Nature vs nurture: learning conceptions and environment as precursors to learning strategy patterns and their outcomes

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Abstract

This study investigates formal learning experiences in higher education by examining the relationship between conceptions of learning and the learning environment, their combined effects on learning strategies (which include processing and regulation), and outcomes. Psychology students (n=242) from a major state-supported university completed the Inventory of Learning Styles (ILS), the Course Experience Questionnaire (CEQ) and a student Satisfaction scale. A fully-forward latent SEM approach was taken to model the learning process using Bigg's 3P model. Presage variables included conceptions of learning (Construction of Knowledge and Intake of Knowledge) and learning environment (Good Teaching and Appropriate Workload), Process variables included (Deep and Stepwise) processing and (Self-, External and Lack of) regulation strategies. Finally, Product variables included Generic Skills, Satisfaction and Achievement (end-of-term grade). Gender and Year of Study were used as controls. Both conceptions and teaching environment had large effects on processing strategies, while other predictions evidenced established learning patterns (e.g. meaning-directed and reproduction-directed). Deep Processing and Lack of Regulation mediated positive and negative effects respectively between Appropriate Workload and Achievement. Intake of Knowledge predicted Lack of Regulation, which is indicative of insufficient regulation provided by external sources. Latent profile analysis on the Presage variables revealed three subgroups, which were labelled: Inactive, Passive-Idealist and Environment Driven. Students did not readily differentiate between the learning conceptions examined. Some subgroups might be influenced in varying degrees by environmental factors while others reported greater influence by their learning conceptions. Implications for theory and practice are discussed.

Introduction

Student processing strategies and their effects on learning outcomes have been studied extensively (e.g. Lizzio, Wilson, & Simons, 2002; Diseth, 2007; Vermunt & Donche, 2017; Dinsmore & Alexander, 2012), but what leads students to adopt these strategies in the first place? Educators cannot directly control how students process information or regulate themselves, but can affect students' perceptions of the learning environment (Asikainen & Gjibels, 2017) and leverage previous student experience (Vermunt, 1995). Students' approaches to learning (SAL) describes how students react to the learning environment (e.g., through course experiences; see Ramsden, 1991; Wilson, Lizzio, & Ramsden, 1997) and adopt approaches students perceive as being the most appropriate to the context (Marton & Säljö, 1976; Entwistle & Tait, 1990; Biggs, 1999b). Learning conceptions, as described by learning patterns (LPs; Vermunt 1996, 1998) theory, guide the use of learning strategies (Vermunt & Donche, 2017). Both theories have independently been shown to affect processing and achievement (e.g. Lizzio et al., 2002; Martínez-Fernández & Vermunt, 2015). Researchers (e.g., Richardson, 2011) have called for the rapprochement of the two theories. Biggs' 3P model (1993a) provides a framework to embed both SAL learning environment and LP learning conceptions precursors (Presage) to simultaneously test effects on learning strategies (Process) and outcomes (Product).

Building on previous work that investigated effects of course experience on learning patterns (Law & Meyer, 2011) and approaches to learning using the 3P model (Lizzio et al., 2002; Diseth, Pallesen, Hovland, & Larsen, 2006; Diseth, 2007), these precursors—i.e., the learning environment and learning conceptions – serve as anchors for the current study, providing a foundation from which to examine the learning experience both deeply (by considering processing, regulation, learning conceptions, course experience and outcomes) and broadly (across the three stages of the 3P model). Intervention strategies are informed by

observed pathways from precursors to learning strategies, to achievement. Person-centred analyses can further clarify these relationships for different subpopulations.

Theories on Learning Experience

Student Approaches to Learning and Course Experience

Students' approaches to learning (SAL; Marton & Säljö, 1984; Biggs, 1999b) describes how students choose processing strategies in reaction to the perceived outcome expectations of a task. These include how they perceive assessments (Marton & Säljö, 1976), teaching methods (Donche et al., 2013), and overall course experiences (Ramsden, 1991, Lizzio et al., 2002; Diseth et al., 2006). Factors such as goals (Authors, 2016), personal interest (Varunki, Katajavuori, & Postareff, 2017), self-efficacy (Trigwell, Ashwin, & Millan, 2013) can affect SAL; however; the approaches to learning are undertaken partly in response to contextual demands (Entwistle & Tait, 1990; Diseth et al., 2006). Deep processing (understanding the material, relating ideas to previous knowledge etc.) has generally been found to lead to higher quality learning outcomes (e.g. Drew & Watkins, 1998; Lizzio et al., 2002) compared to surface processing (reproduction of facts) though these findings have not always been consistent (Dinsmore & Alexander, 2012). The Course Experience Questionnaire (CEQ; Ramsden 1991; Wilson et al., 1997) is widely used (Lizzio et al., 2002; Richardson, 2004; Yin & Wang, 2015) to report the contextual demands students face according to their perceptions of the learning environment.

Learning Patterns

Learning patterns (LPs; Vermunt, 1996, 1998) are characterised as embodying specific aspects of four learning components: learning conceptions, orientations (and motivations), processing strategies, and regulation strategies. Learning conceptions are mental models and beliefs students hold about learning informed by previous experience. These affect

approaches to studying (Richardson, 2011), including learning strategies (processing and regulation strategies; Vermunt & Donche, 2017). A large-scale principle component analysis on the Inventory of Learning Styles (ILS; Vermunt, 1998), measuring aspects of each learning component suggested four learning patterns. Students employing a *meaning-directed* learning pattern construct knowledge, view learning tasks as their own, process information deeply, adopt self-regulation strategies (monitor progress, test, reflect, adjust habits) and are motivated by personal interest. In a *reproduction-directed* learning pattern, students intake knowledge from the teacher through memorisation and reproduction, employ stepwise processing (rote learning), respond to external regulation, and are motivated by demonstrating their success to themselves and others. Students following an *undirected* learning pattern have ambivalent motivation, conceive learning as cooperative and stimulating, are unregulated and do not adopt specific processing strategies. The *application-directed* learning pattern involves adopting a concrete processing strategy, conceiving learning as use of knowledge and motivated by vocation. Studies have replicated these relationships using logistic regression (e.g., Vanthournout, Gjibels, Coertjens, Donche, & Van Petegem, 2012), person-centred (e.g. Heikkilä, Niemivirta, Nieminen, & Lonka, 2011) and path analyses (e.g., Martínez-Fernández & Vermunt, 2015). Detailed reviews have been conducted on learning patterns and related work (Vermunt & Vermetten, 2004; Vermunt & Donche, 2017).

