Relationships between the Learning Strategies, Mental Models of Learning and Learning Orientations of Post-Secondary Students in Hong Kong

Dennis C. S. Law[1], and Jan H. F. Meyer[2]

[1]Caritas Bianchi College of Careers, Hong Kong
dennislaw@cbcc.edu.hk
[2]University of Durham, UK

Abstract. The present study is based on analyses of data resulting from an administration of a Chinese translation of the Inventory of Learning Styles (ILS) to a large sample of post-secondary students in Hong Kong. The ILS is a research instrument developed by Vermunt to capture variation in contrasting forms of learning strategies, mental models of learning, and learning orientations. In what are believed to be the first analyses of ILS data obtained in a Chinese response-context, empirical support is found for the theoretical model that underpins the ILS. Findings also confirm the posited central explanatory role of regulation strategies. In particular, students' processing strategies are found to be most directly influenced by their regulation strategies, while the influence of students' mental models of learning and students' learning orientations on their processing strategies is mostly indirect, via students' regulation strategies.

Keywords: Student Learning, Inventory of Learning Styles, Regulation Strategies

1. Introduction

With the rapid expansion of the post-secondary education sector of Hong Kong in its educational reform [1], the question of how students engage in learning, and with what likely consequences, is an important consideration for various stakeholders. One well established methodology for addressing this question lies in the development of appropriate research instruments for capturing variation in students' educational experiences [2], and particularly their experiences of learning insofar as these can inform endeavours aimed at enhancing the quality of both learning and teaching. The Inventory of Learning Styles (ILS) is one such research instrument developed to capture variation in students' processing and regulation strategies, mental models and orientations of learning, and has been widely used and validated in a number of studies in western higher education contexts. In extending the student learning research literature involving the ILS, the present study utilizes a Chinese translation of it in a new and previously unreported response context; that of post-secondary education in Hong Kong involving six institutions. Reported here are the initial

analyses of the relationships between the conceptually discrete learning constructs operationalized by the ILS, and the proposal of a more general theoretical model to capture and interpret these relationships.

2. Context of the Present Study

Students participating in the present study came from six institutions of Caritas Adult and Higher Education Service (CAHES)[1], an organization which operates under the auspices of Caritas – Hong Kong. At the time of undertaking the study these students were enrolled in various kinds of post-secondary Certificate, Diploma, Associate Degree and Higher Diploma programmes. Over a three month period (March – May, 2005), and with the assistance of teachers from the participating institutions, access to *convenient samples* was made possible the aim being to involve the entire student population. Precise enrolment data for the programmes involved was not collected but the total student enrolment (size of the population) was estimated to be 2515 based on the number of copies of the research instrument (see Section 3) requested by the individual institutions for use in the study. Valid responses were obtained from 1572 students, representing a response rate of 62.5%.

3. Research Instrument

The research instrument employed in the present study is a Chinese translation of the 100-item version of the Inventory of Learning Styles (ILS). The ILS was originally designed by Vermunt [3] for research in the Dutch higher education sector, and it is based on an integrative theory and conceptualization of student learning that encompasses students' processing strategies, regulation strategies, learning orientations and mental models of learning. Details on the development of the ILS can be found in [4] and [5], and [6] provides an excellent review studies based on its application.

Among the four ILS components, *processing strategies* refer to the thinking activities that students use to process the content of learning. These activities lead directly to learning outcomes in terms of, for example, knowledge and understanding. In terms of Vermunt's theorization three main processing strategies are operationalised in five scales: (a) a deep processing strategy which combines the learning activities of *Relating and Structuring* and *Critical Processing*, (b) a stepwise processing strategy which reflects the learning activities of *Memorizing and Rehearsing* and *Analyzing*; and, (c) a *Concrete Processing* strategy with concretizing and applying as its major learning activities.

Regulation strategies refer to students' activities for regulating and controlling the processing strategies and they therefore indirectly lead to learning outcomes. Vermunt

[1] Caritas Adult and Higher Education Service (CAHES) is renamed as Caritas Community and Higher Education Service (CCHES) with effect from 1 September 2007.

distinguishes contrasting aspects of regulation in terms of internal versus external control, with three main strategies or experiences being consistently observed and operationalized by five scales: (a) a *Self-regulation* strategy (comprising two scales) in which students perform most regulative activities for their learning, (b) an *External Regulation* strategy (comprising two scales) in which students let their learning activities be regulated by teachers, textbooks and other external means and, (c) *Lack of Regulation* in which students face difficulties resulting from both their inability in self-regulation and their experience of insufficient external regulation. It should be noted that students' application of regulation strategies in their learning is in fact an active area of research, see [7] for some examples.

