Journal of Problem Based Learning in Higher Education

VOL. 2, No. 1, 2014 – Page 45-62
http://dx.doi.org/10.5278/ojs.jpblhe.v2i1.1008

From cases to projects in problem-based medical education

*Diana Stentoft, Meg Duroux, Trine Fink, Jeppe Emmersen **

ABSTRACT

Problem-based learning (PBL) based on patient cases has become a well-established worldwide educational approach in medical education. Recent studies indicate that case-based PBL when used throughout an entire curriculum may develop into a counter-productive routine for students as well as teachers. Consequently, there is a need to develop PBL approaches further allowing students to work with more ill-defined problems and alternative learning structures. In this paper, we argue that this can be realised by introducing project-PBL into the medical curriculum, as in the medical education at Aalborg University, Denmark. We outline organisations of case- and project- PBL in the medical curriculum and present an explorative study of 116 first and second year students' experiences working in the two settings of PBL. Results reveal that students generally rate their PBL experiences positively however, project-PBL is rated more positively than case-PBL on all parameters studied. These results invite further consideration of the differences in working with cases and projects. Two central differences are discussed; the nature of the problem as the trigger of learning and students' possibilities for directing their own learning processes. The study demonstrates that introducing project-PBL may contribute significantly in problem-based medical education. However, the need for extensive research into advantages and limitations of the combined use of case- and project-PBL is also emphasised.

INTRODUCTION

For well over 40 years, problem-based learning has been adopted in medical education programmes as an approach to teaching and learning. Problem-based learning (PBL)

* Diana Stentoft, Department of Health Science and Technology, Aalborg University, Denmark.
Email: stentoft@hst.aau.dk
Meg Duroux, Department of Health Science and Technology, Aalborg University, Denmark.
Email: megd@hst.aau.dk
Trine Fink Department of Health Science and Technology, Aalborg University, Denmark.
Email: trinef@hst.aau.dk
Jeppe Emmersen Department of Health Science and Technology, Aalborg University, Denmark.
Email: emmersen@hst.aau.dk

fundamentally rests upon an assumption that learning is intrinsically tied to a relation of past experiences to new scenarios in the efforts to construct new knowledge. Almost a century ago, Dewey described the following set of premises for engaging with 'educative experiences':

"They are first that the pupil have a genuine situation of experience—that there be a continuous activity in which he is interested for its own sake; secondly, that a genuine problem develop within this situation as a stimulus to thought; third, that he possess the information and make the observations needed to deal with it; fourth, that suggested solutions occur to him which he shall be responsible for developing in an orderly way; fifth, that he have opportunity and occasion to test his ideas by application, to make their meaning clear and to discover for himself their validity" (Dewey, 1916 p. 192).

Resonating well with these premises, problem-based learning emerged and has been continuously developed. Although PBL today is adopted as the educational philosophy in multiple fields and in multiple variations some shared criteria exist as defined by e.g. Barrows; that PBL is student-centred, students work in small groups, teaching occurs as facilitation or guidance, learning is organised around problems which are central to developing problem-solving skills and students are directing their own learning (Barrows, 1996 pp 5 - 6). In addition to the development of both problem-solving skills and self-directed life-long learning skills, PBL should enable students to construct an extensive knowledge base, to become effective collaborators and should make students intrinsically motivated to learn. However research on the motivational effect of PBL is sparse *(Hmelo-Silver, 2004 p. 240)*. One explanation could be that issues concerning why student should be motivated to learn including factors stimulating intrinsic motivation such as autonomy support, feedback and emotional support are only to a limited extent included in medical education curricula (Kusurkar et al., 2012). This is the case despite strong suggestions that intrinsic motivation is an indisputable ingredient to achieve deep student learning (e.g. Biggs & Tang, 2007; Brophy, 2010).

Establishing medical educations based on an approach of problem-based learning thus rests upon intentions for students to develop both scientific and meta-cognitive competencies in preparation for clinical practice and working life in general. However, recent findings from Maastricht University indicate that there is a tendency towards erosion of the PBL approach characterised by changes in students' processing of information, changes in students-staff ratios leading to increasing group sizes and fear of subject matter not being sufficiently covered by students (Moust et al., 2005). Simultaneously, studies show how over time students as well as teachers develop "PBL fatigue" when continuously working within a PBL setting organised solely around cases. This fatigue is counterproductive to the intentions of PBL as it leads to surface learning, poor collaboration, and lack of sharing knowledge in groups (Czabanowska et al., 2012; Moust & Roebertsen, 2010). It is argued that case-based PBL appears challenging and interesting to new students out of secondary school but becomes

too much of a routine for more mature students. To overcome these challenges to PBL it is proposed that alternative organisations of PBL could be introduced e.g. students working with more ill-defined problems and being offered greater possibilities for directing their own learning. The question, however, remains, whether students will experience a greater sense of motivation and engagement with their learning when problems are more ill-defined or when their possibilities for self-directed learning are enhanced. Or rather can we enhance student experiences of learning in medical education by integrating varying PBL alternatives into the curriculum?

In this paper, we examine differences in the organisation of case- and project-PBL and how students experience working with these PBL variations. In the first part we report on an explorative study of students' experiences when working with cases and projects in a problem-based learning environment. The aim of the study was to uncover if students' subjective experiences of the two PBL alternatives are significantly different. The study provides a preliminary comparison of project- and case PBL in undergraduate medical education and will provide a first indication of the relevance of projects as an alternative to cases. This is particularly relevant in light of the experiences of PBL-fatigue which clearly calls for development of new PBL alternatives. The latter part of the paper contains a brief discussion of the two factors identified at Maastricht as possible remedies for limiting PBL-fatigue i.e. the use of more ill-defined problems and enhanced possibilities for students to direct their own learning. The discussion points to some considerable differences between case and project-PBL which need further examination. The paper hence contributes both an experiential and a theoretical comparison of case- and project-PBL and is concluded by raising a range of additional questions to be further investigated.

