

# Learning Contexts as Ecologies of Resources: Issues for the Design of Educational Technology.

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**Abstract** The question that motivates the discussion at the heart of this paper is how can we use technology to help learners (and teachers, peers and parents) to adapt the resources they find within a particular location to best support their learning needs. We present a description of a learning context as a *Learner Centric Ecology of Resources* and associated *Organising Activities* that can be deployed variously but with a concern to promote and support mediations, including those of the teacher and learner. For theoretical grounding, we look to sociocultural theory and in particular the Zone of Proximal Development (ZPD) with its emphasis upon the internalization of the interactions that occur within a learner's context. This internalization process results in the decontextualization of social interactions within the head of the individual. It means that the resultant internal processes are defined by the context from which they originate. The ZPD can be thought of as a context in which productive interactivity can take place. The constructs of, situation definition, intersubjectivity and semiotic mediation as presented by Wertsch are explored in order to extract a specification of context for use in the design and evaluation of learning technologies. Likewise, the Zone of Available Assistance, the Zone of Proximal Adjustment and the Broadband Learner Model: all previously used by us to inform the development of educational software.

## Introduction

This paper discusses the importance of learning context as a design parameter. We suggest that one way to understand an educational context is to perceive it as a "Learner Centric Ecology of Resources" that can be deployed variously but with a concern to promote and support various mediations, including those of the teacher and learner. The main contribution of this paper is the presentation of an embryonic theoretical framework for this characterization of a learning context. This characterization aims to help educational technology designers to take advantage of the potential benefits afforded by a wide range of technologies from the traditional

desktop PC to mobile, pervasive and ubiquitous applications. Our motivation is to inform the development of educational experiences supported by technology to enable learners (and teachers, peers and parents) to adapt the resources at their disposal to best support their learning needs.

Previous research has indicated that the impact of technology is heavily dependent upon the specifics of an educational culture (Wood, Underwood and Avis, 1999). Wireless, mobile, and ubiquitous technologies bring with them the opportunity to link a learner's experience across multiple locations. We should be able to enable learners to access resources wherever and whenever they need them, to collect and record information in situ and to make selections about where they wish to work with greater flexibility than is offered by tethered desktop technology alone. These pervasive forms of technology also enable researchers to collect data about a learner's educational experience including the use of technology across multiple contexts with previously unattainable reliability. In other words we are poised to take advantage of the potential offered by these technologies for the creation of learning experiences that will engage learners in activities in real world learning situations, across multiple contexts and that can support collaboration and communication across time and space. We should be able to allow learners of all ages and motivations to access resources, such as information, software and experts or more knowledgeable peers, to enrich their educational experience and increase their understanding. However, the nature of what constitutes a learning context and the question of how best to apply mobile technologies in learning contexts is still open for discussion and exploration. Appropriate theories and frameworks are in their early stages of evolution and guidelines are only just starting to emerge.

In this paper we explore the nature of a learning context, the resource elements that comprise such a context, the way in which technology can be used to bridge different locations and how it might adapt, or help learners to adapt a learning context to meet their needs. There has been significant previous debate concerning the extent to which technology can and should control what and how a learner interacts with a particular subject or with other people. The emphasis within this paper is placed more upon exploring the extent to which technology might support learners, teachers, peers and parents in their organization of the resource elements that make up a learning context. Some locations such as classrooms are designed and then further adapted to greater or lesser extents to meet the needs of learners, other locations, such as a tropical rain forest may offer the potential for rich learning experiences, but have not been adapted to suit learners at all. These are of course two extremes, and there will be many shades of adaptation in between. The

question at the heart of this paper is how can we use technology to help learners (and teachers, peers and parents) to adapt the resources they find within a particular location to best support their learning needs.

The paper that follows opens with a discussion of some of the theories that might usefully inform such an activity. We then consider the nature of a learning context and the elements that comprise it. We present a framework for understanding context as an "Ecology of Resources". Elsewhere (Luckin, du Boulay, Smith, Underwood, Brewster, Fitzpatrick, Holmberg, Kerawalla, Pearce and Tunley, under review) we present three case studies extracted from projects that use technology to link learners' experiences across multiple locations in order to test this framework.

