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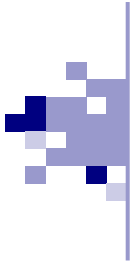
## The impact of a PBL curriculum on students' motivation and self-regulation.

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L'éducation et la formation constituent des enjeux fondamentaux pour la société contemporaine. Deux équipes de recherche à l'UCL se préoccupent de ces questions : le GIRSEF et la CPU.

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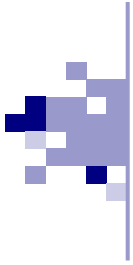
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## **Abstract**

Problem-Based Learning (PBL) is more and more widespread in Higher Education. Among other advantages, PBL is assumed to foster students' motivation and self-regulation. But empirical evidence supporting this claim is scarce, especially at a curriculum level. The aim of this study is to evaluate the impact of a PBL curriculum on the motivation and the cognitive engagement of undergraduate students. The study was conducted in an engineering faculty where a new two-year PBL curriculum has been implemented. The last cohort of students who attended the old curriculum was compared with the first cohort of students who

attended the new PBL curriculum. Those students completed a questionnaire on perception of instructional practices, goal orientations, self-efficacy, self-regulation strategies, and learning strategies at the end of their curriculum (data collected in 2001 and 2002). Multivariate analyses show some positive effects in favour of students from the PBL curriculum, but they also point to some problems linked to the implementation of this new curriculum (work-overload, incoherent assessment). Perceptions of instructional practices partially mediate the PBL curriculum effects. Implications for attempts to improve students' engagement in Higher Education are discussed. ■

A shift from elite to mass education together with a growing emphasis on contribution to graduate employability is nowadays one of the major challenges faced by higher education institutions. (Strata-Etan expert group, 2003). To cope with these challenges, more and more universities foster the implementation of more student-centred and competencies driven curriculums. Problem-Based Learning (PBL) is one of the most well known approaches inspiring these changes. Within PBL environments, students usually work on projects that represent ill-defined, complex real-world problems that have no single right answer (Dumont, 1999). Students are often asked to work in team to understand these problems and/or to achieve these projects (Pochet, 1995).

Among other advantages, PBL is assumed to foster students' motivation and self-regulation (Evensen & Hmelo, 2000). Motivational beliefs (e.g. perceived

ability, goal orientations) and use of self-regulation strategies (i.e. the way students regulate their time, effort, attention, etc.) and learning strategies (i.e. the way student process information to learn) are well-documented determinants for the quality of learning and achievement (Zimmerman & Schunk 2001). This claim about the positive impact of PBL on students' motivation and self-regulation is consistent with research on situated learning (Frenay & Bédard, in press) and on cooperative learning (Slavin, 1995), but direct empirical evidence supporting this claim is scarce, especially at a curriculum level (Blumberg, 2000). Most available evidence is focused on achievement effects (Dochy, Segers, Van den Bossche & Gijbels, 2003). For practical reasons, most of the randomised and controlled studies are conducted at a course level and/or on a relatively short period of time. Studies at a curriculum level are usually less controlled. Moreover, the majority of available evidences are focused on the education of

health professionals. So despite the volume of literature on PBL, our knowledge about the effects of PBL on the quality of learning in different contexts and in different instructional designs does not appear very “safe” (Newman, 2003).

In 2000, the School of Engineering of our university shifted the curriculum of the first two years of its undergraduate program from a “traditional”, lecture-based curriculum, to a problem-based learning curriculum (see [www.fsa.ucl.ac.be](http://www.fsa.ucl.ac.be)). In this new curriculum, problems and projects are situated in realistic professional contexts and incite students to build upon existing knowledge to acquire new knowledge. Communities of learners are fostered through teamwork to stimulate individual learning. The role of staff moved from teachers and assistants into tutors and facilitators. At the beginning of 2001, the Unesco Chair of university teaching and learning was requested to collaborate in the assessment of this new PBL curriculum (Jacqmot et al., 2002). The

timing of this collaboration allowed us to compare students’ outcomes at the beginning of the next academic year after the completion of a 2-years curriculum, either lecture-based or problem-based. This provides an opportunity to assess the impact of long-term (two years) enrolment in a PBL environment on motivation and self-regulation. Student’s effort was also measured through attendance and study time because it influences learning opportunities. The aim of this study is thus to evaluate the impact of a PBL curriculum on the motivation and the self-regulation of undergraduate students. Moreover, we wanted to see if possible effects could be explain by differences in students’ perception of instructional practices, which was shown to be an important factor for students’ engagement (Midgley, 2002). Evidence of a mediation by perceived instructional practices would support the attribution of possible effects to curriculum change, and could contribute to identify key practices associated with improve quality of learning. ■

