Development of a New Inventory of Attitude towards Statistics among Postgraduate Students

Wan Nor Arifin, Universiti Sains Malaysia, Malaysia
Mohamad Saiful Bahri Yusoff, Universiti Sains Malaysia, Malaysia
Aniza Abd Aziz, Universiti Sultan Zainal Abidin, Malaysia
Hazwan Mat Din, Universiti Sains Malaysia, Malaysia
Sarimah Abdullah, Universiti Sains Malaysia, Malaysia

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Abstract
Statistics is often viewed negatively based on our experience and also conducted studies. As statistics is an important component of postgraduate studies, it is important to assess attitude towards statistics to enable appropriate educational actions to improve the attitude. To our knowledge, currently there is no inventory specifically developed for postgraduate students. Preexisting inventories are unsatisfactory due to different target population, weak theory, lack of confirmatory analysis, parceling issue and overlapping domains. To address the need of such inventory, a new inventory constructed in English measuring attitude towards statistics among postgraduate students was developed using modified Delphi technique. The process was conducted in five phases: 1. Identification of domains on attitude towards statistics from experts. 2. Verification of identified domains. 3. Defining the domains. 4. Identification of relevant and representative items for each domain. 5. Final verification of domains and items. Three domains based on tripartite theory of attitude (affect, behavior, cognition) were agreed upon by three experts considering relevant literature, inventories and experience. Suitable definition for the domains were provided in relation to statistics. A total of 58 items were agreed upon by the three experts and an invited expert not involved in first four rounds, considering their relevancy and representativeness: Affect (22 items), behavior (17 items) and cognition (19 items). The resulting inventory was named as USM-AS that stands for Universiti Sains Malaysia's Attitude towards Statistics. USM-AS is considered a potential inventory to measure attitude towards statistics. However, further validation studies are required to determine its psychometric properties.

Keywords: attitude towards statistics, postgraduate students, inventory

Introduction

Statistics is an important component of any postgraduate studies, in which quantitative evaluation of research outcomes is prevalent. Despite its importance, it is often viewed negatively as evidenced by conducted studies and our own experience of providing statistics consultation to postgraduate students. Based on their feedback, most of them viewed statistics as a difficult subject that they are forced to learn to complete their studies. They are also unable to appreciate statistics as an integral part of any quantitative research.

At its extreme, learning statistics was suggested to be comparable to learning a foreign language in term of difficulty (Lalonde & Gardner, 1993). Onwuegbuzie and Wilson (2003) estimated that between two-third to four-fifth of postgraduate students had uncomfortable level of statistics anxiety. In addition, Ashaari, Judi, Mohamed, Tengku and Wook (2011) and Sami (2010) reported negative attitude towards statistics among undergraduate students. In a recent study by Zhang et al. (2012) among postgraduate students, negative attitude was also reported.

Therefore, it is quite evident that the negative attitude towards statistics is commonplace. It should be reiterated that although statistics is deemed compulsory for postgraduate programs, the negative attitude could hinder effective learning of the subject (Daher & Amin, 2010; Ashaari et al., 2011). It is important to assess the attitude towards statistics so as to enable appropriate educational actions to improve the attitude in positive direction.

Attitude is generally a person's evaluation on people, objects and ideas (Lawrence, 2008). It is also defined as a mindset or a tendency to act in a particular way due to a person's experience and temperament (Pickens, 2005). Therefore, of our concern is the student's evaluation and mindset on statistics.

In our search for valid and reliable inventories measuring attitude towards statistics, we encountered a number of inventories that differed drastically in term of domains and theoretical backgrounds, as well as validation approaches and the quality of validation evidence. As reviewing these inventories is out of context of this paper, readers are referred to a systematic review on these inventories (Nolan, Beran & Hecker, 2012). Of all the inventories, the most notable and extensively studied are Survey on Attitudes Towards Statistics 28 and 36 (SATS-28 and SATS-26).

SATS-28 was developed by Schau, Stevens, Dauphinee, and Del Vecchio (1995), consisting of four domains (affect, cognitive competence, value and difficulty) and 28 items, measured by seven-point Likert scale at pre- and post-statistical course on a sample of undergraduate students. An updated version namely SATS-36 was proposed by Schau (2003), of which two additional domains (interest and effort) with four items each were added on to SATS28. The inventory went through exploratory and confirmatory factor analysis in its development process, as well as being cross validated in numerous studies. In general, the construct validity and reliability are good (Nolan et al., 2012). However, we noted a number of issues with both SATS versions: 1. Parceling was used in confirmatory factor analysis. The use of the use of parceling for confirmatory factor analysis is controversial (Vanhoof, Kuppens, Sotos,

Verschaffel, & Onghena, 2011). 2. Overlapping domains (multicollinearity) on confirmatory factor analysis without parceling (Schau et al., 1995; Tempelaar, Van DerLoeff & Gijselaers, 2007; Vanhoof et al., 2011). 3. It was developed and validated for use among undergraduate students.

