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Relationships between student cognitions and their effects on study strategies

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Abstract

Using Vermunt’s model [Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational psychology*, 68, 149–171] of self-regulated learning as a conceptual framework, this study aims to contribute to the development of finer grained models of higher education students’ learning by (1) investigating causal relationships between three student cognitions which feature prominently in the research literature: self-efficacy, conceptions of learning and attributions for academic success and by (2) researching both the direct and indirect effects of these student cognitions on first year university students’ study strategies. To that end a model was developed, respecified, tested, and cross validated using path analyses. Results show that within an educational context learning conceptions are fundamental student cognitions since they directly and/or indirectly influence students’ self-efficacy, attributions for academic success, and study strategy.
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Keywords: Study strategies; Self-efficacy; Conceptions of learning; Attributions; Path analysis

1. Introduction

Vermunt’s theoretical model about self-regulated learning (see Fig. 1) demonstrates that student cognitions (e.g. learning conceptions) influence students’ study strategies (e.g. their learning approach and regulation strategy). This study aims at expanding Vermunt’s model by (1) adding two student cognitions to the model which feature prominently in the research literature: academic self-efficacy and attributions for academic success, (2) by modeling possible causal relationships between student cognitions and by (3) researching both direct and indirect effects of different student cognitions on first year university students’ study strategies. The results are expected to contribute to the development of finer grained models of student learning in higher education.

In Section 2 of this article we explore the theoretical foundation of the central concepts part of this study. Subsequently we summarize the main research results of earlier empirical studies about relationships between academic self-efficacy,

learning conceptions and attributions for academic success and the effects of these cognitions on students’ study strategies.

2. Theoretical base

2.1. Study strategies: learning approaches and regulation strategies

According to Vermunt (1998) a “study strategy” consists of a learning approach (a cognitive strategy) and a regulation strategy (a metacognitive strategy). A deep learning approach is characterized by learning activities such as relating ideas and seeking evidence and reflects an intention to understand what is being taught. A surface learning approach is characterized by learning activities such as rote memorization and other routine processing activities (e.g. repetition) and reflects a focus on recall and reproduction (Biggs, 1987; Entwistle, 1998; Marton & Saljö, 1976; Vermunt, 1992). Educational practitioners encourage their students to adopt a deep learning approach as the latter is expected to result in deeper levels of understanding and better academic results (Entwistle & Entwistle, 1991; Vermunt & Vermetten, 2004).

Regulation strategies describe how students steer their cognitive activities. Examples of regulation activities are checking whether

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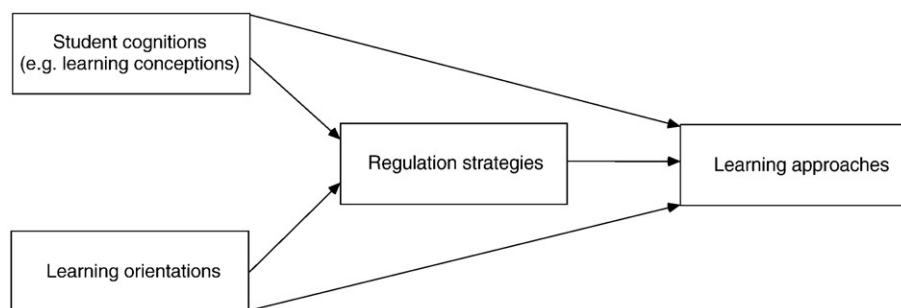


Fig. 1. Vermunt's (1998) model of self-regulated learning.

the learning process proceeds as planned and diagnosing causes for not achieving a learning goal. Vermunt et al. (1992, 1998, 2004) distinguish between three main regulation strategies: “(a) a self-regulated strategy, in which students perform most regulation activities themselves; (b) an externally regulated strategy, in which students let their learning processes be regulated by teachers, books etc.; and (c) a lack of regulation, manifested when students are not only unable to regulate their learning processes themselves, but also experience insufficient support from the external regulation provided by teachers and the general learning environment” (Vermunt & Vermetten, 2004). A self-regulated strategy usually encourages the adoption of a deep learning approach while an externally regulated strategy usually invokes the adoption of a surface learning approach (Vermunt, 1998). In this context it is to be noted that providing students with the knowledge and skills enabling them to self-regulate their study process is a central goal of higher education (MacLellan & Soden, 2006).

