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New learning environments and constructivism: The students' perspective

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Abstract. Research into students' perceptions of their learning environments reveals the impact of these perceptions on the way students cope with these learning environments. Consequently, students' perceptions affect the results of their learning. This study aims to investigate whether students in a new learning environment (NLE) perceive it to be more constructivist when compared with the perceptions students have of a conventional lecture-based environment. Using a questionnaire consisting of seven key factors of constructivist learning environments, the results show that students in the NLE perceive it to be more constructivist when compared to the perceptions of students in a conventional lecture-based environment. The difference was statistically significant for four of the seven factors. According to the effect size, as measured by the *d*-index, the difference in perception between the two groups was greatest for the factor 'conceptual conflicts and dilemmas'.

Keywords: constructivism, higher education, students' perceptions

In recent years, education has frequently been blamed for graduates not being sufficiently able to apply their knowledge to solve complex problems in a working context. The development and implementation of instructional practices that will foster students' skills to communicate, think and reason effectively, make judgements about the accuracy of large volumes of information, solve complex problems and work collaboratively in diverse teams, remains an important challenge for today's higher education (Pellegrino et al., 2001). New Learning Environments (NLEs), based on constructivist theory, claim to develop an educational setting to reach this goal, making the students'

learn the core issue and defining instruction as enhancing learning (Lea et al., 2003). The gap between educational practice and the theory of constructivism seems to be difficult to bridge, however (De Corte, 2000). One major problem is that it has been difficult to characterise a constructivist learning environment (Windschitl, 2002). Constructivism can be seen as an umbrella term that groups learning perspectives with the same basic assumption about learning: the understanding that knowledge is actively constructed by the learner (Harris & Alexander, 1998; Tynjälä, 1999; Birenbaum, 2003). In this sense all learning environments are constructivist since, even in teaching situations such as drill and practice, students are constructing knowledge and this is simply because that is the way the mind operates (von Glaserfeld, 1993). Many discussions between the different theoretical positions of constructivism, all with varying emphases, have inhibited the narrowing of the bridge between theory and practice (Kennedy, 1997). Different perspectives of constructivism emphasise either individual cognitive processes, such as cognitive constructivism which is concerned with the knowledge construction of the individual, or social co-constructions of knowledge, such as social constructivism which stresses the collaborative processes in knowledge building (Windschitl, 2002). Despite many animated discussions, there seems to be no incompatibility amongst the theories and integrative approaches seem to be developing (Resnick, 1994; Vosniadou, 1996; Tynjälä, 1999). Despite ongoing debates, the constitution of the instructional principles of constructivist theory, which guide the nature and quality of educational materials and the learning environment, remains unclear (Harris & Alexander, 1998; Tenenbaum et al., 2001). Both teachers and researchers are in need of more concrete anchors to support their thoughts and actions in applying constructivism to educational practice (Windschitl, 2002).

Key factors of constructivist learning environments

During the past decade, some authors attempted to define the key features of constructivist learning environments and developed questionnaires to evaluate their presence in daily educational practice. Taylor et al. (1997) developed the new Constructivist Learning Environment Survey (CLES), based on the original CLES (Taylor & Fraser, 1991), to assess the degree to which students in secondary education perceive a mathematics or science learning environment to be consistent with the key dimensions of constructivism. Small-scale qualitative studies, as

well as large-scale quantitative studies, were conducted. In the qualitative studies, the researchers visited classrooms as participant-observers, interviewed students and teachers and analysed documents from the curriculum. In both cases, the focus was on the way the students made sense of responding to CLES items and how the data from the CLES were compatible with the observations. The qualitative part resulted in a 30 item questionnaire, divided into 5 scales of 6 items. The statistical characteristics of this questionnaire were determined in two large-scale quantitative surveys. The final version of their survey consists of 5 scales of 6 items, each to be answered on a 5-point Likert scale. The 5 scales that Taylor and colleagues identified for secondary education are: (1) personal relevance, (2) uncertainty, (3) critical voice, (4) shared control and (5) student negotiation. Taylor et al. (1997, p. 300) argue that, because of the satisfactory internal consistency and factorial validity of the 5 scales, the CLES can be used "to monitor the development of constructivist learning environments in school science in Western cultures".

