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Problem-based learning and theories of learning

Introduction

Problem-based learning emerged from a rich pool of inquiry in how people acquire and transfer knowledge. Ideas that preceded our time have left us with a legacy that underpins current problem-based approaches to teaching and learning. As the field of psychology has gained prominence, the evolving and continuing debates prompted by proponents of different theories about the nature and process of learning have created a minefield of overlapping concepts, with few clear frameworks for understanding the relationship between the context and the experience of the learner. In order to come to terms with these differences, learning theories have traditionally been grouped into categories, the primary ones including behavioural and cognitive theorists, with a range falling somewhere in between, and with full acknowledgement that categories may overlap each other.

While this chapter is by no means an exhaustive account of the psychological or educational perspectives that have influenced the development of problem-based learning, we believe it useful to discuss some of the theories of learning related to the approach. Thus we explore the relationship between problem-based learning and a number of learning theories, namely behavioural, cognitive, developmental and humanistic approaches. Theories of learning that centre on the experience of students and the role of tutors have grown in importance since the 1980s, and therefore we also present theories that focus on the value of meaning construction, personal transition, the learning context and learner identity.

Problem-based learning and behavioural theories

While some behavioural theories seem to run contrary to problem-based learning, the approach has certain elements that can be classified as

behavioural in nature, as they gave us some of our first conceptions of how people learn. Some behavioural theories, such as the classical conditioning model posed by Watson and operant condition proposed by Skinner, seem to run contrary to problem-based learning, but theories such as those espoused by Thorndike provided an understanding of improvement of learning through feedback, clear goals and practice, concepts that underpin many forms of problem-based learning. In addition, Hull's work and his notion of Drive Reduction Theory, which asserts that behaviour is determined in part by learner motivation, promotes a key aspect of problem-based learning, which asserts that students should be motivated as stakeholders attempting to solve an important problem.

One of the problems with behavioural notions is that they generally assert that we cannot observe learning except through behavioural changes. Thus they see learning as a relatively permanent change in behaviour brought about as a result of experience or practice. This makes the product or outcome the most important factor, rather than the iterative process of learning that problem-based learning tries to promote. There are other assumptions that emerge from the behavioural tradition as well, such as the belief that outcomes and benchmarking standards will somehow make learning better, or will prove competence to practice, or even make what is taught auditable across the same subject in different universities.

Early behavioural theories took too simplistic a view of learning and have resulted in some lasting influences, such as the development of use of performance objectives in learning. These behavioural objectives are usually manifest in programmed instruction, competency-based education and skill development and training, that are not suitable for understanding the complex learning that we seek in academe, such as learning multifaceted ideas and theories, and developing metacognitive skills. For behaviourists, learning activities should be organized to optimize acquisition of information and routine skill, which is too confining for both problem-based learning and many tutors in higher education.

Problem-based learning and cognitive theories

Unlike behavioural theories, cognitive theories focus on mental processes and thus provide an interesting lens for understanding the origins of problem-based learning. In contrast to the behaviourist theories, cognitive theories are directly concerned with mental processes (which include insight, information processing, memory and perception) rather than products (behaviour), which some would suggest is more in keeping with the process approach of problem-based learning. Cognitive theorists seek to understand how individuals learn and what goes on inside the mind when learning occurs. This kind of education focuses on cognitive structuring which is essential for developing capacity and skills for better learning, or to learn how to learn, one of the primary goals of problem-based learning.

Cognitive theories tend toward the more abstract, as they are generally more difficult to measure or evaluate scientifically than behaviourist theories, much like outcomes in problem-based learning may be more challenging to measure than is performing a specific task taught through skills-based instruction.

