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A psychological model explaining why we love or hate statistics

Tommy Prayoga, Juneman Abraham*

Psychology Department, Bina Nusantara University, Jakarta 11480, Indonesia

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ABSTRACT

Students of social sciences often hate statistics and therefore cannot utilize statistics optimally. As only a few studies are available on the antecedents of the attitude towards statistics, the authors investigated five possible antecedents in a hypothetical model. The sample for this study was 255 psychology students across Greater Jakarta, Indonesia (52 males, 203 females; $M_{age} = 20.309$ years old, $SD_{age} = 1.182$ years). Using path analysis, it was found that mathematics self-efficacy and appreciation towards history of mathematics can predict statistics appropriation, while ambiguity tolerance can predict previous bad mathematics experience. Finally, both statistics appropriation and previous bad mathematics experience can predict attitude towards statistics, thus confirming the hypothesized model. The overall psychological model had a good fit (χ^2 (7, N = 255) = 7.72, $p > .05$).

Introduction

Mathematics has long been considered as the language of any natural and social science (Choudhury & Das, 2012) as it provides a scientific basis that signifies empiricism (Al-Agili, Bin Mamat, Abdullah, & Maad, 2012). Studying statistics as "a branch of mathematics dealing with the collection, analysis, interpretation, and presentation of masses of numerical data" (Smith, 2011, p. E5) gives us the opportunity to make more logical and positive decisions in solving problems (Ulpah, 2009). Statistics helps us to: (1) describe phenomena in a simpler and more concrete manner, (2) identify the relationships between factors in dealing with problems and, (3) predict future outcomes (Huang, 2015). Due to these functions, statistics plays an important part in the study of psychology in determining the credibility of psychological research methods and results.

However, despite the importance of mastering statistical skills in psychology, there has been a tendency to dislike and even avoid number-associated statistics among college students (Slootmaeckers, Kerremans, & Adriaensen, 2014). The negative responses students have towards statistics (scary, confusing, and hard) eventually creates the tendency for students to avoid using quantitative methods in conducting research (Kurniati, 2012).

Attempts have been made through many studies to explain this phenomenon of disliking statistics, and a main focus deals with the attitude towards statistics, defined as an individual's tendency to respond to statistics based on their potential, evaluation, and act (Margono, 2013). The reason attitude is considered to be able to explain the phenomenon is because it reflects an individual's response to statistics based on their feelings, behavior, and beliefs (Schau & Emmioğlu, 2011). As Wirth and Perkins (2008) stated, learning is not just acquiring knowledge, rather it is an approach towards developing an attitude toward what

* Corresponding author.
E-mail address: juneman@binus.ac.id (J. Abraham).
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is learned. Moreover, studying attitudes towards statistics could identify the potential risks and help students engage further in the learning process. The tendency to avoid or respond negatively towards statistics still prevails among students, yet there is only a small body of research on attitude towards statistics in Indonesia, making a deeper analysis of attitude even more necessary.

The objective of this study was to explain psychology students' attitude towards statistics through a theoretical model by outlining and examining some of the important factors that could potentially predict or influence the attitude, that is, mathematics self-efficacy, appreciation towards history of statistics, statistics appropriation, ambiguity tolerance, and previous bad mathematics experience (see Figure 1).

Literature Review

Attitude Towards Statistics

The attitude in this study is conceived by an interpretive approach to give meaning and interpret the interactions between components of attitude and to relate it better to real life examples (Di Martino & Zan, 2015). One of the most illustrious examples of this definition is contained in the model developed by Schau (2003), which described attitude as a construct comprised of six subjective component dimensions (Ramirez, Schau, & Emmioğlu, 2012)—affect, cognitive evaluation, value, difficulty, interest, and effort. The first component, *affect* indicates a student's subjective emotions and feeling towards statistics, that is reflected in their enthusiasm, comfort, and enjoyment in learning statistics. Having a positive affect means students are enjoying learning statistics, feel no threat and will focus on the lesson more, while having a negative affect means a student is more likely to get bored, be fearful, and to dislike statistics (Schau & Emmioğlu, 2011).

Cognitive evaluation is the subjective evaluation made by the students themselves regarding their cognitive competency in understanding statistics. *Value* shows how important and valuable statistics are toward the student. It reflects the subjective perception of whether they feel statistics are relevant and beneficial not only academically, but also personally. The fourth component, *difficulty* indicates the subjective perception of difficulty toward statistics-related lessons and activities (Schau & Emmioğlu, 2011). It does not reflect the true difficulty of the subject, as sometimes an easy lesson could be regarded as hard by some students, and vice versa. *Interest* is the subjective level of curiosity and willingness to engage in learning statistics. The final component, *effort*, is the subjective perception of how much effort students have to invest to learn statistics. It is not limited to understanding lessons; it could take the form of doing an assignment, taking a test and maybe collaborating with others.

