THE PROBLEM OF CONTEXT:
THE CIRCUMSTANCES IN WHICH ICT CAN SUPPORT LEARNING

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Abstract
Context matters to learning; it is complex and local to a learner. Conceptualizing context so that designers and educators can understand and use it to better support the development of technology-rich learning activities is an important challenge. This paper discusses the way in which the Ecology of Resources model and design framework address this challenge by providing a way to characterize a learner in terms of the interactions that form that learner’s context. It offers an interpretation of Vygotsky’s ZPD theory in the form of an abstract representation that can be shared by practitioners, technologists and beneficiaries as they explore the potential learning benefits afforded by the wide range of available resources, in particular technologies. The Ecology of Resources represents learners holistically with respect to the interactions that make up their context. The Ecology of Resources model also acts as the foundation for a design framework which is intended to help researchers, technologists and educational practitioners to design technology-rich learning experiences with and for teachers and learners. We draw upon an empirical example to demonstrate how this design framework has proved useful in the development of technologies and activities for learners within and beyond formal education in subjects such as science and foreign languages.

Introduction
When observing and studying learners, one is struck by the complexity and importance of the relationship between learners and their contexts. We started to explore ways in which we could understand more about this relationship and its impact upon the manner in which learners (and teachers) might best use ICT. One could think of context as the circumstances in which learning takes place, but what do we know and understand about these circumstances and their relationship to what people learn through ICT?

There is nothing new about the suggestion that one should explore a learner’s context in order to understand more about their learning (see, for example, Mercer, 1992; Wood, Underwood, & Avis, 1999). Previous research has confirmed the importance of looking at the wider environment but has been largely limited to specific environmental locations,
such as university lecture halls, school classrooms, or ‘the workplace.’ This approach limits consideration to just one of the many environments with which and in which a learner interacts.

A learner-specific definition of context is needed if we are to address this limitation and develop technology-rich learning that takes advantage of the potential afforded by the wide range of evolving ICTs that can support interaction across multiple physical and virtual spaces, multiple knowledge domains, multiple time periods, and multiple collaborators. The provision of such a definition is not an easy task — context is a complex concept (Nardi, 1996) and very difficult to ‘pin-down’ in a way that enables it to be used as the basis for constructing a design framework.

In Luckin’s (2010) discussion of context is initiated through consideration of the range of ways in which the term “context” is used within and across multiple disciplines. The aim was to identify common themes that transcend disciplinary boundaries and to arrive at a definition of context that can be used as the basis for developing a framework to support the design of technology-rich learning activities. The discussion encompasses work drawn from geography and architecture, anthropology and psychology and from education and computer science and concludes with the proposal that:

Context is dynamic and associated with connections between people, things, locations and events in a narrative that is driven by people’s intentionality and motivations. Technology can help to make these connections in an operational sense. People can help to make these connections have meaning for a learner. A learner is not exposed to multiple contexts, but rather has a single context that is their lived experience of the world; a ‘phenomenological gestalt’ (Manovich, 2006) that reflects their interactions with multiple people, artefacts and environments. The partial descriptions of the world that are offered to a learner through these resources act as the hooks for interactions in which action and meaning are built. In this sense, meaning is distributed amongst these resources. However, it is the manner in which the learner at the centre of their context internalizes their interactions that is the core activity of importance. These interactions are not predictable but are created by the people who interact, each of whom will have intentions about how these interactions should be. (p. 18)

This specification offers a starting point for developing a clearer way of talking about context, but it needs further integration with learning theory if we are to use it to develop something really useful to support the development of ICT for learning. The socio-cultural approach of Vygotsky (1986) offers compatibility with a context-based model of learning. In particular, if one considers the Zone of Proximal Development (ZPD) as the crystallization of the internalization process that is at the heart of learning, then the ZPD can be thought of as a context of productive interactivity. This conceptualization emphasizes the important role played by the society within which the learner interacts and in particular the more knowledgeable, or more able, members of that society — members who are lecturers, teachers, trainers, and parents, for example. The ZPD is
useful, but it requires further clarification and specification (Wertsch, 1984; Wood, Bruner, & Ross, 1976). The Zone of Collaboration is an interpretation of the ZPD concept that offers a way to provide this clarification and specification. It involves two constructs: the Zone of Available Assistance (ZAA) and the Zone of Proximal Adjustment (ZPA). The ZAA describes the variety of resources within a learner’s world that could provide different qualities and quantities of assistance and that may be available to the learner at a particular point in time. The ZPA represents a sub-set of the ZAA that is appropriate for a learner’s needs.

