Studies in Higher Education

The impact of students' conceptions of constructivist assumptions on academic achievement and drop-out

Sofie M. M. Loyens a; Remy M. J. P. Rikers a; Henk G. Schmidt a

a Erasmus University Rotterdam, Netherlands

Online Publication Date: 01 October 2007

To cite this Article: Loyens, Sofie M. M., Rikers, Remy M. J. P. and Schmidt, Henk G. (2007) 'The impact of students' conceptions of constructivist assumptions on academic achievement and drop-out', Studies in Higher Education, 32:5, 581 - 602

To link to this article: DOI: 10.1080/03075070701573765

URL: http://dx.doi.org/10.1080/03075070701573765

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.informaworld.com/terms-and-conditions-of-access.pdf

This article maybe used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.
The impact of students’ conceptions of constructivist assumptions on academic achievement and drop-out

Sofie M. M. Loyens*, Remy M. J. P. Rikers and Henk G. Schmidt
Erasmus University Rotterdam, Netherlands

This study investigated the impact of students’ conceptions of constructivist learning activities on academic achievement and drop-out. Although constructivism represents an influential view of learning, studies investigating how students conceptualize this perspective have not been conducted before. A structural equation modelling approach was adopted to test different models relating students’ conceptions to their achievement in the university setting. Results suggested an indirect relationship between conceptions and achievement, mediated by actual learning activities. What students believe about the role of knowledge construction in learning predicts the actual learning activities they undertake. How important they consider inability to learn and motivation for learning predicts their study time.

Introduction

People’s conceptions of learning and knowledge vary widely. They serve as a frame of reference for how people approach learning tasks. Theories of what knowledge consists of, and how it can be acquired, influence these learning tasks (Bereiter & Scardamalia, 1989). Similarly, students bring along a variety of conceptions of learning when they enter university that they may have inherited from their previous educational experiences (Marton et al., 1993). Therefore, conceptions of learning may play an important role in students’ study processes.

Conceptions of learning have come to attention again due to the influence of new views on learning, in which personal knowledge constructions and subjective beliefs of learners play a pivotal role (Wigfield et al., 1996). This constructivist perspective is embodied in numerous ways, but most constructivist theories share four core
assumptions that should be considered while creating learning environments for students (Marshall, 1992; Woolfolk, 2004).

The first assumption concerns the way knowledge is acquired by the learner. It implies that deep understanding of subject matter is a result of knowledge construction and transformation, not merely information acquisition and accumulation (Blumenfeld, 1992; Lonka et al., 1996). The central idea behind knowledge construction is that learners interpret new information by using and relating it to knowledge that they have acquired previously. This process is called elaboration, and it has been shown to produce significant learning gains (Pressley et al., 1987; Willoughby et al., 1993).

A second dimension of constructivism is cooperative learning (Slavin, 1996; Ryan, 2000). Social interactions with fellow students, teachers, and others contribute to the construction of knowledge (Steffe & Gale, 1995). Although constructivist theorists differ with regard to the extent that cooperation contributes to knowledge acquisition, they share the idea that social negotiation and interaction is an important factor in this process (Greeno et al., 1996). In his review of research on cooperative learning, Slavin (1996) highlights the elements of cooperative learning that promote achievement. Cooperative learning leads to higher motivation, stronger social cohesion, and it enhances mental processing like cognitive elaboration. Each of these effects has been demonstrated to be beneficial for students’ learning outcomes.

A third key concept underlying the constructivist perspective is that students use their meta-cognitive skills to set academic learning goals for themselves or, in other words, that they are self-regulated learners (Zimmerman, 1989). Self-regulated learning implies having knowledge of effective learning strategies and knowing how and when to use them (Schunk & Zimmerman, 1994; Winne, 1995). To be able to regulate your own learning is viewed as the key to successful learning in school and beyond (Boekaerts, 1999). In a study by Pintrich and de Groot (1990), self-regulation evolved as the best predictor of academic performance of all the outcome measures studied. Also, high- and low-achieving students appear to differ on self-regulated strategy use, with high achievers reporting a significant greater degree of engagement in such strategy use (Cantwell & Moore, 1996; VanZile-Tamsen & Livingston, 1999). Self-regulation has a substantial additive value even on top of intelligence in explaining academic performance (Minnaert & Janssen, 1999).

Finally, the usefulness of authentic, ill-structured problems for education is the fourth core assumption put forward by constructivists. Confronting students with complex problems, similar to the kinds of problems they will face in their future profession, makes learning situations more similar to real-life, professional situations, which, consequently, would promote transfer of knowledge (Mayer & Wittrock, 1996; White & Frederiksen, 1998). Ill-structured problems also serve as facilitators for processing new information, since discussing these problems activates relevant prior knowledge to which new knowledge can be related (Schmidt et al., 1989; Hmelo-Silver, 2004).