Higher achievement and higher quality learning outcomes are generally associated with the meaning-directed LP (Donche et al. 2014; Martínez-Fernández and Vermunt, 2015), while lower quality outcomes are usually exhibited by those employing an undirected LP (Vermunt, 2005; Donche et al., 2014). The other two learning patterns have reported mixed results. Another learning pattern, passive-idealistic has previously emerged (Vermunt & Donche, 2017) containing all conceptions of learning, but no learning activities.

Students might not clearly differentiate between use of LPs and are influenced by context (Vermunt & Donche, 2017). LPs are not stable psychological traits but learning dimensions that are more holistic and multidimensional than SAL (Vanthournout, Coertjens, Gjibels, Donche, & Van Petegem, 2013). In comparison, SAL theorises that deep and surface approaches to learning are adopted in reaction to specific contexts (Biggs, 1993b) and does not consider regulation, nor learning conceptions explicitly.

Relationships between learning components of the ILS along with effects on outcomes have been tested in many higher education contexts. Belgian engineering students' regulation and processing strategies were studied longitudinally, finding that deep processing and self-regulation predicted each other across three time-points (meaning-directed LP; De Clercq, Galand, & Frenay, 2013). Loyens, Rikers and Schmidt (2008) found that Dutch fourth-year university psychology students' motivation to learn affected self and external regulation positively and lack of regulation negatively. Self-regulation predicted deep, stepwise and concrete processing, while external regulation predicted stepwise processing, lending support to the existence of meaning-directed and reproduction-directed learning patterns. Martínez-Fernández and Vermunt (2015) found that in Spanish and Latin American undergraduates, construction of knowledge, deep processing and their effects on students' effort predicted achievement, while intake of knowledge negatively predicted achievement. Application-directed LPs have been found to emerge predominantly in professional contexts, for example in cardiology residents in Argentina (de Lima et al., 2008).

Though LPs are linked dynamically to contextual factors (e.g. disciplinary differences and course experience; Vermunt & Vermetten, 2004), few studies have considered course experience together with learning patterns. Law and Meyer (2011) examined the relationships between learning patterns, course experience and outcomes (satisfaction and expected achievement) within secondary students in Hong Kong. Controlling for age, gender, prior

academic performance and area of study, multiple regression path-analysis and partial correlations were used, testing one outcome at a time. The undirected LP associated with lower expected achievement. Generic skills correlated with external regulation and all learning conceptions. Good teaching correlated with construction of knowledge. LPs mediated the effects of appropriate workload on expected achievement, though specifics on which LPs were unclear due to modelling limitations.

3P Model

Biggs' (1993a) 3P model provides a framework for integrating constructs of course experience with the components of learning patterns. The model describes classroom learning in three sequential stages, situating variables either in the Presage, Process or Product stages. The Presage contains teaching context (e.g. curriculum, teaching methods and workload) and student context (e.g. prior knowledge, motivations and abilities). These variables feedforward to the Process stage, which considers task processing, including learning strategies (traditionally SAL, e.g. surface or deep strategy; Biggs 1993b). The Presage and Process lead into the Product stage (outcomes). The 3P model allows for the analysis of course experience with learning patterns in a fully-forward manner.

Results on SAL learning strategies predicting achievement using the 3P model have been inconclusive. Lizzio et al. (2002) analysed the learning experiences of undergraduate students, finding that good teaching (Presage) more strongly predicted outcomes than prior achievement (Product). Both deep and surface strategy (Process) predicted achievement (Product). Diseth et al. (2006) tested the effects of CEQ (Presage) on SAL (Process), and subsequently, SAL on exam grades (Product) for undergraduate psychology students. Good teaching and appropriate workload predicted deep approach positively, and surface approach negatively. Neither surface nor deep learning approaches affected examination grade. Drew

and Watkins (1998) described relationships observed in Hong Kong undergraduate students between academic self-concept, causal attributions (Presage) on surface and deep learning approaches (Process) and learning approaches on academic achievement (Product). Academic self-concept predicted deep processing, which predicted academic achievement while a surface learning approach negatively predicted achievement.

Person-centred perspectives on Processing Strategies

Person-centred approaches to analyses have clarified how subgroups of students differentiate between the use of different learning components (ILS) and react to the environment (CEQ). Authors (2018) investigated the structure, development of and movement between subgroups of Japanese undergraduate students based on (self, external and lack of) regulation, surface and deep learning strategies (Trigwell & Ashwin, 2006) and GPA. A four-subgroup model fit best over two time-points. Three of the subgroups reported similar levels of all regulation strategies within the subgroup, suggesting that students do not readily differentiate based on regulation strategy. Heikkilä et al. (2011) identified three subgroups in Finnish university students based on students' processing and regulation strategies: non-academic students, self-directed students and helpless students. Differences were found on deep understanding, self-regulation and lack of regulation. Non-academic and helpless subgroups reported similar profile shapes (for a discussion on profile shapes, see Morin & Marsh, 2015) with higher lack of regulation and lower levels of self-regulation. The self-directed subgroup reported a contrasting shape on regulation and deep understanding scales in comparison to other subgroups. Vanthournout et al. (2013) analysed interrelations in students undergoing teacher-training in Belgium between processing strategies using the Study Process Questionnaire (Biggs, Kember, & Leung, 2001) and found four subgroups: deep approach, surface approach, all-low and all-high profile. Vermunt and Vermetten (2004) reported that students in higher

education experienced more differentiated use of learning patterns, despite some mixed results reviewed above.

