How can students succeed in computer-supported interprofessional team-based learning? Understanding the underlying psychological pathways using Biggs' 3P model

Abstract

Adopting Biggs' (2003) 3P (presage, process, product) model, this study examined the role of individual preparedness, member's contribution, motivation, enjoyment in students' learning, readiness for interprofessional learning, and attainment of desired outcomes in the context of computer-supported interprofessional team-based learning (CS-IPTBL). A sample of 531 health and social care students (Chinese medicine, medicine, nursing, pharmacy, occupational therapy, and social work) from two universities in Hong Kong participated in the study. Mediational analysis showed that task value (motivation and enjoyment) and utility (perceived usefulness) played a significant mediating role between perceived preparedness and perceived individual contribution and outcomes. The study enriched the extant research by showing possible pathways that determined students' achievement in CS-IPTBL. Findings suggest that students' achievement (product) in CS-IPTBL is influenced by their motivation, enjoyment, and perceived usefulness (process) which were derived from two sources: individual preparedness and members' valuable contribution (presage). Key findings and their implications for program enhancement and teaching are provided.

Keywords: team-based learning, computer-supported instruction, interprofessional education, mediational analysis

1. Introduction

Team-based learning (TBL) has become increasingly popular in health care education because of the importance of team management in providing quality patient care (Wilson-Delfosse, 2012). It emphasizes active learning, collaboration, and the use of authentic application exercises following a sequence of three activities: phase 1= pre-class preparation (out of class), phase 2 = readiness assurance (in class), phase 3= application exercises (in class). This approach which originated from business education (Michaelsen, Sweet, & Parmelee, 2008) underscores students' accountability by coming to class prepared thereby saving time for a more important in-class activities (Michaelsen, Knight & Fink, 2002). As Sweet & Pelton-Sweet (2008, p. 29) explained, "what sets TBL apart from other forms of small group learning is its accountability structure—a rhythm of moments in which students' social and intellectual experiences of the classroom become interlocked and amplified". This sense of accountability enables the students to have an overview of the fundamental concepts that will prepare them to contribute meaningfully in the team-based learning session (Anwar, Shaikh, Dash, & Khurshid, 2012; Cheng et al., 2014; Kumar & Gadbury-Amyot, 2012; Letassy, Fugate, Medina, Stroup, & Britton, 2008; Stein, Colyer, & Manning, 2016; Vasan, Defouw, & Compton, 2011; Wiener, Plass & Marz, 2009; Zingone et al., 2010).The extant literature has shown that pre-class preparatory activities (e.g., making sense of pre-class study materials such as book chapters, journal papers or even video clips) are linked to a higher level of learning and promotion of active rather than passive learning (Letassy et al., 2008; Nieder, Parmelee, Stolfi, & Hudes, 2005; Punja, Kalludi, Pai, Rao, & Dhar, 2014; Vasan et al., 2011). These studies have shown the direct effects of preparedness on achievement but do not capture the psychological processes of

students involved in TBL. Less is known about the mechanisms through which students' preparation individually and as a team member influence their academic learning in teams.

To gain a more nuanced understanding of students' experiences in a TBL environment, there is a need to take into account the key psychological processes that underpins students learning experiences in TBL. To date, it appears that there are scant studies regarding the systematic analysis of the learning process on TBL from psychological perspectives most especially in the context of interprofessional education (IPE) where TBL is posited to be a suitable pedagogy (Bishop, Phillips, Lee, Sicat, & Rybarczyk , 2015; Chan et al., 2017).

What are the motivational processes of students who internalize accountability and demonstrate preparedness in team-based learning activity? Does this readiness, indexed by students' perceived preparedness to engage in interprofessional activities, directly impact their learning or are there other mediating factors (e.g., motivation, enjoyment, utility) which lead to achievement outcomes? To find answers to these questions, it is necessary to have a nuanced understanding of the psychological pathways that students go through before, during, and after the team-based learning activity. These are important research questions which suggest a closer examination of mechanisms through which positive perception of teamwork drives task value (motivation and enjoyment) and utility (usefulness) which may lead to better achievement gains. These are the gaps in the literature that this study intends to investigate.

1.2 Computer-assisted interprofessional team-based learning (CS-IPTBL)

Interprofessional education (IPE) works by putting students from two or more disciplines together to learn *with*, *about*, and *from* one another to enable effective collaboration leading to improved health outcomes (CAIPE, 2002; D'Amour, Ferrada-Videla, San Martin Rodriguez, & Beaulieu, 2005; Leathard, 2003; World Health Organization, 2010). The use of active learning

pedagogy called team-based learning (TBL) is relevant as a means to attain the outcomes of IPE (Black, Blue & Foss, 2015; Chan et al., 2017). The integration of IPE with TBL gave way to IPTBL which is a large-scale project involving students from The University of Hong Kong (biomedical sciences, Chinese medicine, medicine, nursing, pharmacy, and social work) and The Polytechnic University of Hong Kong (medical laboratory science, nursing, occupational therapy, physiotherapy, radiography, and social work).

Traditional TBL has been popularly implemented using the immediate feedback assessment technique or IF-AT (e.g., Barak & Rafaeli, 2004; Beatty, Kelley, Metzger, Bellebaum, & McAuley, 2009; Koles, Stolfi, Borges, Nelson, & Parmelee, 2010; Michaelsen & Sweet, 2008; 2011; Orr et al., 2015; Whitley et al., 2015). IF-AT is a system of scratch-off answer forms for multiple-choice questions (MCQs) with the correct/best answer indicated by a star hidden in MCQ choices (Whitley, Bell, Eng, Fuentes, Helms, Maki, & Vyas, 2015). It is a self-scoring form where the number of attempts to get the correct answer determines the score in a given MCQ. If the answer is correct on the first attempt, a full mark is given but is reduced depending on the number of attempts before arriving at the correct answer. IF-AT is particularly useful in a number of TBL activities (e.g., team readiness assurance test, application exercise) when dealing with small number of teams. However, the greatest challenge of this method is efficiency when dealing with a large number of students (Haidet & Fecile, 2006; Michaelsen et al., 2002; Michaelsen & Sweet, 2008; Parmelee & Michaelsen, 2010).

To address this limitation, an electronic platform called Learning Activity Management System (LAMS, developed by LAMS Foundation, LAMS International, and the Macquarie E-learning Centre of Excellence) was adapted for IPTBL. LAMS facilitated the management of the complex but structured TBL process and is especially useful in managing a large number of

participants. It is a system for creating, managing, and implementing sequences of learning activities which can be customized to suit specific requirements (Figure 1). With the use of mobile devices, students completed activities using the LAMS which provided them immediate feedback to stimulate them to enrich their discussion in teams. During peer evaluation, the LAMS allowed them to check in real time the average scores given to them by all other team members on the four interprofessional collaborative practice competencies: values/ethics, roles/responsibilities, interprofessional communication, teams and teamwork.

The content experts received instant statistics about specific answers of the teams and the class in general, got the summary of team appeals real-time, and monitored the team progress across all the IPTBL activities (Chan et al., 2017). The use of LAMS as an electronic platform was expected to aid students in achieving the goals of IPE using TBL.

FIGURE 1, INSERT HERE

In comparison with traditional TBL, the implementation of TBL with technology (e.g., LAMS) can potentially offer students with a tool in fostering a social interaction and feedback amongst learners and teachers. This can trigger a higher level of motivation and enjoyment to impact students' learning and readiness for interprofessional learning given that digital natives in general respond with enthusiam to technology-assisted activities (Brown, 2001). Theoretical and empirical data lend strong support to the benefits of computer-aided learning environments in improving students' achievement gains, particularly computer-supported collaborative learning (Beer, Slack & Armitt, 2005; Keller & Suzuki, 2004; Lehtinen, 2003). However, the motivational processes of students in an interprofessional team-based learning remain underexplored which the present study intends to examine. Attending to these gaps in literature,

this study hopes to provide understanding about students' psychological processes in the context of computer-supported interprofessional team-based learning.

