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Towards a generalised conceptual framework for learning: the Learning Environment, Learning Processes and Learning Outcomes (LEPO) framework

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Abstract
We argue in this paper is that there is a lack of clarity about learning in its broadest form, and we address this by proposing a generalised and integrated conceptual framework for learning. The Learning Environment, Learning Processes and Learning Outcomes (LEPO) framework conceptualises learning as having three components: the environment which facilitates learning (Learning Environment), the activities which are part of learning (Learning Processes) and the knowledge, behaviours, skills or understanding which can be demonstrated (Learning Outcomes). Two general actors interact with these three components, the student and the teacher. The paper discusses the origins of the framework, justifies its form and validates it against other conceptual frameworks. It concludes with a brief discussion about how it can be used to improve both the educational design of educational innovations and evaluate/ research into the effectiveness of educational innovations.

Introduction

Despite substantial research over many years about how learners learn, our understanding of that process is incomplete. Educational research has produced a myriad of models and frameworks, many of which are quite narrowly focused, and few of which have broad applicability. Much work has been done in the field of Instructional Design, but this focuses on how to design environments from which learners learn, or on environments which seek to teach learners at various levels. There is also a large literature base about how to teach learners. Our starting point in this paper is that there is a lack of clarity about learning in its broadest form.

This paper proposes a generalised and integrated conceptual framework for learning, attempting to lift the 'lens' on learning to a more general level by integrating concepts from other frameworks to arrive at a broad description of what occurs in learning and teaching environments. The paper is deliberately positioned to encourage discussion about this issue, both at the conference and elsewhere, in order to further validate it.

The scope of this paper is broader than the scope of the ED-MEDIA conference, looking at learning in general, but it is presented to this forum because so much of the current work in learning is associated with the use of various technologies. However, to keep discussion focused, this paper considers only the higher education sector.

This work explicitly focuses on the learner not the teacher. The emphasis is on learning as a process rather than teaching as an activity. However, the level of our discussion is broadly within the field of education rather than,

for example, cognitive psychology or neuroscience, although these disciplines may enrich the framework once it has been refined at a philosophical level.

Learning

There can be many interpretations of the word 'learning' and these meanings cloud discussion about it. Grammatically, 'learning' has three forms. The first is as a noun, with two distinct definitions in The Cambridge Online Dictionary [http://dictionary.cambridge.org]:

- "the activity of obtaining knowledge"; and
- "knowledge obtained by study".

The former definition is clearly related to activities which students undertake in order to develop their understanding – a process. The latter definition relates to a product or outcome constructed by the learner which can be demonstrated to others as evidence of acquired level(s) of understanding. The noun 'learning' can also function in an adjectival manner (gerund) by modifying another noun, for example, the learning process. Learning can also be used as the present participle of the verb (I am learning), and this present participle can also be used as an adjective (e.g. the student practiced hard, learning how to do a titration). The semantic nuances surrounding 'learning' can lead to different interpretations of what is meant by e-learning and m-learning, making it difficult to develop a shared understanding of these emerging areas of scholarship.

Learning is something which, arguably, all humans do regularly in their day-to-day life. Such informal learning and problem solving can be contrasted with learning which occurs in formal educational contexts, where learners take the role of students, working towards some sort of qualification. However, it would be inaccurate to claim that only formal learning occurs in an institutional educational context. While many students at all levels of education attend classes taught by teachers, they also work on their own and in groups outside of class to develop their understanding of the subject area. This is informal learning in a formal setting. Students at university also develop their human capacities, which may or may not be triggered by activities in their formal classes, at coffee shops and drinking establishments.

The Learning Environment, Learning Processes and Learning Outcomes (LEPO) Framework

This paper conceptualises[1] learning as having three components: the environment which facilitates learning (Learning Environment), the activities which are part of learning (Learning Processes) and the knowledge, behaviours, skills or understanding which can be demonstrated (Learning Outcomes). Two general actors interact with these three components, the student and the teacher. For convenience, we have called this the LEPO (Learning Environment, Process, Outcomes) framework. The interactions between the five elements of the framework are modelled in Figure 1 as a concept map. This framework is derived from, and encompasses, various models of learning as well as research about the characteristics of students and teachers. The relationship of these other models to the LEPO framework will be discussed in subsequent sections. Each of the five components has its own characteristics, which will also be discussed below.