The scarcity of literature discussing the students’ perspective on these aspects of learning is in sharp contrast to the abundance of studies demonstrating the effects of constructive activity on learning. How do students conceptualize constructive learning activities? And how are these conceptions linked to their performance? In
other words, do students believe that rephrasing subject matter in one’s own words improves learning? Or that discussing subject matter with peers helps? And do these beliefs actually influence learning?

The way in which students understand the nature of learning, that is, students’ conceptions of learning, has become an increasingly significant construct in recent research on effective learning. Similarly, conceptions of knowledge (i.e. epistemologies) have also come to the fore in educational research (e.g. Schommer-Aikins, 2002), although Hofer and Pintrich (1997) have argued that it is better from a theoretical point of view that conceptions of learning and epistemologies, albeit indisputably related to each other, are kept separate. With respect to conceptions of learning, Boyle et al. (2003) report these to be an important determinant of effective learning, together with deep learning and self-regulated learning. Conceptions of learning also have a central role in taxonomies such as Säljö’s (Säljö, 1979; Marton et al., 1993). Furthermore, several studies have linked conceptions of learning with academic achievement (Dahlgren & Marton, 1978; Van Rossum & Schenk, 1984; Crawford et al., 1994; Mclean, 2001). Therefore, a question that comes to mind is: to what extent do these findings generalize to student conceptions of constructivist practices? And if so, how are these constructivist conceptions related to actual learning? Is there a direct relationship between them and achievement? Or do they have an impact on achievement solely via mediating variables such as study strategies? The study reported here addresses these questions.

Students’ conceptions of constructivism were measured through a questionnaire in which students’ beliefs about the usefulness for their own learning of knowledge construction, cooperative learning, self-regulation and the use of authentic problems were measured. In addition, beliefs about the effects of self-perceived inability to learn and about the role of motivation in learning were taken into account. Self-perceived inability to learn refers to feelings of doubt concerning one’s own learning capacities. It has been observed that open, constructive learning environments require a great deal of responsibility from learners in terms of being socially apt, self-regulated knowledge constructors. Some learners may experience this as a positive challenge and as part of their learning process, but others may relapse into uncertainty, confusion, and even anxiety (Duke et al., 1998). Motivation to learn is a widely acknowledged factor influencing students’ learning (e.g. Schunk, 1991; Pintrich & Schunk, 1996), and was therefore also included. Students’ conceptions were measured at the beginning of the academic year, and their predictive validity for students’ grades at the end of the academic year, and possible drop-out, was investigated. Self-study time and other students’ learning activities (as observed by their tutors) were included as possible mediating variables.

It was hypothesized that students’ conceptions have primarily an indirect influence on students’ academic achievement, because we assumed that what students believe about learning has mainly an impact on what they do. The actual learning activities they undertake, in turn, would influence academic performance. A structural equation modelling approach was adopted to test different models concerning the impact of students’ conceptions on academic success.
Method

Participants

Participants were 180 students (126 female and 54 male) enrolled in the first-year, problem-based learning psychology curriculum of Erasmus University Rotterdam, the Netherlands. The mean age of the students was 19.94 and the response rate was 74.4% of the first-year student population.

The learning environment in which the study took place

The psychology curriculum in this study applies a problem-based learning approach. Problem-based learning has its roots in constructivist learning theories. Students work in small groups on authentic problems, under the guidance of a tutor (Barrows, 1996). First, students discuss a problem and possible explanations or solutions are proposed. Since their prior knowledge of the problem-at-hand is limited, this discussion leads to the formulation of issues for further self-directed learning. Subsequently, students spend time studying literature relevant to the issues generated. After this period of self-study, students share their findings, elaborate on knowledge acquired, and have an opportunity to correct misconceptions (Schmidt, 1983; Hmelo-Silver, 2004). The first-year curriculum studied here consists of eight consecutive courses of five weeks each.

Measurement of students’ conceptions

Students’ conceptions of constructivist assumptions were measured by means of a 55-item questionnaire (Loyens et al., 2007). The constructs of self-perceived inability to learn and motivation to learn were also included in the questionnaire. All statements had to be rated on a 7-point Likert-scale ranging from -3 (entirely disagree) to +3 (entirely agree) with 0 reflecting a neutral opinion about a particular statement. Examples of items are shown in Table 1.

The questionnaire is influenced by research on self-regulated learning and motivation (Pintrich & de Groot, 1990), mental models (Vermunt, 1992), conceptions of learning (Marton et al., 1993), conceptions of knowledge (Schraw et al., 2002) and constructivist literature (Marshall, 1992; Eggen & Kauchak, 1999; Woolfolk, 2004), with respect to its theoretical background. However, the questionnaire developed focuses explicitly on conceptions of constructivist learning activities, and is therefore different from existing instruments. Previous research has demonstrated that the questionnaire was able to measure students’ conceptions in a reliable and valid fashion. Students were able to identify the six dimensions comprising the questionnaire, as indicated by the fit of the hypothesized model. The test for measurement invariance showed that factor loadings were equivalent across different groups of students, and that the questionnaire’s underlying factor structure gave evidence of cross-validation. The reliability of the six latent constructs was assessed using coefficient H (Hancock & Mueller, 2001), ranging from .60 to .86 (Loyens et al., 2007).
Measurement of study time and students’ observed learning activities

Students’ self-study time for each five-week course was measured by asking students at the end of each course to estimate the mean number of hours spent on self-study per week.