In the recent years, there has been an intensified interest in the use of technology in teaching and learning (e.g., Plass et al., 2013). The proponents of technology-based learning suggest that technology can be used to translate educational and learning theory into best practices in education (e.g., Clair & Chihara 2012; Collins & Halverson, 2009; Gee, 2003; Mayo, 2007; Shaffer, 2008; Squire, 2008). In TBL, perhaps because of the recognition of the importance of technology integration in teaching and learning, there is a methodological shift in the way TBL is delivered from traditional paper format to computer-supported TBL (e.g., Antoun, Nasr, & Zgheib, 2015; Chan et al., 2017; Hernandez-leo, Moreno, Chacon, & Blat, 2014; Kam, & Katerattanakul, 2014; Khogali, Smithies, Gray, Manca, & Lafferty, 2014).

Specific to the technology used in the current study, the interactivity in the way LAMS was developed is expected to make IPTBL learning fun, engaging, and interesting. Given these essential features of the LAMS, it is therefore necessary to formulate research agenda that will promote an understanding of students' psychological processes in computer-assisted IPTBL.

1.2 The 3P model

The 3P model (Biggs, 2003) of student learning provides a framework in understanding how students approach learning. Central to the model is the relationship of the sequence of three activities: presage, process, and outcome. We utilized this model to help examine the psychological pathways that contribute to students' academic achievement in the context of IPTBL which is a program designed to promote collaborative working. This model has been commonly used to investigate students' learning and psychological processes (e.g., Kizito, Munyakazi, & Basuayi, 2016; Zhang, 2000).

The *presage* component refers to individual or institutional states or characteristics. At the individual student level, it refers to the students' characteristics which include prior knowledge, abilities, approaches to learning, values, and expectations (Biggs, 1996). Presage includes variables that exist prior to classroom learning (Huang, 2008; Nield, 2007; Zhang, 2000). In the context of the study, *presage* represents the individual students' perception to engage in TBL activities and perception of team member's valuable contributions to learning prior to learning engagement (Freeth & Reeves, 2004). Tempone (2001) defined *presage* factors to include prior experience and beliefs that students bring into the learning experience and their expectations of the new experience. Extant literature suggests that presage factors affect the process factor (Biggs, 1987; Freeth et al., 2004; Jones, 2002; Tam, 1999).

The *process* component represents students' learning experiences from classroom teaching. The process refers to students' expectancies (how confident they are to succeed) and task values (how significant, useful, or enjoyable the tasks). In the context of the present study, the process includes students' expectancies (perceived motivation) and value (perceived enjoyment and perceived usefulness) during the learning process which is consistent with the expectancy-value theory (Eccles, 1983; Wigfield & Eccles, 2000). We conceptualized that subjective task value which represents students' motivations for engaging in CS-IPTBL subsumes intrinsic values (perceived motivation and perceived enjoyment in CS-IPTBL) and utility value (e.g. *What is the usefulness of CS-IPTBL to me?*). The *process* component leads to the *product* component of students' learning.

The *product* represents the learning outcomes (Biggs, 2003). In the current study, this represents the perceived learning, readiness to engage in interprofessional learning and the attainment of IPE learning outcomes. Furthermore, aside from perception of learning, we also

included perception of readiness to engage in interprofessional learning, and attainment of desired IPE learning outcomes to underscore the outcomes of IPE component of the model. Taken together, students who show optimism by means of preparing both individually and as a team member (presage) will demonstrate high motivation, enjoyment, and utility (process) which will facilitate their eventual achievement (product).

2. The present study

To elucidate the psychological mechanism through which perceptions of individual and team contribution (presage) relates to motivational processes (process) influencing achievement (product), we examined the structural relationships of perceived individual preparedness (IP), perceived team members' valuable contribution (TMVC), perceived motivation (PM), perceived enjoyment (PE), perceived usefulness (PU), and perceived learning (PL), readiness for interprofessional learning (RIPL) and attainment of IPE outcomes (AIPEO) in one path analytic model through path analysis. Although there are previous studies that explored whether computer-supported activities or collaborative activities are related to learning (e.g., Gomez, Wu, & Passerini, 2010), less attention has been paid to the issue of whether computer-supported activities using team-based learning can foster achievement and interprofessional readiness in the context of IPE in the health and social care programs in the Asian context in general and in Hong Kong in particular.

Part of the hypothesized model was initially explored by Gomez et al., (2010) in the context of master-level information system class (n=73), and by Huang and Lin (2017) involving undergraduate business students (n=120). To the best of our knowledge, no study has been conducted yet to test the model in the context of interprofessional education using team-based learning as a pedagogy. Extending previous research (e.g. Gomez et al., 2010; Gomez,

Wu, Passerini, & Bieber, 2009; Huang & Lin, 2017), we enriched the model by adopting Biggs' 3P model (Biggs, 2003). The 3P model provides justification of the nomological network of the variables.

The study was conducted within the Hong Kong context, which provided an avenue to extend previous research in a new classroom setting – the interprofessional team-based learning (see Chan et al., 2017) involving Chinese students who are said to be relatively underrepresented in the social and educational psychology literature (Liem, Martin, Porter, & Colmar, 2011). To test the theoretical model, we used the strength of path analysis to test the fit of a hypothetical model (Figure 2) with the present empirical data.

FIGURE 2, INSERT HERE

We formulated the following hypotheses as suggested by extant literature:

- Individual students' preparedness predicts perceived motivation from CS-TBL (**H1a**), perceived enjoyment from CS-TBL (**H1b**) and perceived usefulness (**H1c**);
- Favourable team-members' valuable contributions to CS-TBL predict students' motivation (**H1d**), perceived enjoyment (**H1e**), and perceived usefulness of CS-IPTBL (**H1f**);
- Perceived motivation in CS-IPTBL predicts students' learning (**H2a**); readiness to engage in interprofessional learning (**H2a**); and attainment of IPTBL learning outcomes (**H2c**);
- Perceived enjoyment in CS-IPTBL predicts students learning (**H2d**); readiness to engage in interprofessional learning (**H2e**); and attainment of IPTBL learning outcomes (**H2f**);
- Perceived usefulness of CS-IPTBL predicts students learning (**H2g**); readiness to engage in interprofessional learning (**H2h**); and attainment of IPTBL learning outcomes (**H2i**).

- The relationships of individual preparedness, team member valuable contributions (presage) and perceived learning, readiness for interprofessional learning, and attainment of IPE (product) are mediated by perceived motivation (**H3a**), perceived enjoyment (**H3b**), and perceived usefulness in CS-IPTBL (**H3c**).

2.1 Overview of the hypothesized model

Figure 2 shows the theoretical model depicting a directional relationship of presage, process, and product. The *presage*: perceived individual preparedness (IP), and perceived team member's valuable contribution (TMVC), which are hypothesized to influence the *products*: perceived learning (PL), readiness for interprofessional learning (RIPL), and attainment of IPE outcomes (AIPEO) via the *process* – the subjective task values: perceived motivation (PM) and perceived enjoyment (PE), and utility: perceived usefulness (PU).

The process is posited to mediate the relation between presage and product (e.g., Diseth & Kobbeltvedt, 2010). Using path analysis, we examined how well the hypothesized model fits the current data from a large number of health care and social care students in Hong Kong. This study is the first one that simultaneously tested the structural relationships of the study variables using path analysis in CS-IPTBL environment in the Asian context. To better understand the theoretical model (Figure 2), the various paths demonstrating the relationships of presage, process, and product are explained in the following section.

