FLEXIBILITY IN LEARNING: a case report on problem-based learning

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ABSTRACT

The need for change in higher education has had quite some attention in recent years. Societal needs require educational systems to produce graduates to be better equipped with highly specialized and qualitatively superior professional skills. Economical needs require educational programmes to be both efficient and cost-effective. The vanishing boundaries between countries require educational systems to be transparent and internationally orientated. Developments in science have led to an explosion of knowledge, forcing educational systems to be dynamic and flexible. The rapid change in knowledge forces educational systems to emphasize learning skills and the maintenance of competence, rather than the provision of knowledge alone. Educational technology obliges educational programmes to use multimedia and computer technology. Progression in educational theory requires educational systems to activate the learner and to critically reflect upon traditionally accepted adagia of educational practice.

In this context it is argued that flexible educational systems will require a shift from teaching programmes towards learning programmes. The distinctive characteristics of both approaches will be outlined in this article. Subsequently, these principles will be illustrated by an explanation of an existing learning programme. This programme uses problem-based learning as an instructional method. A typical week of a medical student's studies will be outlined to explain a number of educational principles, including self-directed learning, choice of teaching and learning formats, assessment of achievement, and curricular and organisational management.

INTRODUCTION

Educational programmes in higher education, particularly in Europe, have a long standing tradition. The fundamental bricks of the teaching methods used in these programmes have not changed for several hundred years and perhaps even longer than that. Teaching is an activity which has been modelled by our own teachers, has been copied for our own teaching activities and will serve again as a model for our students. Many teachers have not been trained or specifically prepared for their teaching roles. Even with a certification in their discipline most teachers are assumed to be qualified, usually for life, for their teaching tasks. It is therefore not surprising that educational programmes and teaching activities are mainly governed by tradition. As far as changes occur in educational programmes, they are usually restricted to changes of content, but are hardly ever related to the underlying concepts of teaching.

The question to be raised is whether this situation is desirable. In this article we will reflect upon a number of reasons for the necessitating of change in education and challenge some of the more fundamental assumptions of regular teaching programmes. We will subsequently discuss a new educational method called problem-based learning (Barrows & Tamblyn, 1980). By no means should this new model be considered as the golden standard for innovative education, but as one attempt to change educational programmes. The purpose is to critically reflect upon education and not to 'sell' the educational model. It is truly a case report in order to demonstrate the viability of educational innovation, and the reader should realize that the model described is one among many options. Before describing this model we will review some of the reasons for educational change and discuss general characteristics of existing and desirable educational programmes.

REASONS FOR EDUCATIONAL CHANGE

In this century, and particularly after the Second World War, virtually all Western countries have undergone the same changes in higher education for obvious political and societal reasons — a larger part of the population is now taking part in higher education training. The number of students has therefore dramatically increased. Not only did this increase require a further change from the classic apprenticeship model used in teaching in the last centuries, it also required a substantial investment of resources. Governments nowadays have a problem of trying to control continuously growing budgets for (higher) education. These *economical reasons* have led many governments to urge reductions in cost, and more accountable methods of quality control in education. Economical pressure forces

educational programme managers to consider change from a production perspective — rather than an academic perspective: how many graduates of a particular quality can we produce in a particular amount of time? The consideration of efficiency and effectiveness is a completely new issue for most educational programmes and their managers. Although the various European countries still differ greatly in the degree that economic reasons affect education, it is only a matter of time before this becomes universal. Exclusive reliance on academic criteria in defence of the quality of educational programmes will become increasingly difficult to maintain.

In a similar way changes in society induce changes in education. The independent academic position of universities and other institutions of higher education is increasingly challenged. In business, engineering, health care and other fields, particular expertise profiles and skills are emphasized, adapted to contemporary needs in these fields. These needs are often badly met by educational programmes. Thus, *societal reasons* will have an increasing impact on change in education.

Another important reason for change in education is the advancement of science and the *explosion of knowledge*. The problem of selection and coverage of content is an emerging one and many educational programmes suffer from 'overload'. Moreover, the progressive advancement of scientific knowledge will make any curriculum outdated within a few years. Therefore, life-long learning skills are more essential than the consumption of temporary knowledge and the fostering of such skills must be a task of educational programmes.