Promoters of the cognitive tradition, including Tolman, Koffka, Kohler, Lewin, Piaget, Ausubel and Bruner, have argued that new information has to be interpreted in terms of both prior knowledge and shared perspectives. Thus the existing cognitive structure is the principal factor influencing meaningful learning. In practice this indicates that meaningful material can only be learned in relation to a previously learned background of relevant concepts. Problem-based learning advocates, as well as advocates of other forms of active learning, argue that students enter any learning environment with pre-existing knowledge and cognitive structuring. The focus in this approach thus centres on helping students to utilize their previous knowledge and ways of thinking, and constructing it into a new form that is understandable and meaningful to them.

Maps, gaps and interaction

One of the earliest cognitive theories, bridging the gap from behaviourism to constructivism, came through Tolman's work on sign theory and cognitive mapping. Tolman (1948) believed that learners have goals and follow signs on the way to the goal. Meaningful new stimuli are associated with those already existing to create a cognitive map. Thus he suggested that we create, add to and modify our maps as we learn. As with the behaviourists, for Tolman learning is always purposive and goal-directed. In contrast, the Gestalt theories posited that learning results from experiencing a perceptual whole rather than individual stimuli and can also result from a discontinuous process, which relates to the holistic view of learning that we have come to understand. The focus of the theory, then, is on the idea of grouping and an emphasis on higher-order thinking skills – those skills that are particularly important in the problem-based learning approach.

Wertheimer was particularly interested in problem solving and suggested that the essential aspect was being able to see the overall process. Thus learners should try to find the overall structure of the problem and then the gaps and incongruities are stimuli for learning. In practice this means that instruction should be based on the organization of learning (Ellis 1938; Wertheimer 1923, 1959), which problem-based learning does through providing a problem without all of the information necessary to solve it. The resulting 'gaps' become learning issues for students, who must explore them in order to make progress towards finding viable solutions to the real world problem situation.

More recently there has been increased understanding of the relationship that exists between social development and problem-based learning.

Social development theory posits that social interaction is essential to learning. Vygotsky (1978) proposed the idea of the Zone of Proximal Development (ZPD), which suggests that learners have limited capabilities for learning beyond their current level. Thus effective learning can be reached by providing sufficient challenge without going beyond the learner's capability. This optimal zone can be extended through guidance and collaboration. Therefore in problem-based learning with an experienced facilitator to guide the process and collaboration with peers, a student's optimal zone is extended, and learning often exceeds what tutors and students originally deemed probable or possible.

Deep and surface approaches

The notion of approaches to learning is rooted in the cognitive tradition, emerging from the work of Marton and Säljö (1976a, 1976b) who distinguished two different approaches to learning: those learners who could concentrate on memorizing (surface approaches to learning) and those who put meaning in their own terms (deep approaches to learning). Entwistle (1981) at the University of Lancaster, UK, extended the work of Marton and Säljö in what are known as the Lancaster studies, which were first undertaken to identify the factors associated with academic success and failure at university. Entwistle then built upon the work on surface and deep approaches to learning as well as the work of Pask (1976), who claimed that there are two general categories of learning strategy that can be identified in cognitive tasks: holists, students who identify the main parameters of a system and then filled in the details, and serialist students, who progressively work through details to build up the complete picture as they go.

Ultimately Entwistle extended the definitions of deep and surface categories and also added a third category: a strategic approach. These three approaches are thus delineated by the following characteristics:

- Deep approach
  Intention to understand
  Vigorous interaction with content
  Relate new ideas to previous knowledge
  Relate concepts to everyday experience
  Relate evidence to conclusions
  Examine the logic of the argument
- Surface approach
  Intention to complete task requirements
  Memorize information needed for assessments
  Failure to distinguish principles for examples
  Treat task as external imposition
  Focus on discrete elements without integration
  Unreflectiveness about purpose or strategies

- Strategic approach
  Intention to obtain highest possible grades
  Organize time and distribute effort to greatest effect
  Ensure conditions and materials for studying are appropriate
  Use previous exam papers to predict questions
  Be alert to cues about marking scheme

These approaches connect well with problem-based learning and students may often begin by engaging with the problem using a surface approach and then as they become more experienced tend to adopt deep or strategic approaches. However, an interesting challenge may occur, for tutors and the team, when students with diverse strategic approaches work together since this is likely to result in conflict among team members.