### **Theoretical Background**

A sociocultural (Vygotsky, 1978, 1986) approach is based upon the principle that the process through which an individual's mental functioning develops is an interaction between that individual and her sociocultural environment. The nature of this interaction influences the nature of her resultant mental processes. This emphasis upon the importance of learners' interactions with their environment makes sociocultural theory attractive for our current enterprise of exploring context. Another potential theoretical perspective is that of Activity theory. This too has evolved from the same sociocultural roots, with subsequent extension from Vygotsky by Leont'ev (1978 and 1979), Zinchenko (1979), and Gal'perin (1969) for example. This approach has been used to excellent effect by those studying the application of technology to education (Issroff and Scanlon, 2002 for example). In this paper we explore some of the elements of sociocultural theory, in particular the Zone of Proximal Development, in order to identify which of its features might contribute to our understanding of learning contexts.

The basic ideas of Vygotsky's approach are expounded in the "general law of cultural development". This states that: "All the higher functions originate as actual relations between human individuals" (Vygotsky, 1978). The link between the external activity of this 'interpsychological' activity that is contextualized in the individual's culture, and the 'intrapyschological' processes within her mind allows the internalisation of the higher mental processes from their social origins. This process of internalisation is central to Vygotsky's work. It is not a simple 'transfer' or 'copying' process, the structure and functions of the process change during its internalisation and lead to the formation of an "internal plane of consciousness" (Leont'ev, 1979). The individual gains control over, or masters, the external sign

forms of her social activity, such as language (Wertsch and Stone, 1985). As a result, there is a transition from a level where sign functioning is contextualized to that where the sign operates independently of the context in which it occurs. In this way the individual learner is able to use these sign forms to mediate and organize her own activity. The psychological functioning within the individual that emerges from this process therefore reflects the nature of the culture and context from which it was derived (Rogoff and Wertsch, 1984). This internalisation process has been referred to as the "decontextualization of mediational means" (Wertsch, 1985).

This work is important for our purposes because it identifies the nature of the link between a learner's context and the learning that occurs as a result of her interactions within that context. It confirms that the nature of the context is a vital component in an individual's development, that different contexts will result in different social interactions and in so doing in the development of different mental processes within that individual. This places a large responsibility upon those responsible for providing the context within which learners interact. The internalization of the interactions that occur within that context are, as Wertsch points out, decontextualized within the head of the individual, nevertheless their nature is defined by the context from which these interactions originate.

In order to understand more about this internalization process, which is the key to learning and development, we turn our attention to the Zone of Proximal Development (ZPD). The ZPD represents the crystallization of the internalisation process and describes the most fertile interactions which occur between learners and more able members of society, it emphasises that learning and development arise from an individual's social experience. In Vygotsky (1978) the ZPD is described as defining the mental functions that have not yet matured. In order to understand the child's mental development it is essential to identify two levels: "the actual developmental level and the zone of proximal development." The ZPD is something that must be created through instructional interactions, it 'awakens' the internal developmental processes which can only operate when the child is interacting with other people in the environment. For instruction to be lucrative in terms of developmental gains within the individual learner it must involve interactions between the learner and more able members of her culture. These more able partners are responsible for providing assistance, including ensuring that the resources available within a particular environment are organized and activated appropriately for that learner.

The ZPD can be thought of as a context in which productive interactivity can take place. But exactly what type of context might this be? Wertsch (1984)

introduces three additional constructs in an attempt to clarify and extend the ZPD. These constructs can help us to extract from the theory some of the implications for the specification of an educational context that might result in the creation of a ZPD between those individuals interacting within it. The constructs introduced by Wertsch are:

- situation definition,
- intersubjectivity and
- semiotic mediation.

A situation definition describes the manner in which a context is actively constructed and represented by those who are operating within it. The situation definition should incorporate an action plan and will differ between the interacting individuals. The communal action plan may not coincide exactly with that constructed by any individual. Intersubjectivity exists when two participants share the same situation definition and know that they share it. If the learner and the more able partner/s have different individual or personal situation definitions, collaboration within the ZPD may require a third interpsychological communal situation definition. This shared definition may correspond to the learner's personal situation definition or it may differ from both the learner and her more able partner's situation definitions. Intersubjectivity and situation redefinition will require a means of communication and negotiation, which is where semiotic mediation through, for example, language comes into play. We can now extract some functions that we need to support within our specification of an educational context. We need to define ways in which we can:

