Understanding the TPB, the TAM, Cultural Intelligence and Factor-Based PLS-SEM

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Abstract
This short communication paper aims to share with readers of the journal three areas that the author is recently focusing on in his research related to education. The first area is about the comparison between the theory of planned behavior (TPB) and the technology acceptance model (TAM). It is recommended that the TAM may be more powerful than the TPB in explaining personal use of a technology, while the TPB may be preferred to the TAM in technology usages involving collaboration. The second area is about the study of cultural diversity in classroom learning. It is recommended that cultural intelligence may be able to help improve students’ cultural adaptation capability, resulting in maximizing the benefits of cultural diversity when students are learning in a cross-cultural environment. The third area is about factor-based partial least squares structural equation modeling (factor-based PLS-SEM). This statistical technique is appropriate for examining the relationships between multi-item variables posited in theoretical models when researchers have to face situations, such as small samples, non-normality assumption, and formative variables.

Keywords: Theory of planned behavior; technology acceptance model; cultural intelligence; CQ; cultural diversity; factor-based PLS-SEM; consistent PLS-SEM; e-learning; group work

Abbreviations: TPB: Theory of planned behavior; TAM: Technology Acceptance Model; UTAUT: Unified Theory of Acceptance and Use of Technology; SEM: Structural Equation Modeling; CBSEM: Covariance Based SEM; VBSEM: Variance Based SEM

Introduction
Psychological and behavioral theories are continuously applied in education. They help to explain a lot of phenomena in order to help improve teaching and learning in a classroom, or non-classroom, setting. As inspired by Dr. Samuel KW Chu of the Faculty of Education, The University of Hong Kong, I have developed my interest in studying students’ group performance. Further to what I have done in the past few years, I recently focus on three areas that I would like to share with readers of this journal. Through this short communication paper, I expect to see more discussion on these areas that may be of interest to the researchers in education and others beyond education.

The TPB Versus the TAM
Most of those who are interested in behavioral research in education should know very well about the theory of planned behavior (TPB) and the technology acceptance model (TAM). In education, these two theories have been widely used to study teachers’ and students’ technology acceptance behaviors.

Figure 1 illustrates a typical model structure for each of the two theories. The TPB posits that attitudes toward the behavior, subjective norms, and perceived behavioral control are predictive of behavioral intentions, which, together with perceived behavioral control, predict the specific behavior [1]. The three exogenous variables are also posited to be predicted by individual beliefs, namely behavioral, normative, and control beliefs (Figure 1). This theory can be applied to explain various intended behaviors [2]. Many researchers have used it to study technology acceptance behaviors [3,4].

The TAM, on the other hand, posits that perceived ease of use and perceived usefulness are predictive of attitudes toward the use of technology, while perceive ease of use also predicts perceived usefulness [5]. Moreover, perceive usefulness and attitudes toward the use of technology predict behavioral intentions, which in turn predict the specific behavior. The TAM was derived from the TPB and was specifically made for...
the study of technology adoption intentions [6,7]. As noted by Cheon et al. [8], perceived ease of use and perceived usefulness are actually the behavioral beliefs of attitudes toward the behavior. Due to some conceptual differences between the two theories, researchers have indicated their preferences toward the use of them. Some researchers have suggested developing new theories based on both theories, such as the unified theory of acceptance and use of technology (UTAUT) [9], while some others have compared the two theories and have argued that one is better than the other [10,11].

![Figure 1: The TPB and the TAM.](image)

Recently, I came across a paper by Chu and Chen [12] who argued that the choice of which theory to use should be context-dependent. They suggested that the TAM may be more powerful than the TPB in explaining personal use of a technology, while the TPB may be preferred to the TAM in technology usages involving collaboration. From the perspective of social influences, this does make sense. It is because when a group of people adopts a technology for collaborative work, interpersonal interactions become more important [12]. In addition, personal abilities and supports from others are excluded in the TAM. In one of my recent studies on students’ use of wikis for group work [2], I have found significant relationships of subjective norms and perceived behavioral control to intentions. When looking for improving students’ group work performance, the influence from the teacher and group members, together with their supports, should not be ignored [13]. Therefore, future research may attempt to find which theory is appropriate for which context. Researchers should also be careful in selecting the right theory for studying a particular setting.

