*do not reject* H_0". What conclusion does Pepillo make?

Item 5 and Item 6

Consider the hypothesis statements:

$$H_0: \mu = 14.3, H_a: \mu \neq 14.3.$$

Assume that the population standard deviation is $\sigma = 1$ and that *any* sample taken from this population will have a sample mean $\bar{x} = 14.$

Item 7

What do we want to determine by conducting this hypothesis test?

Item 7