- Help individuals who are interacting within a particular context to externalize and share their situation definitions
- Help individuals in their construction of a communal action plan
- Provide the means for the communication and negotiation between individuals.
- Identify ways in which we can scaffold learners to a shared situation definition and therefore to intersubjectivity

We too have previously introduced two additional constructs in order to try and clarify the way in which the ZPD can be operationalised (Luckin, 1998) and have applied these to the design of educational software. The two additional constructs are: The Zone of Available Assistance (ZAA) and the Zone of Proximal Adjustment (ZPA). The ZAA describes the variety of qualities and quantities of assistance that need to be available to enable the more able participants to offer appropriate

assistance to the less able learner. When we develop educational experiences and environments our aim must surely be to maximize the variety of qualities and quantities of assistance that can be made available. A context or teacher who knows how to access a large ZAA has the potential, in principle, to deal with a wide variety of learners. However, the assistance that is selected and actually offered or otherwise made available to the learner needs to be matched to that particular learner's ZPD. This is where the Zone of Proximal Adjustment (Murphey, 1996) comes into play. The ZPA represents a selection from the ZAA appropriate for a given individual within a particular context. Clearly, if the ZAA is impoverished then this will limit the possibilities for the ZPA. Although, there will be situations in which careful selection of the most appropriate forms of assistance can nevertheless lead to some productive learning experiences even when the range of possibilities is severely limited. Conversely, even if the ZAA is versatile, an inappropriate selection of ZPA can be made. In other words the existence of a rich set of resources alone is not sufficient.

If we now take into account the ZAA and ZPA, the aim for the educational designer could be interpreted as:

- maximizing the ZAA within a learning context and
- providing a means to target or enable people who are interacting within that context to target the available forms of assistance to create a ZPA that it is as close as possible to an individual learner's ZPD.

This process of Maximizing and Targeting may in fact be completed by making obvious the forms of assistance that already exist within a context and likewise finding a means to represent the learners' needs so that she and her collaborators can select appropriately. Alternatively, the process might be achieved through assessment of the learner's ZPD and subsequent adjustment of the context to take account of this assessment. This latter approach has been used to good effect with some standard classroom desktop computing applications that we discuss later.

The final element that we bring to the discussion of theory and its application to the design of technologically-enriched learning contexts is a socio-culturally grounded design framework called the Broadband Learner Model. This framework focuses upon the learner model and is an extension of a previous operationalisation of the ZPD within a piece of educational software (Luckin, 1998). This Broadband Learner Model framework is based upon a concept that we define as a *learner model created through the use of networked technology to link a learner's educational experience across time and context*. The term Broadband is influenced by, but not

synonymous with the term as it is applied to network connection speed, we use it to describe the bandwidth of learner experience that we want to capture within the learner model. The concept and the design framework that we have developed from it are described elsewhere (Luckin and du Boulay, 2001, Luckin, Underwood, du Boulay, Holmberg and Tunley, 2004 and Tunley, du Boulay, Luckin, Holmberg & Underwood, 2005, for example). The framework specifies the need for educational systems to embody, either within software, or within the other resources available in the environment, such as people, the following types of Knowledge: Knowledge about the Learner, Knowledge about the available educational resources, Knowledge about Pedagogy and Knowledge about how to engender Collaboration. Our activity towards developing the “Ecology of Resources” framework is an extension of the Broadband Learner Model in order to encompass a richer description of a learning context.

Our analysis of the ZPD and its socio-cultural routes has identified the following activities that need to be supported for a learner to progress. There are activities that relate to the nature of the subject or skill that is the focus of learning, such as arithmetic or cake decorating. The socio-cultural grounding we have adopted necessitates that this knowledge is initially contextualized within a particular environment. Such *organizing activities* include:

- The representation and communication of the teacher/expert/more able peers' situation definition: the way in which more able individuals, such as teacher's and experts, understand a particular subject or skill. This understanding will relate to a particular context and will include an action plan.
- The representation and communication of each learner's situation definition, their understanding of their context and their action plan.
- This representation of the learner needs to be accessible by that learner, other people and devices within and beyond a single location.
- A means to identify and represent the range of qualities and quantities of assistance that can be made available to the learner.
- Mechanisms through which individuals can communicate and negotiate to decontextualise their interactions and increase their understanding of the subject or skill being studied.
- Assistance to support participants to collaborate in their formulation of a shared situation definition: an agreed understanding of their context and the actions to be completed in it. This will include a means to represent the communal situation definition as it evolves. This activity is at the heart of the scaffolding metaphor, that

was introduced by Wood, Bruner and Ross (1976) to describe the recognition - production gap that needs to be bridged during education.