This Zone of Collaboration concept is integrated with the description of context outlined above to form the Ecology of Resources model of context. This model is intended to act as a useful mediating artefact to integrate work across the various subfields involved in the development and use of ICT to support learning: computing, psychology and education, for example.

**The Ecology of Resources Model of Context**

The Ecology of Resources model (Figure 1) develops the ZAA and ZPA concepts into a characterization of a learner along with the interactions that form that learner’s context (its full detail can be found in Luckin, 2010). Here we describe it briefly in order to support the suggestion that it might act as a useful mediating artefact to integrate work across various subfields; to situate the presentation of the design framework, and to ground an empirical example.

![Figure 1: The Ecology of Resources Model](Luckin, 2010)
The resources that comprise a learner’s ZAA embrace a wide range of categories including people, technologies, buildings, books, and knowledge. Considering the different types or categories of resource that might be available is useful in order to identify them and the relationship they bear to the learner and to each other. One of the resource categories that the learner needs to interact with is the ‘stuff that is to be learnt’: the knowledge and skills that are the subject of their learning. A second category of resource is that described as “Tools and People” in Figure 1. This category includes books, pens and paper, technology, and people who know more about the knowledge or skill to be learnt than the learner does. The last category of resource is that represented by the “Environment” label in Figure 1. This category includes the location and surrounding environment with which the learner interacts: for example, a school classroom, a park, a virtual world, or a place of work.

In many instances, a relationship exists between the resources within these three categories: Knowledge and Skills, Tools and People, and Environment. For example, the book resources appropriate for learning science are located in the science section of the library and formal lessons probably take place in a particular location in school. Hence, in Figure 1 the categories of resource surrounding the learners, and with which they interact, are joined together. In order to support learning, the relationships between the different types of resource with which the learner interacts need to be identified and understood. They may need to be made explicit to the learner in order to build coherence into the learning interactions. For example, if we wish to teach the concept of food chains, then we might decide to make a visit to a pond or a garden in order to observe the animals and plants that live there and to talk about the feeding relationships that are required to support the particular ecosystem.

This food chain learning example highlights another factor that needs to be taken into consideration. As a teacher one might organize for learners to make a trip to a local pond or garden. This is an example of the way in which learners’ interactions with the available resources are often filtered by the actions of others rather than experienced directly and unimpeded by the learners. In this example the teacher usefully filters learners’ interactions with the world to illustrate food chains “in the wild.” Filters can be positive or negative. For example, the subject matter to be learnt is usually filtered through some kind of organization, such as a curriculum, that has been the subject of a process of validation by other members of the learner’s society. This resource filter is stronger for subjects such as formal educational disciplines than for more grounded skills. However, even with skills-based subjects there is, to some extent at least, still some formalization of what is recognised as the accepted view about the nature and components of the skills that need to be mastered.

The tools and people that may be available to the learners are also organized or filtered in some way. For example, a teacher taking a science class is probably only available during that class, or perhaps at some other times via e-mail. Classroom technologies are not always available to learners whenever they want: school rules and protocols restrict the learner’s access to these resources. Finally, and again as reflected in the food chain
example, a learner’s access to the Environment is mediated by that Environment’s organization. This resource filter is more obvious in formal settings such as schools, where timetables and regulations have a strong influence on the ways in which learners interact with their environment. In the same way that a relationship may already exist between the different resource elements in the outer circle of the figure, a relationship may also exist between the filter elements. The coherence of the learner’s experience can be enhanced through careful consideration of the existing relationships between the filter elements and between the individual resource elements and their associated filters.

All of the elements in any Ecology of Resources bring them a history that defines them, as well as the part they play in the wider cultural and political system. Likewise, individuals at the centre of the Ecology of Resources have their own history of experience that affects their interactions with each of the elements in the Ecology.