In Indonesia, the main reasons students detest statistics are: they perceive the subject to be irrelevant and non-beneficial in studying psychology, a lot of calculation has to be done and formulas remembered, and lessons are not interesting, boring and hard (Kurniati, 2012); all of which align with the component dimensions of attitude towards statistics.

Statistics Appropriation

Appropriation is a term describing the adoption and use of an object to fit the user's need and intention (Gaskin & Lyytinen, 2011). Statistics appropriation involves not only the utilization of statistics for classroom practices and testing but also using statistics to deal with personal problems (Erfjord, Hundeland, & Carlsen, 2012). For example, psychology students may remember related statistical principles when deciding to avoid traffic in a rush hour.

In this study, statistics appropriation is not measured directly as concrete behavior, but rather as a tendency that will determine an individual's attitude. A higher tendency to appropriate predicts a positive effect in individuals, representing their interest and perceived value in statistics and considering the effort they have to invest in and the realization that they have the capacity of doing so. Therefore, the following hypothesis was proposed: *H1: "Statistics appropriation can predict an individual's attitude towards statistics positively."*

Appreciation Towards History of Mathematics

History of mathematics comprises previous events and problems in the field of mathematics that bring knowledge of procedures and practicality in dealing with problems

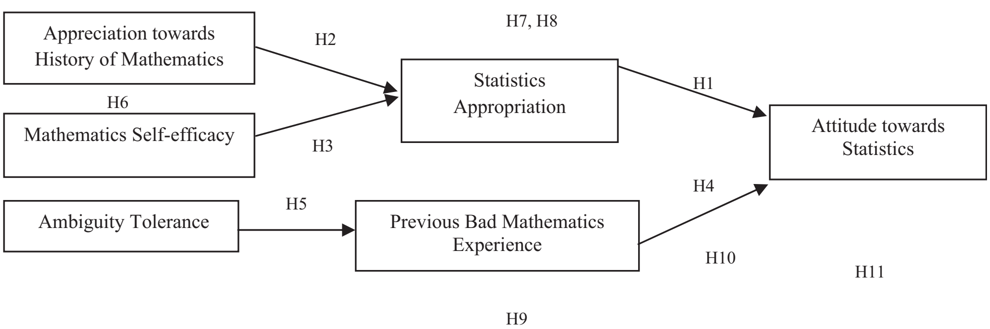

Figure 1 Theoretical model

(Lawrence, 2010). It is not just the historical events describing what happened in the past regarding a mathematical subject, but also the actions and thoughts that we can learn from previous scholars and their works that allow our minds to be opened to the infinite possibilities of mathematics (Haverhals & Roscoe, 2010). It gives students new ideas and ways of thinking in dealing with statistical problems (Panasuk & Horton, 2013; Smestad, 2012).

As history of mathematics can provide a positive view and effect for learners (Goktepe & Ozdemir, 2013), appreciation as a tendency to feel gratitude and positive experience (Piragasam, Majid, & Jelas, 2013) towards the history should be expected from a learner with a higher interest in statistics. Students who appreciate the subject will be more likely to appropriate it, using statistics in a different manner from what is taught. Therefore, the following hypothesis was proposed: *H2: "Appreciation towards history of statistics can predict an individual's statistics appropriation positively."*

Mathematics Self-Efficacy

Mathematics self-efficacy refers to the belief individuals have of their ability to perform mathematics-related activities (Clutts, 2010), such as using a formula and solving problems. It does not determine the cognitive capacity an individual possesses, but rather how much cognitive effort will be exhibited in dealing with a problem. Individuals with higher mathematics self-efficacy are more likely to use a deeper cognitive strategy and maintain their self-regulation to accomplish the mathematical task (Neuville, Frenay, & Bourgeois, 2007).

As statistics has many applied benefits, individuals with higher mathematics self-efficacy believe they can work with statistics and will be more likely to appropriate it. Therefore, the following hypothesis was proposed: *H3: "Mathematics self-efficacy can predict an individual's statistics appropriation positively."*

Previous Bad Mathematics Experience

Past experience regarding a situation can usually predict how individuals will approach and perceive a similar situation in the future, and finally, form an attitude towards it (Sommer, 2011). This is due to any elements of past experience, such as thought and feeling regarding a subject, being generalized to similar situations (Perepiczka, Chandler, & Becerra, 2011). Since students have known of numbers since childhood, and of statistics since high school, it is possible that any experience they had in high school—good or bad—could influence how they perceive statistics and their forming of an attitude. The focus of the measurement in this study will be on 'bad experiences' that predict attitude toward statistics negatively. Therefore, the following hypothesis was proposed: *H4: "Previous bad mathematics experience can predict an individual's attitude towards statistics negatively."*