Cognitive development theories

The developmental theorists offer us models that take account of cognition and development. The teacher's concern here is in enabling students to develop both understandings of the nature of knowledge and ways of handling different conceptions of the world, so that knowledge acquisition is seen as an active process. From this field, a number of innovative studies have arisen. Piaget's Cognitive Development theories (Piaget 1929), for example, rely on the notion of cognitive structures. Like Vygotsky, Piaget believed that the activities learners could complete matched their cognitive stage or readiness. Piaget defined four major stages of development from birth where motor actions are developed (Sensorimotor) through to adolescence where abstractions are understood (Formal operations). Piaget's theory is perhaps one of the first that looked at how learners grow and develop over time and how the actual act and process of learning changes. Later Perry extended this concept in his qualitative study of men at Harvard. He devised nine positions that described how students' conceptions of the nature and origins of knowledge evolved (Perry 1970, 1988). This classic study put issues of learner experience centre stage and argued that students proceed through a sequence of developmental stages. In this description of the attainment of intellectual and emotional maturity, the student moves from an authoritarian, polarized view of the world, through stages of uncertainty and acceptance of uncertainty, to finally an understanding of the implications of managing this uncertainty. The student then accepts the need for orientation by adopting a commitment to values and eventually gains a distinct identity through a thoughtful and constantly developing commitment to a set of values.

Belenky *et al.* (1986), stimulated by Perry's work to explore diverse women's perspectives, identified five categories of 'ways of knowing' and from this drew conclusions about the way women saw truth, knowledge and authority. For example, women began from a position of silence where they saw themselves as mindless, voiceless and subject to the whims of external

authority. In later stages women constructed knowledge; the women viewed all knowledge as related to the context in which it occurred, and experienced themselves as creators of knowledge. Similarly Ausubel's assimilation theory of learning (Ausubel *et al.* 1978) posits the idea that better learning occurs if people can find meaning in the learning. Learning occurs when a learner is presented with new information that possesses some external or internal characteristics that enables the learner to associate it with previous learning. This theory shares with the Gestalt theories the idea that learning requires a view of the whole. According to Ausubel, advanced organizers, or a bridge between new material and existing ideas, are instrumental for learning. It is the work of these developmental theorists that seems to offer some of the more tenable models of learning. They are models which, to a degree, acknowledge that what is missing from many curricula is a recognition of the role and relevance of learning from and through experience, which can prompt the shaping and reconstructing of people's lives as learners and teachers.

Problem-based learning draws from all of the cognitive theories: students compare new information to existing cognitive structures, they seek to determine the overall structure of the problem, their learning capabilities may be extended through guidance and collaboration, they learn through progression of experience and they learn best when they can see the meaning in learning. Norman and Schmidt assert that research on memory, mastery, transfer and categorization are important parts of problem-based learning from the cognitive psychologist's view (Norman and Schmidt 1992).

Humanist theories

Humanist theories, including the work of psychologists such as Maslow and Rogers, offer us a further understanding of problem-based learning. Maslow (1968) posited a hierarchy of needs that ranged from essential physiological and safety needs to self-actualization and transcendence. These psychologists see learning as a personal act designed to fulfil potential. Learners, they believe, have both affective and cognitive needs so the goal of learning is to become self-actualized and autonomous, and education should facilitate development of the whole person. Those in the humanistic field contend that significant learning is to be obtained only within situations that are both defined by, and under the control of, the learner (for example, Rogers 1983). Learning involves moving to self-development of a fully functioning person. The prior experience of the learner is acknowledged and it is also recognized that students may be constrained by their own negative experiences of learning. In keeping with this theory, in a problem-based learning environment, the tutor (termed in this tradition facilitator) helps to provide a supportive environment in which learners are enabled to recognize and explore their needs. Learning in problem-based learning, like in the humanist tradition, is seen as involving the whole person, and not just the intellect.