In the field of university teaching, Tenenbaum et al. (2001) recently empirically defined and examined key features of constructivist learning environments and their incorporation into two different learning environments (on-campus and distance learning). In the first phase of their study, they carried out a survey using an international electronic mailing list to explore the concept of constructivism, the processes underlying constructivist learning, and its facilitation. In the second phase, they elaborated further on the key features of constructivism in the learning environment and developed a questionnaire using the results of phase 1. A subsidiary aim of this second, quantitative phase was the development of a questionnaire that could be used by other researchers in different educational settings to investigate the presence and/or absence of constructivist practices. The results of the study in both phases were very similar and resulted in a survey containing thirty 5-point Likert scale questions. Seven key factors of constructivist learning environments underlie this questionnaire: (1) arguments, discussions, debates; (2) conceptual conflicts and dilemmas; (3) sharing ideas with others; (4) materials and measures targeted toward solutions; (5) reflections and concept investigation; (6) meeting student needs; and (7) making meaning, real-life examples. Comparison of students' perceptions of the seven factors in different units within the same educational setting revealed that the extent to which the seven factors were experienced differ between various units. Furthermore, comparison between the designers' perceptions and the students' perceptions indicated that the seven factors are not very strongly present in the learning environment from the perceptions of the students, despite the belief of the designers

that they had created the learning environments in such a way. The difference was clearest for the factors 'sharing ideas with others' and 'making meaning, real life examples'.

New learning environments: the case of problem-based learning

Generally, the theory of constructivism is frequently referred to when discussing NLEs. New learning environments, such as project-based education, case-based learning and problem-based learning are claimed to have the potential to improve the educational outcomes for students in higher education (Simons et al., 2000; Lea et al., 2003). Problem-based learning is probably the best known example of a NLE claiming to be highly consistent with constructivist features (Russell et al., 1994; Savery & Duffy, 1995; Hendry et al., 1999; Segers et al., 1999; Birenbaum, 2003). Although new in some aspects, Problem-Based Learning (known as PBL) is generally based on ideas that originated earlier and have been nurtured by different researchers (Dewey, 1910, 1944; Piaget, 1954; Bruner, 1959, 1961; Rogers, 1969; Ausubel et al., 1978). PBL originated in the 1950s and 1960s. Nowadays, PBL is developed and implemented in a wide range of domains. In spite of the many variations of PBL that have evolved, Barrows (1996) describes a core model of PBL in which six fundamental characteristics can be distinguished. The first characteristic is that learning needs to be student-centred. Secondly, learning has to occur in small student groups, under the guidance of a tutor. The third characteristic refers to the tutor as a facilitator or guide. Fourthly, authentic problems are encountered in the learning sequence, before any preparation or study has occurred. Fifthly, the problems encountered are used as a tool to achieve the required knowledge and the problem-solving skills necessary to eventually solve the problem. Finally, new information is acquired through self-directed learning.

Although all NLEs are designed to educate students to analyse and solve problems in an efficient way, empirical studies regarding the effects of such learning environments do not always demonstrate the expected learning outcomes (Segers, 1996). Understanding and improving educational effects demands a 'multi-directional attack' (Goodyear & Hativa, 2002). Research shows that the way the learning environment is perceived by the students, rather than the factual curriculum, affects to a large extent how students cope with the learning environment and, consequently, their learning results (Fraser et al., 1987; Entwistle & Tait, 1990; Brekelmans et al., 1997; Segers &

Dochy, 2001). It follows that educational interventions will be ineffective unless they modify students' perceptions in the intended way. A recent study of students' perceptions of PBL (Dochy et al., 2005) indicated that students perceive the characteristics of the problem-based learning environment, translated into statements, as being present and of high consequence for their learning. If one ponders the implementation of NLEs, a major question is whether students from NLEs achieve goals in a more effective way than students who receive more conventional instruction. Conventional instruction methods are those that are marked by large group lectures and instructor-provided learning objectives and assignments (Albanese & Mitchell, 1993). Since constructivism is the underlying theory referred to when superior effects of NLEs are postulated, we assume that the extent to which students perceive the constructivist principles in the learning environment as being present will be related to the expected effects of the learning environment. The main aim of the present study is, therefore, to verify whether students in NLEs perceive the learning environment to be more constructivist when compared to the perceptions students have of a conventional lecture-based environment. A question of particular interest is for which factors the differences between the NLE and the conventional lecture-based environment are the largest. The NLE used in this study is highly consistent with the characteristics of PBL, as will be outlined below.