Ambiguity Tolerance

Ambiguity tolerance describes emotional and perceptual characteristics of individuals when dealing with information in unfamiliar contexts and situations (Furnham & Marks, 2013). It is a disposition that shows a tendency to perceive ambiguous situations to be comfortable (or disturbing), and to then determine how to act on that, or make sense of (or avoid) it (Dewaele & Wei, 2013). As a disposition, ambiguity tolerance develops from a young age when individuals learn to react toward everything new they experience in the surroundings (Merrotsy, 2013), and it could be a predictor of a learning obstacle (Atamanova & Bogomaz, 2014). Hence, ambiguity tolerance can predict an individual's tendency to feel the experience in learning mathematics.

Ambiguity tolerance could not directly predict attitude, as it requires a more concrete and specific "embodiment" of the tolerance like mathematics experience to be able to relate it with attitude towards statistics, thus requiring the mediation of mathematics experience. Therefore, the following hypothesis was proposed: *H5: "Ambiguity tolerance can predict an individual's previous bad mathematics experience negatively."*

The hypotheses formed from previous arguments can be represented by a theoretical model shown in Figure 1. Based on the arguments relating to each hypothesis regarding how each predictor relates with the endogenous or dependent variable, the formed model should be able to explain attitude towards statistics. The following hypotheses were proposed: *H6: "Mathematics self-efficacy and appreciation towards history of mathematics can predict statistics appropriation simultaneously"; H7: "Statistics appropriation mediates the relationship prediction between appreciation towards history of mathematics and attitude towards statistics"; H8: "Statistics appropriation mediates the relationship prediction between mathematics self-efficacy and attitude towards statistics"; H9: "Previous bad mathematics experience mediates the relationship prediction between ambiguity tolerance and attitude towards statistics"; H10: "Previous bad mathematics experience and statistics appropriation can predict attitude towards statistics simultaneously"; H11: "Mathematics self-efficacy, appreciation towards history of mathematics, statistics appropriation, ambiguity tolerance, and previous bad mathematics experience, altogether can be used to explain attitude towards statistics significantly through a theoretical model."*

Methods

Participants and Data Collection

The participants consisted of 255 Indonesian college students aged 17–25 years ($M_{\text{age}} = 20.309$ years, $SD_{\text{age}} = 1.182$ years), being 52 males and 203 females studying psychology in universities across Greater Jakarta, Indonesia. Convenience and snowball sampling were used in each university, to provide greater access to large-scale participation. All data collection instruments (questionnaires) were adapted from existing ones and reworked to fit the participant and context of the study. The reliability of each instrument was tested against Cronbach's alpha criteria ($\alpha \geq 0.600$). Item validities were tested using corrected item-total correlation index criteria ($CIT \geq 0.250$).

Attitude towards statistics was measured using *Survey of Attitude towards Statistics* (SATS-36) by Hilton, Schau, and Olsen (2004). Examples for the items were “I like statistics” for affect, “I can understand statistics” for cognitive evaluation, “Statistics is not valuable to me” for value, “Learning statistics requires high discipline” for difficulty (unfavorable item, reversely scored), “I am interested in using statistics” for interest, and “I am planning to work hard on a statistics course” for effort. Responses were obtained by asking participants their level of agreement with each statement, through a 6-point Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*). Three items were omitted during reliability and validity testing, resulting in 33 items in the final version of the instrument, with a reliability index of $\alpha = 0.940$ and the *CIT* ranged from 0.265 to 0.797.

Previous bad mathematics experience was measured using the indication of previous experience by Pavlou and Fygenson (2006) that was fitted into the context of the study. Before filling out this section, the participant was asked to imagine their high school experience. Examples of items were “How often did mathematics make you uncomfortable?” and “How often did you enjoy mathematics?” The participant was asked to indicate the frequency of each experience described through a 6-point Likert scale from 1 (*never*) to 6 (*always*). No item was omitted during reliability and validity testing, keeping six items in the final version of the instrument, with a reliability index of $\alpha = 0.887$ and the *CIT* ranged from 0.523 to 0.806.

Ambiguity tolerance was measured using the compilation of an ambiguity tolerance scale by Chumakova and Kornilov (2013). To avoid confusion and provide clarity as to what ambiguity meant, the authors added a simple definition of ambiguity: “Ambiguity is a situation that is unfamiliar or novel, due to its unstructured, confusing nature and contains various meanings for an individual” in Indonesian. Examples of the items were “I am easy and can be willing to take any risk” and “I tend to avoid ambiguous situations” (unfavorable item, reversely scored). Responses were obtained by asking participants to indicate their agreement towards each statement using a 6-point Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*). Two items were omitted during reliability and validity test, resulting in 20 items in the final version of the instrument, with a reliability index of $\alpha = 0.821$ and *CIT* ranged from 0.314 to 0.582.