Observed study activities undertaken by each student were measured through a tutor rating scale. At the end of each course, the tutor evaluates each of their students based on a number of criteria. These include: (1) how well they have prepared themselves with respect to the subject matter studied, (2) how active and motivated they were in the group activities, and (3) how well they fulfilled their roles as chair and scribe. Tutors rated their students for each of these different dimensions on a scale ranging from 1 (student did not show these activities at all) to 5 (student showed these activities to a large extent). After completing this scale, an average rating of observed learning activities was computed, resulting in a rating ranging from 2 to 10. The average of these ratings over all eight courses was used as a measure of the extent and quality of the learning activities undertaken. Reliability analysis of the three subscales (i.e. preparation, participation, and role as chair and scribe) gave evidence of good internal consistency, with Cronbach’s alpha values of .85, .89, and .86 respectively. The rating scale is shown in Table 2.

Outcome measures

Academic achievement. At the end of each course, students took a course test. They received a grade (ranging from 0 to 10) for their performance on each of these tests. Hence, academic achievement was measured by students’ performance on the eight course tests.

Drop-out. The drop-out-variable consisted of the number of course tests not taken before final attrition. Hence, this variable ranged from 0 (took all course tests) to 7.
S. M. M. Loyens et al.

Table 2. Tutor rating scale for observed learning activities (translated from Dutch)

<table>
<thead>
<tr>
<th>Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The student gave evidence of high-quality self-study activities.</td>
</tr>
<tr>
<td>2. The student’s contributions to the group discussion were of high quality.</td>
</tr>
<tr>
<td>3. The student was able to distinguish main and side issues in the subject matter.</td>
</tr>
<tr>
<td>4. The student studied relevant additional literature on top of the minimal requirement of two literature sources per problem.</td>
</tr>
<tr>
<td>5. The student was able to explain the subject matter in his/her own words.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. The student took part actively in the brainstorm and problem analysis of the problem to be studied.</td>
</tr>
<tr>
<td>7. The student took part actively in the discussion of the problem.</td>
</tr>
<tr>
<td>8. The student was motivated to specify problems to be studied in detail.</td>
</tr>
<tr>
<td>9. The student brought profundity in the group discussion by asking critical questions.</td>
</tr>
<tr>
<td>10. The student looked for relationships among theories and/or group members’ contributions.</td>
</tr>
<tr>
<td>11. The student listened carefully to contributions of other group members.</td>
</tr>
<tr>
<td>12. The student gave evidence of interest and involvement.</td>
</tr>
<tr>
<td>13. The student was on time for the tutorial meetings.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Role as chair and scribe</th>
</tr>
</thead>
<tbody>
<tr>
<td>14. As a chair, the student had prepared him or herself well. He/she had a clear overview of the subject matter that needed to be discussed in the tutorial group.</td>
</tr>
<tr>
<td>15. As a chair, the student structured the group discussion well.</td>
</tr>
<tr>
<td>16. As a chair, the student summarized the subject matter well and at the right moments.</td>
</tr>
<tr>
<td>17. As a chair, the student stimulated all group members to contribute to the discussion.</td>
</tr>
<tr>
<td>18. As a chair, the student asked the group concrete questions to stimulate the discussion.</td>
</tr>
<tr>
<td>19. As a scribe, the student was able to write down contributions of group members in a short and clear way.</td>
</tr>
</tbody>
</table>

(only took one course test before dropping out). Students who did not take any course tests at all were excluded from the analyses.

Procedure

The questionnaire was administered to the first-year psychology students at the beginning of the 2003–04 academic year. The questionnaire’s instruction stated that there were no right or wrong answers to the items, all answers were correct as long as they reflected students’ personal opinions. No information was given about the assumptions underlying the questionnaire. Filling in the questionnaire took approximately ten to fifteen minutes. The remaining measurements were collected throughout the academic year and compiled at the end of the year.

Statistical analysis

A descriptive analysis was initially conducted. Data were then subjected to structural equation modelling, and hypothesized structural relationships among the variables were established. A two-stage approach was followed in the analysis. The first stage
Note: For clarity, correlations among the six conceptions of constructivism were omitted. e = error, measurement error of observed variables; res = residual, error in the prediction of endogenous factors from exogenous factors.

Figure 1. Hypothesized model with academic achievement as dependent variable
involved the testing of the measurement model, and the second stage involved testing of the structural models, depicted in Figure 1 and Figure 2.

Measurement model. Academic achievement was modelled as a latent factor underlying measured variables (being the results of the eight course tests). Confirmatory factor analysis was conducted as a first step to determine the adequacy of factor loadings and model fit of the academic achievement variable using Amos 5.0 (Arbuckle, 2003).

