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Learning engagement via promoting situational interest in a blended learning environment

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Abstract

In educational psychology, the theories of interest and self-determination have been well studied to find the relationships between learning attitudes and learning outcomes. However, the instructional design and the learning behaviors are the two missing elements which have not been fully investigated in the learning process. Therefore, we conducted two studies longitudinally with 2 years data from a 13-week engineering course at the City University of Hong Kong in a blended learning environment to verify the criticalness of these elements in these studies. With engagement records being collected from the learning management system in the second year, we further correlated the relationship from situational interest to engaged learning and finally the academic performance. Our findings make theoretical contributions by combining these two theories and link the model with behavior and achievement of students. It also demonstrates the importance of these theories on the instructional design.

Keywords Situational interest · Theory of interest · Self-determination theory · Instructional design

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Introduction

Attitudes change behaviors which affects the outcome/achievement (Hui et al. 2018). In educational psychology domain, the theory of interest (ToI) and self-determination theory (SDT) are the two major theories that receive researchers' attentions in recent decades. The ToI focuses on the person-object relationship, while the SDT focuses on content specifics (Krapp 2002). Researchers tried to explore antecedents in cultivating students' psychological states for enhancing students' academic performance. It is generally believed that students with learning motivation and feeling interested in the learning environment can improve their cognitive and emotional outcomes and therefore achieve better academic performance (Muller and Louw 2004).

Although there are prior studies using the two theories, they are either partially used or focused on other areas such as Big Five Personalities (Muller and Louw 2004) and technological pedagogical content knowledge framework (Urban-Woldron and Hopf 2011) instead of learning outcome. In addition, previous study pointed out that it is unclear on how the learning outcome be changed based on the learning motivation and interest (Rheinberg et al. 2000). We think that instructional design and the learning behavior are the two missing elements which have not been fully investigated in the learning process causing psychological change and the change of learning outcome. Therefore, we conduct the two studies longitudinally in order to verify the consistency of the model we proposed, as well as showing the importance of instructional design and the learning behavior between learning attitudes and the learning outcomes.

In the first study, we proposed a new conceptual model on how situational interest can be cultivated. The model was empirically verified with data being collected from a 13-week engineering course at the City University of Hong Kong in the academic year 2015/16. The predictive path of the model was being identified. Specifically, this path consists of five sequentially organized nodes as follows: *perceived usefulness of instruction design, learning satisfaction, learning motivation, situational interest, and academic performance*.

Based on the result of the first study, instructional design was enhanced and applied to the class in the academic year 2017/18. The second study was conducted in order to verify the model in the first study again and verify the effect of engaged learning in the model. In the second study, we further verified the model using the data that was collected in the academic year 2017/18. In addition, engagement data in terms of number of page views was collected from learning management system for further analysis on how academic performance was being improved from the situational interest via enhancing the engaged learning under the new instructional design in the blended learning environment.

The findings provide both theoretical and practical contributions. Theoretically, we identify a model to apply both theories with longitudinal empirical support. It also fills the gap between attitude and performance by inserting engaged learning behaviors between them. Practically, we identify that instructional design is an important element in cultivating students' learning satisfaction, learning motivation, and situational interest.

The remaining of the paper is organized as follows. Firstly, we make a brief introduction to theoretical backgrounds and the proposed conceptual model in "Theoretical background and research model" section. Secondly, we explain the research methods of the first study in detail in "Methods" section. Thirdly, we perform data analysis of the first study and show the analysis results in "Data analysis and results of the first study" section. Then, we describe the research methods, findings and analysis of the second study in "Research context, data analysis and results of the second study" section. Furthermore, we discuss both the theoretical implication and practical implication in "Discussion and implication" section. Finally, we make a conclusion of this paper in "Conclusion" section.

Theoretical background and research model

Theory of interest

ToI has been widely used since the 1970s for describing and explaining the processes and results in learning (Muller and Louw 2004; Hoffmann et al. 1998). It discusses the relationship between a person and an object, and classifies the interests into situational interest (SI) and individual interest (II). It was mainly applied in the research of teaching and learning.