**The Ecology of Resources Design Framework**

The Ecology of Resources model offers a way of characterizing a learner in terms of the interactions that form that learner’s context. It is based upon identifying the forms of assistance available to a learner that make up the resource elements with which that learner interacts. The Ecology of Resources model could be viewed statically as merely a snapshot of the set of elements that describe a learner’s ZAA and that can be ‘optimized’ by design and/or by practice. The model can also be seen as the basis for a dynamic process of instigating and maintaining learning interactions in technology-rich environments. The objective of the framework presented here is to support the dynamic process of developing technology-rich learning activities. The aim of the Ecology of Resources framework is to map out the complexity of this design process so that it can be conducted with an enhanced awareness of the complex nature of the learner’s context. This does not mean that the entire complexity can be taken into account within the process, merely that a greater understanding of the complexity enables the process, and the resultant technology-rich learning activities, to be more effectively situated. In particular, the design process supported by the Ecology of Resources framework identifies the ways in which technology, people, and the learners themselves can best support learning. If the Ecology of Resources model and its associated design framework is to be useful to a design team the overarching aim of their design process must be to engage with the learner’s context as part of that process.

The Ecology of Resources Framework offers a structured process, based upon the Ecology of Resources model of context, through which educators and technologists can develop technologies and technology-rich learning activities that take a learner’s wider context into account. The process is iterative and has three phases, each of which has several steps. Each phase and step is intended to be completed through collaboration between beneficiaries and designers through a participatory design process. A full account of the framework can be found in Luckin (2010); here we explain it relatively
briefly through an example as part of the conference presentation. The Ecology of Resources Framework has three phases, each of which has multiple steps.

Phase 1: Create an Ecology of Resources Model to identify and organize the potential forms of assistance that can act as resources for learning:

   Step 1 – Brainstorm Potential Resources to Identify Learners (ZAA)
   Step 2 – Specify the Focus of Attention
   Step 3 – Categorize Resource Elements
   Step 4 – Identify potential Resource Filters
   Step 5 – Identify the Learner’s Resources
   Step 6 – Identify potential More Able Partners

Phase 2: Identify the relationships within and between the resources produced in Phase 1. Identify the extent to which these relationships meet a learner’s needs and how they might be optimized with respect to that learner.

Phase 3: Develop the scaffolds and adjustments to support learning and enable the negotiation of a ZPA for a learner. Phase 3 of the framework is about identifying the possible ways in which the relationships identified in Phase 2 might best be supported or scaffolded. This support might for example be offered through the manner in which technology is introduced, used, or designed.

**The Ecology of Resources Design Framework in Use**

The Ecology of Resources approach has been used in a variety of projects that include science learning in school, informal and formal learning in the developing world, and home education in the UK. It is currently being used to support an adult second language learning study. In the following sections of this paper we expand upon one example in order to explain the framework in action.

The example we draw upon for the case study below was completed with a learning centre in the South East of England that operates a self-managed learning (SML) process for 11–16-year-old learners in an “out-of-school” environment. (For a fuller explanation, with data examples see the wiki at [http://eorframework.pbworks.com/w/page/25030180/001%200%20Study%20Overview](http://eorframework.pbworks.com/w/page/25030180/001%200%20Study%20Overview)). Self-managed learning is about learning to learn within the context of the individual and the wider community. Consequently, learning within the centre is not formalized to the same extent as in more traditional educational contexts. However many of the learners are seeking to gain formal educational qualifications. A key aim of the design process described in this case study was to explore and model learners’ contexts to identify ways in which available resources might best be used to support their learning needs. These issues were addressed through an iterative participatory design approach in collaboration with learners and staff at the
learning centre. The research team required several interview sessions and observations with learners and mentors to identify and clarify the focus of attention used at the start of this case study.

**Phase 1: Design Framework**

*Step 1: Brainstorm potential resources to identify the learners’ ZAA*

Initial explorations with learners and staff at the centre revealed that although learners had access to a wide range of technologies for both formal and informal learning, they did not find it easy to make connections between these technologies, their learning activities and the available spaces for learning. A preliminary generic ZAA was generated based on a loosely framed design motivation, which focused on learners’ selection and use of technologies on trips. This widely framed ZAA is consistent with the aims of the initial step of Phase 1 of the design framework, which is to provide the widest possible ZAA on the basis that this may need to be revisited across several iterations in order to address multiple foci of attention. During subsequent iterations of the design process Step 1 produced the refined ZAA illustrated in Table 1, following a refinement of the Focus of Attention (as discussed in Step 2 below).