The instrument for statistics appropriation was adapted from Lin's (2005) *Zone Experience Study Questionnaire Appropriation* sub-scale, contextualized into statistical context using Tessler's (2013) list of statistics' application, resulting in 13 items measuring participants' tendency to appropriate statistics. Examples of the items were “I often find many useful benefits of Statistics in my life” and “I use the principle of Statistics in analyzing problems I am having”. The response was obtained by asking the participant to indicate their agreement towards each statement using 6 points Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*). No item was omitted during reliability and validity testing, keeping 13 items in the final version of the instrument, with a reliability index of $\alpha = 0.945$ and the *CIT* ranged from 0.528 to 0.830.

Mathematics self-efficacy was measured using the *Mathematics Self-Efficacy Survey* (MSES) by Betz and Hackett (as cited in Clutts, 2010). There were 18 items measuring the participants' belief in their ability to do mathematics-related tasks. Examples of the items were “I can add two large numbers (for example, 5,427 + 1,889) in my head when doing a test that requires calculations” and “I can calculate the sample needed from a 50% smaller population from the previous study”. The response was obtained by asking participants to indicate their agreement with each statement using a 6-point Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*). Two items were omitted during reliability and validity testing, resulting in 16 items in the final version of the instrument, with a reliability index of $\alpha = 0.895$ and the *CIT* ranged from 0.421 to 0.749.

To measure appreciation towards history of mathematics, the authors adapted the measurement instrument of Techio et al. (2010) that measures students' appreciation of past historical events into the context of mathematical history in statistics. Examples of the items were “Understanding history of mathematics in statistics is very important in determining my interest and appreciation in learning statistics”, and “If I were told the story about how a concept in statistics was formed and by whom, I would be inspired to learn more”. For each item, participants were given a story of how a concept or formula was introduced to statistics, to support better understanding for each item presented. For example “In 1976, Fischer introduced the framework to determine hypothesis acceptance”. Participants were asked to describe the importance of each historical event for them, through a 6-point Likert scale from 1 (*not important at all*) to 6 (*very important*). No item was omitted during reliability and validity testing, keeping 10 items in the final version of the instrument, with a reliability index of $\alpha = 0.944$ and the *CIT* ranged from 0.614 to 0.855.

Data Analysis

The design involved a quantitative, non-experimental approach using the predictive correlation method. The data obtained were analyzed using a path analysis with mediation model (Sarwono & Budiono, 2012), supported by the LISREL 8.8 Statistics program.

Results

Twenty-five percent of the respondents were first years and sophomores, and 70 percent were juniors and seniors, while the remainder were taking the 9th semester and above. Forty-five percent took at least 4–6 credits in statistics, 24 percent took only 2–3 credits, and 18 percent took at least 7–10 credits. Finally, 13 percent took more than 10 credits during their study.

The results of the assumption test showed that the data distribution was normal, free from heteroscedasticity, and all independent variables were free from multicollinearity. The prediction's path coefficient magnitude and the t value of significance were obtained for path analysis using LISREL 8.8. For α at the .05 level, the critical value of $t = |1.96|$ was used for judging the statistical significance of the path coefficients (Yung, 2008). The coefficient magnitude and significance were presented in the format (standardized coefficient estimation, t).

The root mean square error of approximation (RMSEA) for the model was 0.02 (which was less than 0.05), with a p value for test of close fit of 0.358 ($p > 0.05$), with χ^2 (7, $N = 255$) = 7.72, indicating the proposed model was a good fit and could be used to explain attitude towards statistics (Figure 2). The results indicated that statistics appropriation could significantly predict students' attitudes towards statistics positively ($\beta = 0.18$, $t = 10.37$, $t > 1.96$). Appreciation towards history of mathematics ($\gamma = 0.62$, $t = 10.66$, $t > 1.96$) and mathematics self-efficacy ($\gamma = 0.23$, $t = 4.89$, $t > 1.96$) can predict statistics appropriation positively. Hence, H1, H2, and H3 were supported by the empirical data.

Previous bad mathematics experience could significantly predict attitude towards statistics negatively ($\beta = -0.28$, $t = -8.03$, $t < -1.96$). Ambiguity tolerance was shown to be able to predict previous bad mathematics experience negatively ($\gamma = -0.09$, $t = -2.54$, $t < -1.96$). Hence, H4 and H5 were supported by the empirical data.