2.2 The path from presage (IP, PMVS) to process (PM, PE, and PU)

In TBL, to facilitate productive student behaviours, students must be encouraged to prepare individually (IP), to contribute to their team (PMVS), and be made aware that they will be accountable for their team performance. Following the flipped classroom approach (a reversal of

traditional teaching, where learners start learning outside of class then class time is used to do the challenging work in class, Bergmann & Sams, 2012), preassigned activities are given to students to allow face-to-face session time in dealing with higher level thinking tasks individually and in collaboration with peers. Guided by teachers' well-defined and preassigned tasks (e.g., reading research article, watching video, etc.), individual preparedness is said to be one of the important and challenging tasks that are necessary for the success of TBL (Baldwin, Bedell & Johnson, 1997; Michaelsen et al., 2008; Touchet & Coon, 2005; Zgheib, Simaan & Sabra, 2010). The main purpose is to prime students to get prepared by reviewing class-related materials so that they can contribute meaningfully in teams (Huang & Lin, 2017).

When students prepare for the lesson in advance (IP) and when they believe that team members can provide valuable contribution (PMVS), it can be expected that there will be positive motivation (PM) and enjoyment (PE) to take place in their engagement in team-based learning activity (Gomez et al., 2009; Michaelsen et al., 2002). Additionally, it can also be expected that this preparedness facilitates the perception of utility (PU) of CS-IPTBL (refer to Figure 2).

2.3 The path from process (PM, PE, and PU) to product (PL, RIPL, and AIPEO)

Studies established the relationship of motivation and engagement with successful learning (Galusha, 1997; Ganotice, Datu, & King, 2016; Reeve & Lee, 2014; Tallent-Runnels et al., 2006). In the classroom context, motivation (PM) can be construed as an internal state that arouses, directs, and maintains behavior (Woolfolk, 2007) which underpins students' achievement (Martin, Marsh, & Debus, 2003; McInerney, Roche, McInerney, & Marsh, 1997). Enjoyment (PE) plays a crucial role in helping students become interested in learning and is linked to positive outcomes (e.g., Villavicencio & Bernardo, 2012). Perceived usefulness (PU) is

defined as the degree to which students believe that the use of learning technology enhances their performance (Davis, 1989). Taken together, PM, PE, and PU are construed to facilitate various outcomes: perceived learning (PL), readiness for interprofessional learning (RIPL), and attainment of IPE outcomes (AIPEO).

2.4 The role of perceived motivation (PM), perceived enjoyment (PE), and perceived usefulness (PU) in CS-IPTBL as mediators

Literature has documented the direct and/or proximal link between task value (perceived motivation, perceived enjoyment) and learning outcomes (Gomez et al., 2010). To enrich the model, we added utility value (perceived usefulness) as mediator between the relationship of presage (IP, TMVC) and product (PL, RIPL, AIPEO). The indirect influence of IP and TMVC on PL, RIPL, and AIPEO through PM, PE, and PU is expected to be significant, indicating mediation.

3. Methods

3.1 Participants

The participants were 531 students (314 females, 200 males, 17 did not indicate sex) from six programs: Chinese medicine (*n*=23), medicine (*n*=195), nursing (*n*=210), occupational therapy (*n*=8), pharmacy (*n*=62) and social work (*n*=33). There were eight (1.50%) in second year, 33 (6.21%) in third year, and 490 (92.28%) in fourth year undergraduate level. These students were from The University of Hong Kong and Hong Kong Polytechnic University. They attended face-to-face session of IPTBL in any of the two instructional units: Anticoagulation therapy (*n*=240) and Depression (*n*=291). We explained to the students whose participation was voluntary that their participation would not affect their learning experiences and grades. However, course credit was provided for medicine, nursing, pharmacy, and social work.

3.2 Measures

Perceived individual preparedness (IP). This construct posits that if individuals prepare for team activities, they will be more engaged and active which can eventually lead to enjoyment and motivation in subsequent team activities. This is composed of two items but aiming to increase the cronbach's alpha of the scale, we added one item (e.g., "*When preparing for the RAT, I come to class ready to participate*", α =.95)

Perceived team members' valuable contributions (TMVC). This refers to the appraisal of team members on the value of contribution of other team members in accomplishing team activities. This subscale is composed of three items (e.g., "*CS-IPTBL activities are worth my time*", α =.89).

Perceived motivation (PM). Motivation is conceptualized as students' energy, drive or intention to engage in specific learning activity. In this study, motivation is contextualized in CS-IPTBL (e., "*CS-IPTBL motivated me to do my best work*"). This subscale is composed of two items only which may create problem in terms of the reliability (Gliem & Gliem, 2003). We added one item (e.g., "*I will surely attend CS-IPTBL again*", α =.82).

Perceived enjoyment (PE). This refers to the emotional state students feel in response to IPTBL activities. There are five items included in this construct which estimates the overall pleasantness of the CS-IPTBL experience (e.g., "*I found myself more interested in the subject with CS-IPTBL*", α =.85).

Perceived usefulness (PU). This construct refers to the assumption that individuals tend to use an application or technology if they believe it can help them perform better. We adapted this construct from Davis (1989) which was adapted within the context of CS-IPTBL. This is

composed of five items (e.g., "*Using CS-IPTBL allows me to accomplish learning tasks more quickly*", α =.92).

Perceived learning (PL). This refers to students' perception of their learning through CS-IPTBL (e.g., "*CS-IPTBL has broadened my knowledge of course related materials*", α =.96)

The subscales IP, TMVC, PM, PE, and PL were adapted from Gomez et al., (2010).

Readiness for interprofessional learning (RIPL). This refers to the readiness of the students to engage in IPE as measured by the Readiness for Interprofessional Learning Scale (Parsell & Bligh, 1999). This scale was earlier validated using Chinese prelicensure heath care and social care students (Ganotice & Chan, 2018). The composite score of the four RIPLS subscales (teamwork and collaboration, negative professional identity, positive professional identity, roles and responsibilities) was used in the study (α =.88).

Perceived attainment of IPE outcomes (AIPEO). This refers to the team members' perception of the degree of attainment of interprofessional education intended learning outcomes through the CS-IPTBL. There are seven outcomes included (e.g., "*collaborate with students in other professions in solving clinical problems,* α =.95). For this part, students responded to the questionnaire using a Likert scale from 1 (to a very small extent) to 5 (to a very large extent).

3.3 Statistical analyses

For the preliminary analysis, we first used confirmatory factor analysis (CFA) to determine the construct validity of the various scales used. We used path analysis, a technique used to examine the direct and indirect effects between variables, as the main analysis. This is especially appropriate when "theoretical, empirical, and commonsense knowledge of a problem" (Cook & Campbell, 1979; p. 307) suggests the structural relationships of the latent variables. The mediation effects were tested by examining the indirect effects of IP and TMVC (presage) on

PL, RIPL and AIPEO (product) through the three mediators: PM, PE, and PU (process). A full mediation process occurs when in the presence of the mediator, the pathway connecting the independent variable (IV) to dependent variable (DV) is completely broken, whereas in partial mediation, the mediator only mediates part of the effect of the IV on the DV suggesting that the IV has residual direct effect even after the mediator is included (Gunzler, Chen, Wu, & Zhang, 2013).

To evaluate model fit, we relied on multiple indices of fit. Comparative fit index (CFI), normed fit index (NFI), Tucker-Lewis index (TLI), and incremental fit index (IFI) values greater than 0.90 and root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) values less than 0.08 indicate good fit (Hu & Bentler, 1999; Kline, 2011). We refrained from relying solely on the chi-square significance test given that with large sample sizes, it is more likely than not to end up with a significant chi-square statistic (Byrne, 2010).

Path analysis using analysis of moment structure (AMOS) was performed using the bootstrapping method, a nonparametric procedure that does not require the assumption of normality of the sampling distribution. In this analysis, parameter estimates and 95% bias-corrected confidence intervals of the indirect effects were generated from 5000 bootstraps (random samples).

3.4 Procedure and data collection

The data we used in this study were taken from the instruments administered as evaluation tools of IPTBL. We explained to the students that the purpose of the study was to gather feedback within which program implementers could refine the program delivery. In sequence, students responded to the following questionnaires: perceived learning, motivation, and

contribution in CS-IPTBL, readiness for interprofessional learning scale, and perceived attainment of learning outcomes.