Learning orientations refer to the whole domain of students' personal goals, intentions, motives, expectations, attitudes, concerns and doubts with regard to their studies. Instead of developing theories on each and every aspects of this whole domain, Vermunt identified major sources of variation among students in this domain and incorporated them into the ILS as five scales; namely *Personally Interested*, *Certificate-oriented*, *Self-test-oriented*, *Vocational-oriented*, and *Ambivalent*.

Mental models of learning refer to a coherent system of knowledge and beliefs about learning and related phenomena, such as the nature of knowledge and the roles that should be assumed by teachers, classmates and the students themselves in learning. In the ILS, five scales are employed to capture the variation among students in this regard, namely *Construction of Knowledge*, *Intake of Knowledge*, *Use of Knowledge*, *Stimulating Education*, and *Cooperative Learning*.

In its adaptation for the present study, the ILS was translated into Chinese and then back translated into English for verification purposes. It was also construct validated for application in the previously unexplored context of the post-secondary education of Hong Kong, mainly through considerations of exhibited values of *Cronbach's coefficient alpha* (for assessing the internal consistency of the discrete scales, see [8] for brief introduction), and *exploratory factor analysis* (for assessing the construct validity of the scales in relation to empirical structure, see [9] for brief introduction). Space limitations prevent disclosure of these detailed analyses and it is simply mentioned here in summary that the alpha values associated with the 20 ILS scales ranged between 0.50 and 0.79, with 12 of them greater than 0.70[2]. These results are comparable to those in three other studies; namely, the original study of the ILS in a Dutch response context as reported in [5], a study by Ajisuksmo and Vermunt [10] in which the ILS was adapted for use in an Indonesian response context, and a cross-checking study of the ILS in a British response context as reported in [11]. In terms of construct validity, the variation in the learning patterns of students found in the present study resembles more closely the findings of [10] rather than those of [5]. This observation is not surprising given that the response context of the former study (Indonesia) arguably resembles more closely that of the present study.

Unlike earlier inventories used in many previous studies of student learning (such as the Study Process Questionnaire (SPQ) and the Approaches to Studying Inventory (ASI), see Chapters 5 and 6 of [12] that focus on students' processing strategies and learning motivations, the ILS is a second generation instrument. It is based on more

[2] Many researchers consider an alpha value of at least 0.7 as desirable or adequate, see [8] for more details.

recent conceptualizations about student learning, and seeks to locate these within a wider range of exploratory constructs (especially students' regulation strategies). With the development of the ILS, Vermunt proposed his model of 'regulation of constructive learning processes', and hypothesized the central role of regulation strategies in this model (see Figure 1). The main purpose of the present study is to test Vermunt's hypothesis and to investigate whether his model is applicable in its empirical manifestation to the post-secondary Hong Kong response context.

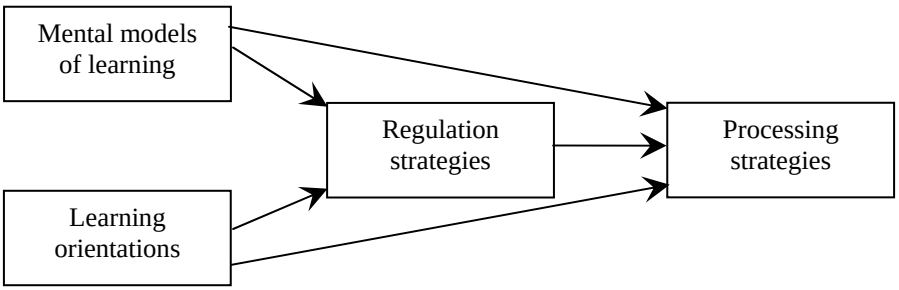

Fig. 1. The Model of Regulation of Constructive Learning Processes
Adapted from Vermunt [5]

4. General Theoretical Model for Analysis

The approach taken here to explore the relationships between the ILS components is based on a more general theoretical model (see Figure 2) proposed by Richardson [13] to investigate the relationships between students' demographic background, perceptions, study behaviour, and outcome measures, and the model proposed by Richardson [14] to investigate the relationships between students' demographic background, motives and attitudes, study behaviour, and outcome measures. The functional relationships depicted in these models arise from the sophisticated application of multiple regression analyses in which the relationships between the constructs being modelled can be determined as being possibly direct, indirect or spurious effects according to the analyses of statistical significance and magnitude of the standardized regression coefficients.