The current study

The interplay between contextual factors (i.e. course experience) with learning conceptions and their effect on students learning strategies and outcomes remains to be clarified. The current study builds on the work presented to this point by testing a fully-forward model based on 3P principles (Biggs, 1993). Specifically, forward linkages between course experiences and learning conceptions (Presage), processing and regulation strategies (Process) and achievement, generic skills and student satisfaction (Product) are tested. These results illuminate potential pathways for interventions supporting achievement and other important outcomes. Subsequently, person-centred analysis with the Presage variables examined existing subgroups, suggesting how individual differences shape learning strategies and resulting outcomes. The findings suggest theoretical and practical implications for the overall context and individual subgroups.

Research Questions

The following research questions and hypotheses guided the current study.

RQ1) How do the learning environment and learning conceptions (Presage) affect learning strategies (Process) and outcomes (Product)?

Hypothesis 1a: Predictions of Presage on Process variables would highlight relationships in established learning patterns. Specifically, meaning-directed LP: construction of knowledge would predict both self-regulation and deep processing. Reproduction-directed LP: intake of knowledge would predict both external regulation and stepwise processing.

Hypothesis 1b: The learning environment (e.g. appropriate workload, good teaching) would be positively predict meaning-directed LP components (e.g. deep processing; Diseth et al., 2006; Lizzio et al., 2002), and negatively predict undirected LP components (e.g. lack of regulation; Law & Meyer, 2011).

Hypothesis 1c: Learning strategies of the meaning-directed LP (e.g., deep processing and self-regulation) would positively predict outcomes (Product; Martínez-Fernández & Vermunt, 2015; Donche et al., 2014) while learning strategies of the undirected LP (e.g., lack of regulation) would negatively predict outcomes (Product; Donche et al., 2014; Vermunt & Vermetten, 2004; Vermunt, 2005).

RQ2) How do learning conceptions and perceived learning environment differ among students? In the person-centred analysis,

Hypothesis 2a: Subgroups will demonstrate clearly contrasting preferences for one of the learning conceptions over others (greater expected differentiation in higher education students; Vermunt & Vermetten, 2004).

Hypothesis 2b: Subgroups with higher construction of knowledge, good teaching and appropriate workload will present higher achievement (Vermunt & Donche, 2017).

Methods

Participant Context and Data Collection

Participants were undergraduate psychology students (*n*=242) in their second and third years of study, attending their spring semester courses at a major state-supported university in

Spain. The majority were female (80.2%), enrolled in their second year (58.7%), and aged between 19 and 25 (96.3%). Participants received a booklet containing the questionnaires, which they completed during regular class time; at the same time they gave written consent for access to their end-of-term grades. Participation was voluntary, and students could opt out at any time. Ethical clearance was obtained from the university.

Instruments

Participants completed the 36-item CEQ (Wilson et al., 1997), evaluating their course experiences on Good Teaching, Clear Goals Standards, Appropriate Workload, Appropriate Assessment, Independence, and Generic Skills scales. Participants also completed the 120-item ILS (Vermunt, 1998) including Learning Conceptions (Construction of Knowledge, Intake of Knowledge, Use of Knowledge, Stimulating Education and Cooperative Learning), Regulation Strategies (Lack of Regulation, External Regulation and Self-Regulation), Processing Strategies (Deep, Stepwise and Concrete Processing scales) and Learning Orientations (Personal Interest, Certificate-Oriented, Self-Test Oriented, Vocation-Oriented and Ambivalent scales) and a separate measure on Satisfaction (a 5-item satisfaction scale (Grace, Weaven, Body, Ross, & Weaven, 2012). All items were measured on a 5-point Likert scale from 1 (*"never or rarely true of me"*) to 5 (*"always or almost always true of me"*).

==========TABLE 1==========

Analyses

M*plus* 7.0 (Muthén & Muthén, 1998-2013) was used for Latent Structural Equation Modelling (SEM) analyses (RQ1) and Latent Profile Analysis (LPA; RQ2; Magidson & Vermunt, 2004). R (R Core Team, 2013) was used for all other analyses (RQ2). Missing data

(< 1%) were handled by Maximum Likelihood Estimation in M*plus* and imputation using multiple imputed chain equations (Buuren & Groothuis-Oudshoorn, 2010) in R.

For Confirmatory Factor Analysis (CFA) and Latent SEM, Comparative Fit Index (CFI) > .90/.95 (McDonald & Marsh, 1990), and Root-Mean-Square Error of Approximation (RMSEA) <.05/.08 (Browne & Cudeck, 1992) provided acceptable and good cutoffs of fit indicators respectively. Square root mean residual (SRMR) <.08 indicated good fit (Hu & Bentler, 1999). Cutoffs for small, medium and large educational effects were given by $|\beta| \geq .05/.10/.25$ respectively (Keith, 2015).

An LPA investigating the learning environment and learning conceptions was undertaken. One to six subgroups were tested. Three information criteria were used to assess model fit: AIC (Akaike's Information Criterion; Akaike, 1987), BIC (Bayesian Information Criterion; Schwartz, 1978) and sample-size adjusted BIC. An elbow, or minimum in BIC was regarded as the most useful criterion (Nylund, Asparouhov, & Muthén, 2007) for determining the number of subgroups. Consistent with previous person-centred research, and that LPA is a mean-based approach, entire scales were used.