Interprofessional TBL teams of students were created with 5-7 members. For example, in instructional unit (IU) Anticoagulation therapy composed of 240 students (medicine = 96, nursing =105, pharmacy 31, social work = 8), 36 teams were formed with 1-3 medicine students, 2-3 nursing students, 1-3 pharmacy and/or social work students for each team. For the IU Depression composed of 291 students (Chinese medicine =15, medicine =99, nursing =105, pharmacy =31, social work =33, occupational therapy =8), 45 teams were formed with 2-3 medicine students, 1-3 nursing students, and 2-3 Chinese medicine, pharmacy, social work, and/or occupational therapy students in each team. Students were preassigned to interprofessional TBL teams. We report the differential effects of team composition in another article.

4. Results

4.1 Preliminary analyses

Table 1 shows the descriptive statistics, Cronbach's alpha, and bivariate correlations among the variables. The Cronbach's alpha reliabilities for the various scales ranged from 0.82 to 0.96 demonstrating adequacy of consistency. We used expectation maximization method (Gold & Bentler, 2000) in dealing with the missing data. Confirmatory factor analyses were conducted to examine the psychometric properties of the scales used. Results indicated adequate fit of our data to the measurement models: IP, TMVC, PM, PE, PU, PL (χ^2 = 1283.11, *df* = 260, RMSEA = .08, CFI=.93 NFI=.91, TLI=.92, IFI=.93), and readiness for interprofessional learning scale (RIPLS, χ^2 = 867.64, *df* = 146, RMSEA = .08, CFI=.91, NFI=.90, TLI=.90, IFI=.92). RIPLS has been validated previously involving Chinese health care and social care prelicensure

students (Ganotice & Chan, 2018). All factor loadings were significant at the $p < .001$ level (Byrne, 2010; MacCallum, Browne, & Sugawara, 1996). In a scale of 1 to 5, students' mean scores on all the variables can be described as high. Of these variables, *perceived team member's valuable contribution* obtained the highest mean (M=3.61), and *readiness for interprofessional learning* obtained the lowest mean (M=3.37, Table 1).

(INSERT TABLE 1 HERE)

4.2 Path analyses

In the first path analysis, we estimated both the direct and indirect paths of predictors to outcomes. The data did not fit the model well: $\chi^2 = 666.980$, $df = 6$, $p < 0.001$; CFI = 0.82; IFI = 82; NFI = .82; AIC = 742.98, SRMR = .08. We then deleted all the non-significant paths and we allowed the error terms for the outcome variables and mediators to be correlated with each other which resulted in a better fit: $\chi^2 = 19.012$, $df = 8$, $p < 0.015$; CFI = 0.99; IFI = 99; NFI = .99; AIC = 91.01, SRMR = .02 (Figure 3). All the paths from IP and TMVC to PM, PE, and PU were significant lending support to hypotheses 1a to 11f. The paths linking PM, PE, and PU to PL, RIPL, and AIPEO were significant except for three paths: PM $\rightarrow$ RIPL, PU $\rightarrow$ RIPL, PL. We then reject accepted hypothesis 2a, 2c, 2d, 2e, 2f, 2i and rejected 2b, 2h, and 2g.

4.3 Direct, indirect, and total effects in the final empirical model

Table 2 shows the decomposition of the direct, indirect, and total effects between predictors and outcomes in the final model. The direct effect of the perceived team members' individual contribution (TMVC) on perceived motivation (PM, $\beta = .59$), perceived enjoyment (PE, $\beta = .63$), and perceived usefulness (PU, $\beta = .56$) were higher than that the direct effect of individual preparedness (IP) on PM ($\beta = .26$), PE ($\beta = .25$), and PU ($\beta = .30$). This suggests that

most of the variance in the PM, PE, and PU was accounted for by TMVC. Interestingly, TMVC has direct effect only on perceived learning (PL, β = .20). IP has no direct effect on any of the three outcomes. A total of 59.8% of the variance in PM, 66.8% in PE, and 63% in PU were explained by two predictors: IP and TMVC.

(INSERT TABLE 2 HERE)

PM has a direct effect on PL (β = .35) and AIPEO (β = .18) but has no direct effect on RIPL. As hypothesized, PE exerted direct effect on PL (β = .39), RIPL (β = .34), and AIPEO (β = .32). Finally, PU has direct effect on AIPEO (β = .13). TMVC was found to be a predictor of PL (β = .20). These variables altogether accounted for 80% of the variance in PL, 11.2% in RIPL, and 38.4% in AIPEO (refer to Figure 3 and Table 2).

(FIGURE 3, INSERT HERE)

5. Discussion

Underpinned by 3P model (Biggs, 2003) this study investigated the pathways that can explain students' achievement (the *product* which is operationalized in terms of perceived learning, readiness to engage in interprofessional learning, and attainment of IPE objectives) in an interprofessional team-based learning using LAMS as an electronic platform. Students' achievement is hypothesized to be influenced by students' entry attributes (the *presage* which is operationalized in terms of preparedness as an individual and preparedness to contribute in team) and their motivational processes (the *process* which is operationalized in terms of task value and utility which students demonstrate in learning). On one hand, the results indicated that students' motivational processes (PM, PE, and PU), fully mediated the relationship between perception of individual preparation (IP) and various outcomes (PL, RIPL, and AIPEO). In other words, our data suggest that IP influenced PL, RIPL, and IPEO via PM, PE and PU (refer to Figure 3). On

the other hand, these motivational processes partially mediated the relationship of TMVC on PL as demonstrated by significant direct and indirect effects.

The first key finding relates with the strong link between member's valuable contribution and task value (motivation, enjoyment) and utility value (perceived usefulness). This suggests that a positive perception of members' valuable contribution promotes motivation, enjoyment, and perception of usefulness of CS-IPTBL providing support to previous study (e.g., Gomez et al., 2010). This finding provides implicit message to the students that their enjoyment and motivation are largely dependent on their readiness to have valued contribution to team functioning. This is particularly relevant in the context of IPE using TBL in which the inherent responsibility of the students from various discipline (e.g., medicine, Chinese medicine, pharmacy) is to represent their own discipline to facilitate other team members' understanding of the clinical case scenarios and the corresponding multiple-choice questions.

Another important finding of this study relates with enjoyment in students' involvement in CS-IPTBL. Literature suggests that students have stronger engagement in enjoyable and fun rather than boredom- and anxiety-inducing school activities (Frenzel, Pekrun, & Goetz, 2007a; Osorno, 2017). Of the three mediators in this study, only enjoyment has direct positive relationship with three outcomes: PL, RIPL, AIPEO. In other words, students who enjoy in CS-IPTBL are driven to learn more (perceived learning), tend to be prepared in interprofessional learning (readiness for interprofessional learning), and achieve the IPE learning outcomes. This finding provides empirical support to the link between students' enjoyment and achievement (e.g., Shiah, Mastropieri, Scruggs & Mushinski-Fulk, 2010) in the context of computer-supported interprofessional team-based learning.

Students' motivation to participate in a computer-supported IPTBL predicted their perception of learning. This provided support to previous studies (e.g., Gomez et al., 2010; Huang & Lin, 2017). It also predicted the attainment of IPE outcomes which lend support to our hypothesis. It did not however predict their readiness for interprofessional learning. In other words, students' motivation drives learning and attainment of IPE outcomes but does not determine their readiness to engage in interprofessional learning.

Our findings suggested differential effects of the mediation model, supporting both partial and full mediation. Specifically, task values (motivation and enjoyment) partially mediated the relationship between team member's valuable contribution and perception of learning, while both task (motivation and enjoyment) and utility values (perceived usefulness of CS-IPTBL) were found to be fully mediating the mechanism between individual preparedness and perception of learning, readiness for interprofessional learning, and achievement of IPE outcomes. In other words, while member's valuable contribution can influence both directly or indirectly (via mediators) the student outcomes, individual preparation (IP) in CS-IPTBL does not immediately translate into students into positive achievement but it is the task and utility values which were elicited by preparedness that caused them to achieve (IP $\rightarrow$ PM, PE, PU $\rightarrow$ PL, RIPL, AIPEO).