SI is the psychological state which a person feels interested in something at a particular time and environment (Dewey 2009). In the education context, it is the teaching and learning environment such as the pedagogy of the course, the learning management system, textbook, notes, team members of a group project, classroom equipment, and instructional design. Instructional design defines the way the course being delivered in the specific learning environment. We argue that instructional design relates positively with students' SI.

Students who are being motivated and feel interested shows higher engagement in the learning process and learning environment. They have a longer term of commitment and longer period of retention of what they have learned than others. They are more willing to make use of their learned knowledge to solve problems in a more proactive and frequent way. Eventually, they can achieve better academic performance than others (Muller and Louw 2004; Rotgans and Schmidt 2011).

On the other hand, II is a relatively stable psychological state. In the education context, II refers to the original stable psychological state of students before the commencement of the course. The theory defines that II and learning motivation are positively related to the SI (Dewey 2009). We therefore argue that that both II and LM are positively related to students' SI.

Self-determination theory

Self-determination theory (SDT) was developed by Deci and Ryan (1985). It was developed according to the prior research about the characteristics of intrinsic and extrinsic motivation (Deci and Ryan 2002; Deci 1975). It stated that intrinsically motivated behaviors represent prototypes of self-determined behavior. On the other hand, some of the extrinsically motivated behaviors can become self-determined "through the developmental processes of internalization and integration" (Deci and Ryan 1994).

The characteristics that are demonstrated by students who are being motivated aligns with the ToI. These characteristics include curiosity, exploration, and interest (Muller and Louw 2004). We therefore argue that learning motivation (LM) is positively related to students' situational interest.

One of the prerequisites of self-determined motivation is the satisfaction of basic psychological needs. In the educational context, we refer these basic psychological needs to the learning environment which the instructional design belongs to Muller and Louw (2004). Therefore, we argue that perceived usefulness of instructional design is positively related to the learning satisfaction and then the learning motivation.

Engaged learning

Engaged learning describes the situation where students proactively invest their times and efforts into the learning process in order to understand and internalize the knowledge (Newmann 1992). It is one of the active forms of learning in both the problem solving and the learning process (Hung et al. 2006). Engaged students normally have higher participation rate in learning activities in order to improve their higher-level thinking skills (Bomia et al. 1997).

Engaged learning can be identified from the cognitive domain, the emotional domain and the social domain (Wang and Kang 2006). In the cognitive domain, students build knowledge, own the learning process and demonstrate self-regulation. In the emotional domain, students demonstrate curiosity while maintain self-confident and security. In the social domain, students are more active in social networking, information sharing, and collaborative learning.

Engaged learning is measured in terms of the participation level of students in learning activities throughout the learning process. In a blended learning environment, teachers can re-design the instruction design in order to encourage students' participations and record this data in a more systematic way. For example, total online duration of students in a learning management system, number of pages being viewed, number of messages being posted in a forum…etc.

Recent studies show that SI is positively related to learning engagement (Arnone et al. 2011; Ainley 2012). We argue that SI is positively related to page views (PV) in the learning management system as a measurement of engagement while the PV is positively related to AP.

Research model

In the first study, we aim to identify the process in cultivating students' SI and whether student's SI is associated with their academic performances (AP). A conceptual model as shown in Fig. 1 was developed based on the ToI and SDT. Seven hypotheses are proposed. First, the fundamental instructional design which can be measured in a reflective way as perceived usefulness of instructional design (PUID) affects positively both the SI and learning satisfaction (LS). Second, the LM relies heavily on the precondition of LS, and is positively related to SI. Third, II is directly related to both LM and SI. Finally, SI is directly related to AP.

Methods

Research context

The course Software Engineering Principles and Practice is offered as a core course to students in Creative Media Major, which aims to produce creative media professionals proficient in computing technology. Students are expected to gain a solid foundation in the creative processes, including video, sound, photography, storytelling, game design, animation, computer graphics, installation, and interactive digital media production. However, some of these students are more media oriented towards their studies resulting in not having much motivation in studying this course.