Scale and Item Refinement for Latent SEM

Almost all previously reviewed variable-centred research on learning patterns and learning environment used path analysis models with manifest variables, or models in which not all paths are simultaneously tested. These constructs cannot be measured directly, so latent variables should be used with SEM (Kline, 2005). Furthermore, a fully-forward approach is undertaken with the 3P model. Due to the exploratory approach of analysis and, the considerable number and diversity of the variables, several steps were taken to reduce model complexity, while safeguarding the validity of the intended collative constructs and answering the research questions.

The complete model of all variables and items along with covariates did not converge. The Personal Interest scale had low reliability (no three items loaded >.45), and Certificate-Oriented scale had items that loaded negatively in a CFA. With greater support in the literature (e.g. Richardson, 2011; Martínez-Fernández & Vermunt, 2005) for learning conceptions as precursors to learning strategies, the learning orientations component was removed. Furthermore, Stimulated Education and Cooperative Learning conception scales were removed as they do not traditionally associate with any processing strategies. Use of Knowledge and Concrete Processing were also removed as an application-directed LP was not appropriate for this context (psychology students). Reliability issues also arose for Independence, Clear Goals and Appropriate Assessment CEQ scales, and were removed.

Item removal for the remaining scales followed guidelines from Hair et al., (2010): 1) Latent variables could be described meaningfully by four items, with three items being acceptable if other latent variables have more than three, and 2) All standardised CFA loadings should be >.50. Each scale separately underwent repeated single-factor CFAs where the lowest loading item was removed each time, until four items were left, or three if loading minimums were not met. The minimum standardised loading over remaining items in the final model was .48 (next lowest >.53). Table 1 presents the highest loading item and number of items for each scale.

The final model was organised based on the 3P framework (see Figure 1). Presage variables contained the learning environment (Good Teaching, Appropriate Workload) and learning conceptions (Construction of Knowledge, Intake of Knowledge). Process variables included (Self-, External, Lack of) Regulation and (Deep, Stepwise) processing strategies. Product variables, following recommendations by Vermunt and Donche (2017) for a richer set of outcomes, included Generic Skills, Satisfaction and Achievement (end-of-term grades). All variables were regressed onto Gender and Year, which were coded as dummy variables

(Female=0, Male=1, Second-year=0, Third-year=1). The variables at each stage (i.e. Presage, Process, Product) were allowed to correlate.

==========FIGURE 1==========

==========TABLE 2==========

Results

Descriptive statistics, correlations and composite reliabilities of scales are presented in Table 2. Correlations were generally in line with theory and previous research, demonstrating relationships with well-known learning patterns and their relationships with learning environment and outcomes. Reliabilities were generally acceptable (ρ>.60; Tseng, Dornyei, & Schmitt, 2006) except for Lack of Regulation which presented marginal reliability (ρ=.59).

Latent SEM Analyses

A CFA of the model resulted in overall acceptable fit (CFI=.92; RMSEA=.035, 90% CI [.028,.041]; SRMR=.053). Significant, meaningful effects from latent SEM analysis and variance explained (R^2) of each variable are presented in Figure 2. From Presage to Process, Appropriate Workload predicted Deep Processing (β=.22, moderate, p<.05, Hypothesis 1a), and Lack of Regulation (β=-.67, large, p<.001, Hypothesis 1a) negatively. Construction of Knowledge predicted both Deep Processing and Self-regulation (β=.28/.49, large, p<.001, Hypothesis 1b). Intake of Knowledge predicted both Stepwise Processing and External Regulation (β=.38/.73, large, p<.001, Hypothesis 1b). These predictions are consistent with theory (Vermunt & Donche, 2017). Intake of Knowledge predicting Lack of Regulation (β=.27, large, p<.05). Construction of Knowledge predicted External Regulation (β=.23, moderate, p<.01). From Process to Product, Deep Processing predicted Achievement (β=.51,

large, $p<.01$; Hypothesis 1c), and Lack of Regulation negatively predicted Generic Skills, Satisfaction and Achievement (β=-.41/-.29/-.48, large, $p<.05/.05/.01$, Hypothesis 1c). From Presage to Product, Good Teaching predicted Generic Skills and Satisfaction (β=.64/.74, large, $p<.001$).

Third-year students reported higher levels of Good Teaching (β=.23, moderate, $p<.001$), Satisfaction (β=.11, moderate, $p<.05$) and Achievement (β=.26, large, $p<.001$). Second-year students reported higher External Regulation (β=-.16, moderate, $p<.05$). Females reported greater levels in Lack of Regulation (β=-.28, large, $p<.001$). Males reported a greater Intake of Knowledge (β=.24, moderate, $p<.01$).

==========FIGURE 2==========

==========TABLE 3==========

As variable-centred results describe the population generally, person-centred results inform how students differentiate between their learning conceptions and their perceived environment.

Person-centred Analyses

LPA indicator values on the Presage variables (Good Teaching, Appropriate Workload, Construction of Knowledge and Intake of Knowledge) are presented in Table 3. For BIC and SABIC, the three-subgroup solution presented the best fit and was chosen. Profiles and mean values are presented in Table 4 while standardised means are shown in Figure 3. Students reported similar levels of the two conceptions in all subgroups (Hypothesis 2a). Considering previous research, subgroups were labelled Inactive (low values on all tested scales; Vermetten et al., 2002), Passive-Idealist (high conceptions, but low on other scales; Vermunt & Donche, 2017), and Environment Driven (high learning environment, but low conceptions) and made up 27%, 29% and 44% of the overall sample respectively. The Environment Driven

subgroup had high learning environment scores with moderate Construction of Knowledge scores. Environment Driven subgroup had significantly higher Achievement than the Passive-Idealist subgroup ($p<.05$; Hypothesis 2b).

