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Problem-based Learning Revisited, introduction of Active and Self-directed Learning to reduce fatigue among students

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Despite several years of successfully applying problem-based learning at Maastricht University, the Faculty of Medicine observed a slow erosion of problem-based practices and “PBL fatigue” among themselves and students. In response to this fatigue and new research into the development of the young adult brain, Active Self-Directed Learning was introduced through the new bachelor of European Public Health programme in an effort to re-energise the classical PBL model and reduce or eliminate erosion. ASDL is split into a four part learning cycle: 1) sensitisation, 2) exploration, 3) integration, and 4) application. The cycle supports problem-based learning and the developing minds of students through the integration of information, critical thinking and self-evaluation, while also teaching self-responsibility and team management skills. When applied as part of a problem-based learning curriculum, ASDL at Maastricht University helped reduce PBL fatigue and re-energised students’ interest in PBL within the first EPH cohort (2006-2009) according to survey feedback obtained after the 5th semester. The positive student response was tempered by recommendations on how to continue improving the ASDL model.

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Introduction

Various faculties at Maastricht University have been using problem-based learning (PBL) as an educational approach for more than 30 years. In 1974, a newly founded Faculty of Medicine started using PBL, which it had adopted from the Faculty of Health Sciences at McMaster University, Hamilton, Canada. Gradually other faculties, such as Law, Economics and Business Administration, Health Sciences and Cultural Sciences, assumed PBL as an educational solution, which has proven to be very successful. Students in the Maastricht faculties using PBL are satisfied with a learning environment that is motivating, student-friendly and effective (Elsevier 2008). Every year Maastricht faculties are among the top three in the country, and the Faculty of Medicine has been at number one for more than a decade based on the results of polls carried out for Consumer Report, a guide to higher education in the Netherlands. In this bi-annual publication, a randomly selected sample of 20,000 students from 14 Dutch universities is asked about, among other things, the quality, content and coherence of the curriculum, and the instructional approach or quality of the teachers. (Steenkamp et al. 2004, 2006, 2008, 2010)

In spite of these quite successful outcomes and the importance of PBL, various signs of erosion have been observed in recent years (Vermunt 2000; Dolmans et al. 2001; Moust, Van Berkel & Schmidt 2005a). In the medical school, this decay manifested as a kind of ritualised work by the students in and outside the tutorial group, where they showed behaviour such as unwillingness to share information and ideas, and assumed a "free-rider" attitude. According to Dolmans and her colleagues (2001), the problems resulted in a more teacher-directed rather than student-directed teaching style from the tutors.

Some steps had to be taken to revisit the traditional PBL approach: finding out the direct causes of erosion, and determining what justifiable modifications could be introduced to improve the educational process. The objective of this article is to show how the introduction of an active and self-directed learning (ASDL) model has contributed to gradually decreasing the effects of PBL erosion at the Faculty of Health, Medicine and Life Sciences at Maastricht University, based on the example of the newly launched bachelor of European Public Health (EPH) programme. Although we are aware of the limitations of using the experiences of a single university, we believe that our approach and solutions can serve as an example for other educational institutions faced with similar difficulties.

Background to the development of ASDL

Prior to the development of ASDL, both students and tutors were exposed to a phenomenon that can be called "PBL fatigue". By using the teacher-directed model, the tutors ended up lecturing in the tutorial groups, a practice which goes against the PBL ethos. Moust and others (2005a) found that students in the School of Health Sciences often skipped parts of the so-called "seven-step" procedure that should have helped them analyse and synthesise the subject matter. The seven-step procedure is a method that encourages students to activate their prior knowledge in analysing a problem and discover gaps in their knowledge, and supports them when they formulate their own learning objectives. Students become motivated to study learning materials and to report, criticise and synthesise new information in the context of the problem (Moust, Bouhuijs & Schmidt 2007). By analysing the problems superficially, the students not only were hindered in studying new information outside the tutorial group in a meaningful and critical way, but also had difficulties integrating the multidisciplinary content. Skipping the elaboration of prior knowledge in the analysis phase also often limited the students to the presentation of only the main results, with no

attempt to appraise opinions and viewpoints, or to integrate and apply the findings. Students seemed to be focused on the first and easiest solution or the "right answer", which can result in prejudices or misconceptions (Houlden et al. 2001).