2.2. Student cognitions

2.2.1. Academic self-efficacy

Academic self-efficacy refers to one's perceived capability to perform given academic tasks at desired levels (Schunk, 1991). Several empirical studies have demonstrated that students with a strong sense of self-efficacy undertake more challenging tasks, engage in more effective self-regulatory strategies, use more cognitive strategies, and are more likely to persist at a task than students who do not believe they are able to carry out that task (Bandura & Schunk, 1981; Bouffard-Bouchard, 1990; Pintrich & DeGroot, 1990; Salomon, 1984; Schunk, 1982; Zimmerman, Bandura, & Martinez-Pons, 1992). As a result, self-efficacy beliefs are strong determinants of learning outcomes (e.g. level of understanding and academic achievement), even after prior knowledge, prior achievement and cognitive skills are taken into consideration (Pintrich & Schunk, 1996).

2.2.2. Students' conceptions of learning

Decades of research has brought the consistent and persistent message that Western higher education students conceive of learning in two fundamentally different ways. Students with a *reproductive* learning conception equate learning with memorizing knowledge while students with a *constructive* learning

conception equate learning with seeking understanding (Purdie & Hattie, 2002).

There is clear empirical evidence showing that students' conceptions of learning affect the way they study (Marton, Dall'Alba & Beaty, 1993). Van Rossum and Schenk (1984) found that students who view learning as a meaning seeking process are more likely to adopt a deep approach to learning than students who view learning as a passive and mechanical process of memorizing information. Vermunt et al. (1992, 1998, 2004, 2005) demonstrated that perceiving learning as the construction of knowledge is associated with a self-regulated and deep oriented study strategy while perceiving learning as the intake of presented knowledge induces a more externally regulated and reproduction oriented study strategy.

Several researchers (Bakx et al., 2006; Burnett, Pillay, & Dart, 2003) found a positive relationship between a constructive learning conception and students' self-perceived level of confidence (e.g. self-efficacy or self-concept). Chan (1999) found that Hong Kong preservice teacher students with a constructive learning conception attributed academic success more to effort than other students.

2.2.3. Attributions for academic success

Individual students differ in their explanations of the causes of their academic success and failure. Weiner (1986) assumed ability, effort, task difficulty and luck are the four most salient causes of academic outcomes. These perceived causes can be classified along three dimensions, origin (internal–external), stability and controllability (Weiner, 1986). Studies have demonstrated that the controllability dimension is very important within academic settings (Schunk, 1990). Several researchers (e.g. Perry, Hladkyj, Pekrun & Pelletier, 2001; Schunk & Ertmer, 2000) have shown that attributing academic success to controllable causes is related to a great number of positive metacognitive, cognitive, motivational, affective, and academic achievement outcomes. For example, students who attribute academic success to effort are likely to feel more efficacious about learning, are more likely to engage in self-regulatory learning and will process the learning material more deeply (Schunk, 1990; Vermunt, 1998).

The results of the empirical research described in this section of the article imply various (mostly not tested) causal

t1.1 Table 1

t1.2 Student cognitions scales with indicative items, Cronbach alpha's and factor loadings of the latent variables on its indicators