Structural models. The hypothesis that the associations between students’ conceptions of constructivist assumptions and academic achievement would be mediated by students’ observed learning activities and self-study time was tested by the structural equation model (Figure 1). In this model, academic achievement is a latent variable specified by eight factors. Students’ conceptions of knowledge construction,
cooperative learning, self-regulated learning, authentic problems, inability to learn and motivation to learn are observed variables. A measurement model of these six variables with their associated questionnaire items was tested in a previous study (Loyens et al., 2007). For the model depicted in Figure 2, the same procedure was completed.

Maximum likelihood estimations were used for the estimation of the models’ parameters. For the evaluation of the models presented in Figure 1 and Figure 2, two groups of fit indices, absolute and incremental, were selected.

In the present study, $\chi^2$, accompanied by degrees of freedom, sample size and $p$-value, as well as the root mean square error of approximation (RMSEA, Steiger, 1990) were used as absolute fit indices. $\chi^2$ has been the traditional statistic to test the closeness of fit between an observed and predicted covariance matrix. A small $\chi^2$ value, relative to the degrees of freedom, is an indication of good fit, and vice versa (Byrne, 2001). Although there is no clear-cut guideline about what value of $\chi^2$ divided by the model’s degrees of freedom is minimally acceptable, it is frequently suggested that this ratio should be less than three (Kline, 1998). RMSEA appears to be sensitive to model specification, minimally influenced by sample size, and not overly influenced by estimation method, and was therefore included (Fan et al., 1999). The lower the value of RMSEA, the better the fit, with a cut-off value close to .06 (Hu & Bentler, 1999).

Two incremental fit indices were included: the Tucker–Lewis index (TLI, Tucker & Lewis, 1973) and the comparative fit index (CFI, Bentler, 1990). Both indices range from 0 to 1, with higher values indicating a better fit. Values greater than .90 are traditionally associated with well-fitting models (Bentler, 1990), although, more recently, cut-off values close to .95 or .96 are suggested (Hu & Bentler, 1999; Byrne, 2001). With respect to the values of the standardized path coefficients, values less than .10 indicate a small effect, values around .30 a medium effect and values greater than .50 a large effect (Kline, 1998).

Finally, $\Delta \chi^2$ tests were used to evaluate the role of the mediating variables (i.e. self-study time and students’ observed learning activities). Alternative hierarchical models of Figure 1 and Figure 2 were constructed, with direct paths between the six conception-variables and academic achievement and drop-out. Each $\Delta \chi^2$ statistic reflects the difference between the $\chi^2$ values of the two hierarchical models; its degrees of freedom equals the difference in the two models’ degrees of freedom. A non-significant value of $\Delta \chi^2$ suggests that the overall fits of the two models are similar (Kline, 1998). With respect to the mediating variables, this implies that the mediated relation between students’ conceptions, academic achievement and drop-out by self-study time and students’ observed learning activities is supported.