The staff reacted by introducing several innovations. First, when constructing the problems for students to work with, they included hints or directions such as questions or keywords, or explicitly suggested references to literature resources. Unfortunately, this "over-guidance" had the opposite result to the one desired: the students limited themselves to answering only the provided questions and to selective study of the literature resources, becoming more and more teacher-dependent. Second, in line with Vermunt's ideas to bring more diversity into the context of a PBLprogramme, the students were offered some variations like "PBL with study teams" and "PBL with student-expert groups" (Moust et al. 2005b). Vermunt states that the traditional PBL process does not change over the years of study. He observes changes in the level of independent, self-directed learning in the Faculties of Medicine and Health Sciences: it increases in the first years of the PBL curricula and slowly declines in the following years. Vermunt makes a plea for more variation in instructional methods that foster students' independent learning in their later years of study (Vermunt 2000, 2003). Based on Vermunt's observations and the previous experience of tutorial instructors, it seemed of the utmost importance to introduce educational innovations. The launch of the EPH programme in September 2006 was a perfect opportunity to implement an ASDL model, a structured four-phase approach to PBL, to help students become autonomous learners and counterbalance "PBL fatigue". Kuiper and others (2011) have previously described the content and architecture of the new program in detail. Here we will discuss the model's effect on "PBL fatigue" itself.

The active and self-directed learning model

Two developments influenced the changes in the educational design of the PBLprogrammes of the former Faculty of Health Sciences. These were the observed signs of erosion of the self-directed learning attitude of students in the health-sciences programmes, and recent outcomes of brain research (Giedd 2004; Sowell et al. 1999; Blakemore & Frith 2005; Jolles et al. 2005) that offered evidence that adolescents' and young adults' brain and cognitive functions develop more slowly with respect to various cognitive skills than previously expected. Particular parts of the brain and their connections develop in middle and late adolescence and do not fully mature until the third decade of life. These include planning, executive control, concept shifting, efficient processing in working memory, attentional processes and the so-called "self-evaluation" and "social monitoring" skills (Blakemore & Choudhury 2006). Epigenetic as well as environmental factors determine the proper functioning of these brain structures, and thus higher cognitive functioning. Jolles et al. (2005) indicated that cognitive skills, which develop from the age of 16 or 17 until the mid-twenties, include the ability to learn in an independent way, plan, set priorities and execute plans, integrate or synthesise information, apply information to new domains of knowledge and use introspection, self-evaluation and social monitoring.

The results of neuroscientific research imply that learners need support, especially in tasks that depend on executive functions. Blakemore and Frith (2005), for example, stated that "… the research on brain development during adolescence shows that secondary and tertiary education is vital. The brain is still developing during this period: It is adaptable, and needs to be moulded and shaped. Perhaps the aims of education for older adolescents might well change to include strengthening of internal control, for example, self-paced learning, critical evaluation of transmitted knowledge, and meta-study skills" (p121). Based on these findings, both curriculum

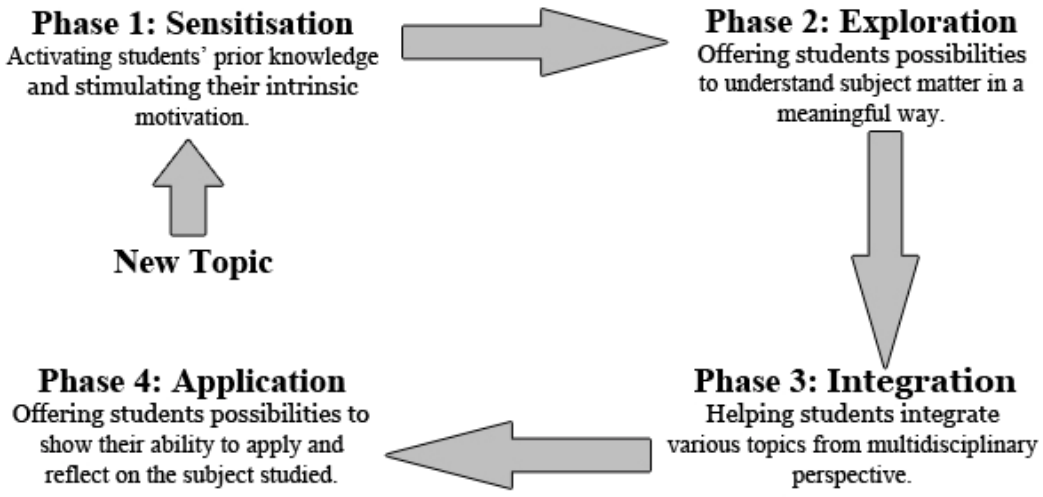
design and instructional approaches should be more aligned to the development of the student's brain.

In order to conquer the signs of erosion observed in conventional PBL, as well as to support more specific cognitive skills as they develop in the brains of young adults, we designed an ASDL model consisting of two components: first, a learning cycle, the so-called ASDL cycle, which is offered to students at regular intervals; second, an ASDL instructional design that fosters students' self-directed learning.

The ASDL cycle

The ASDL model consists of four learning phases: (1) sensitisation, (2) exploration, (3) integration and (4) application (Figure 1); these are intended to help students gradually perform important cognitive functions. As students seem to have problems in integrating and applying information, it was decided to give ample time and support to these important cognitive activities.