Method

Participants

The participants in this study were 229 students studying in a problem-based curriculum and 188 students in a lecture-based curriculum. Students studied in two different universities offering bachelor and masters law programs. In both groups, students studied law and were enrolled in a course on the topic of private law (including the history of private law), offered by both universities in second semester of the second year of their undergraduate law studies.

Instrument

The students completed the questionnaire developed by Tenenbaum et al. (2001) to obtain a view of students' perceptions of the presence of constructivist practices and principles in their learning environments.

The original questionnaire was translated into Dutch by the first author. Four expert educational scientists were given the questionnaire in order to decide if the translation was accurate and phrased clearly enough. To check the latter, the questionnaire was also presented to a small group of students. This resulted in a final translation of the original questionnaire. An example for each factor is presented in Table 1. The first factor, 'arguments, discussions, debates', stresses learning as an active and cumulative construction of knowledge. The extent to which students are confronted with conceptual conflicts indicating that knowledge is not certain is captured by the second factor, 'conceptual conflicts and dilemmas'. The third factor, 'sharing ideas with others', deals with learning as a cooperative process. The goal-oriented aspect of learning is covered by the fourth factor, 'materials and measures targeted toward solutions'. The fifth factor, 'motivation toward reflections and concept investigation', asks about the extent to which metacognitive aspects of learning are stimulated. The student-centred character of the learning process is stressed in the sixth factor, 'meeting student needs'. Finally, the seventh factor, 'making meaning, real-life examples', deals with the contextual aspect of learning. Confirmatory Factor Analysis (CFA) was used to verify whether the original factor structure could be validated. The value for the Root Mean Square Error of Approximation (RMSEA = 0.07) indicates that the data set fits the 7-factor model fairly well (sufficient fit values are smaller than 0.08, Browne & Cudeck, 1993; Guay et al., 2003) whereas the χ^2/df value (2.82) exceeds the guideline of $\chi^2/df < 2$ somewhat. The latter was also the case in the original questionnaire (Tenenbaum et al., 2001).

The Cronbach's α coefficient of 0.91 indicated a high overall reliability of the translated questionnaire. The α coefficients of the subscales are also all judged to be acceptable for assessing differences between groups (Mehrens & Lehmann, 1991): the arguments, discussions, debates scale: 0.79; the conceptual conflicts and dilemmas scale: 0.66; the sharing ideas with others scale: 0.76; the materials and measures targeted toward solutions scale: 0.60; the reflections and concept investigation scale: 0.79; the meeting student needs scale: 0.74; and the making meaning, real-life examples scale: 0.62.

Procedure

In both groups, the questionnaires were administered to all students who were present during one of the meetings near the end of their course. Participation was voluntary and confidential. Students were told that their responses would remain anonymous.

Table 1. Main characteristics and an example for each factor of the questionnaire used in the study

Factor	Main characteristics	Scale example
Arguments, discussions, debates	Learning as an active and cumulative construction of knowledge	The unit allowed for constant exchange of ideas between student and teacher
Conceptual conflicts and dilemmas	Confrontation with conceptual conflicts: knowledge is not certain	The unit caused confusion among conceptual ideas
Sharing ideas with others	Learning is cooperative	The unit allowed social interaction
Materials and resources targeted towards solutions	Learning is goal-oriented	The unit included relevant examples
Motivation toward reflections and concept investigation	Motivating the meta-cognitive aspects of learning	The unit encouraged me to examine several perspectives of an issue
Meeting student's needs	The student-centeredness of the learning environment	The unit took into consideration my needs and concerns
Making meaning, real-life examples	The contextual aspect of learning	The unit was rich in examples

The NLE in this study can be seen as a variant of a PBL course, structured as follows. Over 8 weeks, students worked on a topic in the area of private law. During these 8 weeks the students worked twice a week for 2 h in small groups (maximum 19 students) on different tasks, guided by a tutor. As well as these tutorial groups were enrolled in somewhat bigger practical classes (38 students) for 2 h a week and another 4 h a week (2 sessions of 2 h) in large class lectures. Assessment for this course took place by means of a written exam, immediately after the course.

Students in the conventional lecture-based curriculum worked over 12 weeks of the course on a topic in the area of private law. During these 12 weeks, the students attended lectures of 2 h each, twice a week. Assessment for this course took place by means of a written exam, in the examination period at the end of the year.