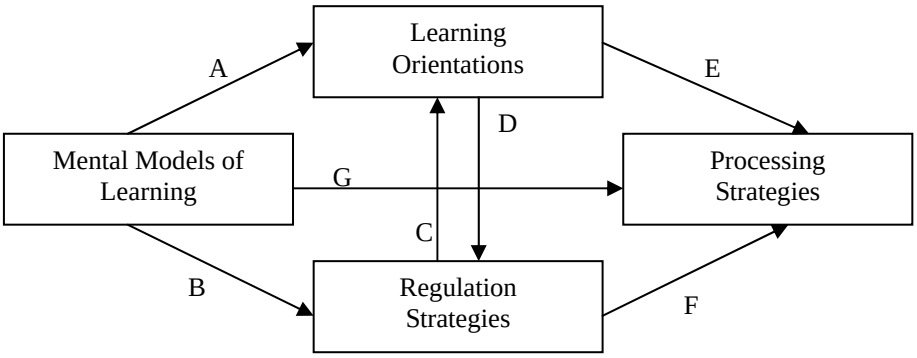

Fig. 2. A General Theoretical Model of Relationships between the Components Measured by the ILS

For example, the relationship between students' learning orientations and processing strategies may contain a direct effect (Path E) and an indirect effect (Path D $\rightarrow$ F). The relationship may also be a spurious effect with students' mental models of learning being a common cause for the variations in learning orientations and processing strategies (directly through Path A and Path G, or indirectly through Path B $\rightarrow$ C and Path B $\rightarrow$ F). However, the regression of students' processing strategies on their mental models, learning orientations and regulation strategies can identify the contribution of these three components as follows:

- A *direct effect* of students' learning orientations on processing strategies is implied by standardized regression coefficients that are statistically significant even when variations in both mental models and regulation strategies are controlled. These findings provide evidence that variations in students' learning orientations give rise to variations in their processing strategies (Path E).

- An *indirect effect* of students' learning orientations on processing strategies is supported by standardized regression coefficients that are significant when only variations in mental models are controlled but that are attenuated, eliminated or even reversed when variations in both mental models and regulation strategies are controlled. These findings provide evident that variations in students' learning orientations give rise to variations in their regulation strategies (Path D) and that variations in their regulation strategies in turn give rise to variations in processing strategies (Path F).

- A *spurious effect* is implied by standardized regression coefficients that are significant when variations in mental models and regulation strategies are not

controlled, but are attenuated, eliminated or even reversed when only variations in mental models are controlled. These findings provide evidence that variations in students' mental models are simply the common cause of variations in their learning orientations (Path A and/or Path B $\rightarrow$ C) and variations in their processing strategies (Path G and/or Path B $\rightarrow$ F).

More details on analysis of possible causal relationships among the components of such a model can be found in [13] and [14]. It is worth noting that Vermunt's model (Figure 1) is in fact embedded in the more general model (Figure 2), with the same four boxes denoting the ILS components, and the five links in Vermunt's model corresponding to Path B, Path D, Path E, Path F, and Path G in the more general model. In appealing to the more general model the present study was able to both apply the techniques developed by Richardson in analyzing the relationships among the ILS components, and also explore the status of Paths A and C which do not appear in Vermunt's model. The present study is believed to be the first to thus analyze the relationships between the ILS components.

5. Results and Discussion

Due to space limitations, only the results for analyzing the possible relationships between students' learning orientations and their processing strategies, and the possible relationships between students' regulation strategies and their processing strategies are reported in this section. The results are meant to be examples to show how analyses are conducted using the general theoretical model in Section 4 to delineate the possible direct, indirect and spurious effects among the various student learning constructs, and to provide evidence on the fact that students' processing strategies of learning are mostly influenced by their regulation strategies, both directly and indirectly.