Thus educators in this tradition aim to liberate learners and allow them freedom to learn.

Integrative perspectives on learning

As the twentieth century reached its end, it became less useful to categorize ideas about knowledge as 'philosophical', 'psychological', 'behavioural' or 'cognitive'. Rather, ideas have begun to be drawn from various theories in order to develop more integrative perspectives on learning, and several educational theories have emerged. Problem-based learning to some extent symbolizes an integrative approach to learning, since it draws on a number of learning theories while at the same time acknowledging the importance of learning through experience.

Constructivism

Constructivists believe that knowledge is not an absolute, but is rather constructed by the learner based on previous knowledge and overall views of the world. In its concern with mental processes, constructivism shares some qualities with cognitive theories. Yet, in comparing constructivism with behaviourism and cognitive theories, Cooper suggested:

> The constructivist . . . sees reality as determined by the experiences of the knower. The move from behaviourism through cognitivism to constructivism represents shifts in emphasis away from an external view to an internal view. To the behaviourist, the internal processing is of no interest; to the cognitivist, the internal processing is only of importance to the extent to which it explains how external reality is understood. In contrast, the constructivist views the mind as a builder of symbols – the tools used to represent the knower's reality. External phenomena are meaningless except as the mind perceives them . . . Constructivists view reality as personally constructed, and state that personal experiences determine reality, not the other way round.
>
> (Cooper 1993: 16)

Constructivism is a theory that was developed by Bruner along with Tolman, Lewin, Bigge and Allport. Constructivists believe that learners construct knowledge and are predisposed towards learning. They also suggest how knowledge may be structured and sequenced so that it can be learnt, arguing that the learner must be active, because only she can select and interpret information from the environment. Thus constructivism posits that understanding comes from interactions with the environment, cognitive conflict stimulates learning, and knowledge occurs when students negotiate social situations and evaluate individual understanding. Students on problem-based learning courses have the opportunity to construct knowledge for

themselves, to make comparisons with other students' knowledge and to refine knowledge as they gain experience (Camp 1996).

Information processing

Miller's conception of information processing is another connecting model, although more dated than other integrative models. Other theorists in this area include Miller (1956); Newell, Shaw and Simon (1958); Gagne and Dick (1983); Anderson (1984) and Rothkopf (1970). According to information-processing models, memory may be episodic, involving recall of events in detail and sequence, or it may be semantic, involving encoding, storage and retrieval of information. The most widely accepted information processing model has three stages:

1 input or sensory registry;
2 short-term memory processing and rehearsal;
3 long-term memory storage.

According to information-processing theorists, a number of factors can affect rote learning, such as meaningfulness, placement of an item within a list, practice or rehearsal, transfer or interference of prior learning, organization (chunking or categorizing), encoding, context and mnemonics. Several factors also affect meaningful learning, such as abstraction (getting the gist), perceived importance, schema from previous learning (Gagne and Dick 1983; Anderson 1984), prior knowledge, inference, misconceptions, text organization and mathemagenic effects (coined by Rothkopf 1970), to refer to learner strategies to assist learning, such as taking notes or answering additional questions (see for example, Miller 1956; Hilgard and Bower 1975, and Good and Brophy 1986).

Norman and Schmidt (1992) assert that the information-processing model is limited, but claim that it has three aspects relevant to the assessment of problem-based learning:

1 Activation of prior knowledge facilitates the subsequent processing of new information (such as small-group discussion), because working through a problem without consulting resources is a mechanism to activate prior knowledge.
2 Elaboration of knowledge at the time of learning enhances subsequent retrieval (for example discussion, note-taking, answering questions).
3 Matching context facilitates recall (the context includes all features of the environment, whether relevant or irrelevant).

They also believe that problem-based learning students retain information longer, are better able to identify causal relationship and may be better able to transfer concepts to new problems.