Results

Descriptive analysis

Table 3 reports the means, standard deviations, and correlations for each observed variable.
<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Course 1</td>
<td>6.60</td>
<td>1.43</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Course 2</td>
<td>6.03</td>
<td>1.57</td>
<td>.61**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Course 3</td>
<td>4.87</td>
<td>1.74</td>
<td>.50**</td>
<td>.57**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Course 4</td>
<td>4.95</td>
<td>1.71</td>
<td>.63**</td>
<td>.64**</td>
<td>.63**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Course 5</td>
<td>5.76</td>
<td>1.88</td>
<td>.62**</td>
<td>.65**</td>
<td>.66**</td>
<td>.79**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Course 6</td>
<td>5.60</td>
<td>1.85</td>
<td>.62**</td>
<td>.61**</td>
<td>.75**</td>
<td>.78**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Course 7</td>
<td>5.52</td>
<td>1.95</td>
<td>.58**</td>
<td>.60**</td>
<td>.55**</td>
<td>.65**</td>
<td>.66**</td>
<td>.73**</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Course 8</td>
<td>5.28</td>
<td>1.54</td>
<td>.61**</td>
<td>.54**</td>
<td>.56**</td>
<td>.64**</td>
<td>.68**</td>
<td>.67**</td>
<td>.71**</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Observed learning activities</td>
<td>7.24</td>
<td>.57</td>
<td>.42**</td>
<td>.48**</td>
<td>.49**</td>
<td>.57**</td>
<td>.61**</td>
<td>.56**</td>
<td>.54**</td>
<td>.55**</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>10. Self-study time</td>
<td>11.97</td>
<td>5.88</td>
<td>.02</td>
<td>.12</td>
<td>.15*</td>
<td>.18*</td>
<td>.24*</td>
<td>.16*</td>
<td>.20*</td>
<td>.03</td>
<td>.22**</td>
<td>—</td>
</tr>
<tr>
<td>11. Drop-out</td>
<td>.52</td>
<td>1.60</td>
<td>-.24**</td>
<td>-.31**</td>
<td>-.35**</td>
<td>-.49**</td>
<td>-.50**</td>
<td>-.42**</td>
<td>-.24**</td>
<td>-.20**</td>
<td>-.34**</td>
<td>-.29**</td>
</tr>
<tr>
<td>12. Knowledge construction</td>
<td>1.46</td>
<td>.51</td>
<td>.05</td>
<td>.22**</td>
<td>.13</td>
<td>.09</td>
<td>.14</td>
<td>.13</td>
<td>.12</td>
<td>.05</td>
<td>.23**</td>
<td>.06</td>
</tr>
<tr>
<td>13. Cooperative learning</td>
<td>.77</td>
<td>.72</td>
<td>-.07</td>
<td>.03</td>
<td>.07</td>
<td>.04</td>
<td>.07</td>
<td>-.05</td>
<td>-.03</td>
<td>-.02</td>
<td>.12</td>
<td>.15*</td>
</tr>
<tr>
<td>14. Self-regulated learning</td>
<td>-.51</td>
<td>.70</td>
<td>.02</td>
<td>.05</td>
<td>-.09</td>
<td>.03</td>
<td>-.03</td>
<td>.01</td>
<td>-.01</td>
<td>.05</td>
<td>.09</td>
<td>.00</td>
</tr>
<tr>
<td>15. Authentic problems</td>
<td>.84</td>
<td>.71</td>
<td>-.08</td>
<td>.00</td>
<td>.08</td>
<td>.11</td>
<td>.10</td>
<td>.04</td>
<td>.09</td>
<td>-.05</td>
<td>-.02</td>
<td>.12</td>
</tr>
<tr>
<td>16. Self-perceived inability to learn</td>
<td>-.44</td>
<td>.77</td>
<td>.15*</td>
<td>.12</td>
<td>.12</td>
<td>.07</td>
<td>.14</td>
<td>.17*</td>
<td>.11</td>
<td>.12</td>
<td>-.05</td>
<td>.16*</td>
</tr>
<tr>
<td>17. Motivation to learn</td>
<td>.42</td>
<td>1.02</td>
<td>-.06</td>
<td>.07</td>
<td>.00</td>
<td>.07</td>
<td>.15*</td>
<td>.09</td>
<td>.14</td>
<td>.03</td>
<td>.15</td>
<td>.23**</td>
</tr>
</tbody>
</table>

Table 3. Descriptive statistics and correlation matrix for the observed variables
Table 3—Continued:

<table>
<thead>
<tr>
<th>Variable</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Drop-out</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Knowledge construction</td>
<td>−.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Cooperative learning</td>
<td>−.13</td>
<td>.35**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Authentic problems</td>
<td>−.12</td>
<td>.27**</td>
<td>.04</td>
<td>−.23**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Self-perceived inability to learn</td>
<td>−.08</td>
<td>−.29**</td>
<td>−.21**</td>
<td>−.44**</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Motivation to learn</td>
<td>−.05</td>
<td>.28**</td>
<td>.23**</td>
<td>.20**</td>
<td>.11</td>
<td>−.17*</td>
<td></td>
</tr>
</tbody>
</table>

Note: *n* = 180. **Correlation is significant at the .01 level. *Correlation is significant at the .05 level.
Analysis of the measurement model

The proposed measurement model showed a good fit of the model with the data. All eight factor loadings of the course tests were significant, indicating that every course test contributed significantly to the latent factor of academic achievement. The standardized regression coefficients of the eight course test-variables were respectively .73, .74, .72, .86, .89, .87, .79, and .78. The $\chi^2$ analysis of the measurement model revealed the following pattern: $\chi^2(20, n = 180) = 36.72, p > .01$. The fit indices showed a CFI of .98, a TLI of .98, and an RMSEA of .07. These measures indicate that academic achievement was well defined by the eight course tests.

Analysis of the structural model with academic achievement as a dependent variable

Analysis of the hypothesized structural model depicted in Figure 1 ($n = 180$) revealed a CFI of .95, a TLI of .93, and an RMSEA of .06. These indices indicate an adequate fit of the model with the data. The $\chi^2$ analysis, $\chi^2(82, n = 180) = 142.68, p < .001$, on the other hand, suggests that the hypothesized model does not fit the data very well. However, it should be noted that the $\chi^2$ test of statistical significance has several limitations. The test is based on restrictive assumptions that are typically not met. In addition, the intention of a model is to provide an approximation to reality rather than to fully represent all the complexity in the observed data. Furthermore, the $\chi^2$ statistic is quite sensitive to sample size. Therefore, other indices of fit are to be preferred when evaluating a particular model (Marsh et al., 1994).