Appreciation towards history of mathematics (total effect = 0.11, $t = 7.43$, $t > 1.96$; see Equation (1)) and Mathematics self-efficacy (total effect = 0.042, $t = 4.42$, $t > 1.96$; see Equation (1)) were found to have indirect effects toward attitude towards statistics via statistics appropriation, indicating that statistics appropriation could mediate both variables and attitude towards statistics, but with different levels of magnitude and significance. H6, H7, and H8 were supported by the empirical data.

LISREL Estimates (Maximum Likelihood)

Structural Equations

Attitude =	- 0.28*Past_Exp +	0.18*Appropri, Errorvar.=	11.88, R^2 = 0.41
SE	(0.035)	(0.018)	(1.06)
t	-8.03	10.37	11.20

Past_Exp =	- 0.094*Amb_Tol, Errorvar.=	37.45, R^2 = 0.025
SE	(0.037)	(3.34)
t	-2.54	11.20

Appropri =	0.23*Efficacy +	0.62*History, Errorvar.=	83.58, R^2 = 0.45
SE	(0.047)	(0.059)	(7.46)
t	4.89	10.66	11.20

Reduced Form Equations

Attitude =	0.042*Efficacy +	0.026*Amb_Tol +	0.11*History, Errorvar.= 17.64, R^2 = 0.12
SE	(0.0096)	(0.011)	(0.015)
t	4.42	2.42	7.43

Past_Exp =	0.0*Efficacy -	0.094*Amb_Tol + 0.0*History, Errorvar.= 37.45, R^2 = 0.025
SE		(0.037)
t		-2.54

Appropri =	0.23*Efficacy +	0.0*Amb_Tol +	0.62*History, Errorvar.= 83.58, R^2 = 0.45
SE	(0.047)		(0.059)
t	4.89		10.66

Equation 1 Path analysis result by LISREL: Regression equation

The results also suggested that ambiguity tolerance (total effect = 0.026, $t = 2.42$, $t > 1.96$) had an indirect effect toward attitude towards statistics through previous bad mathematics experience. This suggested that previous bad mathematics experience could mediate the relationship between ambiguity tolerance and attitude towards statistics. H9 was supported by the empirical data. Both previous bad mathematics experience and statistics appropriation could simultaneously predict attitude towards statistics. H10 was supported by the empirical data. Finally, there was a theoretical model explaining attitude towards statistics simultaneously (see also Table 1). H11 was supported by the empirical data.

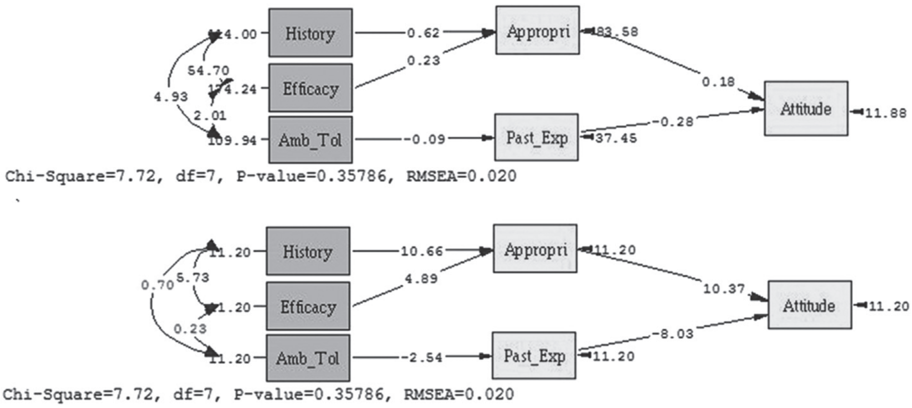

Figure 2 Path analysis result: standardized (top) and unstandardized regression coefficient estimation (bottom) *Notes for* Figure 2, Equation 1, *and* Table 1. History = Appreciation towards history of mathematics; Efficacy = Mathematics self-efficacy; Amb_Tol = Ambiguity tolerance; Appropri = Statistics appropriation; Past_Exp = Previous bad mathematics experience; Attitude = Attitude towards statistics; Errorvar. = Error variance; R^2 = Coefficient of determination (effect size); *SE* = Standard error

Table 1
Composition of predictive relationships

Path	Effect type	Standardized coefficient	*SE*	*t*
History → Appropri	Direct	0.62	0.06	10.66
Appropri → Attitude	Direct	0.18	0.02	10.37
History → Appropri → Attitude	Indirect	0.11	0.02	7.43
Efficacy → Appropri	Direct	0.23	0.05	4.89
Efficacy → Appropri → Attitude	Indirect	0.04	0.01	4.42
Amb_Tol → Past_Exp	Direct	−0.09	0.04	−2.54
Past_Exp → Attitude	Direct	−0.28	0.04	−8.03
Amb_Tol → Past_Exp → Attitude	Indirect	0.03	0.01	2.42