Although the present study provides insightful findings, certain limitations must be considered. *First,* we tested the model solely in the context of IPE. Testing the model in traditional "in silos" classroom may provide a comparison of model fit and therefore will facilitate a comparative understanding about psychological processes between students in IPE context and "in silos context" using TBL. *Second*, it would be useful to know whether students respond more favorably in IPTBL when using LAMS or when using traditional paper-based methods. Future research can consider testing the model into two contexts. *Third*, this study only

involved students from Hong Kong context which limits generalizability of the findings. It may be important to extend this study to other Asian countries to examine the convergence of results. *Lastly*, the self-report nature of our data is also a limitation. Other means of data collection may be used in the future.

These limitations notwithstanding, we are convinced that these do not undermine the importance of our findings. Our study contributes to the body of research on the student preparedness as individuals and as important team members in a computer-supported TBL, and extends it in the context of IPE in the Asian context. Our findings provided understanding on students' psychological pathways in succeeding in CS-IPTBL which have interesting implications to practice. The derived model helps us attain a more profound understanding that students' achievement in CS-IPTBL is greatly influenced by motivation and enjoyment which are derived from two sources: individual preparedness and members' valuable contribution. These findings provide important practical implications for teachers and program implementers. For students in TBL teams, they need to be reminded that achievement outcomes in CS-IPTBL are the product of task value (motivation, enjoyment) and utility value (usefulness) which are influenced by two key factors: their preparation and valuable contribution to team members. For teachers and program implementers of IPE, our findings suggest that the use of computer-supported IPTBL can facilitate motivation and enjoyment which facilitate achievement. This empirical result can be the basis of continuous enhancement of electronic platform in a computer-supported collaborative learning. The inclusion of interactive games designed to foster healthy team competition is a promising feature which is in line with gamification of learning (Cheong, Filippou, & Cheong, 2014; Kim & Lee, 2015). This may also help reduce students' stress and burnout which are prevalent in East Asian learners (Boylan, 2016; Huang, 2017).

Studies on the role of computer in learning (e.g., computer-mediated communication, computer-assisted instruction) have demonstrated consistent findings that it can foster engagement and achievement (Maier, Wolf, & Randler, 2016; Pilli & Aksu, 2013; Wu & Hiltz, 2004). Our study extended these works further by exploring the psychological mechanisms in computer-supported interprofessional TBL. We have raised the question on how to succeed in CS-IPTB. Based on the derived model, two critical factors are needed: individual preparation and contribution to team. The key characteristic of learners in CS-IPTBL which is linked to team success is preparedness as individuals from various interprofessional disciplines and team contribution. It can be said therefore that critical for the interprofessional teams to succeed is harnessing in team players (the students) the value of coming to class prepared as individuals and as important team members who are ready to contribute meaningfully in an interprofessional TBL (presage). These two factors determine student's learning and readiness for interprofessional learning (outcomes) through motivation, enjoyment and perceived use of CS-IPTBL (process).

Finally, we end by quoting an observation of Wilson-Delfosse (2012) that "TBL is a great example of one such promising strategy. It has been well described – the challenge now is to focus on the tools of scholarship that will broaden our understanding and allow us to take the next steps." We hope that this study has responded to this call.

Reference

Antoun, J., Nasr, R., & Zgheib, N. K. (2015). Use of technology in the readiness assurance process of team based learning: Paper, automated response system, or computer based testing. *Computers in Human Behaviour, 46*, 38-44.

Anwar, K., Shaikh, A. A., Dash, N. R., & Khurshid, S. (2012). Comparing the efficacy of team based learning strategies in a problem based learning curriculum. *Apmis, 120*(9), 718-723.

Baldwin, T. T., Bedell, M. D., & Johnson, J. L. (1997). The social fabric of a team-based MBA program: Network effects on student satisfaction and performance. *Academy of Management Journal, 40*(6), 1369-1397.

Barak, M., & Rafaeli, S. (2004). On-line question-posing and peer-assessment as means for web-based knowledge sharing in learning. *International Journal of Human-Computer Studies, 61*(1), 84-103.

Beatty, S. J., Kelley, K. A., Metzger, A. H., Bellebaum, K. L., & McAuley, J. W. (2009). Team-based learning in therapeutics workshop sessions. *American Journal of Pharmaceutical Education, 73*(6), 100.

Beer, M., Slack, F., & Armitt, G. (2005). Collaboration and teamwork: Immersion and presence in an online learning environment. *Information Systems Frontiers, 7*(1), 27-37.

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. Alexandria, VA: Association for Supervision and Curriculum Development.

Biggs, J. B. (1987). *Student approaches to learning and studying*. Hawthorn, Victoria: Australian Council for Educational Research.

Biggs, J. B. (1996). Approaches to learning of Asian students: A multiple. *Asian Contributions to Cross-Cultural Psychology, 4*, 180.

Biggs, J. B. (2003). *Teaching for quality learning at university*. Berkshire, UK: Open University Press.

Bishop, S. E., Phillips, A., Lee, B. B., Sicat, B., & Rybarczyk, B. (2015). Internists, pharmacists, and psychologists on learning teams: An interprofessional team-based learning experience in graduate medical education. *Journal of Interprofessional Education & Practice, 1*(2), 43-47.

Black, E. W., Blue, A. V., & Foss, J. J. (2015). Using team-based learning in interprofessional education to promote content knowledge and team skills applications. *American Journal of Occupational Therapy, 69*, 1463-1466.

Boylan, M. (2016). Here's why East Asian students consistently outpace their Western peers. Retrieved from http://www.businessinsider.com/heres-why-east-asian-students-consistently-outpace-their-western-peers-2016-12.

Brown, J. S. (2001). Learning in the digital age. In *The Internet and the university: Forum* (pp. 71-72). Washington, DC: Educause.

Byrne, B. M. (2010). *Structural equation modelling with AMOS: Basic concepts, applications, and programming* (2nd ed.). New York, NY: Routledge.

Centre for the Advancement of Interprofessional Education. (2002). *Interprofessional education – A definition*. Retrieved from: http://www.caipe.org.uk

Chan, L. K., Ganotice, F., Wong, F. K. Y., Lau, C. S., Bridges, S. M., Chan, C. H. Y., ... & Chu, J. K. P. (2017). Implementation of an interprofessional team-based learning program involving seven undergraduate health and social care programs from two universities, and students' evaluation of their readiness for interprofessional learning. *BMC medical education, 17*(1), 221.

Cheng, A., Eppich, W., Grant, V., Sherbino, J., Zendejas, B., & Cook, D. A. (2014). Debriefing for technology-enhanced simulation: a systematic review and meta-analysis. *Medical Education, 48*(7), 657-666.

Cheong, C., Filippou, J., & Cheong, F. (2014). Towards the gamification of learning: Investigating student perceptions of game elements. *Journal of Information Systems Education, 25*(3), 233.

Clair, K. S., & Chihara, L. (2012). Team-based learning in a statistical literacy class. *Journal of Statistics Education, 20*(1), 1-20.

Collins, A., & Halverson, R. (2009). *Rethinking education in the age of technology: The digital revolution and schooling in America*. New York: Teachers College Press.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design & analysis issues for field settings*. Boston: Houghton Mifflin.

D'Amour, D., Ferrada-Videla, M., San Martin Rodriguez, L., & Beaulieu, M. D. (2005). The conceptual basis for interprofessioanl collaboration: core concepts and theoretical frameworks. *Journal of Interprofessional Care, 19*(suppl 1), 116-131.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 319-340.

Diseth, Å., & Kobbeltvedt, T. (2010). A mediation analysis of achievement motives, goals, learning strategies, and academic achievement. *British Journal of Educational Psychology, 80*(4), 671-687.