A CLOSER LOOK AT TWO ORGANISATIONS OF PROBLEM-BASED LEARNING

PBL has become a pedagogical framework encompassing a multitude of practices for learning bound together by their departure in real-life and ill-structured problems, student centeredness and construction rather than acquisition of knowledge (Barrows, 1986; Davis & Harden, 1999). Thus organising PBL around cases or projects are but a few of several PBL alternatives implemented in a multitude of manners depending on resources available, learning objectives and not least, the degree to which PBL is partly or fully adopted into the curriculum (Davis & Harden, 1999). By embarking on the challenge to lay down a set of ground rules for what can be labelled PBL, it could be added that PBL is both a philosophical and methodological approach which ideally should be supported across the curriculum (Maudsley, 1999 p. 184). In light of this, PBL is not merely a tool for organising teaching and learning but rather it is a way to perceive the learner and the entire learning process.

The undergraduate programme of medicine at Aalborg University, Denmark, is anchored in a PBL curriculum structured around both case- and project-PBL. In the following, we provide a

brief contextualisation of PBL as manifested in this particular setting of studying medicine at a University firmly rooted in a strong tradition of project-oriented PBL (Krogh & Jensen, 2013; AAU, 2010). For the sake of clarity, the two PBL alternatives are denoted case-PBL and project-PBL, respectively.

Case-PBL

In medical education, PBL is predominantly associated with learning through collaborative processes centred around hypothetical or real patient cases often with ill-defined problems and with learning objectives emerging through students' active engagement with a case (Barrett & Moore, 2011; David et al., 1999; El-Moamly, 2010; Evensen & Hmelo, 2008; van Berkel et al., 2010). In this light, PBL is conceived as departing in a scenario, dilemma or case that serves to trigger student engagement guided by a facilitator towards learning outcomes specified in the curriculum (Barrett et al., 2011; Savin-Baden & Major, 2004).

At Aalborg University, the problem-based case elements comprising the majority of learning activities in the B.Sc. curriculum are inspired by the structure found at Hull York University where students work in groups with a case for one week based on the seven-jump model (David, et al., 1999). The seven jump model was developed at Maastricht University and has been widely applied for several decades (e.g. Albanese, 2010; Moust, et al., 2005; Schmidt, 1983; Wood, 2003). In brief, the seven jump model is organised around a case opening session where students work with 1-3 patient centred case scenarios in e.g. cardiac disease or diabetes. Through jumps one to five the students reach a set of learning objectives, a process guided by a facilitator. The learning objectives are generated by students working together to identify prior knowledge and experiences relating to the case, brainstorming to organise this knowledge and find explanations and subsequently identifying which knowledge gaps have been encountered to fully comprehend the case. Jump six is the study time between case opening and case closure where students gather information and construct new knowledge in their aspiration to fill their knowledge gaps. In jump six students' engagement with learning objectives is supported by plenary lectures, training of clinical skills, clinical practice as well as resource sessions, where students may work with anatomical models, histological slides, or address questions to encourage understanding and reflection. At jump seven, students and facilitator reconvene to share and discuss the information as well as challenges encountered during the week. Case closure thus involves reflections on both the attainment of the specific learning objectives set out by students at the beginning of the case period as well as the learning processes.

While jump six in this model is often presented as private study time where students gather information and work with learning objectives individually (e.g. David, et al., 1999; Wood, 2003), students in this programme are strongly encouraged to organise and direct their learning around collaborative processes. This is reflected in the organisation of the curriculum

as well as physical spaces. Clinical skill exercises, clinical practice, and resource sessions are organised as collaborative activities and all groups have the possibility to book group rooms throughout the week. In encouraging student collaboration between case opening and case closure this problem based case model seeks to take full advantage of collaborative and social learning processes often highlighted in literature as a key component of problem-based learning (e.g. Hmelo-Silver & Eberbach, 2012; Savin-Baden & Major, 2004). This allows for students to continue the process of drawing on joint experiences in their work with learning objectives defined at case opening and it encourages continuous discussions and sharing of learning resources in the student groups. It should be further noted, that in order to develop collaborative skills and generally enable students to manage the complexities of working within a framework of problem-based learning, an introductory course is offered in which students are made familiar with various tools and strategies of organising learning and which is assessed through students' work with both individual and collective reflections e.g. through learning journals (Azer, 2008; Brockbank & McGill, 2007; Sinclair & Tse, 2001). To continuously enhance quality faculty appointed facilitators engage in a workshop once a year that provides a fundamental understanding of case-PBL and ensure a uniform approach to case facilitation. Every case facilitator must attend a workshop before being assigned a group.

Project-PBL

Project-PBL was chosen as the philosophical and pedagogical foundation for learning at the establishment of Aalborg University in 1974 and continues to serve as an organising principle for all education programmes at the university (Kolmos et al., 2004; Krogh et al., 2008; AAU, 2010). Project-PBL departs in students driving their learning through addressing a problem identified by students themselves. Projects run over an extended period and result in a joint artefact, most commonly a project report. Teachers act as supervisors and unlike case facilitation, there is no standardized step-by-step approach to supervision and the learning process. One key difference between project- and case-PBL is that when working on a project, students aim to produce an end-product whereas the aim of case-PBL is to motivate students to study (Helle et al., 2006). All undergraduate and graduate curricula at Aalborg University are designed with periods of project-PBL including the medical programmes. During project periods students do not work with cases or have other scheduled activities. Over the three years of undergraduate medical studies there are four project periods of 3 to 12 weeks.