Discussion

Appropriation is a construct that signifies acceptance, utilization, and adoption of certain information or technology to fit one's need and desire (Salovaara & Tamminen, 2009). Appropriating statistics means using them for more than problem-solving in the test or just research. In this study, we measured appropriation as a behavioral tendency, which means cognition, affect, and beliefs are involved in determining its occurrence. Individuals with a tendency to appropriate already possess certain elements that relate to how they form an attitude. As the results confirmed, emphasizing statistical relevance in the real world to encourage statistics appropriation would be a great way to enhance a positive attitude among students towards statistics (Martinez, 2010).

The results showed that there are two constructs that could predict statistics appropriation. The first is mathematics self-efficacy indicating individuals' confidence toward themselves based on the ability they think they have to achieve accomplishment in the mathematical related task (Smetackova, 2015). As the results of the current study suggested, mathematics self-efficacy can predict an individual's tendency to appropriate, with a higher efficacy predicting a higher tendency. This means that mathematics self-efficacy could be channeled toward a construct that is more innovative, useful, and related to attitude towards statistics itself, that is statistics appropriation.

Second, as the results show, appreciation towards history of mathematics can predict statistics appropriation. Individuals with a higher appreciation of history of mathematics in statistics are expected to have inherited values and gained positive experience from it (Piragasam et al., 2013), and they could be a source of motivation, new ideas, and perspective for learners. As Panasuk and Horton (2013) added, history of mathematics provides a new framework for students to deal with the real world, see it from another perspective, and help to open a new mindset, which could heavily influence how they will approach and use statistics in a different way than expected—that is, appropriate it.

The results confirmed that previous bad mathematics experiences are transferred to future mathematics-related learning (Eden, Heine, & Jacobs, 2013). There might be priming of some significant events from the past that will be associated in a similar, future context (Jansen et al., 2013). For example, having been punished because of bad grades can lead the student to perceive mathematics as a source of pain and discomfort. Generalizing statistics simply as a form of “advanced mathematics that is applied” might hinder any positive approach towards it. To encourage students to develop a positive attitude (love) towards statistics, there are at least two things that need to be done. First, as Thanissaro (2012) suggested, as attitude is formed by habits and experience from time to time; it is important to avoid giving a negative experience that could be associated with mathematics from an early age of learning. Second, efforts to present statistics in a more enjoyable and welcoming manner are encouraged in dealing with disengaged students.

An individuals' disposition toward ambiguity tolerance could predict the intensity of bad experience, at least in learning mathematics, as shown by the results. An individual with a higher tolerance to new situations and information will perceive these to be bearable and will be less likely to experience discomfort and anxiety from less clear matters (Dewaele & Wei, 2013; Furnham & Marks, 2013). These findings do not necessarily indicate that a mathematics lesson is always ambiguous or unstructured, rather it concerns how a mathematical lesson might be presented as ambiguous and confusing for students.

Conclusion and Recommendation

As all the hypotheses were supported by the empirical data, the model proposed can indeed be used to explain attitude towards statistics. It incorporated not only present but past factors (previous bad mathematics experience), individual's disposition in dealing with new situation (ambiguity tolerance), behavioral tendency (statistics appropriation), beliefs (mathematics self-efficacy), and a stimulus trigger that has the potential to spark interest and encourage students to make a greater effort (history of mathematics). These results explain attitude well, especially toward statistics, though many factors should be integrated. In determining whether to encourage a positive attitude or to identify why a student has a negative attitude, all these factors will be pivotal in the analysis.

Conflict of interest

There is no conflict of interest.

References

Al-Agili, M. Z., Bin Mamat, M., Abdullah, L., & Maad, H. A. (2012). The factors influence students' achievement in mathematics: A case for Libyan's students. *World Applied Sciences Journal, 17*(9), 1224–1230.

Atamanova, I., & Bogomaz, S. (2014). Ambiguity tolerance as a psychological factor of foreign language communicative competence development. *Procedia – Social and Behavioral Sciences, 154*, 345–352. http://dx.doi.org/10.1016/j.sbspro.2014.10.161.

Choudhury, R., & Das, D. K. (2012). Influence of attitude towards mathematics and study habit on the achievement in mathematics at the secondary stage. *International Journal of Engineering Research and Applications (IJERA), 2*(6), 192–196.

Chumakova, M. A., & Kornilov, S. A. (2013). Individual differences in attitudes towards uncertainty: Evidence for multiple latent profiles. *Psychology in Russia: State of Art, 6*(4), 94. http://dx.doi.org/10.11621/pir.2013.0408.