The European community allows any graduate to work within any other country of the community. Vanishing boundaries will require educational programmes to change and this will require critical appraisal of licensure requirements. The educational preparation of professionals, capable of operating in an international context, will become more important. Hence, *internationalisation* will require education to change.

The rise of *information technology* has an overall effect on society in general and will provide particular challenges for education. Information technology provides new carriers of information and can make learning less location and time dependent.

Finally, the necessity of change in education is induced by progression in educational theory. Quite some knowledge has accumulated with regard to what conditions facilitate learning and how individuals mature from novices to professional experts. This requires meaningful contexts to store and retrieve information, the importance of repetition of content, the recognition of student learning strategies, the educational impact of examinations, the tools developed for quality control, and the utility of organisational strategies for managing educational programmes are just a few areas where educational theory has something to offer us. Teachers, as professional educators, should be aware of this kind of information and its use should be part of their professionalism and scholarship.

TEACHING AND LEARNING

As the above makes clear, we take the position that there are sufficient reasons to point to the necessity of change in education. However, the question that comes to mind is the direction of that change. What should it lead to; what is the target or objective? In addressing this question we would like to make a fundamental assertion. We would argue that a distinction is in order between teaching and learning. We notice that both concepts are used interchangeably — we tend to take it for granted that teaching will lead to learning. In discussing educational programmes we automatically speak of teaching activities. Yet we would like to argue that both concepts are quite different and that the mission of educational change should emphasize the learning aspect rather than the teaching aspect. After all, learning is what educational programmes should be about, teaching is a vehicle, only one of the vehicles, to achieve learning.

The educational programme of the future should be a learning programme rather than a teaching programme. To describe what we mean by a learning programme, a number of descriptors related to teaching and learning programmes are contrasted in figure 1. We will not discuss each entry in the figure but will restrict ourselves to an overall characterisation.

In a learning programme the centre of the universe is the student. The key issue is to create an environment that stimulates the student to actively acquire knowledge (and skills, attitudes, etc.). Instead of being a (passive) consumer of learning material prescribed by the teacher, the student should become responsible for seeking information offered by the teacher. An active learning attitude is essential in order to achieve self-directed learning skills. This should be the basis for life-long learning. After graduation no

Figure 1: Characteristics of teaching programmes versus learning programmes.

Teaching Programmes	Learning Programmes
● Knowledge transfer	● Knowledge acquisition
● Teacher centered	● Student centered
● Static and rigid	● Dynamic and flexible
● Teaching objectives	● Learning objectives
● Uniform	● Individual
● Reinforces passiveness	● Reinforces activeness
● Students are led	● Students may discover
● Learning paths are described	● Learning paths are offered
● Teachers provide answers	● Teachers ask questions
● Teachers direct students	● Teachers guide students
● Teaching is essential	● Learning is essential
● Lectures are essential	● Assessment is essential
● Lecture halls are essential	● Library and learning facilities are essential
● Supply is essential	● Demand is essential
● Location dependent	● Location independent
● Time dependent	● Time independent
● Uniform study pace	● Individual study pace
● Uniform study sequence	● Variable study sequence
● Uniform content	● Variable content
● Teachers work in isolation	● Teachers work in collaboration

teacher will be available to provide further direction, current knowledge will rapidly decay and professional skills still need to be developed further. Instead of lectures, individual learning and learning in peer groups becomes important. Instead of lecture halls, library and learning facilities become essential. Rather than stacking memorised information to pass the next examination, information should be used to understand phenomena or problems, and *knowledge should be not displayed but applied to relevant contexts.*

Many of our current educational programmes are very distant from a learning programme as envisioned here. Most of our programmes are a concatenation of topics prescribed by teachers and consumed by the students. Not uncommonly, little communication exists between teachers, sections or departments on the content provided in teaching programmes. Usually teachers or disciplinary units are fully autonomous. It is hard to believe that individual teachers can overview an educational programme as a whole. Moreover, teachers, as specialists in their field, are inclined (quite understandably) to over-emphasize the importance of their own discipline in relation to the integral objectives of an education programme. In a system with many individual autonomous elements there is little space for monitoring, quality control, flexibility or, more importantly, synergy between elements. Moreover, the attitude towards professional quality in education is remarkably different from other academic areas. Professional quality in research, for example, is defined, and unequivocally accepted, through rigorous peer review. Quality of education, on the other hand, is left to the professional integrity of the individual.