Table 4 displays the estimates and standard errors of the structural parameters. The estimates account for the hypothesized model that depicts the influence of students’ conceptions of constructivist learning through observed learning activities and self-study time on students’ academic achievement. Five regression paths were significant. Students’ observed learning activities appeared a very strong predictor of academic achievement. Surprisingly, self-study time did not significantly contribute to academic achievement, but it did show a significant relationship with observed learning activities. This suggests that the number of hours students spend on self-study is not directly linked with performance, but individual study hours do show in students’ activities as observed by their tutors. With respect to observed learning activities, knowledge construction appeared a significant predictor. This finding implies that students’ beliefs about being the central agent for their own knowledge acquisition have consequences for the actual learning activities they undertake. No other conceptions of learning contributed significantly to observed learning activities. Self-perceived inability to learn and motivation to learn had significant, positive path estimates leading to self-study time.

$\Delta \chi^2$ test for the structural model with academic achievement as a dependent variable

Finally, a model assuming direct paths from students’ conceptions to academic achievement was compared with the hypothesized model as suggested by Figure 1.
This was done to examine whether the effect of students’ conceptions on academic achievement is necessarily mediated by learning activities and self-study time. This alternative model was identical to the model in Figure 1, but it assumed additional paths from the conceptions directly to academic achievement. The $\chi^2$ test that tested the difference between these two models was non-significant at the .05 level: $\Delta\chi^2 (df = 6) = 11.20$, indicating that direct relations between conceptions and achievement did not lead to a better explanation of the data. Therefore, any relations between conceptions and the endogenous factor (i.e. academic achievement) are entirely mediated by the two mediators.

**Analysis of the structural model with drop-out as a dependent variable**

Testing the hypothesized structural model with drop-out as dependent variable resulted in a CFI of 1.00, a TLI of .97, and an RMSEA of .03, indicating an excellent fit with the data. The $\chi^2$ analysis, $\chi^2 (6, n = 180) = 6.97$, $p > .05$, also supported excellent model fit.

Table 5 shows the estimates and standard errors of the structural parameters of the hypothesized model with drop-out as dependent variable.
The estimates shown in Table 5 revealed six significant path estimates. Similar to the model with academic achievement as dependent variable, observed learning activities emerged as a good predictor of drop-out: the higher tutors rated students’ learning activities, the lower the probability of drop-out. Contrary to the analyses involving academic achievement, self-study time also emerged as an influence on drop-out. The less time students spend on self-study, the higher the probability of premature drop-out. Furthermore, self-study time showed a significant relationship with observed learning activities. With respect to students’ conceptions, a pattern emerged similar to the model with academic achievement as a dependent variable. Students’ conceptions of knowledge construction as an activity that may or may not facilitate learning turned out to be the only significant predictor of observed learning activities. Conceptions regarding one’s own learning ability and about the role of motivation to learn emerged as significant, positive paths to self-study time. Here again, doubts about one’s learning abilities showed a positive relation with self-study time, suggesting that self-perceived abilities in this domain stimulate rather than impede students’ learning processes.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unstandardized Estimates</th>
<th>Standardized Estimates</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed learning activities → drop-out</td>
<td>-.81**</td>
<td>-.29</td>
<td>.20</td>
</tr>
<tr>
<td>Self-study time → drop-out</td>
<td>-.06**</td>
<td>-.23</td>
<td>.02</td>
</tr>
<tr>
<td>Self-study time → observed learning activities</td>
<td>.02**</td>
<td>.21</td>
<td>.01</td>
</tr>
<tr>
<td>Knowledge construction → observed learning activities</td>
<td>.27**</td>
<td>.24</td>
<td>.09</td>
</tr>
<tr>
<td>Cooperative learning → observed learning activities</td>
<td>-.01</td>
<td>-.01</td>
<td>.06</td>
</tr>
<tr>
<td>Self-regulated learning → observed learning activities</td>
<td>.03</td>
<td>.04</td>
<td>.07</td>
</tr>
<tr>
<td>Authentic problems → observed learning activities</td>
<td>-.08</td>
<td>-.10</td>
<td>.06</td>
</tr>
<tr>
<td>Self-perceived inability to learn → observed learning activities</td>
<td>.01</td>
<td>.02</td>
<td>.06</td>
</tr>
<tr>
<td>Motivation to learn → observed learning activities</td>
<td>.02</td>
<td>.04</td>
<td>.04</td>
</tr>
<tr>
<td>Knowledge construction → self-study time</td>
<td>-.21</td>
<td>-.02</td>
<td>.94</td>
</tr>
<tr>
<td>Cooperative learning → self-study time</td>
<td>1.17</td>
<td>.14</td>
<td>.64</td>
</tr>
<tr>
<td>Self-regulated learning → self-study time</td>
<td>.24</td>
<td>.03</td>
<td>.70</td>
</tr>
<tr>
<td>Authentic problems → self-study time</td>
<td>.73</td>
<td>.09</td>
<td>.63</td>
</tr>
<tr>
<td>Self-perceived inability to learn → self-study time</td>
<td>1.76**</td>
<td>.23</td>
<td>.62</td>
</tr>
<tr>
<td>Motivation to learn → self-study time</td>
<td>1.35**</td>
<td>.23</td>
<td>.44</td>
</tr>
</tbody>
</table>

Note: **p < .01.
Including direct paths from the learning conceptions to the drop-out variable resulted in a model with zero degrees of freedom (i.e. a just-identified or saturated model). Therefore, the $\chi^2$ test of the model depicted in Figure 2 also serves as the $\Delta \chi^2$ test, since the saturated model has, by default, a $\chi^2$ of zero. The value of $\Delta \chi^2$ (df=6) = 6.97 was nonsignificant at the .05 level, indicating that direct relations between conceptions and drop-out did not lead to a better explanation of the data. Therefore, any relations between conceptions and drop-out are entirely mediated by the two mediators.