This software engineering course aims to provide practical knowledge and skills in software development using unified modeling language by going through the software engineering process from software requirement analysis, design, and implementation to testing. It also covers more theoretical topics such as software processes, design principles and project management. The course delivery takes the form of 2-hour lecture and 1-hour tutorial/laboratory every week for 13 weeks. Students are asked to work on a semester-long group project. Since they do not have much experience in software development and show less interest in the subject, some of these students find it extremely difficult in studying this course.

Traditionally, we asked students to work on some typical software development projects like library systems and facility management systems etc. Since students

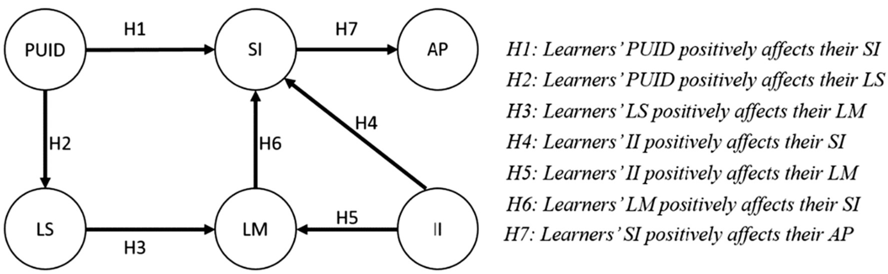

Fig. 1 The proposed conceptual model based on ToI and SDT

were not familiar with the knowledge domains of the chosen projects and thus, with less interest in the course, they found it hard to achieve the learning outcomes and there was a certain percentage of failure every year.

In the academic year 2015/16, we modified the approach of teaching and learning of this course. We aimed to choose a knowledge domain that they might be interested in for the project work; to provide plenty of video learning resources to students as part of the flipped learning; to plan the project work with a series of phase submissions instead of submitting a large piece of work at the end; to provide templates and guidance at every phase; and to provide feedback immediately after the submission so that they were able to improve their work in the next phase.

We chose a game on the Unity3D platform as the basis for the semester project. Unity3D provides a large number of short videos on various topics. We asked students to watch some videos on the selected game before starting the project. We asked students to attempt a short quiz to test their understandings on Unity3D. We guessed that game development was an interesting topic that creative media students might have more interests in learning software engineering practice in this domain. We then asked students to model the chosen game using unified modeling language technique with the help of the software engineering tool Visual Paradigm. We also suggested students to watch video learning resources in Visual Paradigm and the programming language C Sharp. We delivered software engineering knowledge during the lectures and we showed practical skills in using Unity3D and Visual Paradigm during the tutorial/laboratory sessions. Since we guessed that students might have interests in game development on the Unity3D platform, we specifically included some tips in using Unity3D in most tutorial/laboratory sessions so as to cultivate their situational interests. Students are expected to understand the concepts and apply them to complete the project by using the software tools Visual Paradigm and Unity3D.

In order to monitor changes in students' perception on the knowledge domain using this approach, interests on the topics, and the efforts in studying, we asked students to fill in a survey prior and after the course.

Survey instrument data collection

Measurement items were developed based on related previous researchers on LM (Pintrich et al. 1991), LS and PUID (Klein et al. 2006). A list of questions concerning students' interest on various topics of the course were asked for measuring the II and SI before and after the course correspondingly. AP is collected from the actual achievement of students after the examination. PV is collected from the learning management system at the end of thirteenth week of the course in the second study.

A questionnaire was defined based on the measurement items being identified. All measurement items were measured using a 5-point Likert-scale ranging from "strongly disagree (1)" to "strongly agree (5)". The questionnaire was used for the course in the academic year 2015/16.

The questionnaire was distributed to students for measuring the II at the beginning of the course, and for measuring the other constructs at the end of the course.