Until now our discussion of the need and direction for change has been quite theoretical and perhaps perceived as somewhat utopian. To make some of these issues more concrete, we will outline an existing programme where an attempt has been made to apply some of the characteristics of a learning environment.

PROBLEM-BASED LEARNING

This educational method has been applied at the University of Limburg in Maastricht, the Netherlands. Although all faculties of this university use this educational method, with variations adapted to the needs of individual disciplines, we will deal with a faculty in which discipline problem-based learning originated: Medicine. The Medical School has applied problem-based learning since the faculty was founded in 1974 (Van der Vleuten & Wijnen, 1990). In the Netherlands medicine consists of a six-year programme in which the last two years are spent in clinical attachments in both ambulatory and non-ambulatory settings. We focus on the system as it is used in the first four preclinical years of the study.

We do so by describing an exemplary week in the life of a student and discussing the principles behind this programme. This week is schematically represented in figure 2.

Figure 2: A week of a student in a medical problem-based learning programme.

	Monday	Tuesday	Wednesday	Thursday	Friday
am	Skills training	Tutorial group	Communication and attitude training		Tutorial group
pm		Lecture		Health practice contact	

The tutorial group

The heart of the matter is the meeting of the tutorial group. Twice a week a group of approximately 8 students and one staff member, called the tutor, meet. They have a so called blockbook consisting of a number of problems related to the content of that unit of the curriculum. Figure 3 provides a sample problem.

> Mr. Brown, aged 68, comes to your surgery and tells you that he has been feeling dizzy recently. He is seriously worried because he has always been healthy; he has never had any medical problems. But the complaints, which he has had for a few months, are now getting worse and worse. The dizziness occurs when he gets out of bed in the morning, but it can also be provoked by a sudden movement of his head. "When it happens, everything swims before my eyes and I feel unwell, light in the head and a little queasy. When I sit down for a moment, the dizziness slowly disappears."

Figure 3: A sample problem as used in a tutorial group.

Problems are used to ensure a meaningful context for learning. By providing this context knowledge can be integrated with previous knowledge, and knowledge can be better retrieved and applied when necessary (Schmidt, 1983; Norman & Schmidt, 1992). The problems also lead to an integration of disciplines. For the problem presented in figure 3 the students may, for example, study the anatomy of the brain as well as neurological aspects of dizziness. The study of basic sciences and applied sciences are integrated.

In one tutorial session the students will analyse a single problem and discuss their prior knowledge related to the problem. They will subsequently define what they need to know in order to tackle the problem; they will define the learning objectives. In a group discussion one of the students acts as chairperson and one will keep minutes on the whiteboard. These tasks rotate within the group members at every session. The task of the tutor is to monitor the group process. She may, for example, intervene when the discussion is unclear, when individual students do not contribute to the discussion, or when the objectives are too vaguely defined. Often the tutor is not even an expert to the particular problem at hand. The tutor is not teaching, but guiding the students: she may ask specific questions, or probe particular topics. After having defined the learning objectives as a group, the students will then pursue the required information on an individual basis. They are assisted in the use of multiple information sources and the comparison and synthesis of that information (e.g., different handbooks, recent articles). In the next tutorial session they will discuss what they have found. They are required to report in a way that demonstrates understanding of the material learned, (e.g. not by reading their notes, but by presenting an overview or a schematic summary). Unclear concepts are discussed. If necessary, new learning objectives are defined. A tutorial session lasts two hours, usually one hour for reporting back and one hour for discussing a new problem. Tutorial group sessions are held twice a week. A curriculum unit usually consists of six weeks. At the start of every unit, new tutorial groups are formed on a random basis students have no choice in the composition of their group. This forces the students to work effectively in any team, as they will have to do in their later career.