Andragogy

In an early theory of how adults learn, Knowles (1978) argues that culture does not nurture the development of the abilities required for self-direction. He sees this as being problematic because it promotes a gap between the need (organically) and the ability to be self-directed. Thus the model and practices that he proposes are designed to narrow this gap. Knowles (1978) first argued for four key differences:

1 a change in self-concept,
2 experience,
3 readiness to learn, and
4 orientation towards learning.

He later (Knowles *et al.* 1984) added a fifth about motivation and in 1989 a sixth about a 'need to know'.

The strengths of the ideology of andragogy are in its focus upon the self-directed learner and its emphasis on the place of the self in the learning process. However, Knowles's ideals are not based on extensive research findings, nor are they a total picture of adult learning. Jarvis (1995) argues the following regarding andragogy:

- it is not a psychological analysis of the learning process,
- it does not describe why specific aspects of experience are relevant,
- it does not generate a learning sequence for an adult.

Experiential learning

A close connection with problem-based learning may be found in the pragmatic work of Dewey (1938), who emphasized the human capacity to reconstruct experience and thus make meaning of it. Dewey believed in education as a process of continuous reconstruction and growth of experience. He believed that the role of the teacher was to organize learning activities that built on the previous experiences of the students and directed them to new experiences that furthered their growth, and that the curriculum should be closely tied to the students' experiences, developmentally appropriate and structured in ways that foster continuity. Dewey opposed theories of knowledge that considered knowledge specialized and independent of its role in problem-solving inquiry. Dewey's work contributed to the concept of active and experiential learning as well as problem-based learning (Fuhrmann 1996), and it has been argued that problem-based learning fits broadly into the experiential learning tradition (Biggs 1999; Savin-Baden 2000).

Transformational learning

Transformational learning is learning that causes change; in particular, transformational learning shapes people in such a profound way that it affects all subsequent learning. Primary contributors to this theory include Mezirow with perspective transformation and transformative learning (Mezirow 1981), Freire with critical pedagogy (Freire 1972, 1974) and Daloz with the developmental character of formal education in adulthood (Merriam 2001). These theories share common assumptions: people having control over their own situations, the capability to reflect upon them and take action to change them; people constructing their own reality to serve different purposes which they validate through interaction and communication with others; and the transformation of individuals resulting in social transformation. For transformative learning to be successful, education must foster a safe, open and trusting environment, much like problem-based learning advocates suggest.

Styles, identity and contexts

The concept of learning styles has suggested that an individual has a consistent approach to organizing information and processing it in the learning environment, yet the model of learning styles developed by Kolb and Fry (1975), in which they suggest there are four learning styles: converger, diverger, assimilator and accommodator is rather too tidy. They argue that a complete learner is someone who has managed to integrate bipolar components of the four learning styles. Although this is a useful model for helping learners to understand something of their approach to learning, it is problematic in that different learning environments demand different learning styles and thus the complete learner must be someone who can either adapt her style or someone who applies a consistent learning strategy across all environments.

Learner identity expresses the idea that the interaction of learner and learning, in whatever framework, formulates a particular kind of identity. The notion of learner identity encompasses positions that students take up in learning situations, whether consciously or unconsciously. Invariably school leavers attending university have an identity largely formulated through their schooling and arrive at university with a sense of whether they are deemed to be successes or failures by peers and external authorities. These students understand themselves in terms of how they are seen as learners by others. They realize components of their learner identity through the eyes of others, even if they cannot define it for themselves. For more experienced students, learner identity is not related to how they are seen by others but instead through the conditions under which they perceive themselves to be learning. Thus learner identity incorporates not only a sense of how one has come to be a learner in a given context, but also the

perceptions about when and how one actually learns. As a result, learner identity also encompasses affective components of learning that often seem to matter little to those in the business of creating learning environments in institutional settings. Issues of trust and fear that emerge through critical reflection such as questioning, reframing assumptions, learning together, sharing and evaluating researched information, undertaking presentations and arguing one's point are rarely acknowledged in learning environments (Brookfield 1994). Still, learner identity is not to be seen as a stable entity but as something people use to make sense of themselves, and the ways in which they learn best in relation to other people and the learning environments in which they are learning.