| t1.3 | Scale | Representative item | <i>n</i> | α | Factor loadings of the latent constructs on their indicators | | |
|-------|--|---|----------|----------|--|------|-------|
| t1.4 | Self-efficacy | I'm confident I will pass all exams this year. | 3 | 0.91 | 0.92 | 0.89 | 0.86 |
| t1.5 | Understanding requires active processing ^a | Understand what is taught is the result of transforming the learning material into a logical and coherent set of ideas. | 4 | 0.74 | 0.55 | 0.62 | 0.64 |
| t1.6 | Memorizing presupposes understanding ^a | To memorize the learning material successfully you really have to understand the subject matter. | 3 | 0.71 | 0.57 | 0.81 | 0.67 |
| t1.7 | Memorizing can help understanding ^b | Memorizing the learning material sometimes helps understanding it. | 2 | 0.86 | 0.84 | 0.91 | 0.73 |
| t1.8 | Memorization always requires a lot of repetition ^b | Memorizing what is taught requires a lot of repetition even though one understands the learning material. | 3 | 0.71 | 0.67 | 0.83 | -0.53 |
| t1.9 | Attributing academic success to ability | To pass exams you have to be very intelligent. | 2 | 0.85 | 0.84 | 0.89 | |
| t1.10 | Attributing academic success to effort | Passing exams depends on how hard you study. | 2 | 0.68 | 0.71 | 0.73 | |
| t1.11 | Attributing academic success to task difficulty | My chances of passing mainly depend on the difficulty level of the exam questions. | 2 | 0.80 | 0.71 | 0.94 | |
| t1.12 | Attributing academic success to luck | To pass an exam you have to be lucky with the exam questions. | 2 | 0.84 | 0.84 | 0.89 | |
| t1.13 | ^a Indicative of a constructive learning conception. | | | | | | |
| t1.14 | ^b Indicative of a reproductive learning conception. | | | | | | |

relationships between student cognitions on the one hand and between student cognitions and study strategies on the other hand. Vermunt's model of self-regulated learning was expanded by incorporating these implied relationships into the model. For instance, the expanded model hypothesized that attributing academic success to effort heightens students' level of self-efficacy and thereby encourages the adoption of a self-regulated and deep oriented study strategy. The validity of this expanded model was tested in the present study (see paragraph 3.3).

3. Method

3.1. Participants and procedure

A questionnaire was presented to the entire population of freshmen ($n=473$) studying psychology, educational sciences or social work and welfare studies (261, 152 and 60 respectively). The group consisted of 49 male and 424 female students. The questionnaire was administered two and half months after the start of the academic year. Informed consent was obtained of all participating students.

3.2. The questionnaire

Students' cognitions (self-efficacy, attributions for academic success and learning conceptions) were measured on the basis of nine scales made up of 24 questions to be answered on a five-point Likert scale (scores ranging from (1) 'I strongly disagree' to (5) 'I strongly agree'). These scales, inspired by the Reflections On Learning Inventory (Meyer & Boulton-Lewis, 1999) and the Causal Attribution Scale (Chan, 1994), were developed in the context of a previous study (Ferla, Valcke, & Schuyten, submitted for publication). The reliability and validity of the scales was reanalyzed in the present study on the base of a confirmatory factor analysis (CFA, Amos 6 with maximum likelihood estimation) and by calculating Cronbach alpha values. Results demonstrate a good fit: $\chi^2_{120}=329.74$, $p=0.000$, $\chi^2/df=1.527$, GFI=0.951, RMSEA=0.034,

CFI=0.974. The expected theoretical relationships between the latent variables and their indicators are confirmed by factor loadings consistently higher than 0.50 while no cross loadings were observed. No modifications had to be applied to optimize the measurement model. Cronbach's alpha values varied from 0.68 to 0.91. Table 1 presents the nine scales, their Cronbach alpha value, a typical test item and the factor loadings of each latent variable on its indicators.

The scales which measure attributions for academic success are self-explanatory. Academic self-efficacy was operationalized as expectancies for success.² Students' conceptions of learning were determined with four scales developed by the same authors (Ferla, Valcke, & Schuyten, submitted for publication). Exploratory factor analysis made clear that these four scales represent two learning conceptions related to students' conceptions about understanding and memorizing. The scales 'understanding requires active processing' and 'memorizing can help understanding' determine to which extent a student feels that understanding is the result of either meaning seeking activities and/or memorizing. The scales 'memorizing presupposes understanding' and 'memorizing requires a lot of repetition' measure the degree to which a student believes that remembering the learning material is the result of understanding and/or repetition. The scales 'understanding requires active processing' and 'memorizing presupposes understanding' represent a constructive conception of learning while the scales 'memorizing can help understanding' and 'memorizing requires a lot of repetition' represent a reproductive learning conception.