At the highest level, the concept map in Figure 1 indicates that learning environments facilitate learning processes, and these lead to learning outcomes, which, in turn, determine the learning environment. The concept map also indicates that teachers design learning environments, facilitate learning processes and assess learning outcomes, while students work within learning environments, engage with learning processes and demonstrate learning outcomes, as well as interacting with their teachers.

[1] In this paper, we distinguish between a conceptual framework and a theory or theoretical framework. While both attempt to describe and explain a phenomenon, what distinguishes a 'theory' is that it attempts to predict the behaviour of that phenomenon. In this work, we are discussing concepts at a generalised level that are not meant to be specifically predictive of one another. The way in which the concepts interact is described through a framework, and a visual representation of the framework is presented as a model.

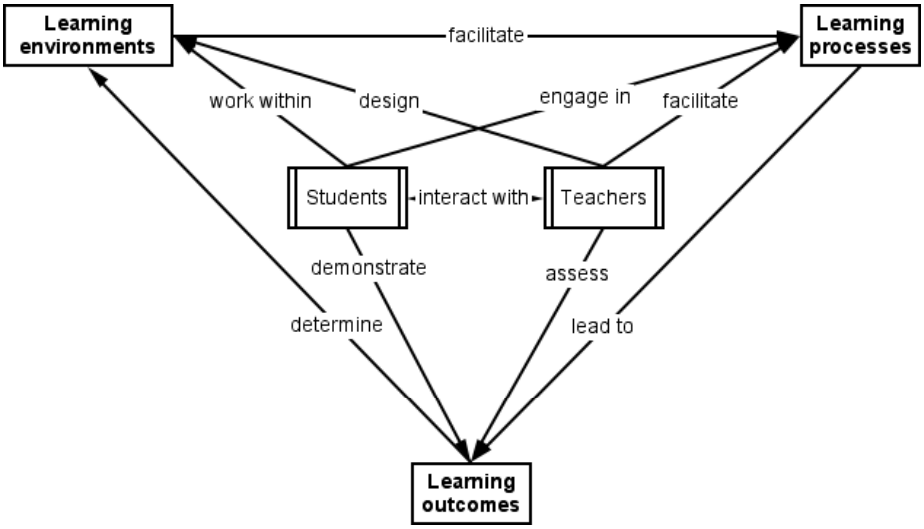

Figure 1: Model of the LEPO framework, showing the interrelationships between learning environments, learning processes, learning outcomes, and the roles of students and teachers.

The Origins of the LEPO Framework

The LEPO model is informed by a range of work in higher education and educational technology research. However, it draws particularly on three pieces of scholarship:

- Biggs' Presage, Process, Product (3-P) model (1989);
- Laurillard's conversational framework (2002); and
- The Learning-centred Evaluation Framework initially conceived by Bain (1999).

These works will be summarised briefly here to provide context for the rest of the discussion.

Biggs' 3-P Model

Biggs (1989) conceived of learning as having three components: Presage, Process and Product, which can be broadly interpreted as what happens before, during and after learning. Figure 2 illustrates the model, showing that the Presage component has two aspects: 'student factors' and 'teaching context', while the process and product components are analogous to the learning processes and learning outcomes components of the LEPO framework.

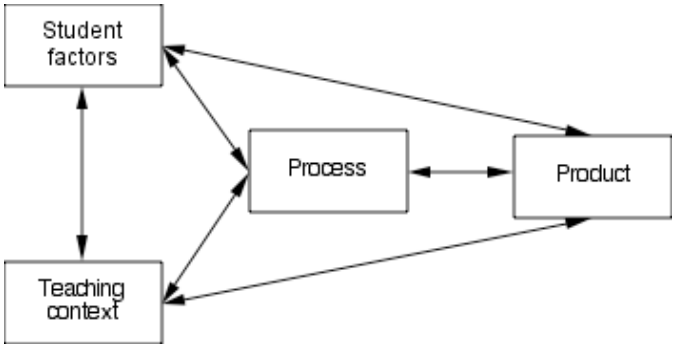

Figure 2: Representation of Biggs' 3-P model

Laurillard's Conversational Framework

Laurillard's conversational framework (2002) approaches learning pragmatically, arguing that there are four main aspects of learning and teaching:

Discussion	between the teacher and learner at the level of descriptions
Interaction	between the learner and some aspect of the world defined by the teacher
Adaptation	of the world by the teacher and action by the learner
Reflection	on the learner's performance by both teacher and learner

Phillips and Luca (2000) extended this model to include discussions between students. An illustration of the extended framework is provided in Figure 3. Laurillard's schema is based on forming an information-rich environment in which the student is able to discover knowledge, but the discovery is supported and scaffolded by extra guidance functions which provide support and feedback for subsequent learning.

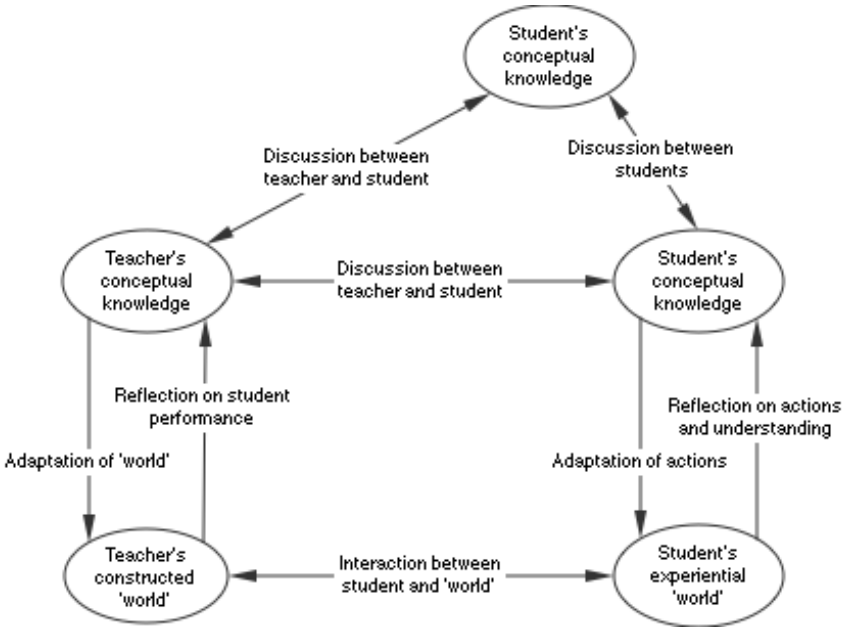

Figure 3: The extended Laurillard conversational framework.

Learning-centred Evaluation Framework

Bain (1999) proposed a framework for evaluating the effectiveness of e-learning, based on earlier work by Alexander and Hedberg, and later developed by Reeves (Alexander & Hedberg, 1994; Reeves & Hedberg, 2003), that mapped phases of evaluation to the phases of an e-learning development project. Bain's (1999) innovation was to add a second dimension, that of the learning environment, learning processes and learning outcome, in planning research and evaluation into e-learning. This work was subsequently extended under the name Learning-centred Evaluation Framework by Phillips, Bain, McNaught, Rice, & Tripp (2000).

Components of the LEPO Framework

Learning Environment

The learning environment provides the context in which the student works. Its characteristics include the campus setting, the structure of the degree program and the student's individual units of study. It is informed by the

desired learning outcomes, and it specifies the content and resources (both traditional and electronic) which support this design. It also encompasses physical and virtual spaces, and the nature of the technology-enhanced environment. In addition, the learning environment specifies the teacher's design of the learning and assessment activities which will facilitate the learning processes undertaken by students.

The learning environment may be specified at varying levels of design depending on the timeframe of the planned activities. At one level, the learning environment might specify the overarching activities and context of a unit of study over a semester, including the learning objectives, assessment activities and deadlines, and content to be covered. At a different level, the learning environment might specify the design of a computer simulation which covers a conceptually difficult area. A (typically) detailed design specification would guide the development team.

An overarching characteristic of learning environments is that they are designed, and they can therefore be described. Sometimes this description is informal, and sometimes detailed. When a learning environment is well-defined, it is easier to evaluate whether it functions as it was designed, and therefore whether it can lead to the desired outcomes.