==========FIGURE 3==========

ANOVA testing of each Presage variable demonstrated that the three subgroups were significantly different (Table 3). All ANOVAs were significant ($p<.001$). Variance explained varied from .19 to .59. MANOVA was used to test the explanatory power of the three subgroups (Wilks' Lambda=.32, $p<.001$, df=4, F=128.51, $R^2=.68$) indicating that the three-subgroup solution explained a substantial amount of variance in the variables assessed.

==========TABLE 4==========

Discussion

Addressing RQ1, latent SEM analysis confirmed relationships mirroring well established learning patterns (Hypothesis 1a). The predictions of Construction of Knowledge on Self-Regulation and Deep Processing are indicative of a meaning-directed LP, while the predictions of Intake of Knowledge on External Regulation and Stepwise Processing affirm a reproduction-directed LP.

The learning environment through Appropriate Workload predicted Deep Processing (meaning-directed LP) positively and Lack of Regulation negatively (undirected LP) as expected, though Good Teaching did not significant predict any processing strategies (Hypothesis 1b). Furthermore, from process to product, Deep Processing (meaning-directed LP) positively predicted Achievement, whereas Lack of Regulation (undirected LP) negatively predicted all of Generic skills, Satisfaction and academic Achievement as expected (Hypothesis 1c).

The person-centred LPA revealed three subgroups whose measured learning conceptions (Construction of Knowledge, Intake of Knowledge) differed by less than half a standard deviation (refuting Hypothesis 2a). Those belonging to the subgroup who reported a better learning environment (Environment Driven) demonstrated greater achievement (Hypothesis 2b).

Implications for Theory

From Presage to Process variables, both course experience and conceptions of learning had large effects on learning strategies. Predictions that mirrored established learning patterns (meaning-directed and reproduction-directed; e.g. Ferla, Valcke, & Schuyten, 2008; Martínez-Fernández & Vermunt, 2005) were confirmed. Intake of Knowledge predicted Lack of Regulation, which should be characteristic of the reproduction-directed LP where students employ External Regulation. Students may resort to a Lack of Regulation when insufficient regulation is provided by their environment leading to dissonance between learning conception and employed regulation strategies and hence lower Achievement (Vermunt & Vermetten, 2004). Similarly, Construction of Knowledge also led to External Regulation. Donche et al. (2013) found that discovery-oriented teaching strategies that would theoretically promote Deep Processing and Self-regulation, also led to External Regulation and Surface Processing. The assessments and teaching activities may cause friction between their intended regulation approach and learning conception. In course experience, the effect of Appropriate Workload on Deep Processing was confirmed (Diseth et al., 2006), while a negative effect on surface/Stepwise Processing (Lizzio et al., 2002) was not observed. Good Teaching also had large effects on Generic Skills and Satisfaction, though Good Teaching did not significantly affect Achievement in this study (Lizzio et al., 2002; Vanthournout et al., 2012).

Deep Processing predicted Achievement, as supported by other studies with the same (Martínez-Fernández & Vermunt, 2005; Vanthournout et al., 2012) and different instruments measuring a deep approach (SAL; Approaches to Studying Inventory; Lizzio et al., 2002; Diseth et al., 2006), but not Self-regulation (Authors, 2016). Self-regulation has been found to predict Deep Processing (Loyens et al., 2008; Martínez-Fernández & Vermunt, 2005), an effect not tested in the current study.

From person-centred analyses, subgroup means of Construction of Knowledge and Intake of Knowledge in the person-centred analysis were close to one another within each subgroup, suggesting that students may not have had a dominant learning conception and that multiple learning patterns can be present within an individual (Vermunt & Donche, 2017). This result does not support theory (Vermunt & Vermetten, 2004) suggesting that even in university, students can remain undifferentiated. The subject context (psychology) might play a role, where both learning conceptions are viewed as relevant. Information may first need to be processed in a stepwise/surface manner, before employing deep processing through relating and structuring. For example, in the Model of Domain Learning (Alexander, 2003), surface processing is employed more often during acclimation stages and diminish, giving way to deep processing as competence is gained.

Shape of profile differences comparing learning conceptions scores relative to learning environment scores were observed. The difference in Achievement between Environment Driven and Passive-Idealist subgroups further accentuated the variable-centred results. The Passive-Idealist subgroup reported greater Intake of Knowledge, which through Lack of Regulation, led to lower Achievement. Appropriate Workload for the Environment Driven subgroup, which in variable-centred results, suggested promoted Deep Processing and leading to higher Achievement.

Overall, the results suggest two converging pathways to promote higher achievement. Appropriate Workload (course experience) and Construction of Knowledge (learning conceptions) both predicted Deep Processing, which then predicted Achievement. However, Intake of Knowledge (likely due to insufficient External Regulation) and (in)Appropriate Workload converge on Lack of Regulation to negatively predict Achievement. The results support Richardson's (2011) assertion that both learning conceptions and context play meaningful roles in determining processing strategies and outcomes.

Implications for Practice

Practical implications are suggested through adaptations of the learning environment targeted at improving specific CEQ and ILS constructs. One means of intervention strongly supported by past research (Vermunt & Vermetten, 2004) is undertaking a process-oriented instruction, which is directed at promoting all aspects of the meaning-directed LP.

Vermunt (1998) characterised conceptions of learning (and learning patterns generally) to be stable, yet still malleable. For example, Vermunt and Vermetten (2004) found that the stability of learning patterns decreases in the presence of innovative teaching methods, and Vermetten, Lodewijks, and Vermunt (1999) found that there was both an individual-bound and context specific component in the use of learning strategies, paralleling the posited dominating influences in the Passive-Idealist and Environmental Driven subgroups respectively found in this study.

Regarding regulation from external sources, classrooms can vary from strongly teacher-regulated to loosely teacher-regulated, where a learning environment with more regulation will support students in shifting away from a lack of regulation (Vermunt & Vermetten, 2004). While this provisional solution may reduce the pathway towards lower achievement, will students self-regulate or lack regulation when left to their own devices?