Among the 71 students in the course in the academic year 2015/16, 62 students submitted their questionnaires. One student has submitted twice and his questionnaire was dropped. As a result, 61 valid records were used in the first study.

The result of the first study was presented at the 11th International Conference on Blended Learning (Hui et al. 2018).

Initial data preparations

Making use of the data returned in the first study, some questions in the questionnaire were removed based on the collinearity check of each construct. The result is summarized in Table 1.

Techniques for data analysis

In the first study, partial least squares was used to test the research model. Partial least squares is a second generation structural equation modeling technique. It is used to assess the construct validity based on the estimation of the loadings of each indicator of the corresponding constructs and the causal relationships among constructs in multi-stage models (Fornell and Bookstein 1982). Moreover, it has fewer statistical identification issues than covariance-based structural equation modeling and is suitable for constructs with relatively small samples (Hair et al. 2011). We conducted the data analysis using the SmartPLS tool (version 3.2.7) available at https://www.smartpls.com/.

Data analysis and results of the first study

Following the partial least squares technique, a two-step evaluation process must be conducted in order to validate a model. First, measurement model assessment is required to verify the reliability and validity of the measurement items of all constructs. This can make sure those measurement items are suitable to be included in a particular construct. Second, structural model assessment is used to evaluate the strengths of path coefficients, impacts and explanatory powers of paths from independent variables to dependent variables (Hair et al. 2011).

Table 1 Number of valid items of each construct

Name of construct	Original number of items	Number of valid items
II	10	7
LM	20	12
AP	N/A	N/A
LS	10	7
SI	10	5
PUID	10	6
PV	N/A	N/A

Measurement model assessment

In the process of assessing the measurement model, we evaluated four measurements. First, outer loadings of each measurement variable were evaluated in order to verify the absolute importance of each measurement variable to its corresponding construct (Cenfetelli and Bassellier 2009). This was to prove that each measurement variable was measuring for the corresponding constructs instead of other constructs. Second, Cronbach's alpha, composite reliability value and average variance extracted were evaluated in order to verify the internal consistency reliability of each construct (Churchill 1979). This was to prove that each construct had sufficient internal consistency reliability to warrant modeling analysis (Fornell and Larcker 1981; Hair et al. 2014). Third, outer loadings and t-value of each measurement variable were evaluated in order to verify the convergent validity of each construct (Fornell and Larcker 1981). Finally, cross-loadings of the measurement variables (Chin 1998), the square root of average variance extracted (Fornell and Larcker 1981; Hair et al. 2014) and Heterotrait-Monotrait Ratio (Henseler et al. 2015) were evaluated in order to evaluate the discriminant validity.

The absolute importance of each measurement variable can be reflected by the corresponding outer loadings since all constructs in the model are reflective constructs. According to Table 2, all outer loadings are higher than the threshold (0.708) (Cenfetelli and Bassellier 2009) ranging from 0.763 to 0.891. This means that all those measurement variables are more important to their corresponding construct than any other constructs.

Cronbach's alpha, composite reliability, and average variance extracted of each construct with their respective measurement variables are used to evaluate the internal consistency reliability (Churchill 1979). According to Table 3, Cronbach's alpha values and composite reliability values are greater than the threshold value (0.708). In additional, all average variance extracted values are greater than the required threshold (0.50). That means all constructs have sufficient internal consistency reliability to warrant modeling analysis (Fornell and Larcker 1981; Hair et al. 2014).

Loading levels and t-values are used to evaluate the convergent validity of all constructs. According to Table 2, all measurement variables have outer loadings substantially and significantly larger than the recommended loading level (0.50) (Fornell and Larcker 1981). In addition, all of the t-values of all constructs are high, which means that low standard errors exist and the convergent validity of all constructs is well justified.