Each unit is interdisciplinary in nature and addresses a particular theme, eg fatigue or blood loss. The units are scheduled according to a master plan in which curricular objectives

are defined in content areas which have been deliberately arranged in such a way that a number of desirable principles can be achieved. The curricular architecture includes increasing complexity, a spiral hierarchy of recurring topics, and a transition from normal to abnormal functioning.

To foster internationalisation, three units are taught fully in English (the other units are in Dutch) and students are encouraged to spend some study-time abroad. The English units allow exchange with foreign students, for instance through the Erasmus programme. A wide network has been established with other schools to send our students abroad.

Practical skills

The intention of the programme is to integrate theory and practice as tightly as possible. Therefore an elaborate skills training programme is arranged, from the beginning of the first year. This skills programme is integrated with the content discussed in tutorial groups. In our illustrative week, two training units are scheduled. For example, for the sample problem in figure 3 the skills training on Monday morning could consist of practising the neurological examination on each other or on a patient. Attitude and communication skills, a pressing societal demand for doctors, is also considered important in our skills training. In each curricular unit every student will have an encounter with a (simulated) patient. In a safe laboratory environment the student can practice her social skills, and, as the curriculum progresses, can practice the application of knowledge in relation to a real (or simulated) patient.The training on Wednesday morning could, for example, encompass the bringing of bad news to a (simulated) patient with a neurological problem.

Health practice contact

The same integrated objectives are pursued with the health practice contact in the week of our student, and a number of these contacts are organised throughout the curriculum. These may include a tour on an ambulance, a week spent nursing patients in a hospital or a day in a midwifery practice. The health practice contacts and the skills programme contribute highly to the motivation of the student. From the start, they can act as 'real' professionals, and in that process, they can obtain an accurate view on the demands of their chosen profession, allowing them to make an informed choice as whether to continue their training in the field or not.

Lectures

Traditional lectures are also part of the curriculum. However, they are carefully planned and should a specific additive function to the learning programme. They are used to introduce a curriculum unit, to activate prior knowledge, to help students on difficult topics, to provide unique information (e.g. from an invited speaker in the field). On average, approximately two lectures are held per week.

Non-scheduled time

The open space in the week of our student is significant. Problem-based learning requires students to work independently. To facilitate self-study, a substantial investment is made in providing facilities for students. Next to a library a 'study-landscape' has been created. This facility provides a library (although books cannot be loaned) with multiple copies of all current handbooks, a video and slide library, computer facilities for computer-assisted learning and, for other information technology applications as well as access to library files, CD-rom, word-processing and statistical facilities, the Internet, etc. copying facilities, and ample space to sit quietly for studying. Throughout the curriculum approximately 10 to 12 hours per week are scheduled activities and the remaining time is for the student to fill in on self-directed learning activities.

In summary, problem-based learning requires students to acquire knowledge by using problems as a learning context. It stimulates self-directed learning for life-long learning and integrates disciplines both horizontally (multiple disciplines integrated with one unit) and vertically (basic and applied sciences — theory and practice are integrated).

ASSESSMENT

The way student achievement is assessed is quite important in a problem-based learning programme. Tests and examinations have a tremendous impact on how students learn. A discipline-oriented assessment programme would be detrimental in a problem-based programme. Similarly, a classical system consisting of course-related examinations in which students go from hurdle to hurdle would not be beneficial for problem-based learning. In a course-related examination system students work to pass for the test. Students in a problem-based programme are expected to define their own (or group) learning objectives, i.e. their self-directed learning is paramount. Test-directed studying is the opposite from that.

Moreover, the focus is on functional knowledge, and little value is attributed to the momentary knowledge of a student cramming for a test.