Results

The students' responses were analysed by means of a one-way multivariate analysis of variance (MANOVA), followed by analyses of variances (ANOVA) using the Bonferroni method on each dependent variable. Calculation of effect sizes (*d*-index) was used to examine the possible differences between the two in the respective factors. Guidelines for the interpretation of the *d*-index generally take $d = 0.2$ as a small effect, $d = 0.5$ as a moderate effect and $d = 0.8$ as a large effect (Cohen, 1988; Kirk, 1996).

Preliminary analysis of the data involved inspection of the normality and homogeneity of the variance assumptions. Normal plots, stem-and-leaf plots and the calculation of skewness and kurtosis were used to check the normality of distribution. To test the equality of group variances the Levene statistics were calculated. All assumptions for the analysis were met.

The results of the MANOVA showed significant differences between the two learning environments on the dependent measures (Wilks's $\Lambda = 0.66$, $F(7,407) = 29.66$, $p < 0.01$). The multivariate η^2 based on Wilks's Λ was quite strong, 0.34 (Green & Salkind, 2003). Table 2 contains the means and the standard deviations of the seven key components of constructivist learning environments in the two groups. All mean differences between the NLE group and the conventional lecture-based group are accompanied by a small to large effect size. The

Table 2. Means and Standard Deviations of the seven key components of constructivist learning environments in the two groups (d = effect size)

Dimensions	Traditional		PBL		d[a]
	M	*SD*	*M*	*SD*	
1. Arguments, discussions, debates	3.15	0.62	3.40	0.71	0.30
2. Conceptual conflicts and dilemmas	2.68	0.73	3.37	0.69	0.81
3. Sharing ideas with others	3.00	0.70	3.61	0.61	0.75
4. Materials and measures targeted toward solutions	3.43	0.67	3.57	0.64	0.17
5. Motivation toward reflections and concept investigation	3.04	0.61	3.18	0.67	0.18
6. Meeting student needs	2.67	0.65	2.99	0.66	0.40
7. Making meaning, real-life examples	3.42	0.61	3.58	0.59	0.21

[a]Effect sizes calculated following Green and Salkind (2003, p. 153).

effect size is about $d = 0.2$ for the factors 'materials and measures targeted toward solutions', 'motivation toward reflections and concept investigation' and 'making meaning, real-life examples'. Somewhat larger effect sizes (about $d = 0.4$) are found for the factors 'arguments, discussions, debates' and 'meeting student needs'. According to the large effect sizes (about $d = 0.7$), the difference in perceptions between the two groups is most salient for the factors 'motivation toward conceptual conflicts and dilemmas' and 'sharing ideas with others'. From the results in Table 2, it seems clear that students in NLEs perceive their learning environment to be more constructivist, compared to the perceptions students have of a conventional lecture-based environment. Using the Bonferroni method, each ANOVA was tested at the 0.007 level (0.05/7). The results of this analysis showed significant differences between the two groups on four of the seven factors: the first factor (arguments, discussions, debates; $F(1,413) = 13.39$, $p < 0.007$, $\eta^2 = 0.03$), the second factor (conceptual conflicts and dilemmas; $F(1,413) = 94.92$, $p < 0.007$, $\eta^2 = 0.19$), the third factor (sharing ideas with others; $F(1,413) = 87.77$, $p < 0.007$, $\eta^2 = 0.18$) and the sixth factor (meeting student needs; $F(1,413) = 24.92$, $p < 0.007$, $\eta^2 = 0.06$). For the other factors, the NLE and the conventional lecture-based learning environment group did not differ significantly from each other. It should be noted, however, that although students perceive the factor 'meeting students needs' as being more present in the NLE, the mean score for this dimension (2.99) is low. On the other hand, it is striking that the factors 'materials and measures targeted toward solutions'

and 'making meaning, real-life examples' are perceived by the students in the conventional lecture-based environment as relatively highly present (with mean scores respectively of 3.43 and 3.42).

Conclusion and discussion

Research into students' perceptions of a learning environment reveals its impact on the way students cope with that learning environment and, consequently, their learning results (Fraser et al., 1987; Entwistle & Tait, 1990; Brekelmans et al., 1997; Segers & Dochy, 2001). This article investigated whether students in a NLE perceive their learning environment as more constructivist compared to the perceptions that students have of a conventional lecture-based environment. Learning environments based on constructivism have the potential to improve the educational outcomes for students in higher education (Lea et al., 2003). The NLE used in this study was a variant of PBL, which is claimed to be consistent with constructivist features (Russell et al., 1994; Savery & Duffy, 1995; Hendry et al., 1999; Segers et al., 1999; Birenbaum, 2003). Moreover, constructivism is the underlying theory referred to when the superior effects of PBL are postulated (Dochy et al., 2003). Of particular interest was the question of for which factors the differences between students' perceptions of the NLE and the conventional lecture-based environment were the largest.