Figure 1: The ASDL Learning Cycle



Since learning is an iterative and incremental process in which one constantly switches between phases, the phases cannot be sharply separated from each other..

Phase 1: Sensitisation

In this pre-exposure phase, students receive a framework and a glimpse of the problems they will encounter in the subsequent weeks of study. It is hoped that the students will thereby become more aware of the problems in the field, and more involved in the subjects offered in the curriculum. Zull gives a great deal of attention to the importance of linking new information with prior knowledge. He states that teachers should know what students already know about a subject: "To begin, find out about existing neuron networks" (2002, p91). Zull states that ignoring or avoiding students' prior knowledge will seriously hinder teaching. Ornstein (1984) states that pre-exposure to information makes subsequent learning proceed more quickly. He thinks the brain has a way of putting information and ideas into a buffer zone or "cognitive waiting room" for rapid access. If

the information is not used over time, it simply lies unconnected and random. If, however, the other parts of the puzzle are offered, the understanding and extraction of meaning is rapid. Jensen (2000) offers several forms of pre-exposure, such as course descriptions mailed out prior to the first class, subject-matter-related mind-maps offered by the teacher, watching a "what to expect" video about the course, colourful peripherals in a training room and specific "previews of coming attractions". He stresses that one of the key characteristics of the brain cortex is the ability to detect and create patterns of meaning by deciphering cues, recognising relationships and indexing information. The recognition of (new) patterns depends heavily on what a learner brings to a teaching and learning situation. Schmidt (1993) also states that students' prior knowledge and the way teachers help them to activate their prior knowledge is essential in deciding the amount of and kind of structure provided for their new learning.

The sensitisation phase has four goals: from the teachers' perspective, to become deeply aware of what students know about a topic and to connect clearly to this knowledge base; from the students' perspective, to (re)activate their prior knowledge about the subject matter and to build up their intrinsic motivation concerning the topics offered in the subsequent teaching and learning activities. The core of this first phase is for the students to become cognitively and emotionally involved with the subject and for teachers and students together to determine what knowledge the students already have about the subject.

Phase 2: Exploration

Once students become aware of the general topics offered in a given semester's modules, they are confronted with authentic problems related to various study subjects. Presenting theoretical, practical and professional problems to students is intended to place them into a learning context that is closely connected to their professional life after graduation. The students will feel the need to clarify the problems by understanding the underlying mechanisms and processes, and by discovering solutions and strategies to solve the problems. The students acquire information by studying learning resources and consulting experts, and therefore are stimulated to understand deeply the background and origin of the problems. In this phase acquisition of new information and giving meaning to this information are essential.

Meaningful learning and in-depth comprehension depends on the association between prior knowledge and new information, and the elaboration of this association. The more prior knowledge can be linked with new information, the more powerful the meaning becomes. Elaborative rehearsals and (re)structuring of the new information are the main learning principles (Schmidt 1993). Elaboration explores the interconnectedness of topics and promotes depth of understanding (Jensen 2000). Some strategies to help students elaborate on the new subject matter can include mnemonics, developing metaphors and analogies, summarising text by constructing concept maps, applying information to their personal life, looking for the "red thread", the general argument or theme of the writer(s) in the literature studied, and hypothesising about the way a story ends. To foster elaboration and (re)structuring, the students are offered ample opportunities to interact with peers and staff members to exchange views, opinions and criticism. In such collaborative meetings, students share their newly found information and negotiate about the meaning. Students are expected to display an exploratory attitude when finding explanations and solutions, while working from both a disciplinary and interdisciplinary perspective.

Phase 3: Integration

As stated above, recent research seems to indicate that adolescents and young adults have difficulties integrating and applying new information because their brains are still developing (Sowell et al. 1999; Blakemore, Frith 2005; Jolles et al. 2005). Students have to learn to reflect on

what they are learning. They should learn to determine what is relevant in working with plans, theories and abstractions. During this phase, it is also important for the students to reflect critically and be creative with respect to the solutions presented. The development of deep understanding of subject matters requires intent, recall, feelings, decisions and judgments (Zull 2006). Students should be explicitly supported in integrating the newly acquired information.
As most academic studies are multi- or interdisciplinary in character, students should be assisted by various staff members to integrate information from the perspective of various different disciplines and points of view. Teachers can provide students with examples of how they, as experts, integrate various disciplines. They can model ways to critique literature and literature resources, or model how to develop solutions when confronted with complex, open and ill-defined problems.