In projects within the medicine programme, students work within a given thematic frame e.g. public health. The students are organised into groups of up to 7, which identify a problem area within the thematic framework. They are active participants in the definition of their specific learning objectives through their formulation of a specific problem which subsequently constitutes the research question around which group members will organise their learning activities. Supported by the supervisor allocated to the group, the students identify how they

wish to work towards understanding and/or solving the problem. This may be in form of questionnaire surveys, laboratory experiments, meta-analysis of other studies, etc. Students are required to work together in groups during project periods and to submit a joint project report. Reaching a satisfactory result, group members depend on the efforts of all members towards achieving the desired learning outcomes. Concluding the project period, the group participates in a joint oral examination. However, students are graded individually. The curriculum, defining the structure and content of the entire medical programme contains a set of broader learning objectives for each project period which guide the students' work and ensure a fair examination despite the diversity in projects. These broader learning objectives could be to develop skills in hypothesis formulation or analyzing and presenting data in a scientific manner, develop skills to apply specific methods or theories to the group-selected problem, demonstrate knowledge relating to specific scientific domains or competencies to disseminate scientific results. One of the many roles of the supervisor is to ensure that groups keep within the broad boundaries of the project theme outlined in the curriculum, thus ensuring a valid assessment in relation to the overall learning objectives of the curriculum.

As seen above, the organisation of case- and project-PBL differ considerably, although the overall objectives and intentions for students learning are shared. In order to understand the differences in greater detail and to determine how alternative scaffolding of PBL may supplement each other and enrich medical education, it is relevant to explore if students experience working with case- and project-PBL differently.

A PRELIMINARY GLANCE AT STUDENTS' DIFFERING EXPERIENCES OF PROJECT AND CASE-PBL

Variations in student engagement with and commitment to their learning in case- and project-PBL have been observed by case facilitators and project supervisors over several years. Students working with cases were often referred to as less engaged and enthusiastic than students working with projects. However, it was not clear if these observations by staff reflected actual student experiences. These broad observations coupled with research from Maastricht University reporting of PBL-fatigue and advocating for PBL alternatives such as e.g. working with projects called for a clear comparison of students' immediate experiences of the two PBL alternatives. Our observations and previous research led to a hypothesis that students experienced working with projects more positively than working with cases.

This led to the design of an explorative study with the purpose of comparing students' attitudes towards the two PBL alternatives. The study was exclusively concerned with students' subjective ratings of issues central to assumptions embedded into PBL e.g. motivation, autonomy and learning outcome and did not seek to determine exact causes or factors significant to these experiences.

Consequently, the purpose of the study was to enable a comparison of case- and project-PBL from a student perspective taking the first step towards a deeper understanding of two PBL alternatives resting upon the same set of underlying theoretical and philosophical premises, yet organised and implemented in very different ways. The questionnaire was organised around a five-point, semantic differential scale which is particularly useful when researching attitudes and subjective opinions of respondents (Cohen et al., 2007). The questionnaire further included two open-ended questions allowing students to elaborate on factors which they felt contributed to their feelings of motivation for cases and projects respectively.

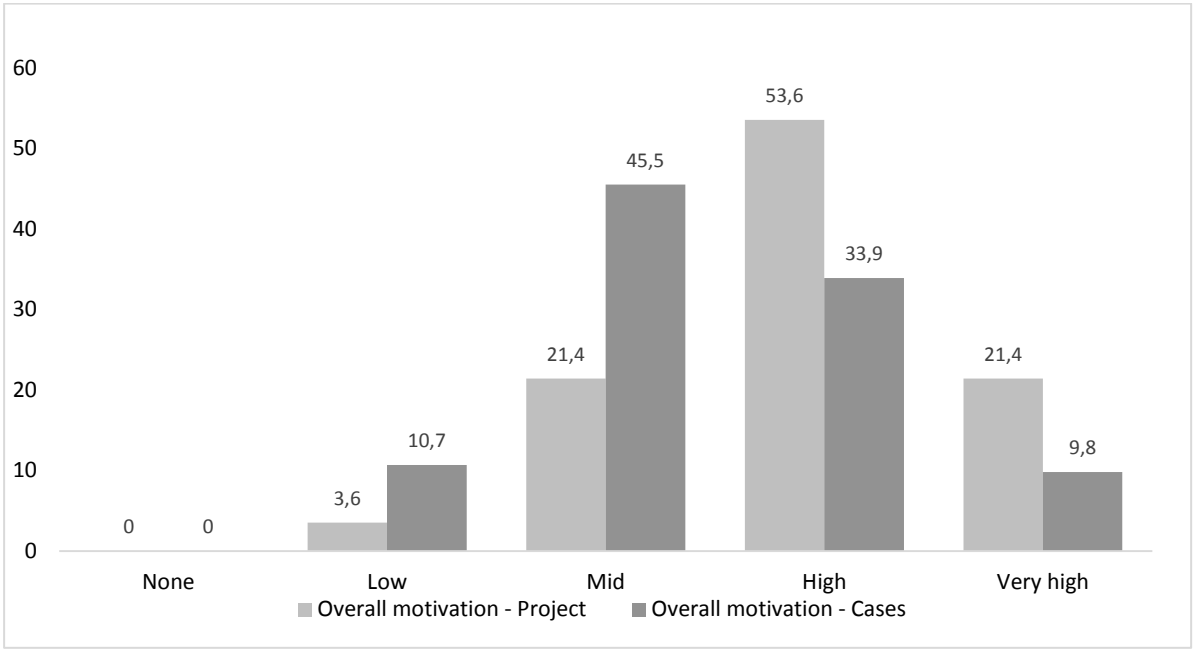
The questions were all self-reported high level evaluations related to outcomes difficult to measure in standard assessment. Kuh lists five conditions in relation to the validity of self-reports: Information is clear; questions are phrased clearly; the questions refer to recent activities; respondents know the purpose; and the questions do not violate the personal integrity of the respondents (Kuh, 2001). The questionnaire was designed with these principles in mind to ensure validity. The aim of the questionnaire was to collect data which would allow a comparison of students experience with the two PBL alternatives. This meant we were concerned with the degree of motivation and autonomy experienced by students and with possible variations between the two PBL alternatives. We did not intend to attribute particular characteristics to these notions as e.g. whether motivation in students was intrinsic or extrinsic (Ryan & Deci, 2000a, 2000b). This meant that the study could only give an indication of differences but not provide explanations of how and why. As a consequence of this strategy and the explorative nature of the study, we could not in the analysis of results infer particular meanings of motivation, autonomy or learning outcome which is anyhow problematic due to the multidimensional nature of these notions (Kember & Ginns, 2012). However, the construction of the questionnaire did allow us to conclude if students felt positively or negatively about their case and project work as it is reasonable to assume respondents would attribute similar meanings to the notions of motivation, autonomy and learning outcome when considering responses throughout the questionnaire.