² This is not redefining the construct. In fact, several educational researchers have operationalized academic self-efficacy as expectancies for success (Meece, Wigfield, & Eccles, 1990; Malpass, O'Neil & Hocevar, 1999; Schunk, 1995). Schunk (1984) argued that in achievement situations there may be little difference between expectancy and efficacy judgments. Furthermore, Schunk (1995) found a strong relationship between expectancies for success and general self-efficacy in an academic setting. Admittedly, Pajares (1997) does warn that global self-efficacy measures diminish predictive validity for criterion tasks such as academic performance.

| | | |
|-------|---|--|
| t2.1 | Table 2 | |
| t2.2 | ILS-scales: learning approaches and regulation strategies | |
| t2.3 | Scale name and description | Meaning |
| t2.4 | Relating and structuring ^a | Inferring relationships within the subject matter as well as relationships with other knowledge and structuring parts of knowledge into a logical whole. |
| t2.5 | Critical processing ^a | Being critical to the opinion of the author, comparing one's ideas to that of teachers, etc. |
| t2.6 | Concrete processing ^a | Seeking examples, trying to personalize and relate to one's own experience, and trying to use acquired knowledge outside a study context. |
| t2.7 | Memorizing ^b | Memorizing by repetition of important facts, definitions, etc. |
| t2.8 | Analyzing ^b | Step by step processing of the subject matter and paying much attention to detail. |
| t2.9 | Self-regulation | Controlling the study process yourself, by orientation, planning, monitoring, evaluating, etc. |
| t2.10 | External regulation | Depending on an external source for regulation of the study process, e.g., taken learning goals or directions and questions of teachers to heart. |
| t2.11 | Lack of regulation | Having difficulties regulating one's study process: lack of clear goals, not knowing which study method to use etc. |
| t2.12 | ^a Indicative of a deep learning approach. | |
| t2.13 | ^b Indicative of a surface learning approach. | |

199 Students' learning approaches and regulation strategies were
200 determined with 55 ILS-items (Inventory of Learning Styles;
201 Vermunt, 1992). ILS-items are scored on a five-point Likert
202 scale with scores ranging from (1) 'I never or hardly ever do
203 this' to (5) 'I (almost) always do this'. These items make up
204 eight subscales: 5 subscales measure students' learning
205 approaches³ and 3 subscales measure the nature of students'
206 regulation strategies. The optimal psychometric properties of
207 the ILS have been repeatedly demonstrated in the literature
208 (Coffield, Mosely, Hall & Ecclestone, 2004).

209 Table 2 presents an overview of the different subscales and
210 their meaning. The subscales 'relating and structuring', 'critical
211 processing' and 'concrete processing' refer to a deep approach
212 to learning; a surface learning approach is indicated by high
213 scores on the subscales 'memorizing' and 'analyzing'.

214 3.3. Data-analysis

215 To test Vermunt's expanded model (cf. paragraph 2) a two-
216 step strategy was used (Byrne, 2001). In the first step the entire
217 sample was split up into a calibration sample ($n_1=237$) and a
218 cross validation sample ($n_2=236$). Next the expanded model, in
219 which all variables were considered to be endogenous, was
220 tested for goodness-of-fit by use of a path analysis. As the fit
221 wasn't satisfactory the model was respecified until satisfactory
222 fit was obtained. Respecification involved removing insignif-
223 icant paths and adding new paths as suggested by modification

indexes. The latter was only applied when theoretically viable. 224
No error covariance between variables was allowed. The second 225
step of the analysis strategy involved the cross validation of the 226
final model using the data of the cross validation sample. 227

4. Results 228

Table 3 presents the goodness-of-fit-indices for the final 229
model for the calibration and the validation sample. The results 230
reflect consistent and very acceptable goodness-of-fit-indices 231
suggesting that the developed model fits the data of both the 232
calibration and the validation sample. 233

Fig. 2 depicts the final model and includes standardized path 234
coefficients and the percentage of explained variance for the 235
dependent variables (calibration sample). In Appendix A, Table A1 236
presents the unstandardized regression weights while Tables A2, 237
A3 and A4 respectively present the total, the direct and the indirect 238
standardized effects between the variables part of this study. 239