The learning environment as conceived here draws from the 'teaching context'/ situational aspect of the presage component of Biggs' 3-P model, although it is arguably broader. The learning environment is also analogous with the 'teacher-constructed world' component of Laurillard's conversational framework (2002).

The learning environment should consider the characteristics of the students it is designed for; this aspect will be explored below.

Learning Processes

Learning processes are the ways in which students engage with the learning environment and the learning activities embedded in it. The characteristics of the learning processes in the LEPO framework draw heavily on Laurillard's conversational framework (2002), where students engage with ideas/ concepts/ resources to develop conceptual knowledge; interact with the learning environment designed by their teacher; and discuss their conceptions with their teachers and other students (T. Anderson, 2005). The framework recognises that participation in social practice is a fundamental form of learning (Bransford, Brown, & Cocking, 1999). The learning processes may also include interaction between the student and technology, whether with resources delivered by computer or learning activities facilitated by a computer or other device (Phillips, 2004).

There is a clear distinction between learned problem-solving skills in novice learners and the specialised expertise of individuals (Bransford, et al., 1999). An important goal of higher education is for novices to become experts in particular discipline areas. Bransford, et al. (1999) distinguished between novices and experts in the following way:

> Understanding expertise is important because it provides insights into the nature of thinking and problem solving. It is not simply general abilities, such as memory or intelligence, nor the use of general strategies that differentiate experts from novices. Instead, experts have acquired extensive knowledge that affects what they notice and how they organize, represent, and interpret information in their environments. This, in turn, affects their abilities to remember, reason, and solve problems. (p. 2)

The learning processes also incorporate the 'approaches to study' component of the 3-P model (Biggs, 1989, 1993).

Learning processes refer to all cognitive activities that contribute to learning, (e.g. problem solving, reflection) as well as the manner in which these activities are carried out (e.g. individually, in groups, teacher- or student-directed). The learning processes refer to what the student actually does, whether intended or not. It may vary according to the intentions of the teacher (and of the student).

The range of activities characterized as learning processes in the LEPO framework is quite broad. The framework recognises that learning can be institutional or non-institutional. However, the learning processes are fundamentally at the level of personal activity, whether through individual cognitive activities or through social engagement with others (Bransford, et al., 1999).

In an institutional context, learning processes comprise formal learning or assessment activities and informal learning activities out of scheduled classes. Learning processes can also have varying amounts of teacher mediation.

Teaching can assist students to be more metacognitive and self-regulatory (Bransford, Brown, & Cocking, 2000). Hence, it is an important role of the teacher in higher education to assist students to develop these and other

generic lifelong-learning skills. Metacognitive strategies, where students reflect on their actions and understandings, and adapt them accordingly, are also part of the learning process derived from Laurillard's work (2002).

Learning Outcomes

Learning outcomes refer to the things students are able to demonstrate as a result of their engagement in a course of study. This includes both discipline-specific and generic skills. Learning outcomes correspond to the "knowledge obtained by study" definition of learning given in the introduction. It is the product of the learning processes. But what is 'knowledge' in this context? Without delving too far into epistemology, the wikipedia definition of learning starts to unpack this: "Learning is acquiring new knowledge, behaviors, skills, values, preferences or understanding, and may involve synthesizing different types of information."

This definition encompasses different dimensions of 'knowing', including cognitive and conceptual understandings (Bloom's cognitive domain: L. W. Anderson & Krathwohl, 2001; Bloom, 1956; Krathwohl, 2002) and physical behaviours and skills (Bloom's psychomotor domain: Harrow, 1972). This definition also includes professional skills, a range of literacies and learning skills, as well as societal beliefs and values (partially involving Bloom's affective domain: Krathwohl, Bloom, & Masia, 1964).

The term 'learning outcome' is often not used precisely in higher education practice. There is a fuzziness in the distinction between 'learning outcomes' and 'learning objectives'. At times, both seem to be used interchangeably. Semantically, objectives are what it is intended that you are able to do after a course of study, and outcomes are what you can actually do. Allan (1996) distinguished three types of learning outcomes:

- "subject-based outcomes, which subsume learning objectives and which are complex, discipline-based which are capable of being assessed;
- personal transferable outcomes, including acting independently, working with others, using information technology, gathering information, communicating effectively, organisational skills; and
- generic academic outcomes, [such as] making use of information, thinking critically, analysing, synthesising ideas and information." (1996, p. 107)

According to Allan (1996) and Eisner (1979), there is little distinction between subject-based outcomes and learning objectives. The essential criteria are that they are broad enough to enable deep learning and specific enough to be assessable. Subject-based outcomes should require demonstration of the range of knowledge and skills required by the revised Bloom's taxonomy.