The questionnaire was distributed among first and second year students in the undergraduate medical programme. The study was carried out following terms where students had engaged in both case- and project-PBL. The questionnaire was distributed after the completion of both case and project periods but prior to the announcement of any exam results. Thus, responses were not biased by students' reactions to exam results. Of 210 students, 116 students participated in the study (n=116) giving a response rate of 55.2%.

Results

Considering the similarities in philosophical and theoretical principles underpinning project and case-PBL the data analysis revealed significant differences in students' experiences which appeared to be consistently more positive towards project-PBL. Below we briefly present the key findings of the study which further emphasises the need to understand in more detail the differences in both organisation as well as experiences of project and case-PBL.

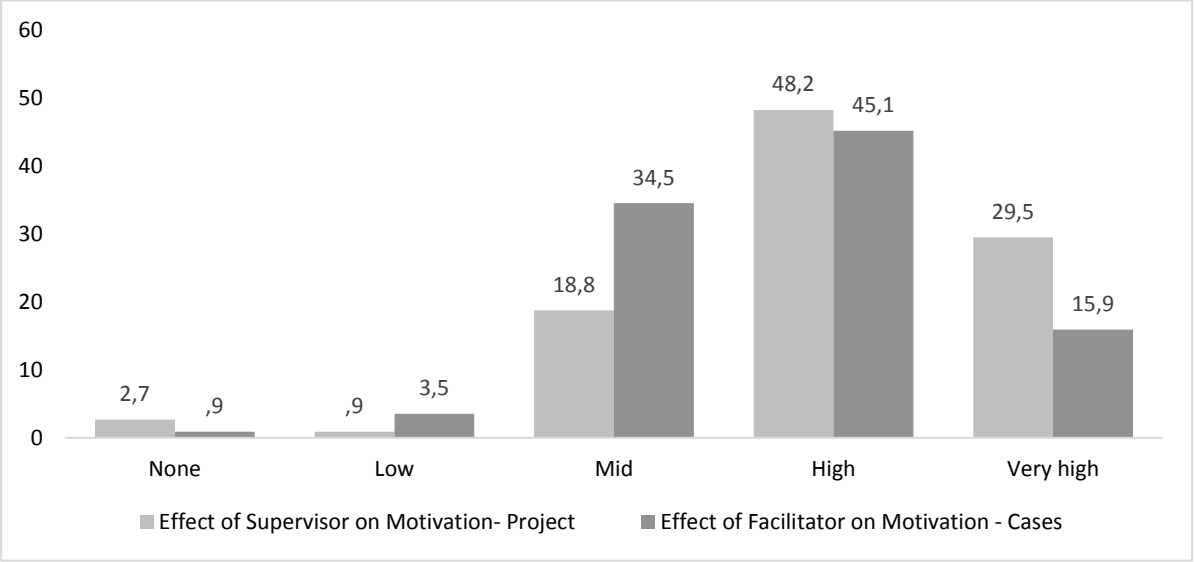
Figure 1



Students' experience of motivation

Figure 1, illustrates students responses to the questions 'how did you experience your motivation for working with cases?' and 'how did you experience your motivation for working with projects?' From the figure, it is evident that very few students report experiencing little or no motivation whether working with cases or projects (10.7% and 3.6% respectively). However, what is also noticeable is how students generally appear to be more motivated when working with projects. 43.7% of the respondents report high or very high motivation working with cases, whereas 75,0% experience high or very high motivation when working with projects.