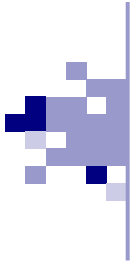
## Method

### Participants and procedure

A survey was conducted in an engineering faculty where a new two-year PBL curriculum has been implemented. As part of a larger study, 170 students of the last cohort who completed the old curriculum were surveyed in November 2001, and 133 students of the first cohort of who completed the new PBL curriculum were surveyed in November 2002. All the students were in the 3rd year of their training when they participated in the study. They completed a questionnaire during regular lecture time. This questionnaire was administered by members of the research team to insure the confidentiality of the answers. The students were 19 to 23 years old (mean = 20 years) and 85 % were male. Age and gender distributions are similar among cohorts, and participation rates are equivalent (57 % vs. 53 %).

### Measures

The questionnaire was constructed on the basis of a compilation and translation of various scales that were selected from an extensive review of the literature. Priority was given to scales already validated in French when available. This compilation was submitted to a panel of experts and to another panel of faculty members from the School of Engineering where the study was to take place. This stage resulted in changes in the original draft (change in the wording of some items, addition or removal of some items). This second draft was submitted to individual and group pretests among students from another faculty to check for proper understanding of the items. Factorial analyses were then performed on the remaining items to compose scales, and the internal consistency, discriminant validity and predictive validity of those scales were examined. More details about the



validation of this questionnaire are presented in Galand, Bourgeois and Frenay (2002) and in Bourgeois, Galand and Frenay (2003).

All scales are based on 1st order factorial analysis. Number of items and internal consistency coefficient of those scales are presented below. For all items, a 5-point scale Likert type response format was used (anchors: 1 = strongly disagree, 5 = strongly agree; except for self-regulation and learning strategies: 1= never, 5 = very often). For the items about perceived instructional practices, participants were instructed to refer to their experience of the two past academic years. For all other items, participants were instructed to refer to what they were doing now. Two examples of items for each scale are shown in annex 1.

*Perceived instructional practices.* Students reported their perceptions of the extent to which their teachers provided them cognitive and emotional support (coaching, 9 items,  $\alpha = .82$ ), promoted authentic learning and transfer of learning to “real-life” context (transfer facilitation, 6 items,  $\alpha = .80$ ), emphasize competition among students (emphasis on competition, 6 items,  $\alpha = .70$ ). They also reported their perceptions of the extent to which they were confronted with work overload in their study (work overload, 4 items,  $\alpha = .60$ ) and the learning assessment practices (tests and exams) were fair (assessment fairness, 5 items,  $\alpha = .71$ ).

*Motivational beliefs.* Students answered questions about their perception of their own ability to succeed in their learning tasks (perceived ability, 10 items,  $\alpha = .82$ ). Students were also asked to report the extent to which different types of goals guide them in their study. More specifically, they answered

questions referring to learning goals, i.e., focus on learning, understanding and mastery (6 items,  $\alpha = .74$ ), performance goals, i.e. focus on demonstrating competence (5 items,  $\alpha = .70$ ), and work avoidance (3 items,  $\alpha = .54$ ).

*Self-regulation strategies.* Students answered questions about the frequency of their use of five self-regulation strategies: (a) supervising oneself when going about a learning task (supervision, 6 items,  $\alpha = .66$ ), (b) controlling one’s progress in learning tasks (monitoring, 3 items,  $\alpha = .69$ ), (c) facing difficulties in managing potential distractions from learning (distraction vulnerability, 3 items,  $\alpha = .53$ ), (d) managing content-related information, like, for instance, searching for other sources of information when a part of the textbook is not understood (information search, 4 items,  $\alpha = .71$ ), and (e) low persistence when facing problems (lack of persistence, 3 items,  $\alpha = .55$ ).

*Learning strategies.* Students answered questions about the frequency of their use of five learning strategies: (a) making links between different pieces of information (relating, 6 items,  $\alpha = .81$ ), (b) searching the relevance of learning material for real-life situations (contextualizing, 4 items,  $\alpha = .79$ ), (c) having a critical stand toward learning material (criticizing, 4 items,  $\alpha = .67$ ), (d) underlying and summarizing learning material (organizing, 4 items,  $\alpha = .60$ ), and (e) memorizing and rehearsing learning material (rehearsing, 3 items,  $\alpha = .61$ ).