Using the questionnaire of Tenenbaum et al. (2001) to probe into students' perceptions of their learning environments, it became clear that students in the NLE perceive their learning environment to be more constructivist when compared to the perceptions students have of a conventional lecture-based environment. According to the effect size as measured by the *d*-index, the difference in perception between the two groups was most salient for the factor 'conceptual conflicts and dilemmas'. Tenenbaum et al. (2001) argue that this factor, stressing the idea that knowledge cannot be found 'out there' and consequently is not certain, represents the constructivist approach more than others. A second factor, called 'sharing ideas with others' also clearly distinguished between the two learning environments. A recent study by Chernobilsky et al. (2004) indicated that effective cooperative learning communities function better and are associated with more meaningful knowledge construction. These two factors determine the strength of PBL in incorporating constructivist principles. Tutors should be aware of the importance of facilitating these two

factors to create a well functioning, cooperative tutorial group that promotes meaningful knowledge construction.

Although the students' perceptions differed significantly on four of the seven factors in the questionnaire and effect sizes varied from sufficient to large, the differences between the two learning environments are not 'extremely' large. For the conventional lecture-based course this means that, according to the perceptions of the students, constructivist principles are also partly incorporated. For the NLE this means that, if the NLE claims to be highly consistent with constructivist features, at least in the perception of the students, a lot of opportunities still remain to be taken up. In particular, the factor 'meeting students' needs' was only moderately present in the NLE. This indicates that students in the NLE only had a relatively small say in the learning process. On the other hand, the conventional lecture-based environment succeeds in paying relatively large amounts of attention to the factors 'materials and measures targeted toward solutions' and 'making meaning, real-life examples', indicating that working with real-life contexts and authentic problems are not the restricted hallmark of NLEs.

The contents of some courses lend themselves more easily to a constructivist approach than others. The question of whether the contents of the courses were sufficiently comparable should, therefore, be discussed. Although a lot of attention was paid to selecting comparable courses, no two courses are exactly the same. Nevertheless, the significant differences between units reported in the study by Tenenbaum et al. (2001) involved differences in disciplines such as arts, business, education, commerce and engineering, while in our study both courses covered the topic of private law at the level of a second year law course at the university.

It should be noted that students' perceptions are not only based on the actual learning environment, but are also based on their former learning experiences and recent experiences (Segers & Dochy, 2001). In both the NLE and the conventional lecture-based environment, the courses involved in this study took place during the last part of the second year. As a consequence, the learning experiences of the students in the conventional lecture-based group are based on other lectures in the first and second years of the curriculum, while the learning experiences of students in the NLE group are based on other courses in the PBL curriculum. It is possible that students in the NLE group judged the course under study as less (or more) constructivist, when compared to previous courses in the PBL curriculum. This is also the case for the students in the conventional

lecture-based group: there is a possibility that the course under study was more (or less) congruent with previous courses in the lecture-based curriculum. Students' perceptions of a PBL course after experiences in a conventional lecture-based curriculum and students' perceptions of a lecture-based course after experience in a PBL curriculum would probably show a bigger gap between the two learning environments. This was also seen in the results of a recent study by Dochy et al. (2005).

As students' perceptions of the learning environment are seen as a powerful factor in the way that students cope with that learning environment, it follows that educational interventions will be less effective if they don't succeed in modifying students' perceptions in the intended way. Research into students' perceptions provides us with more information on the way NLEs are perceived in the intended – constructivist – way. The NLE under study in this paper, a variant of PBL, is perceived by the students to be more constructivist than the conventional lecture-based environment under study. However, it seems that students' perceptions of constructivist principles in the learning environment are triggered by a greater variety in learning environments. Therefore, a global implementation of problem-based curricula, although perceived as more constructivist by the students, is not recommendable. Rather, we believe that future research on NLE should focus on the engineering of an optimal mix of learning environments and take into account students' perceptions of the blend of lectures, problem- and case-based learning groups, practical work, task-oriented learning, workplace learning, online learning opportunities, etc.

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