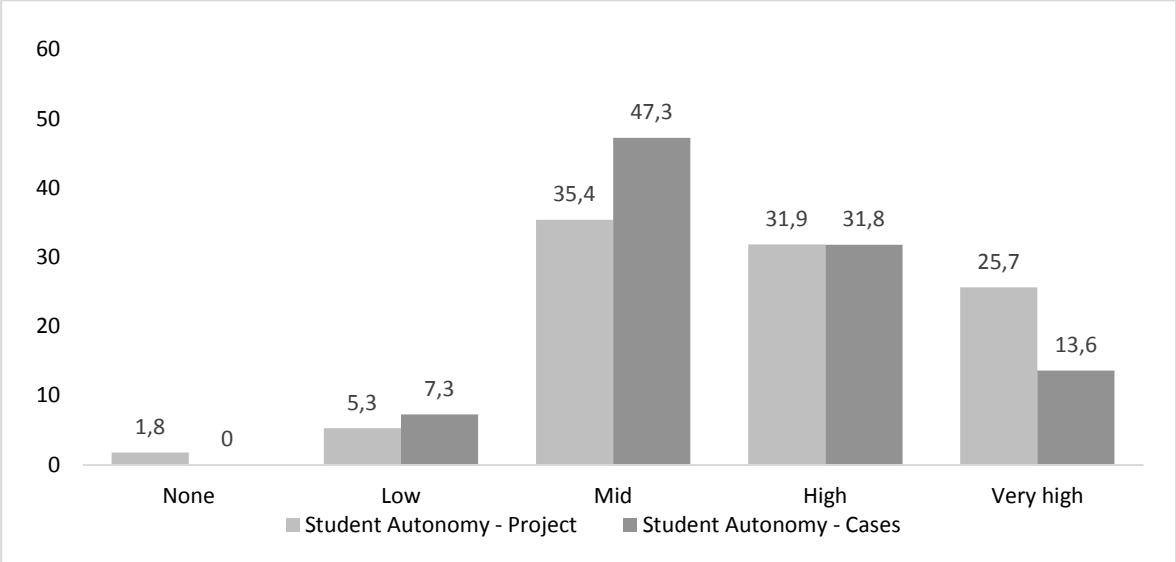
Figure 2



Students' experiences of case facilitators' and project supervisors' contribution to their sense of motivation

The aim of the study was to explore student experiences rather than asking for student evaluation of these experiences. For this reason, respondents were requested to assess their experience of the contribution of their case facilitator and project supervisor towards their sense of motivation for their work. Figure 2, illustrates responses to the questions 'How did you experience your case facilitator contributing to your sense of motivation for working with cases?' and 'how did you experience your project supervisor contributing to your sense of motivation for working with the project?'. As was also observed in figure 1, few students found their facilitator or supervisor demotivating with 4.4% in cases and 3.6% in projects. In both case and project work, facilitators and supervisors were seen by the majority of students to be motivating or very motivating, 61.0% in cases and 77.7% in projects.

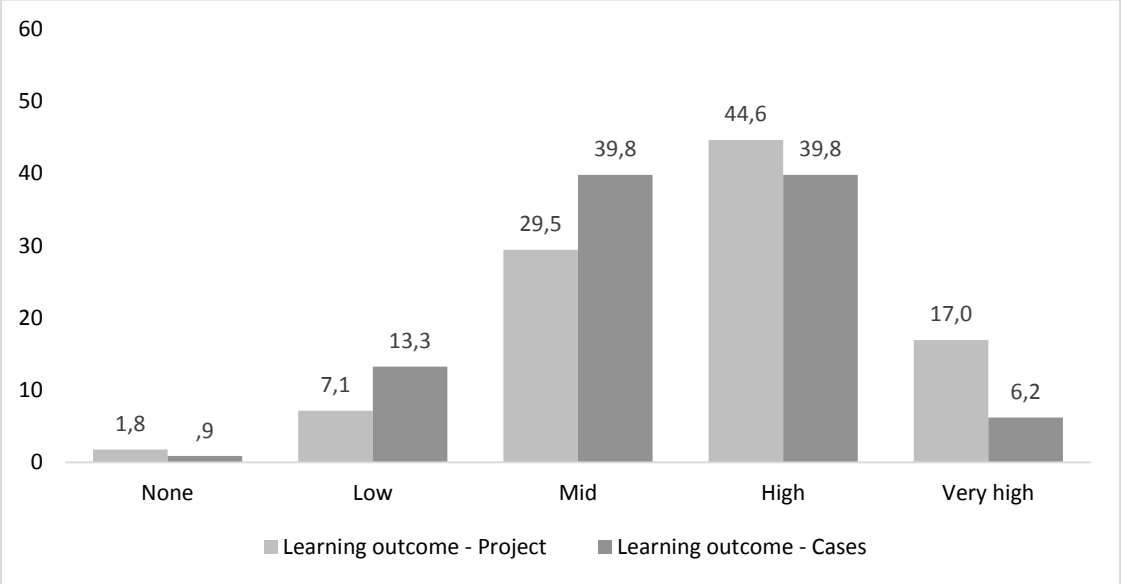
Figure 3



Students' possibilities to autonomously explore scientific topics

A similar picture emerges when analysing students responses to the questions 'How have you experienced to have autonomy to explore scientific topics within the framework of the case' and 'How have you experienced to have autonomy to explore scientific topics within the framework of the project', see figure 3. In case as well as project work, very few students experience little or no autonomy to explore scientific topics (7.3% for case and 7.1% for project). However, in project work students experience considerably more autonomy to explore scientific topics as 45.4% of respondents report a high or very high level of autonomy when working with cases and 57.6% working with projects.

Figure 4



Students' perception of their learning outcome

Figure 4 illustrates students' perceptions of their learning outcome from working with projects and working with cases as they responded to the questions 'how great was your learning outcome from working with cases during the term?' and 'how great was your learning outcome from working with the project during term?' Responses were made prior to announcement of exam results and thus reflect students' experiences and possibly expectations of results. Relatively few students experienced a very small or small learning outcome whether working with cases or projects (14.2% for cases and 8.9% for projects). As was the case with previous questions it is evident that students are generally more positive about their learning outcome in their project work. 46.0% of respondents state that they have experienced great or very great learning outcome when working with cases. Working with projects the response in these two categories increases to 61.6%.