Students should be supported with specific activities such as identifying and targeting conceptions, promoting reflection, challenging misconceptions and providing feedback, which have been shown to promote deep and self-regulated learning (Lonka & Ahola, 1995). Students in the Passive-Idealist subgroup should be offered additional (external) regulation by the teacher (Vermunt & Vermetten, 2004) to minimise lack of regulation. Students' workload should be monitored and adjusted accordingly to compensate for the dissonance/friction (Vermunt & Vermetten, 2004) and reduction in study pace (Lonka & Ahola, 1995) students may experience. Assessments should be constructively aligned (Biggs, 1993b) with learning outcomes which require deep processing. However, practitioners should note that introducing "active learning" or promoting "more engagement" alone might be insufficient to support deep processing in learning (Gijbels, Coertjens, Vanthournout, Struyf, & Van Petegem, 2009).

Targeting only processing and regulation is analogous to treating symptoms rather than the cause. Vermunt and Vermetten (2004) encouraged a holistic approach including promoting Construction of Knowledge, helping to facilitate pathways to increased Achievement. Vermunt (1995) promoted reflection on learning processes in undergraduate psychology students in the Netherlands by linking their preconceptions about studying and diagnoses of their own method of learning to individually tailored teaching. This resulted in a shift away from reproduction-directed and undirected LP variables towards the meaning-directed LP. Such an approach in this and similar contexts may yield fruitful results, especially for students in the Environmental Driven subgroup.

Finally, all these interventions are likely to benefit the Inactive subgroup, leveraging the feedback and feedforward loops proposed by Vermunt & Donche (2017) and the 3P (Biggs, 1999a) models.

Limitations and Future Directions

The results presented in the study should be treated with caution. All measures except Achievement were obtained through self-report and from one domain of study. Generalisability should not be assumed. Using the same items in other geographic and subject contexts would examine external validity of the results. The marginal Lack of Regulation scale may need revision.

Although the 3P framework facilitates a fully-forward model, the self-reported data is cross-sectional. The 3P model (Biggs, 1993a) and learning patterns model of student learning (Vermunt & Donche, 2017) indicate that the processes are bidirectional. Longitudinal studies with multiple waves would allow for the testing of these bidirectional relationships, and the development of learning patterns over time (e.g. Loyens et al., 2008).

Going forward, the authors encourage a shift away from mean-based multiple regression and path analysis techniques. The variable-centred analysis of the proposed model indicated acceptable fit suggesting that a latent approach to learning patterns and course experience research is possible. These variables cannot be directly measured and are formed from a collection of indicators and should be treated as such. Further testing and refinement of the instruments will strengthen the relationships between the learning components in describing learning patterns.

Conclusion

A cross-sectional dataset measuring undergraduate psychology students' responses of the ILS, CEQ and a Satisfaction measure underwent fully-forward latent SEM using the 3P framework (Biggs, 1999b; Lizzio et al., 2002). The effects of course experience and learning conceptions on learning strategies (processing and regulation), and subsequently on outcomes (Achievement, Satisfaction and Generic Skills) were studied. Many of the consequential

relationships found in learning patterns research were replicated (Vermunt & Donche, 2017; Vermunt & Vermetten, 2004). Appropriate Workload and Construction of Knowledge both predicted Deep Processing which served as an intermediary to predict Achievement positively, while (in)Appropriate Workload and Intake of Knowledge both predicted Lack of Regulation, which negatively predicted all outcomes. These two pathways highlighted the pivotal roles that both learning conceptions and the learning environment play in the learning experience. Intake of Knowledge predicted a Lack of Regulation, suggesting the traditional boundaries between learning patterns may be blurred when insufficient regulation is provided (Vermunt & Vermetten, 2004). Person-centred results indicated that students did not readily differentiate between Construction and Intake of Knowledge, suggesting combinations and different processing approaches may be used. A process-oriented approach targeting all aspects of the meaning-directed LP is recommended. The present research would benefit from replication in additional subject and geographic contexts to test generalisability. This study takes a step towards using higher-quality statistical techniques that account for measurement error and construct validity, a step we hope is replicated by future studies in this area.

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Table 1: Highest loading items of scales used.

Scale	Highest Loading Item (Number of items)
Presage	
CEQ: Appropriate Workload	The workload is too heavy. (3, scored in reverse)
CEQ: Good Teaching	Teaching staff here work hard to make subjects interesting. (4)
ILS: Construction of Knowledge	I should try to think up examples with the study materials of my own accord. (4)
ILS: Intake of Knowledge	I should repeat the subject matter on my own until I know it sufficiently. (3)
Process	
ILS: Deep Processing	I try to see the connection between the topics discussed in different chapters of a textbook (4)
ILS: Stepwise Strategy (Memorising & Rehearsing)	I memorize definitions as literally as possible. (4)
ILS: External Regulation	When doing assignments, I train myself thoroughly in applying the methods dealt with in a course. (3)
ILS: Self-Regulation	I add something to the subject matter from other sources. (3)
ILS: Lack of Regulation	I notice that I have trouble processing a large amount of subject matter. (3)
Product	
CEQ: Generic Skills	The course has improved my written communication skills. (4)
Satisfaction	Overall, I would recommend this course to others. (4)