Discussion

Impact of conceptions of constructivism on achievement and drop-out

The present study investigated the impact of students’ conceptions of constructivist assumptions on academic achievement and student drop-out. Upon entering university, students in a problem-based psychology curriculum were questioned about their beliefs as to the utility of knowledge construction, cooperative learning, self-regulated learning and the use of authentic problems for learning. In addition, their beliefs about their own (in)ability to learn and motivation were studied. Two hypothesized models were tested and a $\Delta \chi^2$ test was used to examine whether the influence of students’ conceptions on achievement and drop-out was mediated by self-study time and students’ observed learning activities. Results revealed a good fit of the models with the data for the two structural models under study. These findings imply that similar to the previously found effects of students’ conceptions on achievement (e.g. Van Rossum & Schenk, 1984; Crawford et al., 1994; McLean, 2001), mediated relations appear to exist between conceptions of constructivism and performance.

Mediated relationship between conceptions and achievement

The second part of our study addressed the question of whether the influence of students’ conceptions on academic achievement was mediated by actual learning activities. To that end, we measured learning activities by mapping students’ self-study time and by having students’ learning activities rated by their tutors. The non-significant $\Delta \chi^2$ tests implied that the relations between the conceptions and academic achievement and drop-out were completely mediated by self-study time and other learning activities, such as whether the student prepared themself sufficiently and whether the student participated actively and enthusiastically in the group activities. What students believe concerning knowledge construction, self-perceived inability to learn and motivation to learn has indeed an impact on what they do (i.e. in terms of self-study time, study preparation, active participation, etc.), and consequently students’ activities influence academic performance and drop-out.
Correlations between observed variables

The correlation matrix suggested a central role for students’ observed learning activities. This variable appears associated with all performance measures (i.e., the course tests) as well as self-study time. In the curriculum under study, an independent tutor rated the students with respect to their learning activities. This assessment takes place at the end of every course and appears to be predictive of students’ subsequent performance. Drop-out was negatively correlated with all other observed variables, but correlations with the conception variables were non-significant. The strongly negative correlations of drop-out with the course tests showed the expected pattern: the higher students score on the course tests, the lower the probability of drop-out. With respect to students’ conceptions of constructivism, several conceptions appear interrelated, which can be expected due to their common umbrella term ‘constructivism’. Self-perceived inability to learn as a determinant of learning showed negative correlations with almost all other conceptions. This finding underlines its negative connotation in students’ learning process. By contrast, conceptions of the role of motivation to learn had significant positive correlations with almost all other conceptions of constructivism, stressing its influential role in learning (Pintrich & Schunk, 1996).

The role of the mediating variables

A closer look at the mediating variables points out again the crucial role of observed learning activities. Observed learning activities showed a large effect on academic achievement and a medium effect on drop-out. Tutors’ judgements about how well students had prepared for the tutorial meetings, and how active and motivated they were in the group activities, appeared good predictors for subsequent success or failure. In line with the correlation results, this finding underlines how crucial it is for students to engage in high-quality self-study activities, explain subject matter in their own words, read additional literature sources, take an active part in the group discussions, demonstrate interest and involvement, and to fulfil the roles of chair and scribe of the tutorial group well.

Self-study time, on the other hand, did not show a direct effect on academic achievement. It had a small average effect on performance, but only through the other learning activities. This finding is in line with a recent study by Plant et al. (2005). In their research, self-study time only emerged as a significant predictor of performance (in their case cumulative grade point average) when other variables were taken into account. Similarly, a study on the relationship between self-study time and academic achievement demonstrated that time spent on individual study correlated poorly with students’ performance on knowledge tests. The authors concluded that the relationship between study time and study success is complex, and that qualitative factors about the way students learn need to be taken into account (van den Hurk et al., 1998). In addition, students’ ability level might also interfere in the relationship between self-study time and performance. With respect to drop-out, however, self-study time
turned out to be a direct predictor: The higher the amount of study time, the lower the probability of attrition.