Discriminant validity of each construct can be examined using three methods. Method one is to evaluate the cross-loadings of the measurement variables to ensure that the loading of each measurement variable in its corresponding construct is higher than its cross loading in other constructs (Chin 1998). By using this method, the discriminant validity can be justified. Method two is to compare the square root of average variance extracted with its correlation coefficient associated with all other constructs. According to Table 4, discriminant validity cannot be justified between LS and LM, as well as between PUID and LS. It is because the square root of the average variance extracted from the construct is smaller than the corresponding value of corresponding inter-construct correlation (Fornell and Larcker 1981; Hair

Table 2 Outer loading (OL) and t-value of each measurement variable in each construct

	Measurement variables											
	1	2	3	4	5	6	7	8	9	10	11	12
PUID												
OL	.802	.813	.861	.786	.856	.849						
t-value	13.506	11.052	18.055	10.224	15.371	16.575						
SI												
OL	.855	.864	.882	.793	.884	.856						
t-value	24.24	25.063	18.201	14.196	26.932	20.637						
II												
OL	.889	.763	.865	.867	.891	.796	.815					
t-value	7.95	5.049	7.333	7.842	7.586	4.565	5.803					
LM												
OL	.858	.806	.887	.821	.816	.873	.814	.824	.813	.890	.808	.765
t-value	18.523	15.577	24.123	10.358	13.67	19.282	12.504	18.278	13.186	28.071	13.907	11.045
LS												
OL	.838	.841	.840	.786	.847	.857	.827					
t-value	13.299	17.46	17.299	8.637	13.261							

Table 3 Cronbach's alpha, composite reliability, and average variance extracted of each construct

Construct	Cronbach's alpha	Composite reliability	Average variance extracted
PUID	0.908	0.929	0.686
SI	0.927	0.943	0.733
II	0.938	0.945	0.709
LM	0.959	0.964	0.692
LS	0.927	0.941	0.695

Table 4 Construct correlation matrix and the square root of average variance extracted

	II			LM			LS			PUI			SI		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
II	**.842**					1.011									1.062
LM	.231	.212		**.832**											3.291
LS	.102	.152		*.897*	*.949*	1.011	**.834**								
PUID	.149	.160		.827	.884		*.878*	*.941*	1.000	**.828**					3.187

The figures in bold are the square root of average variance extracted of the corresponding construct. The figures with italic font show discriminant validity issues. A: inter-construct correlation; B: heterotrait-monotrait ratio; C: variance inflation factor

et al. 2014). By using this method, the discriminant validity cannot be fully justified. Method three is to evaluate the Heterotrait-Monotrait Ratio. According to Table 4, not all values are higher than the threshold (0.9) (Henseler et al. 2015). By using this method, discriminant validity cannot be justified.

Multi-collinearity assessment on exogenous constructs are required because discriminant validity cannot be fully justified. According to Table 4, all inner variance inflation factor have a value below 5.00. This means that the multicollinearity among the exogenous constructs will not affect the structural equation modelling investigation of causal relationship (Fornell and Larcker 1981; Hair et al. 2014) and measurement model assessment is verified. This means that all measurement variables of the questionnaire are well designed for measuring the corresponding instead of other constructs. Therefore, the structural model assessment evaluation can be proceeded.

Structural model assessment

Structural model assessment consists of the evaluations on the path coefficient, the coefficient of determination (R^2 means the variance that can be explained by the model), effect size (f^2), relative predictive relevance (Q^2) and the goodness of model fitting (Hair et al. 2014). Bootstrapping and blindfolding procedures in SmartPLS are used for generating these values (Cohen 1988; Gefen et al. 2011; Hair et al. 2012). These values are discussed in five steps.

Step one, the path coefficients of each hypothesis, the significant level of each path coefficient, and the level of R^2 were evaluated. According to Fig. 2, path coefficients are significant with $p < 0.05$ for hypothesis H1, H4 and H5 and very significant with $p < 0.01$ for hypothesis H2, H3, H6 and H7. The R^2 of SI, LM, and LS are over 70% which shows strong explanation power. On the other hand, the R^2 of the AP is weak (about 10%).