The contemporary world requires university graduates to have a range of other skills to be successful knowledge workers and citizens. These are Allan's personal transferable and generic academic outcomes, including a range of interpersonal skills, literacies and learning skills. These generic learning outcomes combine with subject-based knowledge to produce the 'expertise' of a graduate (Bransford, et al., 1999). However, Barrie (2005) recognised "that some generic outcomes are complex interwoven aspects of human ability, which are difficult to explicitly teach or assess in traditional university experiences". These include societal beliefs and values, lifelong learning skills and ethical perspectives.

While learning outcomes are a component of the 3-P framework, they are not as well developed in that framework. Similarly, learning outcomes are represented on the right-hand side of Laurillard's conversational framework, at the student's 'conceptual knowledge' and 'experiential world'.

Students

Educational research has had a tendency to view students as homogenous entities, rather than real human beings with lives outside of their study commitments. The LEPO framework recognises that students have individual characteristics that can influence how they learn.

A constructivist educational philosophy (Duffy & Jonassen, 1992; Marra & Jonassen, 1993) recognises that students bring their existing knowledge and abilities to their study. Their socio-economic context and expectations of success will also impact on their ability to study effectively. Students also bring with them a range of ways of thinking (e.g. the popular works of Gardner on multiple intelligences: Gardner, 1983, 1993) and have varying levels of emotional maturity (e.g Goleman's work on emotional intelligence: Goleman, 1998). All these factors influence their beliefs about how they should behave as university learners and how they should operate in various educational

contexts (e.g. the work on students' approaches to learning as being characterized as deep or surface: Biggs, 1999; Gibbs, 1992; Ramsden, 1988, 1992).

A student's motivation to learn is a relevant factor in success, the so-called conative domain (Snow, Corno, & Jackson, 1996). Reeves (2006, p. 297) characterises conation with the "will, desire, drive, level of effort, mental energy, intention, striving, and self-determination to actually perform at the highest standards".

Teachers[2]

Beliefs about how teaching is done at university is deeply entrenched in the university worldview (Ballard & Clanchy, 1988), and these beliefs are often accepted uncritically. Many university staff have limited teaching experience when they start to teach students. Developing from a background in disciplinary research, many will have deep contextual knowledge and expertise, but may have variable expertise in teaching. Bransford et al. (2000) found that disciplinary expertise was no guarantee of ability to teach others about their area of expertise. As well as varying abilities in explaining core concepts, teachers have varying abilities to perform in class and motivate students to learn. The personal beliefs and mental models of lecturers (Bain & McNaught, 2006; Steel, 2009) strongly influence the ways that teachers structure their learning environments and facilitate the embedded learning processes.

Teachers are explicitly present on the left side of the Laurillard model (Figure 2) as they design and improve the learning environment and facilitate understanding by students. Teachers are only present as designers of the learning environment in the 3-P model.

Critique of the LEPO Framework

The LEPO framework, while inclusive of all aspects of learning, is largely pedagogically neutral, in that it does not prescribe how students and teachers interact with learning environments, processes and outcomes. At the same time, it is a very broad framework, seeking to include other models and frameworks as subsets of the LEPO 'whole'. In this section, we consider how other pedagogical frameworks map onto the LEPO framework, in an attempt to validate or discredit the framework.

A traditional, teacher-centred approach to higher education maps well onto the LEPO framework, although the *quality* of the components may not be in line with research findings about effective learning. For example, learning outcomes may be poorly defined, the learning environment might over-emphasise content and learning processes may focus on transmission by teachers and surface learning for reproduction in exams.