Phase 4: Application

During the final phase, the students are expected to apply what has been learned and reflect on the whole learning cycle. Consideration should be given to the extent to which the problems can be solved effectively, how a solution can be applied and what progress has been made in absorbing and understanding the information. The students should be able to identify shortcomings that may still exist and area-specific problems that still need to be solved. Summative as well as formative assessment should be part of this phase. Writing papers about specific topics, an example of a summative assessment, helps students become aware of their level of integration and application concerning the subject matter.

A portfolio is an example of a formative assessment. Students are asked to fill out questionnaires on a regular basis that help them assess their own and their peers' skills in areas like leadership, teamwork and communication. After receiving feedback from their peers (and eventually from staff members), students are urged compare their data along a timeline and ask themselves: Am I developing as a professional? Finally they produce a reflection report about their strengths and weaknesses and the way they want to improve their performance.

The assessment should be offered from a short-term perspective (e.g., at the end of a module: what do you know now?) as well as from a long-term perspective (e.g., what do you know over the whole period of study?). This long-term perspective can be assessed with a regularly scheduled progressive or cumulative test on the content of the curriculum. Such a testing modality shows whether students are able to integrate and apply the subject matters studied in the previous semesters.

The ASDL instructional design

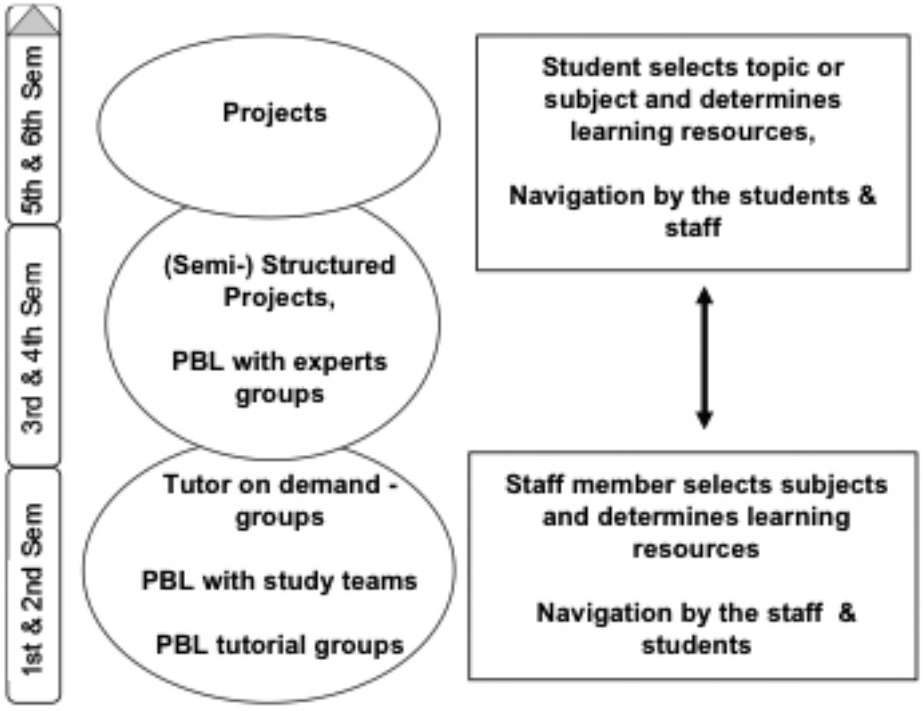
The second key element of the ASDL model is the way the staff promotes students' self-directed learning. The goals of self-directed learning (SDL) are to enhance learners' ability to be proactive in their learning and to foster transformational learning (Merriam et al. 2007). Merriam et al. (2007) state that,

> *"a part of the job of educators is to help learners … to be able to plan, carry out, and evaluate their own learning and to become critically aware of what has been taken for granted about one's own learning…. Such self-knowledge is a prerequisite for autonomy in self-directed learning"* (p107).

SDL is also assumed to be important for life-long learning. According to Bolhuis (2003), there are economical and societal arguments for developing life-long learning: knowledge production is recognised as an important economic factor, and students will increasingly become members of the "global village" with a worldwide economy, mobility and media. This implies that students should be able to upgrade their knowledge, beliefs, views and habits in a changing environment. SDL implies a shift in the role of the learner and teacher. While learners gradually play a more important role in the planning, monitoring and evaluation of the learning process, teachers become its navigators.

There is some evidence that SDL is fostered in a problem-based learning context (Blumberg 2000; Schmidt 2000; Yeung et al. 2003; Lloyd-Jones & Hak 2004). Schmidt (2000) states that the immediate cognitive and motivational effects of SDL are sizeable and well-documented: students in PBL programmes spend more self-study time using a greater variety of learning resources, and they describe themselves as being more intrinsically interested in the subject matter. Vermunt (2000), however, states that conventional PBL does not support self-directed learning in the long run. He states that students should become proficient self-directed learners through being offered instructional methods that ask for more-sophisticated study and team-management competencies. Although these instructional methods should be based on the same grounding as problem-based learning, including constructive, collaborative and contextual learning, students should be challenged more than in the classical PBL model. Some of Vermunt's (2003) suggestions include "PBL with Self-Directing Study Teams", "Project-Centred Learning" and "Dual Learning". Figure 2 gives an overview of the way various instructional methods can be used over several curriculum years in an academic education programme.