Step two, the impact of a specific predictor construct on an endogenous construct was evaluated based on the f^2 value. The three effect levels (small, medium and large) are determined by the f^2 value (larger than 0.02, 0.15 and 0.35 respectively) (Hair et al. 2014). Our findings shows that LS ($f^2 = 4.375$) has a stronger effect than that of II ($f^2 = 0.110$) in producing the R^2 of LM. Similarly, LM ($f^2 = 0.265$) has a higher effect than that of PUID ($f^2 = 0.134$) and II ($f^2 = 0.097$) in producing the R^2 of the SI. Eventually, SI ($f^2 = 0.142$) has a smalller effect in producing the R^2 of the AP and PUID ($f^2 = 3.361$) has a larger effect in producing the R^2 of the LS.

Step 3, the model's predictive relevance can be evaluated by the Q^2 values. The three model's predictive relevance levels (small, medium and large) are determined by the Q^2 values (larger than 0.02, 0.15 and 0.35 respectively) (Hair et al. 2014). Our findings shows that LM ($Q^2 = 0.507$), LS ($Q^2 = 0.477$) and SI ($Q^2 = 0.489$) are having large predictive relevance while AP ($Q^2 = 0.116$) has small predictive relevance.

Finally, a model fit can be evaluated by measuring the standard root mean square residual, which was found to be 0.084. Since it is smaller than the threshold (0.10) (Henseler et al. 2014), the model has a good model fit.

The first study shows that the questionnaire is well designed so that the measurement variables are measuring for and only for the corresponding construct. The proposed model is a good model that can explain the data being collected. This shows that situation interest can significantly explain the academic performance while the situational interest can be cultivated through learning motivation via enhancing learning satisfaction by better perceived usefulness of the instructional design.

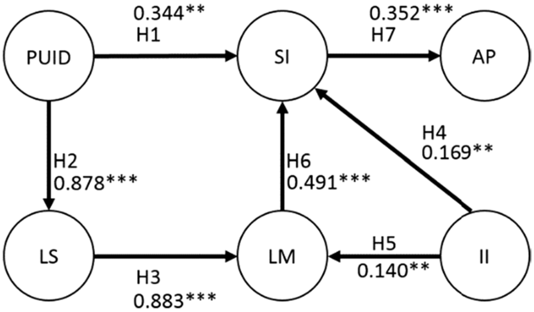

Fig. 2 Path coefficient and R2 of the first study

Research context, data analysis and results of the second study

Although the model in the first study was verified by empirical analysis in the first study, the R^2 value was just about 10% which was low. We believe there are intermediate steps from attitudes to actual outcomes. In order to find out the intermediate construct which links the psychological learning attitude to the actual academic performance, we conducted the second study by introducing engaged learning behavior to the model.

Research model of the second study

In the second study, engagement information was collected. We enhanced the model in order to make it more comprehensive to include the instructional design, learning attitudes, learning behaviors and academic performance (Hui et al. 2018). Two more hypotheses are proposed. First, the SI is directly related to the engagement level measured in PV. Second, the PV is directly related to the AP. Please refer to Fig. 3 for the model being used in second study.

The same questionnaire used in the first study was used in the second study in the academic year 2017/18. Among the whole 70 students in the course in the academic year 2017/18, 65 students submitted their questionnaires. One student has submitted blank questionnaire and was dropped. As a result, 64 valid records were used in the second study.

Partial least squares was used to verify hypothesis H1 to H6 same as the first study. R (version 3.4.1) was used for analyzing H7 and H8 according to the cluster groups based on the grades students obtained by combining the course work, mid-term test and examination.