Table 2: Correlations, Descriptive Statistics, Reliability

	AW	GT	CoK	IoK	DP	SP	ER	SR	LoR	GS	Satis	Ach
Appropriate Workload	-											
Good Teaching	.16*	-										
Construction of Knowledge	.03	.04	-									
Intake of Knowledge	-.05	.15*	.19**	-								
Deep Processing	.20**	.17**	.22***	.05	-							
Stepwise Processing	-.07	.09	.08	.49***	.09	-						
External Regulation	.03	.14*	.31***	.33***	.38***	.27***	-					
Self-Regulation	-.01	-.02	.22***	-.05	.49***	.04	.21**	-				
Lack of Regulation	-.39***	-.05	.09	.20**	-.07	.16*	.13*	..03	-			
Generic Skills	.11	.47***	.08	.08	.17**	.10	.05	.11	-.17**	-		
Satisfaction	.25***	.63***	.13*	.11	.19**	.07	.14*	.05	-.23***	.52***	-	
Achievement	.15*	.08	.10	-.08	.26***	-.11*	.05	.08	-.28***	.05	.20**	-
M	2.71	2.77	4.15	3.17	3.44	2.89	3.36	3.70	2.62	3.31	3.30	0 (Z)
SD	.87	.79	.59	.83	.82	.97	.80	.87	.88	.82	.87	1 (Z)
Raykov's Rho (ρ)	.69	.78	.74	.64	.78	.79	.71	.64	.59	.75	.88	-

Note: ***p<.001,**p<.01,*p<.05

M: Mean, SD: Standard Deviation,

Scales measured 1 to 5 except for Achievement (Ach).

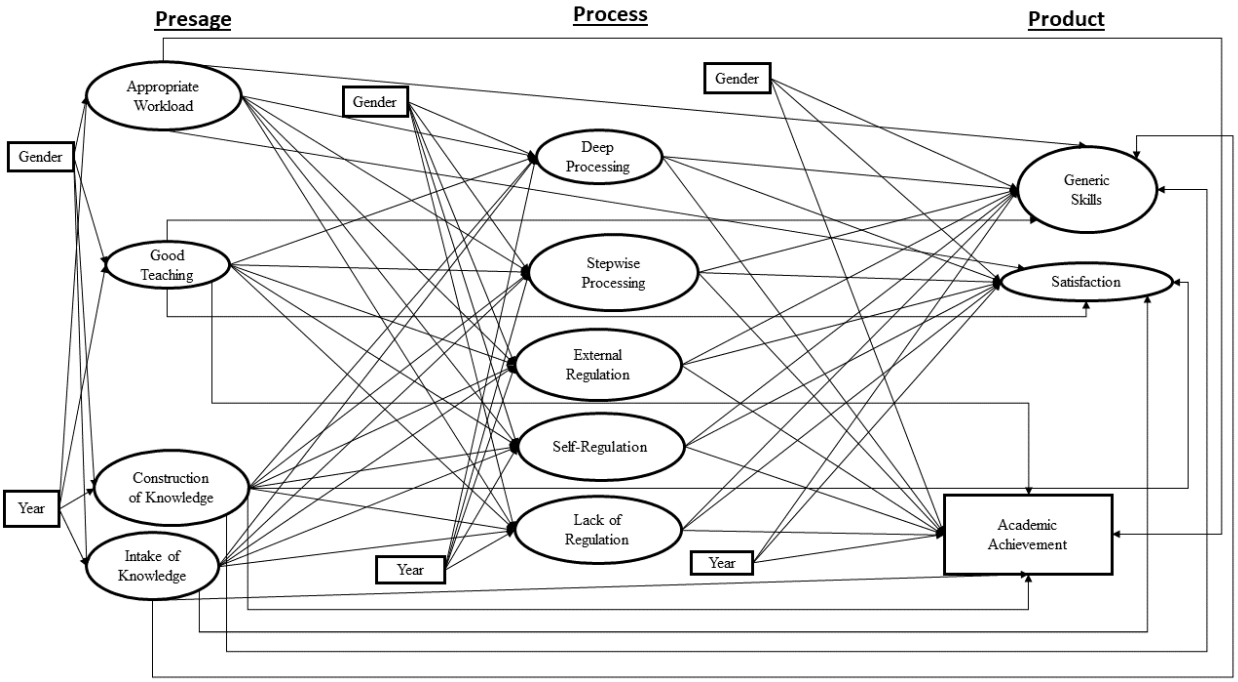

Figure 1: Fully-forward 3P model, all paths tested simultaneously.