Other approaches, which focus on deep construction of knowledge, also fit within the LEPO framework. Brown, Collins and Duguid (1989) proposed a model of teaching based on "the notion of learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life" (p. 2). This situated learning model (also called 'cognitive apprenticeship') has been extended in recent years by the notion of authentic learning (Herrington & Oliver, 2000) with the following characteristics:

1. provide authentic contexts that reflect the way the knowledge will be used in real life;
2. provide authentic activities;
3. provide access to expert performances and the modelling of processes;
4. provide multiple roles and perspectives;
5. pupport collaborative construction of knowledge;
6. promote reflection to enable abstractions to be formed;
7. promote articulation to enable tacit knowledge to be made explicit; and
8. provide coaching and scaffolding by the teacher at critical times.
9. Provide for authentic assessment of learning within the tasks.

The first two of these characteristics define the learning environment itself, the context of use. The other characteristics are all associated with learning activities (both student-centred and teacher-centred) with which

[2] The LEPO framework views 'teacher' broadly. It should not be interpreted to mean a single teacher; it can include teams of teachers, as well as teacher supports (tutors, teaching assistants, librarians, e-learning advisors and instructional/ educational designers)

students will engage as part of their learning process. The situated and authentic learning models are consistent with the LEPO framework; it is simply the specific nature of the learning environment and learning processes which distinguishes these models from others.

Not all learning problems can be treated using an authentic or 'apprenticeship' model. In abstract fields it is not sensible to use a situated-learning approach. We cannot experience a chemical reaction at the molecular scale, so we cannot simulate this real world environment. The 'cognitive flexibility theory' (Spiro, Coulson, Feltovich, & Anderson, 1988) shares some similarities with situated learning, but it is applicable to abstract situations. Cognitive flexibility theory advocates a learning environment which includes:

- using multiple knowledge representations;
- linking abstract concepts in cases to depict knowledge in use;
- demonstrating the conceptual interconnectedness or web-like nature of complex knowledge;
- emphasising knowledge assembly rather than reproductive memory; and
- introducing both conceptual complexity and domain complexity early.

This model is also consistent with the LEPO framework, although there is more emphasis on the learning environment and less on learning processes.

In 1997, Reeves and Reeves proposed a model for interactive learning on the Web which has many similarities with the LEPO framework. This model is summarised in Table 1. It posits that students bring certain attributes to their study (a set of input conditions analogous to the student characteristics in the LEPO model); go through a process of education (analogous to the learning processes); and this process results in an output (learning outcomes in the LEPO framework).

Input	**Process**	**Output**
Cultural habits of mind	Opportunity to construct learning	Knowledge and skills
Aptitude and individual differences	Task ownership	Robust mental models
Origin of motivation	Sense of audience	Higher order outcomes
	Collaborative support	
	Teacher support	
	Metacognitive support	

Table 1: Components of the Reeves and Reeves (1997) 'Process' model of interactive learning on the Web.

In more recent work, Reeves (2006) identified eight critical factors impacting on the success of a learning environment: 1) goals, 2) content, 3) instructional design, 4) learner tasks, 5) instructor roles, 6) student roles, 7) technological affordances, and 8) assessment. These are all consistent with the concept of the learning environment presented here.

Conclusion

This paper has presented a generalised and integrated conceptual framework for learning, with five components: the learning environment, the learning processes, learning outcomes, student characteristics and teacher characteristics. The LEPO framework is broad and pedagogically neutral, it covers a range of contexts, and it is consistent with, and encompasses, other frameworks of learning. We do not claim that the LEPO framework supersedes other models of learning; each has its own foci and strengths. What it does, however, is provide a view of learning which integrates elements of other conceptual models in one generalised framework.

Our intention is that the LEPO framework can contribute to improvements in learning and teaching environments in two ways. Firstly, it can contribute to improved educational design of learning and teaching environments, by focussing attention on all aspects of learning, while allowing educational designers to choose specific strategies most appropriate to the learning context.

Secondly, the LEPO framework has been developed to guide evaluation and research into educational innovations. Our ongoing work is in using the LEPO framework to scaffold the development of robust plans to make judgements about the effectiveness of e-learning innovations, and understand better how students engage with, and learn from these innovations. In this way, we hope to guide novice evaluators of e-learning towards appropriate research in this emerging discipline. We also hope that this work will contribute to improved quality in e-learning research, an area Reeves (1993; 2000; 2005) has consistently criticised.

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