Bernstein (1992) argues that through experiences as students, individuals within higher education are in the process of identity formation. He suggests that this process may be seen as the construction of pedagogic identities that will change according to the different relationships that occur between society, higher education and knowledge. Pedagogic identities are defined as those that 'arise out of contemporary culture and technological change that emerge from dislocations, moral, cultural, economic and are perceived as the means of regulating and effecting change' (Bernstein 1992: 3). Thus pedagogic identities are characterized by the emphases of the time. For example, in the traditional disciplines of the 1960s, students were inducted into the particular pedagogical customs of those disciplines, whereas pedagogic identities of the 1990s were characterized by a common set of market related, transferable skills. The difference between learner identity and pedagogic identity is that, while pedagogic identities are seen to be those that arise out of contemporary culture and technological change, learner identities emerge from the process through which students seek to transcend subjects and disciplines, and the structures embedded in higher education. Thus in developing their learner identities, some students are enabled to shift beyond frameworks that are imposed by culture, validated through political agenda or supplied by academics. They are facilitated in developing for themselves, possibly through learning such as problem-based learning, the formulation of a learner identity that emerges from challenging the frameworks, rather than having the frameworks and systems imposed upon them.

Learning context

The notion of the learning context has been discussed in a variety of ways by authors who have predominantly been concerned with students' learning experiences. For example, Ramsden (1984, 1992) suggested that a student's perception of the learning context is an integral component of his learning. The learning context is created through students' experiences of the constituents of the programmes on which they are studying, namely teaching methods, assessment mechanisms and the overall design of the curriculum.

Students, Ramsden suggests, respond to the situation they perceive, which may differ from that which has been defined by educators. Yet, however much it is denied, educators tend to think of learning contexts as static environments. Each year the programme or module is on offer, and is usually fairly similar to the one offered the previous year and so students are taught in the same way with the same material. It is as if people, and students in particular, are put into contexts and watched while they move about inside them. Yet learning contexts are transient in nature, and much of the real learning that takes place for students occurs beyond the parameters of the presented material.

Taylor (1986) has argued that since educational programmes are temporary environments, it is important to raise students' awareness of the changing natures of the learning environment, peers, tutors and themselves. Therefore, recognition of students' perceptions of the formal learning context is the key to facilitating students' ability to manage learning effectively. However, we argue that the concept of learning context incorporates more than just the students' experiences of the component's teaching methods, assessment mechanisms and the overall design of the curriculum. Equally, learning context comprises more than that which can be defined according to the situation and perhaps even the disciplinary area of study. Thus the notion of learning context incorporates the interplay of all the values, beliefs, relationships, frameworks and external structures that operate within a given learning environment. Learning context also incorporates the way in which the curriculum is situated within the university and the broader framework of higher education, and thus the way it is situated within such systems and frameworks will affect what it means to be a learner in such a context. Furthermore, the notion of learning context does not only comprise the formal curriculum but also the informal ones – the ones students' create for themselves. This might suggest that the smallest component of any learning context could be said to be the formal curriculum, since the learning context is in reality rarely bounded by formal structures but instead by those who comprise and define it.

Conclusion

There are a variety of perspectives about how people learn and all have limitations, but problem-based learning is an approach to learning that has been constructed from a perspective that considers a whole range of theories. While the originators of this approach were medical educators and not trained psychologists or educators, they were influenced by common conceptions about how people learn. It was the context and culture of the time that led to the creation of this approach, which drew from the ideals of what we have come to know and understand about how people learn. They worked to develop an integrated curriculum and our next chapter examines models of curricular practice.