Research context of the second study

We observed that students have shown improving interests for the tutorial/laboratory part as they needed to learn something before they could proceed to start the project. On the other hand, students still showed less interests in the lectures as they considered that there was no direct relationship between the lecture and their practical work. We guessed by inserting the relevant game examples in lectures might help to improve the situation. In order to further increase the situational

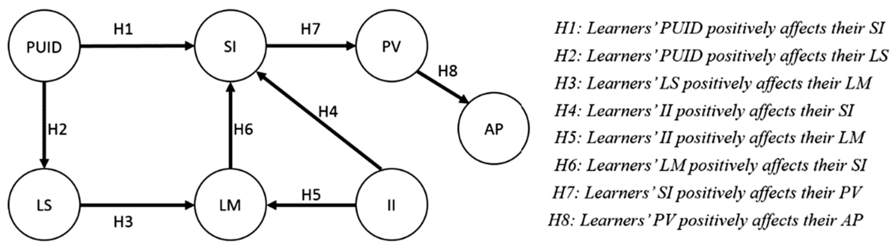

Fig. 3 The conceptual model for the second study

interest, we modified our instructional design in the academic year 2017/2018. We added some game examples similar to their project work in the discussion of various topics such as UML techniques, testing and design principles, etc. We also added some discussion on the background knowledge of the tools including Unity3D and Visual Paradigms so that they would have some ideas before getting on with the practical work. At the same time, we provided more practical tips to help students getting familiar with the tools and acquiring simple techniques to start their practical works. Practical examples could be downloaded during the laboratory sessions for hands-on exercise so as to help them better engaged in the practical sessions.

Data analysis and results of the second study

In the second study, we use SmartPLS to evaluate the first six hypotheses. The findings were similar to the first study. The effect size predictive relevance and model fit were the same as that of the first study. The hypothesis H7 and H8 were evaluated using the R by grouping students into three clusters based on their final grades of the course. Average page views and average situational interest represents the PV and SI were used for the analysis. Path coefficient, path significance and R^2 of hypothesis H1 to H6 of the second study, and the path significance and R^2 of H7 and H8 can be found in Fig. 4. This is not only re-verified the model in the first study related to the process of cultivating the situational interest, but also further extend the model by including the learning behavior (i.e. the engaged learning being measured by PV) in-between the learning attitude (i.e. the SI) and the learning outcome (i.e. the AP). It shows that SI is significantly associated with the PV, though with low R^2 while PV is very significantly associated with the AP with significant R^2 value which is over 30%.

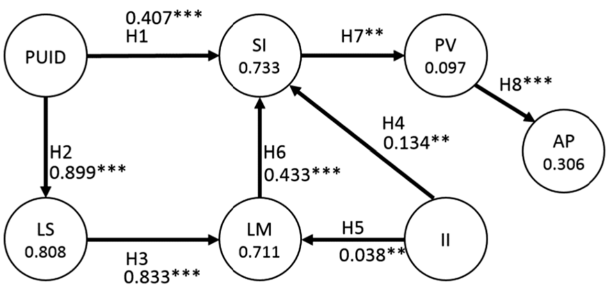

Fig. 4 Path coefficient and R^2 of the second study

Discussion and implication

Discussion

Our studies proposed a model based on the ToI and the SDT and validated longitudinally using data from two academic years.

It was found that SI significantly predicts AP in the first study. The second study using data from academic year 2017–2018 further endorse the findings. We chose an interesting knowledge domain for the course project in the two academic years, this change in instructional design can enhance students' SI. It was found that students who feel interested in the 13-week course significantly perform better than those who feel uninterested in the course. In order to find out the missing link between the psychological change and learning outcomes, we proposed to add PV as the learning behavior to the model. The Findings in the second study shows that AP was actually influenced by PV (R^2 value over 30%) instead of directly by the SI.

Moreover, among LM, II and PUID, LM has the highest predictive power in predicting the SI. Since the students need to complete the assigned project in different phases, the course instructional design was designed in a way that students can achieve the goal of each phase with immediate feedbacks in order to be encouraged and motivated. It is observed from the findings that cultivating SI through enhancing LM is more effective than the direct impact from the instructional design though both are statistically significant.

Furthermore, the PUID is fundamental for enhancing the LS and then LM. The instructional design were carefully designed in order to enhance students' LS. For example, a lot of video learning resources as part of the flipped learning design were provided in different phases of the project, as well as templates and guidance were given to enable students achieving the goals of each phase.