Clutts, D. W. (, 2010). *Mathematics self-efficacy of community college students in developmental mathematics courses* (Unpublished doctoral dissertation). Lynchburg: Liberty University.

Dewaele, J., & Wei, L. (2013). Is multilingualism linked to a higher tolerance of ambiguity? *Bilingualism, 16*(1), 231–240. http://dx.doi.org/10.1017/s1366728912000570.

Di Martino, P., & Zan, R. (2015). The construct of attitude in mathematics education. In B. Pepin, & B. Roesken-Winter (Eds.), *From beliefs to dynamic affect systems in mathematics education* (pp. 51–72). Switzerland: Springer International Publishing.

Eden, C., Heine, A., & Jacobs, A. M. (2013). Mathematics anxiety and its development in the course of formal schooling—A review. *Psychology, 4*(6), 27–35.

Erfjord, I., Hundeland, P. S., & Carlsen, M. (2012). Kindergarten teachers' accounts of their developing mathematical practice. *ZDM: The International Journal on Mathematics and Education, 44*(5), 653–664. http://dx.doi.org/10.1007/s11858-012-0422-1.

Furnham, A., & Marks, J. (2013). Tolerance of ambiguity: A review of the recent literature. *Psychology, 4*(9), 717–728. http://dx.doi.org/10.4236/psych.2013.49102.

Gaskin, J., & Lyytinen, K. (2011). Psychological ownership and the individual appropriation of technology. *Information Systems Theory, 29*, 25–39. http://dx.doi.org/10.1007/978-1-4419-9707-4_2.

Goktepe, S., & Ozdemir, A. S. (2013). An example of using history of mathematics in classes. *European Journal of Science and Mathematics Education, 1*(3), 125–136. Retrieved from http://scimath.net/articles/13/132.pdf.

Haverhals, N., & Roscoe, M. (2010). The history of mathematics as a pedagogical tool: Teaching the integral of the secant via Mercator's projection. *Montana Mathematics Enthusiast, 7*(2/3), 339–368. Retrieved from http://scholarworks.umt.edu/tme/vol7/iss2/12/.

Hilton, S. C., Schau, C., & Olsen, J. A. (2004). Survey of attitudes toward statistics: Factor structure invariance by gender and by administration time. *Structural Equation Modeling: A Multidisciplinary Journal, 11*(1), 92–109. http://dx.doi.org/10.1207/s15328007sem1101_7.

Huang, A. H. (2015). *Definisi dan manfaat statistik – Globalstats Academic*. Globalstats Academic. Retrieved from http://goo.gl/23oUQj.

Jansen, B. R., Louwerse, J., Straatemeier, M., Van der Ven, S. H., Klinkenberg, S., & Van der Maas, H. L. (2013). The influence of experiencing success in math on math anxiety, perceived math competence, and math performance. *Learning and Individual Differences, 24*, 190–197. http://dx.doi.org/10.1016/j.lindif.2012.12.014.

Kurniati, S. (2012). Program statistik: Upaya memotivasi mahasiswa untuk senang belajar statistika. *Media Bina Ilmiah, 6*(4), 62–67. Retrieved from http://goo.gl/CFbczG.

Lawrence, S. (2010). What works in the classroom – Project on the history of mathematics and the collaborative teaching practice. In *Proceedings from sixth congress of the European society for research in mathematics (CERME 6)* (pp. 2752–2761). Lyon, France: Service des publications, INRP. Retrieved from http://goo.gl/441NpP.

Lin, Y. (2005). *Understanding students' technology appropriation and learning perceptions in online learning environments* (Unpublished doctoral dissertation). Columbia: University of Missouri.

Margono, G. (2013). Aplikasi analisis faktor konfirmatori untuk menentukan reliabilitas multidimensi. *Statistika, 13*(1), 17–24. Retrieved from http://goo.gl/TBim7j.

Martinez, G. (2010). *How to help students not hate statistics*. Faculty.isi.org. Retrieved from http://faculty.isi.org/blog/post/view/id/298/.

Merrotsy, P. (2013). Tolerance of ambiguity: A trait of the creative personality? *Creativity Research Journal, 25*(2), 232–237. http://dx.doi.org/10.1080/10400419.2013.783762.

Neuville, S., Frenay, M., & Bourgeois, E. (2007). Task value, self-efficacy and goal orientations: Impact on self-regulated learning, choice and performance among university students. *Psychologica Belgica, 47*(1), 95. http://dx.doi.org/10.5334/pb-47-1-95.

Panasuk, R. M., & Horton, L. B. (2013). Integrating history of mathematics into the classroom: Was Aristotle wrong? *Journal of Curriculum and Teaching, 2*(2), 37–46.