**The pattern of path coefficients**

With respect to the standardized path coefficients, the impact of students’ conceptions of constructivism revealed the same significant effects for both hypothesized models (i.e. for academic achievement and drop-out as dependent variables). Conceptions of knowledge construction significantly predicted observed learning activities, and the conceptions of self-perceived inability to learn and motivation to learn had a significant positive effect on self-study time. The first finding implies that the more students agree with actively constructing their own knowledge, and the beneficial effect of relating new knowledge to previously acquired knowledge, the higher the ratings they receive from their tutors. The same implications hold for inability to learn and motivation: the more students agree on the importance of these concepts, the more hours they spend on self-study. For conceptions of self-perceived inability to learn, its positive effect on self-study time seems rather counter-intuitive, because it is a factor that is commonly referred to as a possible negative by-product of constructivist learning environments (Duke et al., 1998). However, Block (1996) argued that students’ encounter with their perceived inability can have beneficial effects. After all, students will work harder to manage this uncertainty and, by doing so, they may come to a degree of acceptance or tolerance of uncertainty, which makes them less averse to it. Similarly, McInerney et al. (1997) concluded, from their study of computer achievement and computer anxiety, that the anxiety experienced by their participants was not debilitating but actually facilitating in terms of performance. Our finding concerning self-perceived inability to learn confirms that, the more insecure students believe they are with respect to their learning process, the more they study. However, bearing in mind the study of van den Hurk and colleagues (1998), this finding does not shed light on the quality of students’ study hours, only on the quantity. In sum, even though students in constructivist learning environments might experience feelings of inability, confusion or anxiety, these feelings do not appear detrimental in terms of study hours. With respect to the importance of motivation to learn, students’ conceptions seem to be in line with numerous studies that actually demonstrate the positive impact of motivation on learning (Pintrich & Schunk, 1996).

Students’ conceptions of cooperative learning, the usefulness of authentic problems and self-regulated learning activities did not show significant effects on learning activities or self-study time. The question is why this is the case. One could argue that cooperative learning and authentic problems differ from the other elements of constructive learning, because they are describing the learning environment rather than behaviours of students. Both concepts refer to context factors, and students possibly experience more difficulty in estimating the effects of these factors. Estimating the impact of concepts in which they themselves have a clearly defined role (e.g. relating subject matter to previously acquired knowledge or feeling doubts concerning which subject matter to study) may be easier. If this is true, then it is puzzling...
why beliefs about the role of self-regulation did not have significant effects on the mediating variables. Self-regulation is a student-generated activity, just like the construction of knowledge. A possible explanation could be that the students involved in this study had just entered university, and could only rely on their previous educational experiences in secondary school. Especially for self-regulated learning, this may have coloured their answers, since secondary education is typically teacher-centred: the teacher indicates which book chapters are important, the teacher clarifies subject matter, and the teacher helps students preparing for the tests. Perhaps the participants involved could not foresee what it would mean to be responsible for one’s own learning, and to plan, monitor, and regulate one’s own learning activities independently.

In summary, what students believe concerning knowledge construction predicts the learning activities they undertake, and the importance they ascribe to their inability to learn and motivation can make predictions with respect to students’ study time. All significant effects emerged in two different hypothesized models, and were clearly predictive in nature, since students’ conceptions were measured at the very beginning of the academic year, whereas all other data were collected throughout the academic year. Although not all conceptions showed effects on the mediating variables, the present findings demonstrate the relative importance of students’ conceptions of constructivism for their learning.

Implications

The relationship we found between some conceptions of constructivist learning and study activities, and consequently academic achievement, indicates that, in order to improve academic achievement, changing study activities is not sufficient, since these activities are to some extent dependent on students’ conceptions. What students believe with respect to learning, and constructivism in particular, plays a role, though indirect, in students’ learning outcomes. Conventionally, the teacher, instructional methods, learning materials and study activities are considered as the elements of change in order to achieve the necessary knowledge reconstruction to promote performance (Sinatra & Pintrich, 2003). Our study suggests that the learner can and has to act as a controller. Students’ conceptions should receive more attention in education, and specific instruction and training programmes could help students in this respect (Lonka et al., 1996).

Limitations

There is, however, a constraint to our findings that is inherent to working with structural models: the models that were tested are just two of the numerous possibilities that can be proposed concerning the relationship between conceptions of constructivist learning, learning activities and performance measures. Several other variables could have been included in these models (e.g. context effects, students’ ability level, actual self-regulation measures, etc.) However, we aimed for a general and simple
structural model, with conceptions of constructivist learning as the main component, since those conceptions and their impact were the cornerstones of the present study.

Another constraint is that the student population in this study was enrolled in a problem-based learning curriculum. To test generalization, the models should be tested in lecture-based curricula.

**Future research**

Future research should examine whether conceptions change throughout students’ academic programmes. Participants in this study were all first-year students. Therefore, it would be informative to investigate whether changes take place, when they take place, and how this impacts on students’ learning activities and performance. A next step could be to investigate whether conceptions can be changed purposively and whether this would influence students’ learning.

**Acknowledgements**

The authors gratefully acknowledge Prof. dr. Gregory Hancock of the University of Maryland for his invaluable suggestions with regard to the statistical analyses. Also, we would like to thank Vereniging Trustfonds Rotterdam for their financial support.

**References**

Arbuckle, J. L. (2003) *Amos 5.0 update to the user's guide* (Chicago, IL, SmallWaters).