5.1 Relationships between Students' Learning Orientations and Students' Processing Strategies

Table 1 shows the standardized regression coefficients relating students' learning orientations to their processing strategies [3]. The findings indicate that *Certificated-oriented* students tend less to adopt *Relating and Structuring* in their learning, as indicated by the negative direct effect being significant even when variations in students' mental models and students' regulation strategies are controlled. The positive effect of *Personally Interested* or *Self-test-oriented* is mainly an indirect one mediated by students' regulation strategies, as the coefficient becomes insignificant when variations in regulation strategies are controlled.

[3] Following Richardson, a significance level of 0.01 is adopted in this study to reduce the likelihood of Type I errors.

Table 1. Standardized regression coefficients relating students' learning orientations to their processing strategies

Relating and Structuring			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Personally Interested	**+0.155*****	**+0.106*****	+0.007
Certificate-oriented	**-0.193*****	**-0.166*****	**-0.072****
Self-test-oriented	**+0.210*****	**+0.167*****	+0.029
Vocation-oriented	-0.025	-0.044	+0.023
Ambivalent	+0.021	+0.022	+0.026
Critical Processing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Personally Interested	**+0.172*****	**+0.126*****	+0.027
Certificate-oriented	**-0.156*****	**-0.128*****	-0.036
Self-test-oriented	**+0.181*****	**+0.139*****	+0.005
Vocation-oriented	**-0.112****	**-0.141*****	**-0.071****
Ambivalent	**+0.070****	**+0.072****	**+0.085*****
Memorizing and Rehearsing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Personally Interested	+0.056	+0.025	-0.036
Certificate-oriented	-0.020	-0.028	+0.026
Self-test-oriented	**+0.174*****	**+0.137*****	+0.028
Vocation-oriented	**+0.092****	+0.060	+0.050
Ambivalent	-0.001	-0.015	-0.020
Analyzing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Personally Interested	**+0.122*****	+0.077*	-0.010
Certificate-oriented	**-0.108****	**-0.093****	-0.018
Self-test-oriented	**+0.225*****	**+0.181*****	+0.038
Vocation-oriented	-0.021	-0.049	-0.031
Ambivalent	-0.014	-0.018	+0.016
Concrete Processing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Personally Interested	**+0.159*****	**+0.082****	+0.014
Certificate-oriented	**-0.159*****	**-0.139*****	**-0.073****
Self-test-oriented	**+0.157*****	+0.092	-0.021
Vocation-oriented	**+0.145*****	+0.042	+0.061
Ambivalent	-0.020	-0.020	-0.029

a Not controlling for variations in students' mental models of learning and regulation strategies
b Controlling for variations in students' mental models of learning, but including any indirect effect mediated by students' regulation strategies
c Controlling for variations in students' mental models of learning and regulation strategies
*p<0.05, **p<0.01, ***p<0.001 (two-tailed test)

For Critical Processing, the significant direct effects indicate that Vocation-oriented students tend less, and that Ambivalent students tend more, to adopt this processing strategy in their learning. The positive effects of Personally Interested or Self-test-oriented and the negative effect of Certificate-oriented are mainly indirect ones mediated by students' regulation strategies, as the respective coefficients become insignificant when controlling for variations in regulation strategies.

Students' learning orientations have no direct effect on *Memorizing and Rehearsing*. The positive effect of *Self-test-oriented* is mainly an indirect one mediated by students' regulation strategies, as the coefficient becomes insignificant when variations in regulation strategies are controlled. The positive relationship of *Vocation-oriented* and *Memorizing and Rehearsing* is a spurious effect with students' mental models being the common cause, as it becomes insignificant when only variations in mental models are controlled. A combined consideration of the relevant analysis results among all the learning constructs involved (not reported here due to space limitations) indicate that this effect is caused by *Construction of Knowledge*, with the effect on *Vocation-oriented* being direct (via Path A of Figure 2), and the effect on *Memorizing and Rehearsing* being indirectly mediated by regulation strategies (via Path B $\rightarrow$ F).

Students' learning orientations also have no direct effect on *Analyzing*. The findings indicate that when *Certificate-oriented* students tend less, and *Self-test-oriented* students tend more, to adopt this processing strategy in their learning, the main underlining cause is the indirect effects mediated by students' regulation strategies. The positive relationship of *Personally Interested* and *Analyzing* is a spurious effect with students' mental models being the common cause, as it becomes insignificant when only variations in mental models are controlled. A combined consideration of the relevant analysis results among all the learning constructs involved (not reported here due to space limitations) indicate that this effect is caused again by *Construction of Knowledge*, with the effect on *Personally Interested* being direct (i.e. via Path A of Figure 2), and the effect on *Analyzing* being indirectly mediated by regulation strategies (via Path B $\rightarrow$ F).