The final model demonstrates that learning conceptions 240
influence all other variables and that the latter do not explain 241
any of the variance in students' learning conceptions. The other 242
main results of the path analysis can be interpreted as follows. 243

Students with a constructive conception of learning: 244

- Attribute academic success more to effort. 245
- Feel more self-efficacious. 246
- Make a greater use of internal and external regulation 247
strategies. 248
- Report to a lesser extent that their study process lacks 249
direction. 250
- Are more likely to adopt a deep learning approach and make 251
a greater use of both deep and surface processing strategies. 252
253

Students with a reproductive learning conception: 254

- Attribute academic success more to uncontrollable causes 255
(e.g. the difficulty level of examinations) and consequently 256
feel less efficacious than other students. 257
- Rather adopt an externally regulated study strategy and/or 258
feel that their study strategy lacks direction. 259
- Are more likely to adopt a surface approach to learning. 260
261

Students who attribute academic success to the difficulty 262
level of examinations: 263

- Are more likely to attribute academic success to other 264
uncontrollable causes such as luck and ability. 265

Table 3 23.1
Goodness-of-fit-indices^a for the final respecified model for the calibration 23.2
($n_1=237$) and the validation sample ($n_2=236$) 23.2

| | χ^2_{df} | p | CMIN/DF | RMSEA | GFI | CFI | 23.3 |
|--------------------|---------------|-------|---------|-------|-------|-------|------|
| Calibration sample | 62.11 (46) | 0.057 | 1.350 | 0.037 | 0.952 | 0.967 | 23.4 |
| Validation sample | 80.12 (46) | 0.001 | 1.742 | 0.057 | 0.946 | 0.922 | 23.5 |

^a In line with the recommendations of Bollen and Long (1993) several fit 23.6
indices representing different families of measures (e.g. inductive, descriptive 23.7
and information theoretic measures) were used to assess model fit. 23.8

³ Vermunt (1992) makes a distinction between three learning approaches or 23.9
processing strategies: a deep, a surface and a concrete processing strategy. The 24.0
latter represents a learning approach in which the practical application of 24.1
knowledge takes a central place. However in studies with first year university 24.2
students this approach is often not recognised as a distinct one and then 24.3
becomes an element of a deep oriented learning approach (Vermunt & Verloop, 24.4
2000).