Cultural Diversity in Universities

In recent years, I have witnessed the increase in the number of international students, enrolling in courses or programs in the universities of Hong Kong. In a positive way, the non-local students enrich classroom learning, widen local students’ exposure to unfamiliar characters and cultures, and enhance students’ interactions for learning. In contrast, the inclusion of these non-local students in a classroom may also raise such issues as miscommunication, tension, conflicts, and mistrust if such a cultural diversity cannot be dealt with properly [14]. Cultural diversity in learning is certainly worth studying. If we can maximize its benefits and eliminate its drawbacks, students’ learning performance can be improved.

When undertaking some study of cultural diversity, I came across a term “cultural intelligence” (CQ). CQ was first introduced in 2003 by Earley and Ang [15]. It is defined as “an individual’s capability to adapt effectively to situations of cultural diversity” [15]. It can help a person face cultural shock and frustration due to cultural differences [16], so it is able to improve a person’s cultural adaption capability. That is, a person with higher CQ is expected to be more able to deal with a cultural diverse environment. If this is true, we can provide students with training to improve their CQ. In fact, the study of CQ in a cross-cultural setting does not lack [17,18]. Moreover, this construct is multi-dimensional and consists of four major dimensions, which are cognitive, metacognitive, behavioral, and motivational dimensions [15]. Cognitive CQ refers to the “total knowledge and experience concerning cultural adaptation of an individual stored in memory” [19]. Metacognitive CQ refers to “an individual’s cultural consciousness and awareness during intercultural interactions” [20]. Motivational
CQ refers to "an individual's capability to direct energy and attention toward cultural differences [21]. Behavioral CQ refers to "the extent to which individuals possess a wide repertoire of behavioral skills and can appropriately enact verbal as well as non-verbal behaviors in new cultural settings" [22]. Due to their different meanings, these dimensions may vary in their effects on students’ cultural adaption in different learning contexts in terms of disciplines, teaching methods, learning modes, and so forth. This line of research should be pursued.

**Factor-Based (or Consistent) PLS-SEM**

The final one to discuss is not a research topic, but a statistical method. In the older days, multiple regression analysis is one of the major statistical tools to examine the relationships in a theoretical model. Around four decades ago, structural equation modeling (SEM) started replacing multiple regression analysis for studying multi-item variables, which might not be accurately measured [23,24]. It is because SEM takes measurement errors into consideration and is said to be more robust than multiple regression analysis. Since then, researchers have usually used covariance-based SEM (CBSEM), also known as factor-based SEM [25] (e.g., LISREL, AMOS), which works well with random, medium-sized samples [26]. However, when researchers face situations, such as small samples, non-normality assumption, and formative variables, variance-based SEM (VBSEM) should be applied [27], although CBSEM enthusiasts continue to find ways to deal with such unfavorable situations, such as Diamantopoulos’ (2011) discussion on formative variables [28].

On the other hand, partial least squares structural equation modeling (PLS-SEM) was developed as an exemplar tool of VBSEM [27]. After the emergence of user-friendly software packages, researchers have widely used them to examine different theoretical models [25,29]. Despite being popular, this first batch of software packages is known to be regression-based (aka composite-based) PLS-SEM. As noted by Kock [30], regression-based PLS-SEM's estimation is based on "composites" (or the so-called "pseudo-factors"), which are exact linear combinations of indicators and would lead to biased model parameter estimates. Two years ago, some breakthrough occurred, and the new PLS-SEM technique could fully account for measurement errors. This technique is called factor-based PLS-SEM by Kock [30] or consistent PLS-SEM by Hair et al. [31], although their underlying algorithms may be a bit different from each other. For research rigor, the use of either one of these two methods is highly recommended (instead of using regression-based PLS-SEM) if CBSEM is considered to be inappropriate.

**Conclusion**

A final note to readers is that the abovementioned areas, although presented separately, can be linked together to address specific research issues. It is possible to study cultural diversity by use of the TPB or the TAM. For example, is e-learning interaction behavior explained by the TPB or the TAM? To conduct a survey into the behavior, factor-based PLS-SEM may be employed to analyze the empirical data.

**Reference**


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