Figure 2. The ASDL instructional design in the EPH curriculum



A key feature of this design is to give students an active role in the educational process. Therefore, the instructional design has two important characteristics: (1) the way instructional content is delivered to the students and (2) the level of control of the learning process.

(1) In the first study year, staff members mainly select the topics, content and learning resources. The students are offered relevant books and articles, internet sites, lectures, seminars and guided discussions. Gradually students are stimulated to look for their own resources in the library and on the internet. In the later years of the programme students are given increasing freedom to choose topics of their own interest. Students are allowed to learn through working on problems or projects that meet their own interest in specific topics connected to their future professional job.

(2) In the first year, the navigation of the learning process is largely controlled by the staff, in collaboration with the students. In later years, the navigation of the learning process is more controlled by the students, who are stimulated to become responsible for identifying their learning needs and implementing their unique learning paths. They have to find, select and initiate their learning from various information sources and activities. Since the problems that the project groups have to solve are offered to the students by health institutions from outside of the Faculty, the students have to learn in a work-based environment. Students have to collaborate in project groups, which demands team-management skills and responsibility.

To enrich students' learning, five key features should be incorporated in the ASDL instructional design. Jensen (2000) states that stimuli in the learning environment should be novel, challenging and coherent and meaningful, should take place over time, and should offer feedback. It is important to give students various possibilities to take control of their learning environment. To support students to become independent learners, the teachers must develop learning environments that expand students' learning dispositions and stretch their students' capacity to learn. Claxton (2007) describes an epistemic culture that offers this possibility: a so-called potentiating environment, which forces the students to exercise their "learning muscles" in an appealing and challenging way. "In a potentiating environment there are plenty of hard, interesting things to do, and it is accepted as normal that everyone regularly gets confused, frustrated and stuck" (p90). These potentiating milieus should have the following features to increase the likelihood that students will want to take it seriously (Claxton 2007, p126):

- Rich: there is much to be explored.
- Challenging: the topic contains real difficulty.
- Extended: there is time and opportunity to go into it in depth.
- Relevant: the topic connects with students' own interests and concerns.
- Requiring responsibility: students have some genuine control over what, why, how and when they organising their learning.
- Real: solving the problem or making progress genuinely matters to someone.
- Unknown: the teacher does not already know the "answer".
- Collaborative: most students enjoy the opportunity to work together with others on such tasks.

In summary, the ASDL model, which is a variant of PBL, tries to support students' learning by offering additional attention to higher cognitive skills that young adults seem to develop at the start of their academic studies. The ASDL cycle is a structure that offers students and staff explicit possibilities to support cognitive activities, which young adults find quite difficult. The model

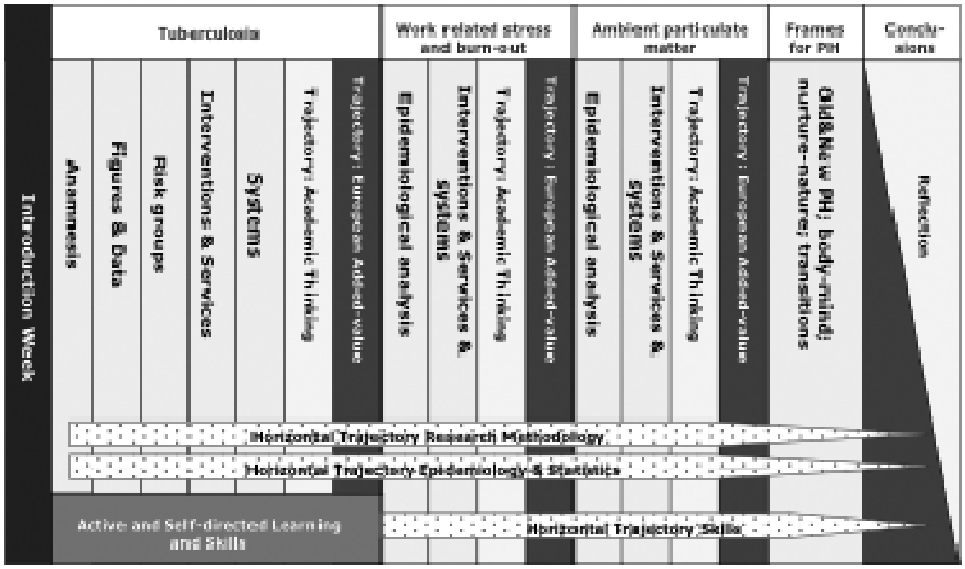
gives special attention to students' autonomy by gradually offering them more and more possibilities to control the learning process by themselves. It is highly oriented on meaning-focused learning: learning to recognise the coherence between concepts and the ability to critically assess these concepts.