Next to integrated unit-related tests, the assessment programme rests heavily on a different format of testing — known as progress testing. A progress test is a comprehensive test (250 test items) covering the end objectives of the curriculum just like a final examination, including all disciplines within the programme. The same test is administered to all the students in the curriculum (year 1 to 6) at the same time. Every three months a new test is constructed and administered. First year students are not able to answer many questions (approximately 20%), second year students somewhat more and so on. A single student will make 24 (6 times 4) progress tests during her study and will find herself becoming gradually more capable in different areas. The average overall growth shows a near perfect linear incline until graduation. Test-directed studying is difficult since students do not know what to expect — any question can be asked. Conversely, by working continuously on their own objectives, students see automatic growth in their knowledge. There is no need for cramming or particular anxiety.The progress test allows students to concentrate on their tutorial group work. Moreover, the test reinforces functional knowledge. Instead of passing from one examination to the other, a progress-testing system continuously assessess previously learned material. For example, although biochemistry is learned in the first year the students are still required to answer biochemistry questions upon graduation.

Other parts of the assessment programme include performance assessments of students who interact with (simulated) patients using direct observation under standardized conditions, and written or computer-based exercises and tests which use problems and patient cases. All tests are submitted to a careful review procedure by interdisciplinary test review committees. Every test becomes public after its administration, and open for critique from the students. Their comments are reviewed by the test committees, and final scores for students are calculated after this process has taken place. Special attention is given to the feedback function of tests, by providing detailed information on profile scores, by peer reference information, and by providing literature references and suggestions. Achievement testing as a learning resource, i.e. as an integral aspect of the educational process, is highly emphasized.

THE EDUCATIONAL ORGANIZATION

The task of the teacher in this programme is clearly different from that of a traditional programme. There is relatively little classical teaching, such as lecturing. The role of the staff is more that of the provider, the developer, the organiser and facilitator. Examples of teaching roles include being tutor in a tutorial group, member of a unit planning group, member of a test review committee, developer of a training programme in practical skills, trainer in a faculty development programme. All new staff members are required to take a number of educational courses on problem-based learning and its specific teaching skills before they are allowed to participate in the programme. The different teaching roles do have a certain hierarchy. For instance, to become a unit coordinator, one must have extensive experience as a tutor and as a member of a planning group. When there are openings for teaching roles staff hve to apply. Part of the selection procedure includes the quality of past performance in previous teaching tasks. In promotion decisions teaching performance is an important criterion. Some of the teaching roles are formally evaluated by students. These evaluations are brought to the attention of department chairs and are used in yearly staff evaluation rounds.

To manage all these activities a matrix-management system is used. The matrix is defined by two axes: disciplines (departments) and educational activities. Depending on the activity, a number of disciplines are involved and staff members of multiple departments are allocated or linked to that activity. Planning an educational unit is an illustration of one educational activity, and a planning group will typically consist of six to nine representatives of departments. There is a wide variety in educational activities, including a number of educational support activities. For instance, a group of people are responsible for library and study facilities, another group for systematic programme evaluation, another for faculty development, etc. The roles of teachers can be quite diverse.

All educational roles are quantified in educational hours. Different roles are differently rewarded depending on their time involvement. Therefore, it is relatively easy to monitor the contribution of departments. The summation of educational credits per department should match the number of staff time-tabled on teaching activities in that department. If that is not the case, the department will lose staff in the long run. If poor quality is delivered individual staff members will have difficulty in competing

for educational roles, which will in turn burden the department because sufficient input in the overall curriculum. On the other hand, the credit system provides flexibility for departments, because it allows the planning of variable teaching loads across the individual members of a department.

The coordination of the curriculum as a whole is organised at a central level. An educational committee with elected members from departments and student representatives determines, to a large extent, overall educational policy. Operational management is in the hands of a separate committee chaired by the Dean for Educational Affairs. Educational input and educational quality is the basis for a yearly review session with all departments. Thus the curriculum is systematically monitored using student evaluation questionnaires which reflect all educational activities. These evaluations are fed back to the responsible educational project groups and changes to programmes are monitored. Review groups within the educational committee periodically make an in-depth evaluation of educational activities. In this way quality control and educational innovation is built in within the programme; i.c. an attempt is made to achieve a 'learning organisation'.