- A mechanism to ensure that the learner is able to access assistance that is complimentary to her individual needs. This may be mediated by another more able person.

### **What is Context?**

It is clear from these theoretical discussion that the organization of learning resources within the learning context must promote the mutual construction of learning activities between teachers and learners. In some situations teachers or more able peers are likely to play a more dominant role in this process, but nevertheless, the organization of resources must maximize the opportunities for interaction between more and less able participants. The focus of this paper is the presentation of a framework for the characterization of a learning context. The purpose of the framework is to help educational technology developers to design technology that enables learners (and teachers, peers and parents) to provide and adapt the resources at their disposal within a context to best support their learning needs. We have chosen to define a learning context as an *Ecology of Resources*: a set of inter-related things that provide a particular context. The resources we have identified can be categorized as illustrated in Table 1. In addition to these resources there are factors that influence the nature of any context. The culture, as well as the Political and policymaking Infrastructure within which a context exists, will be defining factors upon **its** specification. From the perspective of educational technology design, an important motivation for understanding more about a context is to identify the balance between the extent to which a context is adapted for learning and the extent to which a learner needs to adapt to a context. If we can increase our knowledge about this then we may be able to offer scaffolding to support the adaptation process.

In order for these resources to be connected to form an Ecology that is centred around the learner there are *organizing activities*. These are the activities that we identified at the end of our discussion of sociocultural theory, they are summarized In Table 2



Table 1 Categories of Resource that form a Learning Context

CONTENT - THE STUFF TO BE LEARNT	
<p>KNOWLEDGE –</p> <p>a) Intellectual/scientific/formal – accepted beliefs about what knowledge/expertise is in a particular subject. Abstract and often very decontextualised</p> <p>b) Tacit knowledge – more obvious in craft contexts such as chef training and guild based approaches. Usually contextualized which can lead to problems or restrictions whereby master and learner can only operate within a limited contextual sphere.</p> <p>b) Meta - Knowledge</p>	<p>CURRICULUM –</p> <p>a way of structuring the knowledge to form a subset of knowledge organized in a particular sort of way to meet an intermediate/particular purpose. For example, an exam syllabus. The point of the curricular is to formalize the <u>learning</u>. More applicable to scientific knowledge than tacit knowledge. Can be used to ensure that areas of a subject are covered in similar breadth and depth across institutions and that outcomes can be compared across peer groups.</p>
PROCESS - WAYS THAT STUFF CAN BE LEARNT	
<p>TOOLS / MEDIATIONAL MEANS –</p> <p>ways for learners to make contact and connect with knowledge and/or perform skills.</p> <p>a) physical tools such as a paintbrush or a sensor for collecting data.</p> <p>b) semiotic/psychological tools such as language</p> <p>Computing technology can be physical and involve communication through language.</p>	<p>PEOPLE who know more about X or how to do X than the learner.</p> <p>Can build relationships between resources to animate them for the learner. Vast range of interaction possibilities: a student reading a text could be considered to be interacting with the author of that text; a learner and teacher or more able peer could be involved in a one-to-one interaction, a group of peers could be learning together, or a small group of apprentices could be learning their skills from a master.</p>
PLACES IN WHICH LEARNING CAN TAKE PLACE	
<p>LOCATION –</p> <p>physical environment/location and its components such as desks and tables or trees and shrubs. Particular issues of importance for the use of technology include the availability of power, the existence of glare from sunlight or strip light or wet weather affecting safety.</p>	<p>ORGANISATION/ADMINISTRATION OF THE LOCATION –</p> <p>May include time as well as space constraints e.g. lesson length. Technology affords possibilities for circumventing organization, e.g. through virtual locations and networked communication that transcend space and time.</p>

Table 2 Organising Activities for the Resources that form a Learning Context

Activities
The representation and communication of the teacher/expert/more able peers' situation definition
The representation and communication of each learners' situation definition
This representation needs to be accessible by the learner, other people and devices within and beyond a single location
A means to identify and represent the range of qualities and quantities of assistance that can be made available to the learner
The provision of mechanisms through which individuals can communicate and negotiate
Assistance to support participants to collaborate in their formulation of a shared situation definition (scaffolding)
A mechanism to ensure that assistance is targeted to the learners' needs.