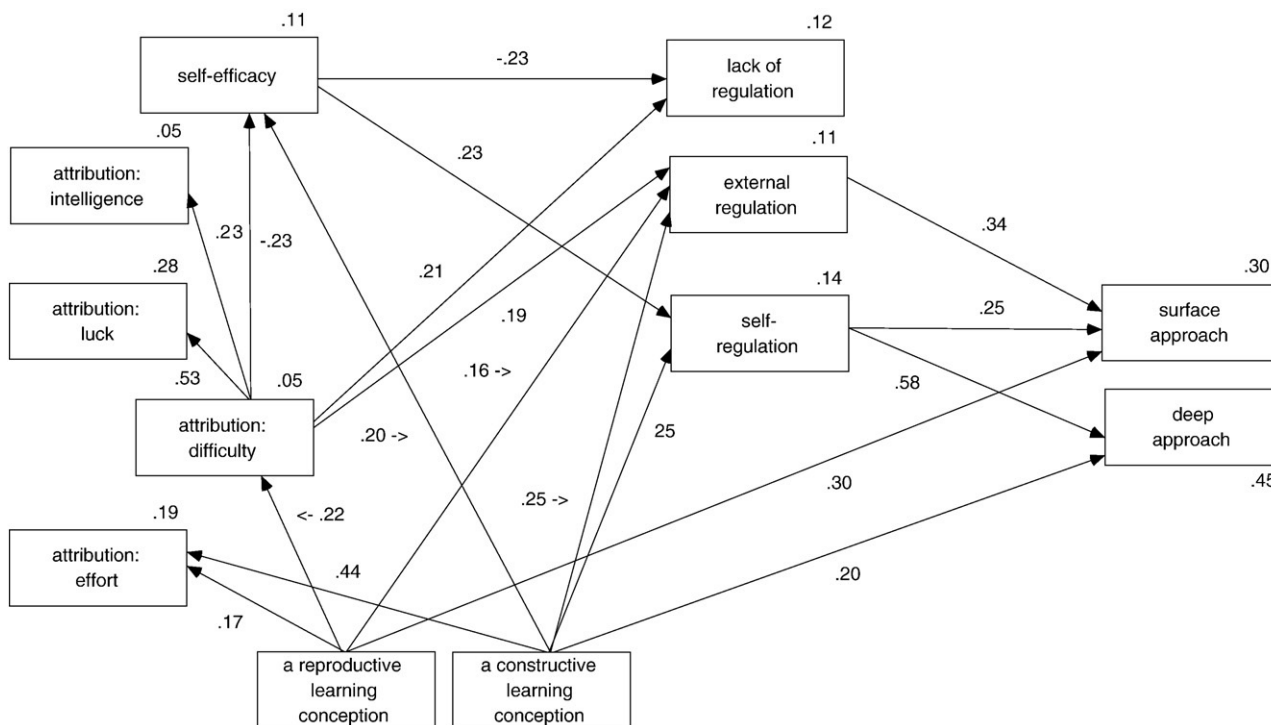


Fig. 2. The final model with standardized path coefficients and explained variance in dependents.⁴

- 266 • Feel less-self efficacious.
 267 • Depend on external sources to regulate their study process
 268 and report more than other students that their study strategy
 269 lacks direction.

270 Self-efficacious students:
 271

- 272 • Are better able to regulate their learning process and
 273 therefore more likely to adopt a deep approach to learning.
 274 • Feel less than other students that their study process lacks
 275 direction.

276
 277 Self-regulated students make extensive use of both deep and
 278 surface processing strategies although their learning approach is
 279 primarily deep oriented. Students who depend on external help
 280 to direct their study process rather adopt a surface approach to
 281 learning.

282 5. Discussion

283 In general the results of the present study validate Vermunt's
 284 (1998) theoretical model of self-regulated learning. Firstly, our
 285 results confirm that learning approaches are primarily deter-
 286 mined by regulation strategies. In accordance with the findings
 287 of Pintrich and DeGroot (1990), the results of this study make
 288 clear that self-regulated students make more use of surface and
 289 deep processing strategies, though their learning approach is

290 primarily deep oriented. Like Vermunt (1998) we found that an
 291 external regulation strategy invokes the adoption of a surface
 292 learning approach.

293 Secondly, our model supports the contention of several
 294 educational researchers (Marton, Dall'Alba & Beaty, 1993; Van
 295 Rossum & Schenk, 1984; Vermunt, 1998) that students with a
 296 constructive learning conception are more likely to adopt a deep
 297 oriented learning approach while students with a reproductive
 298 learning conception tend to adopt a surface oriented learning
 299 approach.

300 Thirdly, the model supports Vermunt's (1998) finding that
 301 learning conceptions directly influence regulation strategies.
 302 Students with a reproductive learning conception are more
 303 likely to adopt an externally regulated study strategy. In
 304 accordance with Purdie, Hattie and Douglas (1996) we found
 305 that a constructive conception of learning induces a stronger use
 306 of both internal and external regulation strategies. Finally, the
 307 results of this study validate Vermunt's assertion (1998) that
 308 student cognitions not only influence learning approaches
 309 directly but also indirectly through mediation of regulation
 310 strategies.

311 Unlike Vermunt's model of self-regulated learning, the
 312 model presented in this study incorporates causal relationships
 313 between student cognitions and consequently also indirect
 314 effects of student cognitions on study strategies. For instance,
 315 our model suggests that a constructive learning conception
 316 enhances self-efficacy and encourages attributions of academic
 317 success to effort. Students with a reproductive learning
 318 conception attribute academic success rather to uncontrollable
 319 causes (e.g. task difficulty) which in turn make them feel less
 320 efficacious. Since students' level of self-efficacy and attributions

⁴ The numbers above the observed variables indicate the percentage of explained variance in that variable.

for academic success partially determine their study strategy, it becomes clear that learning conceptions also influence study strategies through other student cognitions. We give but one example: a constructive learning conception encourages the use of more cognitive strategies through its influence on students' self-efficacy.