DISCUSSION

The results presented above point to two general observations. Firstly, the number of students responding negatively about their experiences of the two PBL alternatives examined is low for all items of the questionnaire. This indicates that the problem-based approach to learning regardless of organisation provides a scaffolding of learning which students find conducive for their learning outcome. Secondly, although problem-based learning organised around cases and projects share characteristics and underlying objectives for the learner (de Graaff & Kolmos, 2003; Kolmos, 2009), it is not surprising that the results above support the hypothesis that varying PBL alternatives will result in varying student experiences and that project-PBL is perceived more positively than case-PBL in all parameters studied. The explorative nature of the study means we cannot conclude on factors leading to the more positive experiences of motivation for projects as seen from a student perspective. However, suggestions from Maastricht that the use of more ill-defined problems and enhancing possibilities for self directed learning may negate experiences of PBL-fatigue may indicate part of the answer. Therefore, in the remaining part of the paper we will demonstrate in more detail how case and project-PBL alternatives significantly differ in the way problems emerge and are addressed and in the way students are offered possibilities for self-directed learning. We do this to emphasise the need to examine the possibilities and delimitations of PBL alternatives to continuously improve PBL curricula in undergraduate medical education.

The role and nature of the problem in case and project-PBL

Several attempts have been made to construct taxonomies of problems and describe their contributions to students' learning in case-PBL. A recent taxonomy considers the kind of knowledge students are intended to engage with according to the curriculum as the basis on

which problems may be organised (Schmidt & Moust, 2010). In this taxonomy, four categories of knowledge which may be embedded into a problem were identified: Descriptive knowledge, explanatory knowledge, procedural knowledge and personal normative knowledge. Depending on the knowledge category, four different problem types have been defined; fact-finding, explanation, strategy, and moral dilemma resolution (Schmidt & Moust, 2010 p. 36). This taxonomy is based on the precondition that although students are offered some freedom in their choice of learning strategy and engagement with the problem, facilitators still retain tight control over the category of knowledge relevant to working with the problem and therefore also which learning objectives students will meet when engaging with the problem. This positioning of the facilitator as responsible for the problem design is visible in the seven-jump case-PBL model where the introduction of the problem to students through the case opening session marks the onset of their learning process (Moust, et al., 2005). In case-PBL, patient cases are designed to enable learning outcomes of the core medical curriculum essential for a medical education to meet the requirements of the profession.

In contrast to the above, problems in project-PBL have been characterised as "... *documented* or *argumented* as an anomaly, a paradox, a contrast or a contradiction. The purpose with the answering or solution of the problem - the work with the project - *understanding or comprehension, change or understanding and change" (Qvist, 2004 p. 90).* In these characteristics of a problem there is no indication as to the complexity or the category of knowledge outcome which may vary depending on how advanced students are in their studies and the broader learning objectives set out in the curriculum. The relevance of a problem is in project-PBL evaluated on the documentation and argumentation presented by students based on their initial research into a scenario within the broader theme of the project. In project-PBL, securing this documentation and developing argumentations underpinning a problem is regarded as a key element in students' learning process. Students are responsible for identifying the specific problem they wish to examine within the overall learning objectives found in the curriculum. In this process, supervisors relinquish the possibility and responsibility of ensuring minute alignment between problems and detailed learning objectives. Students are also responsible for making decisions on how to best utilise resources made available to them during the project period i.e. supervision, laboratory facilities, group rooms, external partners etc. (Spliid & Qvist, 2013). Despite this transference of responsibilities from staff to students, the supervisor is still responsible for ensuring that work delivered by the students meet the broader learning objectives specified for the project.

Relating the nature of problems to students' experience with case-PBL, a previous study has found that the degree of challenge and variety of problems are important contributors to students' experiences of motivation as is the degree to which students are directed in their learning process and their experience of possibilities to engage with realistic problems (Mauffette et al., 2004). The distinction in nature of problems and the way distribution of

responsibilities for identifying and defining these problems may, therefore, be significant factors influencing student experiences of the two PBL alternatives. Clearly the scope and complexity of problems in project-PBL are potentially ill-defined to a much greater extent than what is possible in settings of case-PBL.

Possibilities for self-directed learning

Literature on self-directed learning (SDL) in PBL settings rarely distinguish between PBL alternatives and how these alternatives present varying possibilities for students to direct their own learning and develop as self-directed learners. Some even view all PBL alternatives as similar in this respect (e.g. English & Kitsantas, 2013). The results above however indicate need to address each PBL alternative separately since the difference in possibilities for self-directed learning may contribute to students maintaining motivation for learning.

SDL has emerged from the domain of adult education and is concerned with the adult learners' intentions to learn and foster change in his learning strategies (O'Shea, 2003). Developing such skills is considered a central objective in PBL curricula (Hmelo & Lin, 2008). SDL research has yet to arrive at a fixed definition of SDL and the boundaries between SDL and the study of self-regulated learning rooted in educational psychology are somewhat opaque balancing between the social and individual perspective. Nevertheless three processes of SDL have been observed: *'(a) identifying learning objectives, (b) pursuing learning issues, and (c) self-evaluating learning.'* (Zimmermann & Lebeau, 2008 p. 301). SDL however is not merely about supporting processes but also about the degree to which students retain control over their learning processes (O'Shea, 2003). Studies have shown how development of students' SDL skills improved with more student-centred PBL organisation although it was noted that students should not be left unsupported and learning not without scaffolding (Blumberg, 2008). Similarly, it has been noted that objectives and clear guidance on what is considered relevant subject matters may impact considerably on students' activities during self-study and thus on how they handle their learning processes (Dolmans & Schmidt, 2008). In light of the three SDL processes and the observation of degree of guidance and student-centeredness it is evident that case- and project-PBL offer different varying degrees of SDL.

In case-PBL students define their own learning objectives but within specific knowledge areas defined by the case materials provided by the facilitator. Students organise their collaboration and learning freely within the scope of a very limited time perspective of one week. The conclusion of a case is intended both as a discussion of learning outcome and as a space for evaluating learning and learning strategies. The fixed structure scaffolding learning through the seven-jump model and faculty prepared case-materials ensures a highly scaffolded learning environment in case-PBL. However, these structures also to some extent limit the autonomy of students to organise their learning and their engagement with the subject matter

as students are expected to organise their learning around case-derived learning objectives exclusively.