The next section briefly describes how the ASDL model has been incorporated in the new bachelor of European Public Health at the Faculty of Health, Medicine and Life Sciences at Maastricht University.

Bachelor of European Public Health – new programme based on the ASDL model

The launch of a new multidisciplinary and internationally focused bachelor programme of European Public Health (EPH) in the academic year 2006-2007 at the Faculty of Health Medicine and Life Sciences at Maastricht University created a good opportunity for the introduction of educational innovations. First, the design of the content is spread across vertically designed modules and semesters, combined with additional supportive horizontal trajectories of critical thinking and skills. Second, an interwoven educational method based on the ASDL model also contributes to the increase of the quality of the programme and students' satisfaction with the learning process (Figure 3). The EPH programme focuses upon public health viewed as a collective action for sustained population-wide health improvement, and concentrates on its European dimension within local, regional, national and global public-health contexts. The adaptive and dynamic curriculum poses an educational challenge and opportunity for both teachers and students. Public Health and its European component naturally stimulate transdisciplinary transfer of concepts and principles, creating a learning environment which is conducive to independent learning and integration of knowledge.

Figure 3: An overview of Semester 1: European Public Health Topics Today



Semesters 1, 2, 3 and 5 have the same outline. As an example, see semester 1 in Figure 3. Semesters 4 and 6 are different: semester 4 is a period where students study their minor subject in different locations (even abroad); semester 6 is an internship in which students finalise their thesis.

The vertical axis shows the various modules connected to the semester theme, ending with a specific focus on the European added value. At the end of each semester the European added value as it relates to the covered subjects is presented once more. Staff help students to integrate and apply the knowledge and skills acquired in the previous modules. Every semester ends with a cumulative test and a paper in which the students have to show that they are able to meaningfully apply the information learned in the previous modules in an integrated, systematic and critical way. Leaving room for continuous improvement, a great deal of attention has been devoted to giving feedback to students and receiving feedback from both students and tutors about the whole educational process.

ASDL in EPH practice viewed from students' perspective

In order to evaluate the instructional design of EPH and find out whether the introduction of ASDL contributes to a decrease in "PBL fatigue", we collected feedback from the first cohort of students (study year 2006-2009) about their experiences with the programme. The qualitative information from the students was obtained using a two-step semi-structured approach (Lichtman 2006). At the end of semester 5, all students were invited to bring forward their negative and positive ideas at a general meeting. In total 31 students (100%) were willing to participate in the evaluation. The aim of this discussion was to encourage participation of students with the various parts of the programme. After the discussion each student was invited to put their personal comments on paper using a questionnaire with open questions pointing to the topics discussed in this paper. To support students' memory, each question was accompanied by a graphic similar to the figures presented here. Students' responses were generally positive, especially with respect to

the ASDL learning cycle. They appreciated the sensitising phase, which they found very motivating and which stirred their curiosity. They were less positive about the exploration and integration phases due to the heavy workload and insufficient support from the staff to help them integrate knowledge from various disciplines.

Concerning the self-directed learning approach, the students noticed some problems in their growth to become independent learners. Some students complained about the amount of literature they had to study, which gave them hardly any time for self-directed learning and reflection: "Till the end of our study we received always a huge list of literature (mostly with the link provided) and there was not a lot of room for being active and self-directed." On the other hand, the students were quite positive about the horizontal trajectories related to "academic thinking" and "skills". They also valued the experience of writing papers that challenged them to apply their newly acquired knowledge. The authors find it particularly noteworthy that when students were asked whether they had the impression that they had gained the skills and attitude of a life-long learner, most students (25 out of 32) said "yes" or "yes, but…". The findings from the evaluation show that the introduction of new and innovative educational approaches was a good move towards the development of ASDL practice based on PBL. On one hand it enhanced the benefits of introducing some elements; on the other hand it contributed to the identification of the weaker areas that need to be improved.

Lessons learnt

Based on this three-year experience, we can conclude that the application of the ASDL model to EPH studies proved to be a successful educational intervention that led to improved satisfaction with the PBL method. The implementation of the model turned out to be a complex process that can be elaborated on in various stages of its development, based on the continuous feedback coming from the students. The idea of combining the introduction of the ASDL model with a new educational programme seems to be a good solution, offering the students a curriculum that is educationally and professionally sound with respect to the content and method of instruction. The programme fosters constructive, collaborative, contextual and self-directed learning opportunities, and is overall well appreciated by the students.