Certificate-oriented students tend less to adopt *Concrete Processing* in their learning, and this negative effect comprises mainly a direct component, and to a lesser extent an indirect component mediated by students' regulation strategies. The effect of *Personally Interested* on *Concrete Processing* is largely an indirect one mediated by students' regulation strategies. Both the relationship of *Self-test-oriented* and *Concrete Processing* and the relationship of *Vocation-oriented* and *Concrete Processing* are spurious effects, with students' mental models being the common cause. A combined consideration of the relevant analysis results among all the learning constructs involved (not reported here due to space limitations) indicate that in both cases, the association is caused by the direct effects of *Construction of Knowledge* and *Use of Knowledge* on the constructs concerned (via Path A and Path G of Figure 2).

Overall, the above findings suggest some direct effects of students' learning orientations on their processing strategies, which are mainly manifested in the negative influence of *Certificate-oriented* on *Relating and Structuring* and *Concrete Processing*, the negative influence of *Vocation-oriented* on *Critical Processing*, and the positive influence of *Ambivalent* on *Critical Processing*. Again, it is worth noting that the magnitude of many of the standardized regression coefficients in Table 1 is

substantially reduced when variations in students' regulation strategies are controlled (and consequentially some of these coefficients become statistically insignificant), indicating the significant roles of students' regulation strategies in the indirect effects of students' mental models on their processing strategies.

In a number of the cases reported above, spurious effects have been identified, with the mental model *Construction of Knowledge* being the common cause of variations in the respective learning orientations and processing strategies of students. These findings suggest a minor omission in the theoretical model proposed in [13] and [14] namely that spurious effects from the common cause may not only be exercised via the direct routes (Paths A and G), but also via the indirect routes (Path B $\rightarrow$ C and Path B $\rightarrow$ F).

5.2 Relationships between Students' Regulation Strategies and Students' Processing Strategies

Table 2 shows the standardized regression coefficients relating students' regulation strategies to their processing strategies. For *Relating and Structuring*, the effects of the two self-regulation strategies are basically direct, as indicated by the fact that the respective coefficients remain significant with magnitudes changed only slightly when variations in students' mental models and students' learning orientations are controlled. The effect of *Lack of Regulation* is also direct, but in view of the low magnitude of the coefficient concerned it is less important than those of the self-regulation strategies.

For *Critical Processing*, it was also found that the effects of the two self-regulation strategies are basically direct, as indicated by the fact that the respective coefficients remain significant with magnitudes changed only slightly when variations in students' mental models and students' learning orientations are controlled. After the said control of variations a direct effect of *External Regulation on Learning Results* is found, but it is less important than those of the self-regulation strategies, as indicated by the low magnitude of the coefficient concerned.

Relationships with *Memorizing and Rehearsing* are found in all the regulation strategies. Relationships with *Analyzing* are found in all the regulation strategies except *Lack of Regulation*; and relationships with *Concrete Processing* are found in all the regulation strategies except *External Regulation of Learning Processes*. Each of these relationships comprises a basically direct effect, as the respective coefficients remain significant with their magnitudes changed only slightly when variations in students' mental models and students' learning orientations are controlled.

Overall, and as expected, the above findings suggest significant direct effects of students' regulation strategies on their processing strategies. When the magnitudes of the standardized regression coefficients are taken into account, the direct effects are mainly manifested in the positive influence of self-regulation strategies on *Relating and Structuring*, *Critical Processing* and *Concrete Processing*, and the positive influence of all regulation strategies except *Lack of Regulation* on *Memorizing and Rehearsing* and *Analyzing*.