Eccles, J. S. (1983). Expectancies, values and academic behaviours. In J. T. Spence (Ed.), *Achievement and achievement motives* (pp. 75-146). San Francisco: WH Freeman.

Freeth, D., & Reeves, S. (2004). Learning to work together: using the presage, process, product (3P) model to highlight decisions and possibilities. *Journal of Interprofessional Care, 18*(1), 43-56.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Perceived learning environment and students' emotional experiences: A multilevel analysis of mathematics classrooms. *Learning and Instruction, 17*(5), 478-493.

Galusha. J. J. (1997). Barriers to learning in distance education. *Interpersonal Computing and Technology, 5*(3), 6-14.

Ganotice, F. J. A., & Chan, L. K. (2018). Construct validation of the English version of Readiness for Interprofessional Learning Scale (RIPLS): Are Chinese undergraduate students ready for 'shared learning'? *Journal of Interprofessional Care, 32* (1), 69-74.

Ganotice, F. J. A., Datu, J. A. D., & King, R. B. (2016). Which emotional profiles exhibit the best learning outcomes?. A person-centered analysis of students' academic emotions. *School Psychology International, 37*(5), 498-518.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment, 1*(1), 20.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education*, 82-88.

Gold, M. S., & Bentler, P. M. (2000). Treatments of missing data: A Monte Carlo comparison of RBHDI, iterative stochastic regression imputation, and expectation-maximization. *Structural Equation Modeling, 7*(3), 319-355.

Gomez, E. A., Wu, D., & Passerini, K. (2010). Computer-supported team-based learning: The impact of motivation, enjoyment and team contributions on learning outcomes. *Computers & Education, 55*(1), 378-390.

Gomez, E. A., Wu, D., Passerini, K., & Bieber, M. (2009). Utilizing web tools for computer-mediated communication to enhance team-based learning. *International Journal of Web-based Learning and Teaching Technologies, 2*(2), 21-37.

Gunzler, D., Chen, T., Wu, P., & Zhang, H. (2013). Introduction to mediation analysis with structural equation modelling. *Shanghai Archives of Psychiatry, 25*(6), 390.

Haidet, P., & Fecile, M. L. (2006). Team-based learning: a promising strategy to foster active learning in cancer education. *Journal of Cancer Education, 21*(3), 125-128.

Hernández-Leo, D., Moreno, P., Chacón, J., & Blat, J. (2014). LdShake support for team-based learning design. *Computers in Human Behaviour, 37*, 402-412.

Hu, L. T., & Bentler, P. M. (1999). Cut-off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55.

Huang, C. K., & Lin, C. Y. (2017). Flipping business education: Transformative use of team-based learning in human resource management classrooms. *Educational Technology & Society, 20*(1), 323-336.

Huang, E. (2017). A spate of student suicides is forcing Hong Kong to confront its cutthroat school system. Retrieved from https://qz.com/904483/a-spate-of-student-suicides-is-forcing-hong-kong-to-confront-its-cutthroat-school-system/

Huang, M. H. B. (2008). *Factors influencing self-directed learning readiness amongst Taiwanese nursing students.* Queensland University of Technology. (Doctoral dissertation).

Jones, C. T. (2002). *Biggs's 3P model of learning: the role of personal characteristics and environmental influences on approaches to learning*. (Doctoral dissertation). Griffith University, Brisbane.

Kam, H. J., & Katerattanakul, P. (2014). Structural model of team-based learning using Web 2.0 collaborative software. *Computers & Education, 76*, 1-12.

Keller, J., & Suzuki, K. (2004). Learner motivation and e-learning design: A multinationally validated process. *Journal of Educational Media, 29*(3), 229-239.

Khogali, S., Smithies, A., Gray, A., Manca, A., & Lafferty, N. (2014). Team-based learning in a UK medical school: Using mobile-friendly technology to support the in-class individual readiness assurance test. In *European Conference on e-Learning* (p.273). Academic Conferences International Limited.

Kim, J. T., & Lee, W. H. (2015). Dynamical model for gamification of learning (DMGL). *Multimedia Tools and Applications, 74*(19), 8483-8493.

Kizito, R., Munyakazi, J., & Basuayi, C. (2016). Factors affecting student success in a first-year mathematics course: a South African experience. *International Journal of Mathematical Education in Science and Technology, 47*(1), 100-119.

Kline, R. B. (2011). Convergence of structural equation modeling and multilevel modeling. In M. Williams & W. P. Vogt (Eds.), *Handbook of methodological Innovation* (pp. 562-589). London, England: Sage.

Koles, P. G., Stolfi, A., Borges, N. J., Nelson, S., & Parmelee, D. X. (2010). The impact of team-based learning on medical students' academic performance. *Academic Medicine, 85*(11), 1739-1745.

Kumar, V., & Gadbury-Amyot, C. C. (2012). A case-based and team-based learning model in oral and maxillofacial radiology. *Journal of Dental Education, 76*(3), 330-337.

Leathard, A. (2003). *Interprofessional collaboration: from policy to practice in health and social care*. Hove: Brunner-Routledge.

Lehtinen, E. (2003). Computer-supported collaborative learning: An approach to powerful learning environments. *Powerful Learning Environments: Unravelling Basic Components and Dimensions*, 35-54.

Letassy, N. A., Fugate, S. E., Medina, M. S., Stroup, J. S., & Britton, M. L. (2008). Using team-based learning in an endocrine module taught across two campuses. *American Journal of Pharmaceutical Education, 72*(5), 103.

Liem, G. A. D., Martin, A. J., Porter, A. L., & Colmar, S. (2012). Sociocultural antecedents of academic motivation and achievement: Role of values and achievement motives in achievement goals and academic performance. *Asian Journal of Social Psychology, 15*(1), 1-13.

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1*(2), 130.

Maier, U., Wolf, N., & Randler, C. (2016). Effects of a computer-assisted formative assessment intervention based on multiple-tier diagnostic items and different feedback types. *Computers & Education, 95*, 85-98.

Martin, A. J., Marsh, H. W., & Debus, R. L. (2003). Self-handicapping and defensive pessimism: A model of self-protection from a longitudinal perspective. *Contemporary Educational Psychology, 28*(1), 1-36.

Mayo, M. J. (2007). Games for science and engineering education. *Communications of the ACM, 50*(7), 30-35.

McInerney, D. M., Roche, L. A., McInerney, V., & Marsh, H. W. (1997). Cultural perspectives on school motivation: The relevance and application of goal theory. *American Educational Research Journal, 34*(1), 207-236.

Michaelsen, L. K., Knight, A. B., & Fink, L. D. (2002). *Team-based learning: A transformative use of small groups*. Westport, CT: Praeger.

Michaelsen, L. K., & Sweet, M. (2008). The essential elements of team-based learning. *New Directions for Teaching and Learning, 2008*(116), 7-27.

Michaelsen, L. K., & Sweet, M. (2011). Team-based learning. *New Direction for Teaching and Learning, 2011*(128), 41-51.

Michaelsen, L. K., Sweet, M., & Parmelee, D. (2008). Team-based learning: Small-group learning's next big step. *New Directions for Teaching and Learning, 2008*(116), 1-104.

Nieder, G. L., Parmelee, D. X., Stolfi, A., & Hudes, P. D. (2005). Team-based learning in a medical gross anatomy and embryology course. *Clinical Anatomy, 18*(1), 56-63.

Nield, K. (2007). Understanding the Chinese learner: A case study exploration of the notion of the Hong Kong Chinese learner as a role or strategic learner. *Journal of Hospitality, Leisure, Sport and Tourism Education, 6*(1), 39-48.

Orr, K. K., Feret, B. M., Lemay, V. A., Cohen, L. B., Mac Donnell, C. P., Seeram, N., & Hume, A. L. (2015). Assessment of a hybrid team-based learning (TBL) format in a required self-care course. *Currents in Pharmacy Teaching and Learning, 7*(4), 470-475.