Pavlou, P. A., & Fygenson, M. (2006). Understanding and predicting electronic commerce adoption: An extension of the theory of planned behavior. *MIS Quarterly, 30*(1), 115–143. Retrieved from http://goo.gl/fUvprk.

Perepiczka, M., Chandler, N., & Becerra, M. (2011). Relationship between graduate students' statistics self-efficacy, statistics anxiety, attitude toward statistics, and social support. *The Professional Counselor, 1*(2), 99–108. http://dx.doi.org/10.15241/mpa.1.2.99.

Piragasam, G. A., Majid, R. A., & Jelas, Z. M. (2013). Music appreciation and self-actualization of gifted students. *Procedia – Social and Behavioral Sciences, 90*, 124–132. http://dx.doi.org/10.1016/j.sbspro.2013.07.073.

Ramirez, C., Schau, C., & Emmioğlu, E. (2012). The importance of attitudes in statistics education. *Statistics Education Research Journal, 11*(2), 57–71. Retrieved from http://eric.ed.gov/?id=EJ996041.

Salovaara, A., & Tamminen, S. (2009). Acceptance or appropriation? A design-oriented critique of technology acceptance models. *Future Interaction Design II*, 157–173. http://dx.doi.org/10.1007/978-1-84800-385-9_8.

Sarwono, J., & Budiono, H. (2012). *Statistik terapan: Aplikasi untuk riset skripsi, tesis dan disertasi* (pp. 207–208). Jakarta, Indonesia: Elex Media Komputindo.

Schau, C. (2003). Students' attitudes: The “other” important outcome in statistics education. In *Proceedings from 2003 joint statistical Meetings—Section on statistical education* (pp. 3673–3683). San Francisco, CA: American Statistical Association. Retrieved from http://statlit.org/pdf/2003SchauASA.pdf.

Schau, C., & Emmioğlu, E. (2011). Changes in U.S. students' attitudes toward statistics across introductory statistics courses. In *Proceedings from 58th world statistics Congress of the international statistical institute* (pp. 2802–2808). The Hague, The Netherlands: International Statistical Institute. Retrieved from http://goo.gl/Zy3hcj.

Slootmaeckers, K., Kerremans, B., & Adriaensen, J. (2014). Too afraid to learn: Attitudes towards statistics as a barrier to learning statistics and to acquiring quantitative skills. *Politics, 34*(2), 191–200. http://dx.doi.org/10.1111/1467-9256.12042.

Smestad, B. (2012). Not just “telling stories”: History of mathematics for teacher students—What is it and how to teach it?. In *Proceedings from 12th international congress on mathematical education (ICME12). Seoul, Korea*. Retrieved from http://www.academia.edu/1603960/Not_just_telling_stories_._History_of_mathematics_for_teacher_students_-_what_is_it_and_how_to_teach_it.

Smetackova, I. (2015). Gender stereotypes, performance and identification with math. *Procedia—Social and Behavioral Sciences, 190*, 211–219. http://dx.doi.org/10.1016/j.sbspro.2015.04.937.

Smith, K. J. (2011). *The nature of mathematics* (12th ed.). Belmont, CA: Brooks/Cole.

Sommer, L. (2011). The theory of planned behaviour and the impact of past behaviour. *International Business & Economics Research Journal (IBER), 10*(1), 91–110.

Techio, E., Bobowik, M., Páez, D., Cabecinhas, R., Liu, J., Zubieta, E., et al. (2010). Social representations of history, wars and politics in Latin America, Europe and Africa. *Revista de Psicología Social: International Journal of Social Psychology, 25*(1), 11–26. http://dx.doi.org/10.1174/021347410790193441.

Tessler, J. (2013). *On the importance of learning statistics for psychology students—association for psychological science*. Psychologicalscience.org. Retrieved from http://goo.gl/auYJvc.

Thanissaro, P. N. (2012). Measuring attitude towards RE: Factoring pupil experience and home faith background into assessment. *British Journal of Religious Education, 34*(2), 195–212. http://dx.doi.org/10.1080/01416200.2011.623154.

Ulpah, M. (2009). Belajar statistika: Mengapa dan bagaimana? *Insania: Jurnal Pemikiran Alternatif Pendidikan, 14*(3), 325–335. Retrieved from http://ejournal.iainpurwokerto.ac.id/index.php/insania/article/view/354/319.

Wirth, K. R., & Perkins, D. (2008). *Learning to learn*. Retrieved from http://goo.gl/19K72r.

Yung, Y.-F. (2008). Structural equation modeling and path analysis using PROC TCALIS in SAS® 9.2. In *SAS global forum 2008 (pp. 1–20). San Antonio, TX*. Retrieved from http://www2.sas.com/proceedings/forum2008/384-2008.pdf.