Table 2. Standardized regression coefficients relating students' regulation strategies to their processing strategies

Relating and Structuring			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Self-reg.: L. Proc. & Results	**+0.512*****	**+0.505*****	**+0.499*****
Self-reg.: L. Content	**+0.287*****	**+0.274*****	**+0.268*****
External Reg.: L. Processes	+0.025	+0.031	+0.035
External Reg.: L. Results	+0.002	+0.017	+0.019
Lack of Regulation	**+0.058****	**+0.067*****	**+0.062****
Critical Processing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Self-reg.: L. Proc. & Results	**+0.472*****	**+0.471*****	**+0.463*****
Self-reg.: L. Content	**+0.319*****	**+0.308*****	**+0.296*****
External Reg.: L. Processes	-0.063*	-0.056*	-0.038
External Reg.: L. Results	+0.044	+0.054*	**+0.071****
Lack of Regulation	+0.042*	+0.048*	+0.020
Memorizing and Rehearsing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Self-reg.: L. Proc. & Results	**+0.247*****	**+0.247*****	**+0.253*****
Self-reg.: L. Content	**+0.137*****	**+0.139*****	**+0.148*****
External Reg.: L. Processes	**+0.228*****	**+0.222*****	**+0.213*****
External Reg.: L. Results	**+0.178*****	**+0.175*****	**+0.163*****
Lack of Regulation	**+0.094*****	**+0.092*****	**+0.099*****
Analyzing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Self-reg.: L. Proc. & Results	**+0.387*****	**+0.385*****	**+0.379*****
Self-reg.: L. Content	**+0.248*****	**+0.237*****	**+0.234*****
External Reg.: L. Processes	**+0.195*****	**+0.202*****	**+0.207*****
External Reg.: L. Results	**+0.142*****	**+0.154*****	**+0.158*****
Lack of Regulation	-0.017	-0.009	-0.014
Concrete Processing			
Predictor Variable	Direct, Indirect and Spurious Effects[a]	Direct and Indirect Effects[b]	Direct Effects Only[c]
Self-reg.: L. Proc. & Results	**+0.381*****	**+0.328*****	**+0.326*****
Self-reg.: L. Content	**+0.176*****	**+0.182*****	**+0.179*****
External Reg.: L. Processes	+0.010	+0.012	+0.008
External Reg.: L. Results	**+0.218*****	**+0.211*****	**+0.208*****
Lack of Regulation	**+0.077*****	**+0.083*****	**+0.097*****

a Not controlling for variations in students' mental models of learning and learning orientations
b Controlling for variations in students' mental models of learning, but including any indirect effect mediated by students' learning orientations
c Controlling for variations in students' mental models of learning and learning orientations
*p<0.05, **p<0.01, ***p<0.001 (two-tailed test)

6. Conclusion

The analytical approaches used here are relatively novel and the direct application of Richardson's model and analytical methodology for analyzing the ILS data has been fully justified. Valuable insights have emerged. In particular, and apart from the possibility for the existence of Path A and Path C, the dynamics of Vermunt's model have, in effect, been empirically reconstituted in the Hong Kong post-secondary education response context. Findings also confirm his hypothesis for the central role of regulation strategies; namely that students' processing strategies are most directly determined by their regulation strategies, and that the influence of students' mental models of learning and students' learning orientations on their processing strategies is mostly indirect (via their regulation strategies). Through the real-life examples of *Construction of Knowledge* being the common cause of variations in students' learning orientations and processing strategies (cf. Section 5.5), a minor omission in the models proposed in [13] and [14], namely the possibility of indirect spurious effects has furthermore been identified.

It is also acknowledged that, notwithstanding the novelty of the analytical approach, the inherent problem of causal ambiguity arising from correlational assumptions cannot be completely avoided. As student learning is a complex phenomenon involving many constructs [15], the possibility of the model as depicted in Figure 2 being an insufficient representation of the real world, and thus its associated analyses leading to incorrect causal inference needs to be acknowledged.

The results of the present study are believed to be the first analyses of ILS data obtained in the Chinese response context of the post-secondary education in Hong Kong. These results indicate that the ILS is able to capture the variation in students' learning strategies, mental models of learning and learning orientations in this new response context, and can thus form the basis for the development of an instrument to obtain students' feedback on their learning patterns in the next stage of the research. The quality of student learning is of paramount concern in the educational reform of Hong Kong, especially for the post-secondary education sector in which a substantial expansion in student participation has occurred. The present study demonstrates that Chinese translation of the ILS can be employed by institutions in the sector as part of a diagnostic system for addressing the possible problems of students in their learning, or as a formal means to collect data as part of an evidence-based process to improve the quality of teaching and student learning.

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