*Effort.* Students were asked how many hours a week they usually work outside lessons (study time, 9 point scale, from 0-5 to 41 and more) and which percent of lessons they attend (attendance, 10 point scale, from 10 % to 100 %). ■

## Results

First, several second order factorial analyses were performed on the perceived instructional practices, self-regulation strategies and learning strategies scales in order to reduce the number of variables to handle. Those analyses showed that two factors account for the majority of the variance in each category of those scales. For perceived instructional practices, the two factors are academic support, including coaching and transfer facilitation scales, and organizational structure, including assessment fairness, work overload (negative loading) and emphasis on competition (negative loading) scales. For the self-regulation strategies, the two factors are adaptive strategies, including supervision, monitoring and information search scales, and maladaptive strategies, including distraction vulnerability and lack of persistence scales. For learning strategies, the two factors are deep processing, including relating, criticizing and contextualizing scales, and surface processing, including rehearsing and organizing scales. Factorial scores on those factors were used in the following analyses.

Then, several MANOVAs were performed to compare the answers of the two cohorts of students on each category of variables. Means and standard deviations are presented in Table 1.

*Perceived instructional practices.* Students from the PBL curriculum report more academic support than

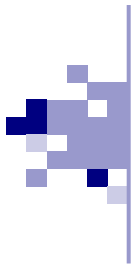
students from the traditional curriculum, but view organizational support more negatively (more work overload, less coherence;  $p < .001$ ).

*Motivational beliefs.* Analyses indicate no significant difference between cohorts regarding perceived ability, learning goals, performance goals, and work avoidance.

*Self-regulation strategies.* Students from the PBL curriculum report using more adaptive strategies (especially information search and monitoring) than students from the traditional curriculum ( $p < .01$ ). This effect is no longer significant when one controls for academic support. There is no effect for maladaptive strategies.

*Learning strategies.* Students from the PBL curriculum report using more deep processing strategies ( $p = .07$ , especially criticizing,) and less surface processing strategies ( $p < .01$ , especially rehearsing) than students from the traditional curriculum. The tendency in use of deep processing disappears when academic support is introduced as a covariate.

*Effort.* Students from the PBL curriculum report more attendance and more study time than students from the traditional curriculum ( $p < .01$ ). The difference in study time is no longer significant when one controls for academic support. ■



**Table 1.** Means and standard deviations

	Lecture-based (n = 170)		PBL (n = 133)	
	M	SD	M	SD
<i>Motivational beliefs</i>				
Perceived ability	3,60	,59	3,59	,55
Learning goals	3,98	,53	4,02	,55
Performance goals	2,23	,73	2,37	,70
Work avoidance	2,53	,82	2,39	,73
<i>Perceived instructional practices</i>				
Academic support <sup>a</sup>	-,34	,98	,44	,83
Organizational structure <sup>a</sup>	,29	1,01	-,37	,87
<i>Self-regulation strategies</i>				
Adaptive <sup>a</sup>	-,16	1,00	,20	,96
Maladaptive <sup>a</sup>	,07	,95	-,09	1,05
<i>Learning strategies</i>				
Deep processing <sup>a</sup>	-,10	1,02	,12	,97
Surface processing <sup>a</sup>	,13	1,03	-,16	,94
<i>Effort</i>				
Attendance	8,09	1,75	8,68	1,12
Study time	3,20	1,51	4,01	1,63

Note. a = factorial score (standardized).



## Discussion

In this study, a cohort of students who followed a lecture-based curriculum was compared with a cohort of students of the same faculty who followed a two-year PBL curriculum. Results of this comparison indicate large differences in the way students perceive the instructional practices they are confronted with. Students who attended the PBL curriculum report more supportive teacher-student relationships and more practices making links between theory and applications. This effect suggests modifications in instructional practices that are consistent with the principles of PBL and with practices reported by teachers of this faculty (Frenay, Bourgeois, Galand, Wouters & Vandeborgh, 2003). But students from the PBL program also report more work overload and less coherence in the program and the assessments. Those problems are also raised by several teachers. These results seem to reflect some difficulties in the implementation of the new PBL curriculum, maybe due to insufficient coordination among teachers.

Results show no significant difference between the two groups of students on motivational beliefs (goal orientations and perceived ability). It could be that a PBL program is not suited to increase students' motivation, but some studies indicate the opposite (Evensen & Hmelo, 2000). Maybe the implementation problems mentioned above could have counterbalanced the positive effect of increased academic support. As goal orientations and perceived ability become more stable with age (Wigfield & Eccles, 2002), it could be also that undergraduates' motivation is less sensitive to contextual factors than secondary school students (Midgley, 2002). Anyway, other differences between the cohorts of students cannot be attributed to variation in motivational beliefs.

On several variables documented to have a positive impact on the quality of learning, such as self-regulation strategies, learning strategies, attendance and study time, the results of this survey show that students from the PBL curriculum get better outcomes than students from the lecture-based curriculum. No negative effect of the PBL curriculum was found.