### **Relevant Work in educationa and computer science**

Contemporary educational practice has been influenced by a sociocultural approach with classrooms being described as Social Learning Contexts and clear recognition of the social and communicative nature of cognitive development (Mercer, 1992). The classroom life of a child is made up of many varied social transactions. Children and adults are interdependent and a "collective" ZPD exists (Moll and Whitmore, 1993). The way in which the participants in this collective zone use the resources provided by the educational culture in which they operate is of central importance. The organisation of the learning resources within the classroom, including the computer, will influence the manner in which these resources are used. Each individual class will have its own unique culture and brand of learning environment (Smagorinsky and Fly, 1993).

Individuals develop learning strategies through their home, playground and classroom settings. The influences upon the development of these learning strategies change as the learner experiences different teachers and classes in her school (Pollard, 1993). Likewise the learner's experience with computers will have an impact upon the learning strategies which she develops and which temper her subsequent interactions with technology. Each learner brings with them to each learning session a continuum of these interactive experiences to which the current episode will form an extension. The nature of the current episode will therefore be derivative of the individual learner's history as well as that of her teacher or peers

(Smagorinsky and Fly, 1993). This attention to the learning strategies developed by the learner, and the process of learning itself, underlines the need for knowledge about the learner. The importance of the link to culture likewise underlines the need for knowledge about a learner's context. Lastly we need to consider the medium of symbolic representations of the world through which communication is effected. Educational media can be classified into discursive, adaptive, interactive and reflective categories. For example, for the educational medium to be 'Interactive' it must involve learner's receiving "meaningful intrinsic feedback" on their task related actions and must result in an observable change to the world that can be attributed to these actions (Laurillard, 1993).

The findings that arise from this educational perspective confirm that the organisation of the learning resources will influence the manner in which these resources are used. They suggest that there is a great variance across individual locations even within the same environment, each will have its own unique culture, such as a class in a school. We need to ensure that we are able to represent and access knowledge about an individual's learning strategies and process, likewise her understanding of her context and the knowledge or skill being learnt. The creation of effective instructional interactions is complex and each learner will need effective feedback that identifies the way in which the context situation definition has changed as a result of her actions.

The work we consider from computer science has arisen from the ubiquitous computing community. Most of this work has been about defining context in a manner that will enable the development of 'context aware' applications. It is therefore motivated by a technical device design aim and is not specific to educational contexts. Context has been defined by Dey (2001) for example as "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves". For application to an educational context an entity could be considered to be the learner and therefore context would be the information that characterizes the learner's situation. This approach might help us to identify the information to which we would wish technology to respond in order to assist the adaptation of the resources in the context to the needs of the learner.

Some more recent work has critiqued this notion of context. Dourish (2004) identifies the challenges that ubiquitous computing technology has brought to human-computer interaction design and the confusion that surrounds what it means for a device to be context-aware. He proposes greater attention be paid to the

nature of human activity. In a similar vein, Chalmers (2004) examines a number of the approaches, origins and ideals of context-aware systems design. He concentrates in particular on the way that history influences ongoing activity and suggests that an individual's experience and history is part of her current context. If we apply this purely to an educational context, there is great consistency with a sociocultural approach in which all the resources within a context will be culturally defined and therefore bring with them a historical definition that will influence a learner's ongoing interactions.

Work which tries to combine the educational and technological perspectives on the nature of context can be found in the mobile learning and AIED literature. The MOBILEARN team have started to look at how context modeling can be applied in a variety of learning contexts in order to build systems that can respond appropriately to contextual features. Beale and Lonsdale (2004) for example, present a hierarchical description of context which they define as "*a dynamic process with historical dependencies.*" This is described as "a set of changing relationships that may be shaped by the history of those relationships". Research within the AIED community has explored how we can design adaptive technology that takes a learners' context and potential collaborators into account (Greer, McCalla, Cooke, Collins, Kumar, Bishop, and Vassileva, 1998, and Murray and Arroyo, 2002 for example). Much of this work is also grounded in a socio-cultural approach to understanding the learning process and has explored the ways in which technology can adapt to scaffold learners' collaborative interactions. As yet however it has concentrated upon desk-top technologies.