CONCLUSION

Problem-based learning intends to create a flexible learning environment. It tries to meet the demands of change as discussed in our introduction. It should be clear by now that learning can be much more than teaching. It is learning which we try to foster and teaching is only a part of it. Teachers are the architects, the managers, the controllers, and the helpers. DBL intended to be a dynamic and flexible process: quality control, rationality, change and innovation are vital elements of our approach to education.

Two questions come naturally to mind: is it any better, and what does it cost? The effectiveness question is difficult to answer. If the spread of problem-based learning is used as a criterion, then it is quite effective. Virtually all over the world problem-based learning has been introduced into many schools of higher education and universities, in both in western and developing countries.

The answer is more difficult if outcome is the criterion. A number of review articles have recently been published (Albanese & Mitchell, 1993; Berkson, 1993). They indicate that generally, knowledge examinations do not demonstrate systematic differences between students in problem-based learning programmes and conventional programmes. On the one hand, this is a reassuring finding, on the other hand, one may alternatively question the need for all the effort. In relation to specific skills, problem-based learning students are often rated to be superior. These include, for example, library skills and practical professional skills. However, the most consistent and conclusive finding in favour of problem-based learning is 'fun': students in a problem-based learning programme have more pleasure in studying and are more motivated. A final difference concerns attrition rates. In the Netherlands, problem-based learning programmes show consistently lower drop out rates and the discrepancy between nominal and actual study-time is smaller. In other words, more graduates are produced in shorter time with at least equal proficiency. Therefore, problem-based learning may be economically more efficient.

No studies have been published comparing the resource requirements of problem-based learning and conventional programmes. However, within our situation in the Netherlands, the situation is quite simple: there are no differences in funding across the universities. The problem-based learning programmes are carried out with the same budget as in other universities. The current popularity of problem-based learning in so many institutions is another token of its feasibility.

Our case-report concerns medicine, yet problem-based learning has been successfully applied in many other disciplines (Boud & Feletti, 1991; Gijselaers et al., 1995; Bouhuijs, Schmidt & Van Berkel, 1995). Naturally, the method may not work identically for every discipline and some changes may be in order. However we would like to stress that the method itself is not so important. More important is the creation of an adequate and flexible learning environment and there may be many ways to achieve that.

LITERATURE

Albanese, M.A. & Mitchell, S. (1993). "Problem-based learning: a review of literature on its outcomes and implementation issues". Academic Medicine, 68, 52-81.

Barrows, H.S. & Tamblyn, R.M. (1980). "Problem-based learning: an approach to medical education". New York: Springer.

Berkson, L. (1993) "Problem-based learning: have the expectations been met?" Academic Medicine, 68 (Supplement), S79-S88.

Boud, D. & Feletti, G. (Eds.) "The Challenge of

Problem-based Learning". London: Kogan Page, 1991.

Bouhuijs, P.A.J., Schmidt, H.G., Van Berkel, H.J.M. (Eds.) "Problem-based learning as an Educational Strategy". Maastricht: Network Publications, 1995.

Dolmans, D.H.J.M. (1994) "How students learn in a problem-based curriculum". Ph. Dissertation, Maastricht: University of Limburg.

Gijselaers, W.H., Tempelaar, D.T., Keizer, P.K., Blommaert, J.M. & Kasper, H. (Eds.) "Educational Innovation in Economics and Business Administration: The Case of Problem-Based Learning". Dordrecht: Kluwer Academic Publishers, 1995.

Norman, G.R. & Schmidt, H.G. (1992). "The psychological basis of problem-based learning: a review of evidence". Academic Medicine, 67, 557-565.

Pochet, B. Le "«Problem-based Learning», une révolution ou un progrès attendu?" Revue Française de Pédagogie, 111, 95-107.

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

Van der Vleuten, C.P.M. & Wijnen, W.H.F.W. (Eds.) "Problem-based Learning: Perspectives from the Maastricht Experience". Amsterdam: Thesis-publ.