To our knowledge, currently there is no inventory measuring attitude towards statistics that is specifically developed for postgraduate students. In general, preexisting inventories are also unsatisfactory due to a number of issues such as different target population (undergraduate students), weak theory, lack of confirmatory factor analysis, parceling issue and overlapping domains (Nolan et al., 2012). In view of these problems, we decided to develop a new inventory measuring attitude towards statistics among postgraduate students.

The newly developed inventory was aimed to have the following properties:

1. Specifically constructed for postgraduate students (master's and Ph.D. programs) with previous exposure to statistics course.

2. Items and response choices are in English.

3. Items are generated and constructed based on strong theory of attitude.

4. Responses are scaled in a way suitable for construct validation by factor analyses.

5. Self-administered format.

Methods

In general, Delphi technique is a structured group communication process that involves four phases: 1. Exploration of a subject by a group. 2. Reaching an understanding of how the group views the subject. 3. Resolving disagreement. 4. Final evaluation (Linstone & Turoff, 2002).

Based on these phases, we utilized modified Delphi technique in the inventory development process, specifically for identification and verification of domains and items. The process was conducted in five phases as follows:

1. Identification of domains on attitude towards statistics: The initial four phases involved three experts with one of the expert acted as a coordinator for all communication processes. The coordinator sent an email to two other experts requesting for possible domains of attitude towards statistics. Every experts provided possible domains based on their own experience and research findings, and also literature reviews. Every contributed domains were continuously appraised until all experts agreed on a number of identified domains to focus on.

2. Verification of identified domains: An email was sent to the experts to verify the identified domains. The verification process involved scrutiny of each domain for appropriateness and applicability to postgraduate students. Only domains that were verified to be appropriate and applicable to the students were carried over to next

phase.

3. Defining the domains: The coordinator sent an email requesting for suitable definitions for the verified domains. The experts kept on improving the definitions and critically appraised other alternative definitions based on literature reviews and expert opinion, while keeping the definitions within the context of postgraduate settings. The email communication continued until all of the experts agreed on provisional definitions for each of the domains.

4. Identification of relevant and representative items: Once the provisional definitions were clear enough to warrant item construction, an email was sent to request for contribution of relevant and representative items for each of the domains. The experts were encouraged to contribute as many items as possible, covering both positively and negatively worded items.

5. Final verification of domains and items: A meeting was organized involving all the three experts and an invited expert who was not involved in the four initial phases. The domains, definitions and items were again appraised in the presence of the new expert. Suitable response choices were also decided in the meeting, weighing on the advantages and disadvantages of different response formats. A final, content validated inventory was produced at this phase.

Results

The five phases were completed in six months from March 2013 to September 2013. Three domains based on tripartite theory of attitude (Lawrence, 2008) were agreed upon in view of literature reviews, related inventories and the experts' own experience. Suitable definition for the domains were provided in relation to statistics and suitability to postgraduate settings. A total of 58 items were agreed upon for the domains (Table 1). Five-point Likert scale was chosen for response options: [1] Strongly Disagree; [2] Disagree; [3] Neutral; [4] Agree; [5] Strongly Agree. While the given scoring is meant for positively worded items, negatively worded items have to be reverse-scored. The resulting inventory was named as USM-AS that stands for Universiti Sains Malaysia's Attitude towards Statistics.

Table 1

Domains, definitions and number of items by domain

Domain	Definition	Number of items	Example item
Affect	Emotional reaction and feeling towards statistics.	22	Statistics lecture is interesting
Cognitive	Thought and belief about statistics.	19	Statistics is important in research
Behavior	Actions resulting from affect and	17	I pay attention in research

	cognition towards statistics.	presentation

Note. Items can be obtained from corresponding author via email.

Discussion

By utilizing modified Delphi technique in our development process, we were able to come up with a new inventory measuring attitude towards statistics. In our opinion, the inventory has a number of appealing features corresponding to our predefined properties. First, the inventory is specifically developed for postgraduate students, which is reflected in the items' postgraduate-specific content. Second, the use of five-point Likert scale is meant for ease of administration and suitability for factor analyses. Third, the inventory is based on generally applicable tripartite theory of attitude (Lawrence, 2008; Pickens, 2005).

However, we have to acknowledge that our development approach is not without limitation. The application of Delphi technique in the development process means the resulting inventory is a result of expert judgment, which makes it vulnerable to distorted understanding and imprecise interpretation (Linstone & Turoff, 2002). Despite this limitation, we are satisfied with the inventory as the domains and items reflected our experience in teaching and providing consultation to postgraduate students.

Conclusion

USM-AS is a potentially valid inventory to measure attitude towards statistics among postgraduate students based on tripartite theory of attitude. In its present form, the inventory consists of three domains, namely affect, cognitive and behavior, and 58 items that are rated on five-point Likert scale. However, further validation studies are required to determine its psychometric properties prior to its use to measure the attitude towards statistics.

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Contact email: wnarifin@gmail.com