### **Socioculturally Informed Technology Design**

It is useful to also consider how both sociocultural theory and the notion of context have been used to date by designers of educational technology. The idea of using sociocultural theory to inform the design of educational technology is not new. The desktop metaphor and the design of Interactive Learning Environments (ILEs) using the scaffolding techniques proposed by Wood and colleagues for face-to-face interactions have been used to implement software scaffolding and have offered designers one way of implementing flexible assistance for learners of different ages. A range of different approaches to scaffolding have been implemented, including systems designed for single learners (Wood, Shadbolt, Reichgelt, Wood, & Paskiewitz, 1992) and to support collaboration amongst groups of learners (Guzdial, Kolodner, Hmelo, Narayanan, Carlson, Rappin, Hubscher, Turns, & Newstetter, 1996). Likewise, there is a large literature on the benefits of peer collaboration in

general (e.g. Dillenbourg *et al.*, 1995), in paired reading (Topping, 1988) and in learning through interactive multimedia (Jackson *et al.*, 1996). The question of effective collaborative assistance has been extended beyond the *content* of the help provided by a collaborator (human or digital), to *how* that help is made available to learners and how well learners can seek the assistance they need. Various recent studies have shown that learners do not always make effective use of the available help (Luckin & du Boulay, 1999; Wood & Wood, 1999; Alevan & Koedinger, 2000; Luckin & Hammerton, 2002; for example).

However whether concerned with designing help, promoting peer collaboration or exploring how learners ask for help, the emphasis of the software scaffolding work completed to date has been directed at the desktop computer metaphor. Some of our previous work has explored what happens when the helper is taken out of the box. In particular, we have conducted empirical studies with digital toy technology that allowed young children to request help directly from the digital toy, from the accompanying software, from their peers, or from a researcher. We found that even with the basic technology used in these studies there was an increase in the level of social interaction that occurred between collaborators when the toy was present as compared to that which we observed when children interacted only with the desk-top screen based interfaces

Moving further beyond the desktop and outside the classroom context, wireless, mobile and ubiquitous technologies can engage learners in hands-on experience and activities in real world learning situations. As we have previously identified in Smith, Luckin, Fitzpatrick, Avramides and Underwood (2005) such activities can lead children to be more imaginative in their understanding, can yield both motivational and cognitive benefits and offer learners greater ownership of their data.

## **Discussion and Conclusion**

We have presented an educational context as an “Ecology of Resources” that can be deployed in a learner centric manner through the implementation of organizing activities. As we stated at the start of this paper our motivation is the development of educational experiences supported by technology to enable learners (and teachers, peers and parents) to adapt the resources at their disposal to best support their learning needs. Different locations will be more or less adaptable, however the smart use of technology can maximize the amount of assistance that the learner can glean from her environment and ensure that it is targeted at her ZPD.

The *Ecology of Resources* framework as we have presented it is still relatively abstract. It consists of a description of the categories of resource elements that constitute a context and the organizing activities that activate these resources to form an Ecology of Resources centred around the learner. This approach has the advantage of encompassing a wide range of context types, and has proved useful in our analysis of case studies (Luckin et al, under review). It does however need further specification to provide a 'richer' description of context. This richer description should yield an ontology for describing educational contexts. Such an ontology could then be used in educational technology design, for example to help link learner and context modeling through a common set of descriptors. At the moment we have talked in terms of the learner, her situation definition, ZPD and need for collaborative assistance. We have not gone into further detail about what we need to know about her emotions and motivations for example. This is currently encompassed within the Broadband Learner Model (BLM).

The organizing activities and ecological metaphor we have adopted also needs further specification so that we can start to identify the inter-relationships that can lead to balance. Likewise, we may be able to identify changes in a particular resource element or activity that will lead to perturbations in other parts of the ecology of the learning context. This is future work that will require further analysis across a wider range of learning contexts than that we have tackled here. Our next step will be to integrate the detail of the Broadband Learner Model framework with a richer description of context resources and organizing activities. In this way we can develop a comprehensive framework for the design and evaluation of all forms of educational technology consistently across multiple projects.

This is a contrast to the approach adopted by the Ubiquitous Computing community. Our emphasis is not for the development of context awareness within the technology itself, other than at some basic level of operation, Rather we would promote the explication of learner and contextual data so that it can be used by teachers and learners to select those resource elements that are best suited to a learner's needs.

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