Most of the differences in favor of the students coming from the PBL curriculum are no longer significant when perceived academic support is controlled. In other words, most of these differences could be explained by changes in perceived instructional practices that are consistent with PBL guidelines. These results support the idea that the implementation of a PBL curriculum has induced more students' self-regulation and higher quality learning (Blumberg, 2000). Moreover, they suggest that these effects could be attributed to increase in coaching and transfer facilitation. Nevertheless, results also underscore some pitfalls in the implementation of this curriculum that may have undermined its effects and that may have negative consequences in the long run if they are not regulated. It shows that a careful monitoring of innovation is often very useful (Hopkins, 2001). Taken together, the results of this study indicate that a problem-based curriculum is an effective and viable way to increase the cognitive engagement of undergraduate students (Jones & Major, 2003).

A limitation of this study is that it relies only on self-reports, some of them presenting low reliability. A new cohort of students will be added to this sample to check if the positive effects of the new PBL curriculum are sustainable over time. Only a limited scope of outcomes was considered in this study, other outcomes are presented elsewhere: results for students' achievement are consistent with the present study (Galand, Frenay & Bourgeois, 2004), but results for team work and students helping each other show no differences between cohorts (Galand, Bourgeois, Frenay & Bentein, 2003). As PBL put forward several kinds of outcomes, multiple criterions should be considered to judge its efficiency. A major limitation of this study is that the students were not randomly assigned to each group and that the measurement is cross-sectional (all the variables in the same time). Obviously, this kind of field studies could not replace systematic, experimental studies. But even if they allow less control, we think that "natural" innovations provide unique opportunities to assess the impact of long-term involvement in different curricula. ■



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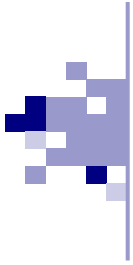
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## Annex 1

Sample items (free translation from French)

Perceived instructional practices

*Coaching.* “In this faculty, teachers provide regular feedback about our progress.” “In this faculty, teachers encourage us to learn from our mistakes.”

*Transfer facilitation.* “In this faculty, teachers show us the possible practical applications of what they teach.” “In this faculty, teachers use concrete examples to explain concepts.”

*Emphasis on competition.* “In this faculty, teachers publicly compare students to each others. In this faculty, teachers favour especially students who are successful.”

*Assessment fairness.* “In this faculty, the grades we get do reflect the students’ level of mastery fairly.” “In this faculty, the content of tests and exams are consistent with the learning objectives.”

*Work overload.* “In this faculty, the requested amount of work doesn’t let us any free time.” “In this faculty, the various teaching activities are well articulated” (reverse score).

Motivational beliefs

*Perceived ability.* “Compared to other students, I feel my abilities are lower” (reverse score). “I am sure to be able to understand the subject-matter in those courses.”

*Learning goals.* “In my study I seek primarily to deepen my knowledge.” “Understanding the subject-matter is more important to me than the grades I get.”

*Performance goals.* “In my study, I seek competition because I found it stimulating.” “It’s important for me to have better grades than other students.”

*Work avoidance.* “In my study, I generally look for easiness.” “I do only what is really needed to pass my next exams.”

Self-regulation strategies

*Supervision.* “When I am facing a difficulty to understand a part of the content, I try to analyse finely the nature of the problem.” “Before I begin to study a subject-matter, I plan in which order I will study it.”

*Monitoring.* “To test my progress in my study, I try to answer questions I ask myself about the subject-matter.” “To check whether I master a subject-matter, I try to think of other examples than those we have had in the class.”

*Distraction vulnerability.* “Most of the time, I wait till the last moment to do my work.” “When I attend lessons, I make sure my attention is totally focused on it” (reverse score).

*Information search.* “I tend not to read more than what is expected for the exams” (reverse score). “If I don’t understand a part of the subject-matter, I try to find relevant information from other sources.”

*Lack of persistence.* “If I don’t understand something, I give up and do something else.” “I do an effort even when what I’m studying is not interesting” (reverse score).

## Learning strategies

*Relating.* “I try to find the similarities and the differences between notions presented separately.” “I try to see the connections between the content of several courses.”

*Contextualizing.* “I try to find the relevance of what I learn in my courses in my daily life.” “I use what I learn at university in my activities outside university.”

*Criticizing.* “I drawn my own conclusions from the data presented by the teachers.” “I compare my own point of view with those presented in the courses.”

*Organizing.* “I make a list of the main points to memorize.” “I summarize the main ideas of my courses.”

*Rehearsing.* “I repeat the main parts of the matter until I know it by heart.” “I try to learn word by word the content of the courses.”



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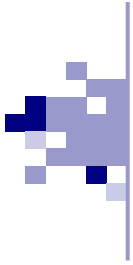
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