However, our experience also shows that there is still room for improvement, and considerable effort is called for to introduce some changes at the integration and application phases of the ASDL learning cycle. Although we tried to be supportive in helping students with the integration and application of the multidisciplinary content, the students indicated that we were not that successful; instead, we overloaded them with information and teaching activities. It may be that in their enthusiasm and under the pressure of the "information age", staff members underestimated the amount of information and activities that could be successfully offered to the students. Zull (2002) warns explicitly against imbalance in a curriculum. When students have to acquire too much information, they hardly have time to comprehend, integrate and understand in a meaningful way what they have studied. Teachers should also take into account the way human cognitive architecture is designed, since, according to the cognitive load theory, the students will have learning difficulties when the limitations of the working memory are not respected; this can result in problems related to processing and organising new information in their long-term memory (Sweller et al. 1998; Van Merriënboer & Sweller 2005).

Another area that requires more attention from staff is the way students perceive the learning environment. As most students come from rather conventional learning settings within secondary

education in Europe, they may be overwhelmed with the way they have to study in the EPH programme. The characteristics of the learning environment themselves do not have direct influence on student learning (Könings et al. 2005). Although the learning environment can be designed to be very powerful, students' perceptions of that learning environment will determine what kind of learning activities will be employed. That is why more attention should be paid to such aspects as students' concepts of learning, their motivation and learning goals, the way they regulate the learning process and different kinds of cognitive processing strategies, as these have a crucial effect on student learning. Because students come from various countries in Europe, their expectations and perceptions are quite diverse, and some students require additional support in an unfamiliar environment.

Conclusions

We think we are on the right track in offering students a learning environment that helps them to expand their capacity to learn beyond the gates of the university. As Frenk et al. (2010) suggest, the "next generation of learners needs the capacity to discriminate vast amounts of information and extract and synthesise knowledge". PBL and ASDL help develop these skills in the flexible and multidisciplinary context currently recommended in Public Health curriculums (Evans 2009). However, more attention should be paid to the support and development of the learning environment to make it more conducive to self-directed learning. Using adequate evaluation and assessment tools combining perspectives of teachers, students and designers would help in tailoring the program to the needs of the students and faculty. The introduction of a newly designed programme combined with the introduction of the ASDL model, with its richness of various educational activities and forms of delivery, not only contributed to restoring satisfaction with a PBL method, but also seemed to be a good tool for helping the students independently find their own way in the interdisciplinary knowledge maze.

References

Blakemore, S. J. & Choudhury, S. (2006). Development of the adolescent Brain: implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry,* 47, 296-312.

Blakemore, S. J. & Frith, U. (2005). *The learning brain. Lessons for education.* Blackwell Publishing, Malden, MA.

Blumberg, P. (2000). Evaluating the evidence that problem-based learners are self-directed learners: a review of the literature. In Evenson, D. H. & Hmelo, C. E. (Eds), *Problem-based learning: A research perspective on learning interactions,* Lawrence Erlbaum Associates, Hillsdale, NJ, 199-226.

Bolhuis, S. (2003). Towards process-oriented teaching for self-directed lifelong learning: a multidimensional perspective. *Learning and instruction,* 13, 327-347.

Claxton, G. (2007). Expanding young people's capacity to learn. *British Journal of Educational Studies*, 55(2), 115-134.

Dolmans, D., Wolfhagen, I. & Van der Vleuten, C. (2001). Why aren't they working? In Webb, G., Schwartz, P. & Mennin, S. (Eds), *Problem-based learning. Case Studies, Experiences and Practice.* Kogan Page, London.

Elsevier Magazine (2008). The Best Studies 2008. Accessed 19 January 2008 from http://www.elsevier.nl/web/Weekblad/De-beste-studies-2008.htm.

Evans, D. (2009). The role of schools of public health: learning from history, looking to the future. *Journal of Public Health,* 31, 446-450.

Frenk, J., Chen, L., Bhutta, Z. A., Cohen, J., Crisp N., Evans, T., Fineberg, H., Garcia, P., Ke, Y., Kelley, P., Kistnasamy, B., Meleis, A., Naylor, D., Pablos-Mendez, A., Reddy, S., Scrimshaw, S., Sepulveda, J., Serwadda, D. & Zurayk, H. (2010). Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. *The Lancet*, 376, 1923-1958.

Giedd, J. N. (2004). Structural magnetic resonance imaging of the adolescent brain. *Annals of the New York Academy of Sciences*, 1021, 77-85.

Jensen, E. (2000). *Brain-based learning. The new science of teaching & learning,* Corwin Press, Thousand Oaks, CA.