Furthermore, our model also helps in detecting which relationships identified by earlier research are statistically spurious or indirect. Schunk (1990) argued that students who attribute academic success to controllable causes (e.g. effort) are more likely to engage in self-regulatory study behavior and to process the learning material more deeply. Our study suggests the relationship between attributing academic success to effort and the adoption of a self-regulated and deep oriented study strategy is apparently statistically spurious and reflects the direct effect a constructive learning conception has on both.

Several authors suggest that students who feel efficacious are more likely to adopt a deep learning approach (Pintrich & DeGroot, 1990; Zimmerman, Bandura, & Martinez-Pons, 1992). The model presented here suggests that the relationship between high self-efficacy and the adoption of a deep learning approach is mediated through self-regulation. Finally, Vermunt (2004) states that students with a reproductive conception of learning are more likely to adopt an undirected study strategy. Our results support this finding but also make clear that the relationship is an indirect one. Students who equate learning with memorizing attribute academic success more to uncontrollable causes and feel less efficacious. Both effects induce an undirected study strategy.

We conclude that within an educational context, learning conceptions play a very influential role since they influence directly and/or indirectly other student cognitions and students'

study strategy. Students with a constructive learning conception attribute academic success more to effort, feel more efficacious, and make stronger use of both cognitive and metacognitive strategies. In contrast, students with a reproductive learning conception attribute academic success more to uncontrollable causes, feel less efficacious, and are more likely to adopt a surface oriented and undirected or externally regulated study strategy. Our model seems to depict the different levels of study expertise at which university freshmen operate. 'Unsophisticated' students equate learning strongly with memorizing and therefore adopt an externally regulated and surface oriented study strategy. However this study strategy doesn't fit the expectations of the new learning environment in which they are expected to process much more learning material and to study more independently than they are used to. Some of these students realize this which explains why they feel – temporarily or permanently – that their study process lacks direction, why they feel less efficacious and why they think their chances of passing exams strongly depend on luck. In contrast, 'sophisticated' students who equate learning with understanding are better equipped to deal with the challenges of their new learning environment. The latter is demonstrated by their greater total use of metacognitive and cognitive strategies.

As a final remark we stress that next to the model presented in this study alternative models are equally likely. For instance, our model is a fully recursive model. However, it is quite possible that, as Bandura (2001) suggests, student cognitions and study strategies also influence each other reciprocally. Future research should therefore test such models.

6. Uncited reference

Vermunt, 2005

Appendix A

Table A1
Unstandardized regression weights, standard error, *t*- and *p*-value

| Dependents | Independents | β | S.E. | <i>t</i> | <i>p</i> |
|------------------------------|--------------------------------------|---------|------|----------|------------------|
| Deep approach to learning | ← A constructive learning conception | .568 | .145 | 3.919 | *** ¹ |
| | ← Self-regulation | .845 | .075 | 11.302 | *** |
| Surface approach to learning | ← A reproductive learning conception | .599 | .112 | 5.330 | *** |
| | ← External regulation | .414 | .068 | 6.113 | *** |
| | ← Self-regulation | .246 | .055 | 4.465 | *** |
| Self-regulation | ← Self-efficacy | .620 | .167 | 3.707 | *** |
| | ← A constructive learning conception | .493 | .122 | 4.055 | *** |
| External regulation | ← Attribution: task difficulty | .584 | .202 | 2.890 | .004 |
| | ← A reproductive learning conception | .259 | .109 | 2.377 | .017 |
| | ← A constructive learning conception | .391 | .102 | 3.827 | *** |
| Lack of regulation | ← Self-efficacy | -.415 | .115 | -3.600 | *** |
| | ← Attribution: task difficulty | .531 | .166 | 3.195 | .001 |
| Self-efficacy | ← A constructive learning conception | .148 | .046 | 3.235 | .001 |
| | ← Attribution: task difficulty | -.331 | .091 | -3.652 | *** |
| Attribution: effort | ← A constructive learning conception | .149 | .021 | 7.116 | *** |
| | ← A reproductive learning conception | .060 | .022 | 2.768 | .006 |
| Attribution: task difficulty | ← A reproductive learning conception | .116 | .034 | 3.402 | *** |
| Attribution: luck | ← Attribution: task difficulty | .571 | .060 | 9.490 | *** |
| Attribution: ability | ← Attribution: task difficulty | .254 | .072 | 3.518 | *** |