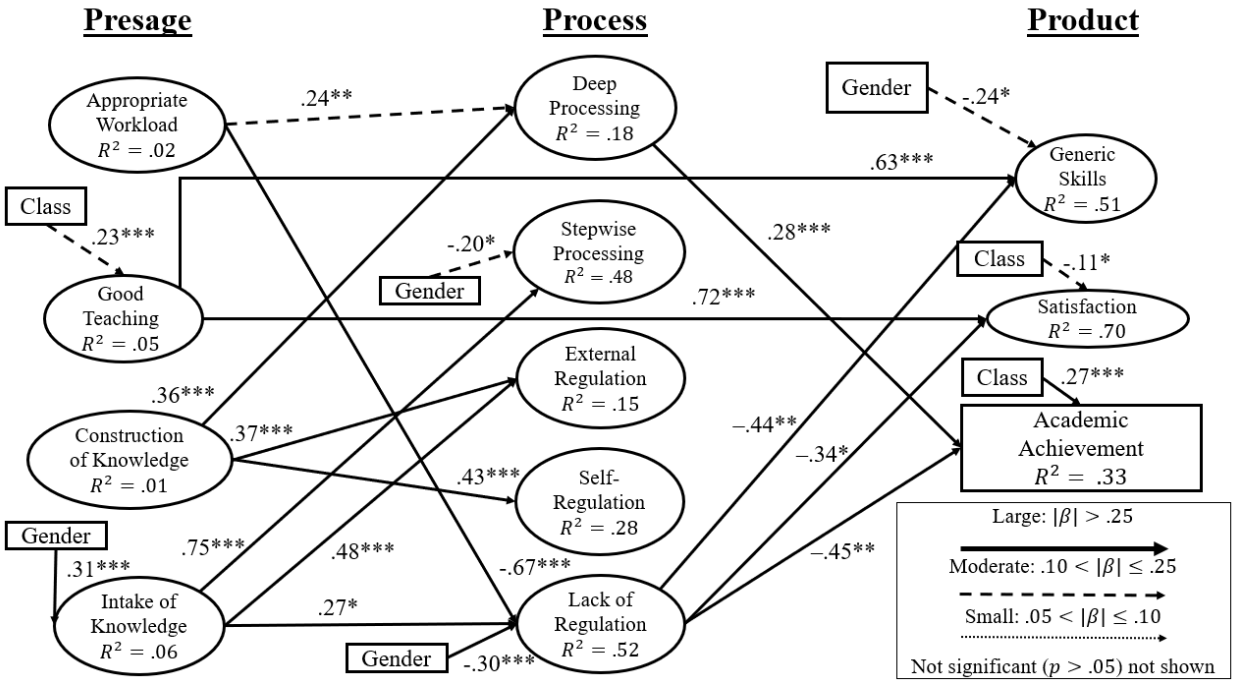

Figure 2. Significant (*p<.05, **p<.01, ***p<.001) paths. Gender: Female=0, Male=1. Year: Second-year=0 and Third-year=1.

Table 3:

Fit for Latent Profile Analysis of Presage variables. AIC – Akaike Information Criteria, BIC – Bayesian Information Criteria, SABIC – Sample-size Adjusted BIC. SG- Subgroup.

	1 SG	2 SG	3 SG	4 SG	5 SG	6 SG
AIC	1905.535	1879.522	1855.822	**1854.615**	1854.975	1855.290
BIC	1933.447	1924.878	**1918.623**	1934.860	1952.665	1970.425
SABIC	1908.088	1883.670	**1861.566**	1861.955	1863.910	1865.821

Table 4:

Mean subgroup and one-way ANOVA. Covariate data (Whole Sample: Female 80.2%, Second-year 58.7%) was not part of analysis. SD: Standard Deviation

	Inactive (n=66)	**Passive-Idealist (n=69)**	**Environment Driven (n=107)**	***ANOVA***		
	Mean(SD)	Mean(SD)	Mean(SD)	***p***	***F***	R^2
Good Teaching	2.17(.52)	2.38(.40)	3.33(.42)	<.001	171.5	.59
Appropriate Workload	2.52(.64)	2.19(.63)	3.14(.62)	<.001	51.34	.30
Construction of Knowledge	3.59(.50)	4.18(.44)	4.04(.49)	<.001	28.05	.19
Intake of Knowledge	2.89(.50)	4.03(.43)	3.54(.45)	<.001	107.8	.47
Year 2 (Year 3)	34.8% (65.2%)	31.9% (68.1%)	48.6% (51.4%)			
Male (Female)	27.3% (72.7%)	11.6% (88.4%)	20.6% (79.4%)			

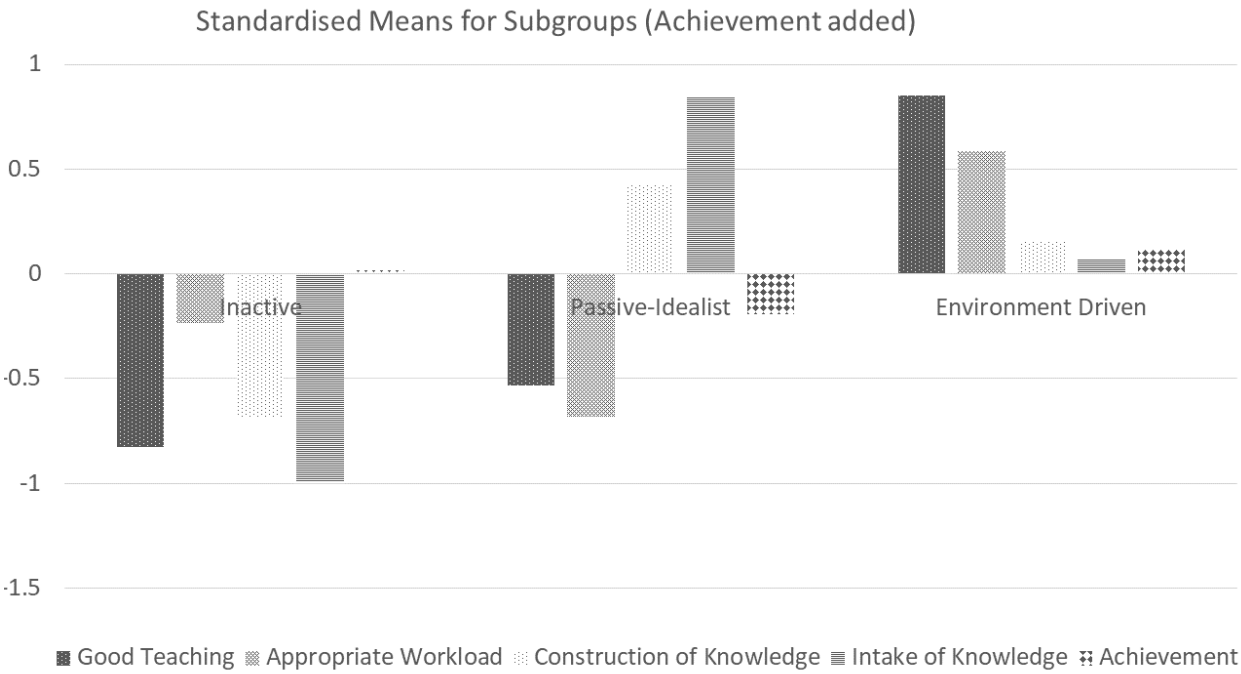

Figure 3: Subgroup profiles (Standardised): Inactive, Passive-Idealist and Environment Driven. Achievement (shown) was not analysed.