Osorno, S. (2017). The fundamentals of online classroom motivation. Connections Academy. Retrieved from http://blog.connectionsacademy.com/the-fundamentals-of-online-classroom-motivation/.

Parmelee, D. X., & Michaelsen, L. K. (2010). Twelve tips for doing effective team-based learning (TBL). *Medical Teacher, 32*(2), 118-122.

Parsell, G., & Bligh, J. (1999). The development of a questionnaire to assess the readiness of health care students for interprofessional learning (RIPLS). *Medical Education, 33*(2), 95-100.

Pilli, O., & Aksu, M. (2013). The effects of computer-assisted instruction on the achievement, attitudes and retention of fourth grade mathematics students in North Cyprus. *Computers & Education, 62*, 62-71.

Plass, J. L., O'keefe, P. A., Homer, B. D., Case, J., Hayward, E. O., Stein, M., & Perlin, K. (2013). The impact of individual, competitive, and collaborative mathematics game play on learning, performance, and motivation. *Journal of Educational Psychology, 105*(4), 1050.

Punja, D., Kalludi, S. N., Pai, K. M., Rao, R. K., & Dhar, M. (2014). Team-based learning as a teaching strategy for first-year medical students. *The Australasian Medical Journal, 7*(12), 490.

Reeves, J., & Lee, W. (2014). Students' classroom engagement produces longitudinal changes in classroom motivation. *Journal of Educational Psychology, 106*(2), 527.

Shaffer, D. W. (2008). Education in the digital age. *Digital Kompetanse, 1*(3), 37-50.

Shiah, R. L., Mastropieri, M. A., Scruggs, T. E., & Mushinski Fulk, B. J. (1994). The effects of computer-assisted instruction on the mathematical problem solving of students with learning disabilities. *Exceptionality, 5*(3), 131-161.

Squire, K. D. (2008). Video games and education: Designing learning systems for an interactive age. *Educational Technology, 48*(2), 17.

Stein, R. E., Colyer, C. J., & Manning, J. (2016). Student accountability in team-based learning classes. *Teaching Sociology, 44*(1), 28-38.

Sweet, M., & Pelton-Sweet, L. M. (2008). The social foundation of team-based learning: Students accountable to students. *New Directions for Teaching and Learning, 2008*(116), 29-40.

Tallent-Runnels, M.K., Thomas, J. A., Lan, W. Y., Cooper, S., Ahern, T. C., Shaw, S. M., & Liu, X. (2006). Teaching courses online: A review of the research. *Review of Educational Research, 76*(1), 93-135.

Tam, M. (1999). Promoting deep learning: A conceptual model. *Learning Matters at Lingnan: Teaching & Learning Centre*, 4.

Tempone, I. (2001). *Variation in student learning in accounting.* (Doctoral dissertation). Swinburne University of Technology, Melbourne, Australia.

Touchet, B. K., & Coon, K. A. (2005). A pilot use of team-based learning in psychiatry resident psychodynamic psychotherapy education. *Academic Psychiatry, 29*(3), 293.

Vasan, N. S., DeFouw, D. O., & Compton, S. (2011). Team-based learning in anatomy: An efficient, effective, and economical strategy. *Anatomical Sciences Education, 4*(6), 333-339.

Villavicencio, F., & Bernardo, A. (2012). Positive academic emotions moderate the relationship between self-regulation and academic achievement. *British Journal of Educational Psychology, 83*, 329-340.

Whitley, H. P., Bell, E., Eng, M., Fuentes, D. G., Helms, K. L., Maki, E. D., & Vyas, D. (2015). Practical team-based learning from planning to implementation. *American Journal of Pharmaceutical Education, 79*(10), 149.

Wiener, H., Plass, H., & Marz, R. (2009). Team-based learning in intensive course format for first-year medical students. *Croatian Medical Journal, 50*(1), 69-76.

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*(1), 68-81.

Wilson-Delfosse, A. L. (2012). Team-based learning: From education theory to emotional intelligence. *Medical Teacher, 34*(10), 781-782.

Woolfolk, A. (2007). *Educational psychology* (10th ed.). New York: Pearson Education, Inc.

World Health Organization. (2010). *Framework for action on interprofessional education and collaborative practice*. Retrieved from: http://www.who.int/hrh/resources/framework_action/en/

Wu, D., & Hiltz, S. R. (2004). Predicting learning from asynchronous online discussions. *Journal of Asynchronous Learning Networks, 8*(2), 139-152.

Zgheib, N. K., Simaan, J. A., & Sabra, R. (2010). Using team-based learning to teach pharmacology to second year medical students improves student performance. *Medical Teacher, 32*(2), 130-135.

Zhang, L. F. (2000). University students' learning approaches in three cultures: An investigation of Biggs's 3P model. *The Journal of Psychology, 134*(1), 37-55.

Zingone, M. M., Franks, A. S., Guirguis, A. B., George, C. M., Howard-Thompson, A., & Heidel, R. E. (2010). Comparing team-based and mixed active-learning methods in an ambulatory care elective course. *American Journal of Pharmaceutical Education, 74*(9), 160.

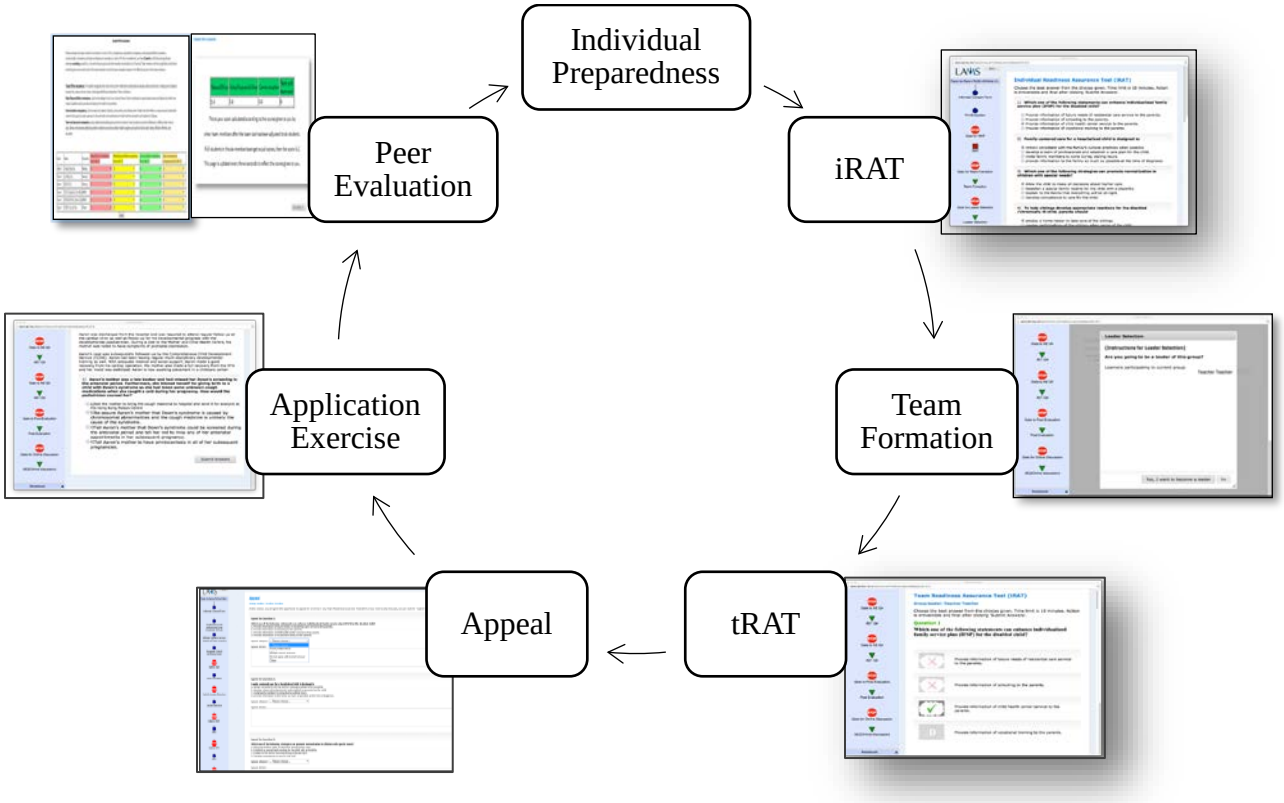

Figure 1. The IPTBL process using the learning activity management system (LAMS) for the project “Interprofesional team-based learning for health professional students” (Chan et al., 2017). iRAT = Individual readiness assurance test, tRAT = team readiness assurance test