In project-PBL students' identification and argumentation for engaging with a problem is considered part of the learning process. Students have autonomy to organise their learning while freely addressing the broader learning objectives defined through curriculum. The extended time perspective means that continuous evaluation of learning and learning strategies through self and peer assessment is essential to reaching a satisfactory learning outcome. Students are both individually and collaboratively responsible for making key decisions about their learning and their use of project supervision. The scaffolding of learning is negotiated in the group in project-PBL and guided by the supervisor. The autonomy to work with scientific topics selected by the students themselves and to determine the organisation and direction of the learning processes within the project groups means that project-PBL offers students wide possibilities to control and direct their own learning. This is the case although scaffolding structures are present in the form of clear overall objectives for the project, accessible project supervision and a clearly defined end-product.

Clearly project-PBL offers students a larger degree of SDL than case-PBL. In project-PBL students have more control over their learning process and both individual and collaborative issues and evaluation of learning is essential to a satisfactory result. The explorative study presented above cannot in detail connect the degree of SDL to students' sense of motivation or autonomy, however the significant variations in students' experiences of project- and case-PBL invite for further research not only into the development of SDL skills in PBL but also into how varying PBL alternatives may to varying degrees support and be constructed around activities demanding students' engagement as self-directed learners.

CONCLUDING REMARKS

Above, we have seen how students report a higher degree of motivation and more autonomy to explore scientific topics in projects-PBL rather than case-PBL. We have also seen how the responsibilities for identifying and establishing the problem itself are shifted from staff to students when moving from case- to project-PBL and how project-PBL not only allows but also requires more SDL. These factors all indicate that project-PBL offers students more possibilities to direct (and develop) their own learning than in case-PBL. Simultaneously, students report a significant impact of case-facilitators and project supervisors on their experience of motivation which further indicates the importance of continuous guiding and scaffolding of learning during more self-directed project periods.

There is clearly a need to explore distinctions of case- and project-PBL further to fully understand how and if project-PBL is a fruitful way of addressing the PBL fatigue experienced elsewhere (Czabanowska, et al., 2012; Moust & Roebertsen, 2010). Here it would be relevant to explore and compare underlying factors contributing to students' experiences of motivation for the two PBL alternatives.

From the preliminary results of the study presented in this paper and from the overall discussion of some key differences of organization of case and project-PBL follows new and unanswered questions: Exactly why are students feeling more motivated for projects than cases? How may we understand the differences in contributions of case and project-PBL towards students' attainment of the overall aims of PBL? And which parts of a medicine curriculum is better suited for cases and which for project-PBL? More research is clearly needed to uncover contributions and limitations of PBL alternatives and to optimise the complimentary use of alternatives in medical education.

References

Albanese, M. A. (2010). Problem-based learning. In T. Swanwick (Ed.), *Understanding Medical Education evidence, theory and practice* (pp. 37-52). Chichester, West Sussex: Wiley-Blackwell.

Azer, S. (2008). *Navigating problem-based learning*. Sydney: Churchill Livingstone Elsevier.

Barrett, T., Cashman, D., & Moore, S. (2011). Designing problems and triggers in different media. In T. Barrett & S. Moore (Eds.), *New approaches to problem-based learning revitalising your practice in higher education* (pp. 18-35). New York: Routledge.

Barrett, T., & Moore, S. (2011). *New approaches to problem-based learning revitalising your practice in higher education*. NY: Routledge.

Barrows, H. S. (1986). A taxonomy of problem-based learning methods. *Medical Education, 20*(6), 481-486.

Barrows, H. S. (1996). Problem-based learning in medicine and beyond: a brief overview. *New Directions for Teaching and Learning, 68*, 3-12.

Biggs, J., & Tang, C. (2007). *Teaching for quality learning at university* (3rd, pb. ed.). Maidenhead: Society for Research into Higher Education & Open University Press.

Blumberg, P. (2008). Evaluating the evidence that problem-based learners are self-directed learners: a review of the literature. In D. H. Evensen & C. E. Hmelo (Eds.), *Problem-based learning: a research perspective on learning interactions* (pp. 199-226). New York: Routledge.

Brockbank, A., & McGill, I. (2007). *Facilitating learning in higher education*. Maidenhead: Open University Press.

Brophy, J. (2010). *Motivating students to learn, third edition*. New York: Routledge.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education (6th edition)*: Routledge.

Czabanowska, K., Moust, J. H. C., Meijer, A. W. M., Schröder-Bäck, P., & Roebertsen, H. (2012). Problem-based Learning Revisited, introduction of active and self-directed learning to reduce fatigue among students. *Journal of University Teaching & Learning Practice, 9*(1), 1-13.

David, T., Patel, L., Burdett, K., & Rangachari, P. (1999). *Problem-based learning in medicine*. London: The Royal Society of Medicine Press Limited.

Davis, M. H., & Harden, A. (1999). AMEE Medical education guide no 15: Problem-based learning: a practical guide. *Medical Teacher, 21*(2), 130 - 140.

de Graaff, E., & Kolmos, A. (2003). Characteristics of problem-based learning. *The International Journal of Engineering Education, 19*(5), 657-662.

Dewey, J. (1916). *Democracy and education*. New York: Macmillan.

Dolmans, D. H. J. M., & Schmidt, H. G. (2008). What directs self-directed learning in a problem-based curriculum. In D. H. Evensen & C. E. Hmelo (Eds.), *Problem-based learning: a research perspective on learning interactions* (pp. 251-262). New York: Routledge.

El-Moamly, A. (2010). *Medical Education in the New Millennium*. New York: Nova Science Publishers.

English, M. C., & Kitsantas, A. (2013). Supporting student self-regulated learning in problem- and project-based learning. *Interdisciplinary journal of problem-based learning, 7*(2), 128 - 150.