Jolles, J., De Groot, R., Van Benthem, J., Dekkers, H., de Glopper, C., Uijlings, H. & Wolff-Albers, A. (2005). *Brain lessons.* Neuropsych Publishers, Maastricht.

Houlden, R. L., Collier, C. P., Frid, P. J., John, S. L. & Pross, H. (2001). Problems identified by tutors in a hybrid problem-based learning curriculum. *Academic Medicine,* 76(1), 81.

Könings, K. D., Brand-Gruwel, S. &Van Merriënboer, J. J. G. (2005). Towards more powerful learning environments through combining the perspectives of designers, teachers, and students. *British Journal of Educational Psychology,* 75, 645-660.

Kuiper, T., Meijer, A & Moust, J. (2011). Innovation in Public Health Teaching: The Maastricht Experience. *Public Health Reviews*, 33(1), 300-314.

Lichtman, M. (2006). *Qualitative research in education, a user's guide.* Sage Publication, Thousand Oaks, CA.

Lloyd-Jones, G. & Hak, T. (2004). Self-directed learning and student pragmatism. *Advances in Health Sciences Education,* 9, 61-73.

Merriam, S. B., Caffarella, R. S. & Baumgartner, L. M. (2007). *Learning in adulthood. A comprehensive guide.* Jossey-Bass, San Francisco.

Moust, J. H. C., Van Berkel, H. & Schmidt, H. (2005a). Signs of erosion. Reflection on Three Decades of Problem-based Learning. *Higher Education,* 50, 665-683.

Moust, J. H. C., Roebertsen, H., Savelberg, H. & De Rijk, A. (2005b). Revitalising PBL Groups: Evaluating PBL with study teams. *Education for Health,* 18(1), 62-73.

Moust, J. H.C., Bouhuijs, P. A. J. & Schmidt, H. G. (2007). *Introduction to problem-based learning.* Wolters-Noordhoff, Groningen.

Ornstein, R. (1984). *The Amazing Brain.* Houghton-Mifflin, Boston, MA.

Schmidt, H. G. (1993). Foundations of problem-based learning. Some explanatory notes. *Medical Education*, 27, 422-432.

Schmidt, H. G. (2000). Assumptions underlying self-directed learning may be false. *Medical Education,* 34, 243-245.

Sowell, E. R., Thompson, P. M., Collin, J. H., Jernigan, T. L. & Toga A. W. (1999). In vivo evidence post-adolescent brain maturation in frontal and striatal regions. *Nature Neuroscience,* 2(10), 859-861.

Steenkamp, F., De Moor, A., & Van Beek, M. (2004). *De keuzegids hoger onderwijs 04/05 (The higher education guide 04/05),* Hoger Onderwijs Persbureau, Leiden, the Netherlands.

Steenkamp, F., De Looper, H. & Bliekendaal, M. (2006). *De keuzegids hoger onderwijs 06/07 (The higher education guide 06/07),* Hoger Onderwijs Persbureau, Leiden, the Netherlands.

Steenkamp, F., Dobber, L. & Jansen, M. (2008). *De keuzegids hoger onderwijs 08/09 (The higher education guide 08/09),* Hoger Onderwijs Persbureau, Leiden, the Netherlands.

Steenkamp, F., Dobber, L. & Jansen, M. (2010). *De keuzegids hoger onderwijs 10/11 (The higher education guide 10/11),* Hoger Onderwijs Persbureau, Leiden, the Netherlands.

Sweller, J., Van Merrënboer, J. J. G, & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10, 251-295.

Van Merrënboer, J. J. G. & Sweller P. (2005). Cognitive load theory and instructional design: Recent developments and future directions. *Educational Psychology Review*, 17, 147-177.

Vermunt, J. (2000). About the quality of learning. in Gijselaers, W & Vermunt, J (Eds.), *Studies for new scholars,* Maastricht University, Maastricht.

Vermunt, J. (2003). The Power of Learning Environments and the quality of Student learning. In De Corte, E., Verschaffel, L., Entwistle, N. & Van Merriënboer, J. (Eds), *Powerful Learning Environments; Unravelling Basic Components and Dimensions*. Elsevier Sciences Ltd, Kidlington, UK.

Yeung, E., Au-Yeung, S., Chiu, T., Mok, N. & Lai, P. (2003). Problem-design in problem-based learning: evaluating students' learning and self-directed learning practice. *Innovations in Education and Teaching International*, 40(3), 237-244.

Zull, J. E. (2002). *The art of changing the brain. Enriching the practice of teaching by exploring the biology of learning,* Stylus Publishing, Sterling, VA.

Zull, J. E. (2006). Key Aspects of How the Brain Learns. *Neuroscience and adult learning. Special Issue of New Directions for Adult and Continuing Education*, 110 (Summer), 3-9.