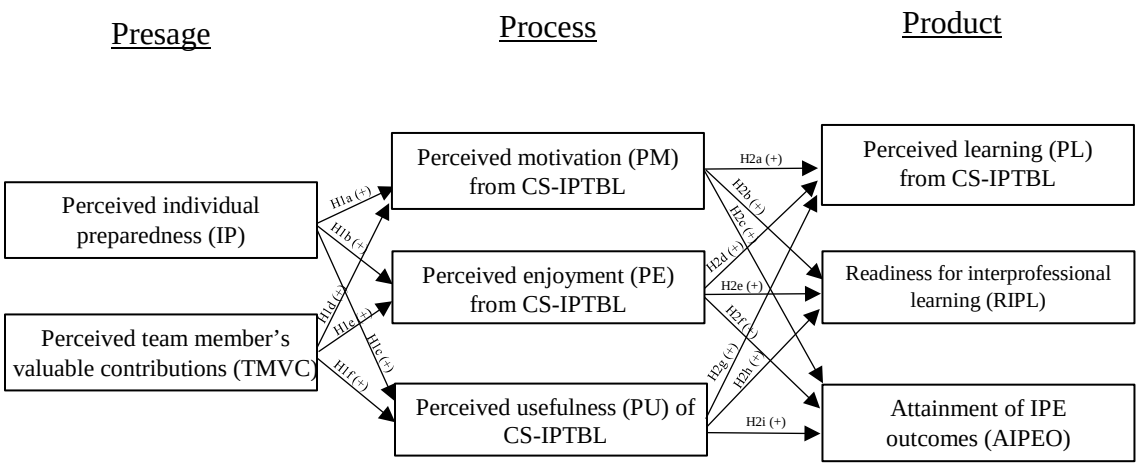

Figure 2. The theoretical model depicting the relations among perceived individual preparedness, perceived team member's valuable contributions (presage), perceived motivation, perceived enjoyment, and perceived usefulness (process) and perceived learning, readiness for interprofessional learning, and attainment of outcomes (product). The model delineates the process playing a mediating role in the relationship between presage and product (presage → process → product). Note: H represents the specific hypothesis and + denotes positive relationships.

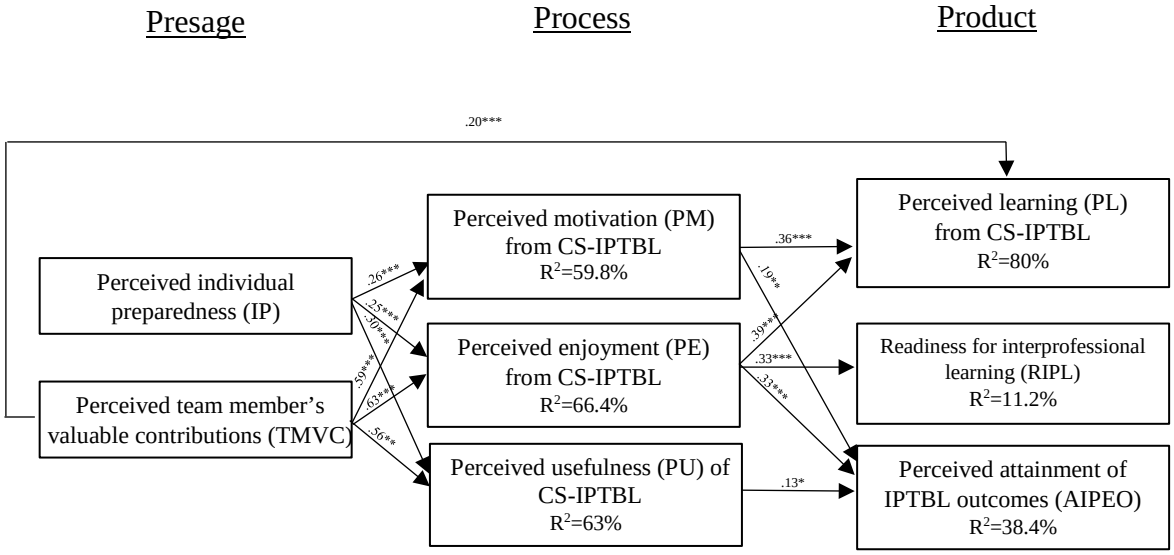

Figure 3. The theoretical model depicting the relations among perceived individual preparedness, perceived team member's valuable contributions (presage), perceived motivation, perceived enjoyment, and perceived usefulness (process) and perceived learning, readiness for interprofessional learning, and attainment of outcomes (product). R^2 is the amount of variance explained. Only standardized path coefficients are shown, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 1. Means, standard deviations, and zero-order correlations of variables in the path analysis (*n*=531)

	N	Possible range	M	*SD*	α	1	2	3	4	5	6	7	8
1. Perceived team member's valuable contribution	531	1-5	3.61	.70	.89	-	.64***	.75***	.79***	.75***	.78***	.33***	.56***
2. Perceived individual preparedness	531	1-5	3.48	.71	.95		-	.62***	.65***	.66***	.62***	.28***	.47***
3. Perceived motivation	531	1-5	3.41	.80	.82			-	.88***	.81***	.85***	.31***	.59***
4. Perceived enjoyment	531	1-5	3.43	.75	.85				-	.84***	.86***	.33***	.60***
5. Perceived usefulness	531	1-5	3.39	.79	.92					-	.78***	.33***	.58***
6. Perceived learning	531	1-5	3.58	.71	.96						-	.31***	.63***
7. Readiness for interprofessional learning	531	1-5	3.37	.42	.88							-	.49***
8. Attainment of IPE objectives	531	1-5	3.48	.66	.95								-

Note: *p<0.05, **p<0.01; ***p<0.001

Table 2. Standardized direct, indirect, and total effects in the final model

Predictor	Criterion	Direct effect	Indirect effect	Total effect
Perceived individual preparedness	Perceived motivation from CS-IPTBL	.26**		.26**
	Perceived enjoyment from CS-IPTBL	.25**		.25**
	Perceived usefulness of CS-IPTBL	.30**		.30**
Perceived team member's valuable contribution	Perceived motivation from CS-IPTBL	.59**		.59**
	Perceived enjoyment from CS-IPTBL	.63**		.63**
	Perceived usefulness of CS-IPTBL	.56**		.56**
Perceived motivation from CS-IPTBL	Perceived learning from CS-IPTBL	.36**		.36**
	Attainment of IPE objectives	.19*		.19*
Perceived enjoyment from CS-IPTBL	Perceived learning from CS-IPTBL	.39**		.39**
	Readiness for interprofessional learning	.33**		.33**
	Attainment of IPE objectives	.33**		.33**
Perceived usefulness of CS-IPTBL	Attainment of IPE objectives	.13*		.13*
Perceived individual preparedness	Perceived learning from CS-IPTBL	-	.19**	.19**
	Attainment of IPE objectives	-	.17**	.17**
Perceived team member's valuable contribution	Perceived learning from CS-IPTBL	.20**	.46**	.66**
	Readiness for interprofessional learning	-	.21**	.21**
	Attainment of IPE objectives	-	.39**	.39**

Note: *p<0.05, **p<0.01