Evensen, D. H., & Hmelo, C. E. (2008). *Problem-based learning: a research perspective on learnnig interactions*. New York: Routledge.

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education: theory practice and rubber sling shots. *Higher Education, 51*(2), 287-314.

Hmelo-Silver, C. E. (2004). Problem-based learning: what and how do students learn? *Educational Psychology Review, 16*(3), 235-266.

Hmelo-Silver, C. E., & Eberbach, C. (2012). Learning Theories and Problem-Based Learning. In S. Bridges, C. McGrath & T. L. Whitehill (Eds.), *Problem-Based learning in Clinical Education: The next generation*. Dordrecht: Springer.

Hmelo, C. E., & Lin, X. (2008). Becoming self-directed learners: strategy development in problem-based learning. In D. H. Evensen & C. E. Hmelo (Eds.), *Problem-based learning: a research perspective on learning interactions* (pp. 227-250). New York: Routledge.

Kember, D., & Ginns, P. (2012). *Evaluating Teaching and Learning, A practical handbook for colleges, universities and the scholarship of teaching*. New York: Routledge.

Kolmos, A. (2009). Problem-based and project-based learning. In O. Skovsmose, P. Valero & O. Ravn Christensen (Eds.), *University science and mathematics education in transition* (1st ed., pp. 261-280). New York: Springer.

Kolmos, A., Fink, F. K., & Krogh, L. (2004). *The Aalborg PBL Model*. Aalborg: Aalborg University Press.

Krogh, L., Brødslev Olsen, J., & Rasmussen, P. (Eds.). (2008). *Projekt pædagogik: Perspektiver fra Aalborg Universitet* (1st ed.). Aalborg: Aalborg Universitetsforlag.

Krogh, L., & Jensen, A. A. (2013). The development of PBL-methodologies in Denmark and current challenges. In L. Krogh & A. A. Jensen (Eds.), *Visions, challenges and strategies: PBL principles and methodologies in a Danish and global perspective* (pp. 17-28). Aalborg: Aalborg University Press.

Kuh, G. D. (2001). Assessing what really matters to student learning: Inside the National Survey of Student Engagement. *Change, 33*(3), 10-17.

Kusurkar, R. A., Croiset, G., Mann, K. V., Custers, E., & Cate, O. T. (2012). Have motivation theories guided the development and reform of medical education curricula? A review of the literature. *Academic Medicine, 87*(6), 735-743.

Maudsley, G. (1999). Do we all mean the same thing by "problem-based learning"? A review of the concepts and a formulation of the ground rules. *Academic Medicine 74*(2), 178 - 185.

Mauffette, Y., Kandbinder, P., & Soucisse, A. (2004). The problem in problem-based learning is the problems: But do they motivate students? In B. Savin, M. & K. Wilkie (Eds.), *Challenging research in problem-based learning* (pp. 11 - 25): Society for Research into Higher Education & Open University Press.

Moust, J., & Roebertsen, H. (2010). Alternative instructional problem-based learning formats. In H. van Berkel, A. Scherpbier, H. Hillen & C. van der Vleuten (Eds.), *Lessons from problem-based learning* (pp. 129-140). Oxford: Oxford University Press.

Moust, J., Van Berkel, H. J. M., & Schmidt, H. G. (2005). Signs of erosion: Reflections on three decades of problem-based learning at Maastricht University. *Higher Education, 50*, 665 - 683.

O'Shea, E. (2003). Self-directed learning in nurse education: a review of the literature. *Journal of advanced nursing, 43*(1), 62-70.

Qvist, P. (2004). Definig the problem in problem-based learning. In A. Kolmos, F. K. Fink & L. Krogh (Eds.), *The Aalborg PBL model* (1. ed., pp. 73-76). Aalborg: Aalborg University Press.

Ryan, R. M., & Deci, E. L. (2000a). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology, 25*, 54 - 67.

Ryan, R. M., & Deci, E. L. (2000b). Self determination theory and the facilitation of intrinsic motivation, social development and well-being. *American Psychologist, 55*(1), 68 - 78.

Savin-Baden, M., & Major, C. H. (2004). *Foundations of Problem Based Learning*: Society for Research into Higher Education & Open University Press.

Schmidt, & Moust, J. (2010). Designing problems. In H. Van Berkel, A. Scherpbier, H. Hillen & C. Van der Vleuten (Eds.), *Lessons from problem-based learning*. Oxford: Oxford University Press.

Schmidt, H. G. (1983). Problem-based learning: rationale and description. *Medical Education, 17*(1), 11-16.

Sinclair, K., & Tse, H. (2001). Writing reflective journals. In D. Kember (Ed.), *Reflective Teaching & Learning in the Health Professions* (pp. 84-101). Oxford: Blackwell Science.

Spliid, C. M., & Qvist, P. (2013). The Aalborg model and management by objectives and resources: A theoretical frame. In L. Krogh & A. A. Jensen (Eds.), *Visions, challenges and strategies: PBL principles and methodologies in a Danish and global perspective* (pp. 87-012). Aalborg: Aalborg University Press.

van Berkel, H., Scherpbier, A., Hillen, H., & van der Vleuten, C. (2010). *Lessons from problem-based learning*. Oxford: Oxford University Press.

Wood, D. F. (2003). ABC of learning and teaching in medicine - Problem based learning. *British Medical Journal 326*, 328 - 330.

Zimmermann, B. J., & Lebeau, R. (2008). A commentary on self-directed learning. In D. H. Evensen & C. E. Hmelo (Eds.), *Routledge* (pp. 299-313). New York: Routledge.

AAU. (2010). The Aalborg PBL model - principles of problem and project based learning (pp. 1-24): Aalborg University.