In addition, the main path of the model is identified based on the effect size of the path coefficients. Based on the main path, we understand that students' learning satisfaction can be triggered by well and properly planned instructional design. The learning satisfaction further enhance students' learning motivation. Learning motivation is the most important element in cultivating students' situational interest.

Finally, the second study further extend the model by including the PV into the model in order to evaluate the effect of learning behavior (engaged learning) in-between the learning attitude (situational interest) and learning outcome (academic performance).

However, despite the positively accepted hypothesis, the R^2 of academic performance in first study and the page view in second study are relatively small. It may be due to the fact that time is required to change the behavior upon the change in attitude. A 13-week course may be too slow to observe such a long-term effect (Muller and Louw 2004; Deci and Ryan 1994).

Theoretical implication

Theoretically, a model in cultivating the situational interest was developed based on the two theories and being verified empirically and longitudinally. Additionally, the main path in the model was identified so that we can know situational interest can be cultivated from learning motivation while learning motivation can be enhanced through learning satisfaction by the proper instructional design. The importance of perceived usefulness of instructional design was identified in the studies. Finally, we extend the model by inserting the learning behaviors (engaged learning) in between the learning attitude (situational interest) and the actual outcome/achievement (academic performance) which aligns findings from other researchers that attitudes change behaviors and then affects outcome/achievement (Shi et al. 2018).

Practical implication

Practically, our findings point out the relationship from instructional design, learning attitudes, learning behaviors, to learning outcomes.

Teachers can design their instructional design under a blended learning environment in order to best cultivate their learning attitudes including learning satisfaction, learning motivation and situational interest, towards learning. Eventually, students' learning behaviors such as engagement will be influenced by their learning attitudes. By investing more in the learning process and learning activities, their academic performance are more likely to be improved.

For example, teachers can give assignments/projects with interesting topics and with proper instructional design such as flipped classroom in order to attract students and gain their satisfaction in the learning process. Students feel being encouraged and motivated through ongoing feedbacks from teachers in each phase of the project by gaining small wins and quick wins. Eventually, situational interest can be cultivated from the learning motivation. Consequently, they will engage more in the learning processes in more proactive ways. As the result, their academic performance can be improved.

In a blended learning environment, technology only serves as tools and platforms to assist the teaching and learning activities. A well-planned instructional design with the proper use of technology is the key to change students' learning attitude, learning behavior and then the learning outcome. This aligns with our recent research on the importance of instructional design adopting the flipped classroom in a blended learning environment (Hui et al. 2018).

Limitation

Further study is required to address the limitations in our studies. First, our studies investigated the psychological elements including the learning satisfaction, learning motivation, and interest without considering other elements such as students' prior academic performance, students' soft skills and their demographic information.

Second, our studies collect data from one course in one institution using subjective survey, which affects the capability in generalizing the proposed model. It is suggested that further studies can consider to include more students from more courses and more institutions, as well as more different types of data.

Finally, despite the fact that the sample size in each of the two studies are more than twice of the requirement based on the 10 times rule (Hair et al. 2014), statistical explanation power can be further improved if a larger sample size is available.

Conclusion

In terms of competency and academic performance, achieving the intended learning outcomes is the ultimate goal of the process of teaching and learning. Developing students' learning attitudes such as learning satisfaction, learning motivation and interest towards learning are frequently studied. The two educational psychological theories, ToI and SDT, attracts frequent discussions and researches in recent decades. We built a model based on these two theories and verify it empirically and longitudinally using two academic years' data from a software engineering course. In the second study, we added the learning behavior (measured by page views in learning management system as a measurement for engaged learning) and learning outcome (the academic performance). This completed the trajectory from instructional design to cultivating learning attitudes, then changing learning behaviors and eventually improving learning outcomes.

Theoretical implications on building a research model with longitudinal empirical support and practical implications for identifying the criticalness of instructional design in a blended learning environment for cultivating students' learning attitudes such as situational interest and then the learning behavior were discussed. Limitations were reviewed and further studies were proposed.

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