$p < 0.001$. The correlation between 'a constructive learning conception' and 'a reproductive learning conception' was estimated to be -0.228 ($p < 0.001$).

Table A2
Standardized total effects

| Variables | A constructive learning conception | A reproductive learning conception | Attribution: difficulty | Self-efficacy | Self-regulation | External regulation |
|---------------------------|------------------------------------|------------------------------------|-------------------------|---------------|-----------------|---------------------|
| Attribution: difficulty | .000 | .220 | .000 | .000 | .000 | .000 |
| Attribution: luck | .000 | .117 | .532 | .000 | .000 | .000 |
| Attribution: ability | .000 | .050 | .227 | .000 | .000 | .000 |
| Attribution: effort | .437 | .170 | .000 | .000 | .000 | .000 |
| Self-efficacy | .204 | -.051 | -.230 | .000 | .000 | .000 |
| Self-regulation | .302 | -.012 | -.053 | .233 | .000 | .000 |
| External regulation | .246 | .197 | .185 | .000 | .000 | .000 |
| Lack of regulation | -.047 | .057 | .258 | -.231 | .000 | .000 |
| Deep learning approach | .378 | -.007 | -.031 | .135 | .582 | .000 |
| Surface learning approach | .160 | .365 | .050 | .058 | .249 | .344 |

Table A3
Standardized direct effects

| Variables | A constructive learning conception | A reproductive learning conception | Attribution: difficulty | Self-efficacy | Self-regulation | External regulation |
|---------------------------|------------------------------------|------------------------------------|-------------------------|---------------|-----------------|---------------------|
| Attribution: difficulty | .000 | .220 | .000 | .000 | .000 | .000 |
| Attribution: luck | .000 | .000 | .532 | .000 | .000 | .000 |
| Attribution: ability | .000 | .000 | .227 | .000 | .000 | .000 |
| Attribution: effort | .437 | .170 | .000 | .000 | .000 | .000 |
| Self-efficacy | .204 | .000 | -.230 | .000 | .000 | .000 |
| Self-regulation | .254 | .000 | .000 | .233 | .000 | .000 |
| External regulation | .246 | .156 | .185 | .000 | .000 | .000 |
| Lack of regulation | .000 | .000 | .205 | -.231 | .000 | .000 |
| Deep learning approach | .202 | .000 | .000 | .000 | .582 | .000 |
| Surface learning approach | .000 | .300 | .000 | .000 | .249 | .344 |

Table A4
Standardized indirect effects

| Variables | A constructive learning conception | A reproductive learning conception | Attribution: difficulty | Self-efficacy | Self-regulation | External regulation |
|---------------------------|------------------------------------|------------------------------------|-------------------------|---------------|-----------------|---------------------|
| Attribution: difficulty | .000 | .000 | .000 | .000 | .000 | .000 |
| Attribution: luck | .000 | .117 | .000 | .000 | .000 | .000 |
| Attribution: ability | .000 | .050 | .000 | .000 | .000 | .000 |
| Attribution: effort | .000 | .000 | .000 | .000 | .000 | .000 |
| Self-efficacy | .000 | -.051 | .000 | .000 | .000 | .000 |
| Self-regulation | .047 | -.012 | -.053 | .000 | .000 | .000 |
| External regulation | .000 | .041 | .000 | .000 | .000 | .000 |
| Lack of regulation | -.047 | .057 | .053 | .000 | .000 | .000 |
| Deep learning approach | .176 | -.007 | -.031 | .135 | .000 | .000 |
| Surface learning approach | .160 | .065 | .050 | .058 | .000 | .000 |

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