<table>
<thead>
<tr>
<th>Refined ZAA (Trip to Royal Observatory to learn about Astronomy)</th>
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<tbody>
<tr>
<td>Learners, staff from learning centre, siblings, peers, friends, relationships, researcher-designer, group size, group/community rules, staff at trip site (museum guides, show narrators specialists, ticket attendants, shop assistants), other learners/visitors, trip site rules (show times, interaction, photography, filming, audio recording, use of mobile phones, cameras, noise levels, freedom of access), interactive exhibits, simulations, models, trip site activities, trip site environment and facilities (open spaces, enclosed spaces, eating spaces, activity spaces), weather (warm, cold, rain, shine), seasons (holidays, summer, winter, spring, autumn), environment (indoors, outdoors, secure, unsecured, private, public, open, restricted, furnished, unfurnished, buildings, proximity, distance, physical location, geographical location, orientation), time (show schedules, as commodity, waiting time, filling time), security, mobility, size, weight, money (mobile phone credit), posters, leaflets, flyers, books, digital information screens (adverts, exhibit information), mobile phones (camera, video, text messaging, games, Bluetooth, talking, image quality, battery life, Internet connectivity, sharing, available networks, GPS), batteries, memory cards, iPods or mp4 players (audio, image, text, video, touchscreen, wifi connectivity), mp3 players (audio only), voice recorder, digital still image camera, digital video camera, combined still image/video camera, headphones (quality, size, comfort, ability to share – dual jacks), energy (food, drink, exercise, interactions, health), co-ordination (physical, relevance, curiosity, novelty, spontaneity, fascination, interest, fun, play,</td>
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interactivity, problem-solving, dialogue/discussion, decision-making, narratives/storytelling, games, activities (leisure, learning, exploring, discovery), information (simple and brief, fascinating facts, interesting, rules, advice, taking photos (for fun, for newsletter, for memories), filming (with video), reviewing photos of past trips/events (using iPod, mobile phone), discussing use of Internet to locate interesting facts, understanding technologies (camera angles, photographic perspectives, image quality, storage needs, power needs, credit needs, film literacy, editing and planning skills), newsletter (taking photos, writing notes, planning trip reports, sketching, drawing, recording information), activity ideas, watching downloaded or previously captured video clips, generating questions to ask in situ trip experts, communication (email, talk, text messaging, GPS networks sensors ‘pushing’ information, Flickr, Google Docs, blog, paper, pen, pencils, notepad, YouTube, Wikipedia, Google, digital video archives, films (e.g. The Golden Compass), DVDs, videos, Internet, computer literacy, media literacy, information literacy, maths, science, engineering, geography, history, culture, astronomy, learning models, process curriculum, Greenwich, Royal Observatory, Planetarium, Planetarium exhibits (information on universe, galaxies, stars, black holes, Milky Way, Meridian line, shows, video clips).

**Step 2: Specify the focus of attention**

At the end of the first iteration of Step 1 the goal of the design process had been specified as being linking learners and technologies to specific trips. A further set of iterations that moved between Steps 1 and 2 of the design framework was required to produce a sufficiently narrow focus of attention that was sufficiently fine-grained to enable progress to Step 3. The refinements through this process required further dialogue and interaction with participants and involved researcher participation in two trips organized by learners: one to a local farm which focused on formal study and learning about biology and becoming a vet and one to the BBC which focused on leisure and learning through film studies and becoming a film producer. In each of these instances, the design team (comprising researcher, learners and learning advisors) was able to observe and discuss available resources, with a particular focus on the category elements and filters of the Ecology of Resources framework. With the increased understandings of the learner’s learning context across multiple locations gained through this participatory design process it was possible to generate an appropriate focus of attention: *How can we support the learner to make appropriate selection and use of available technologies to learn about the Milky Way whilst on a trip to the London Planetarium at the Royal Observatory?*

**Step 3: Categorize resource elements**

The identification of a preliminary set of resources enabled the generation of a preliminary Ecology of Resources model (see Figure 2) that was further refined and reshaped through steps 4–6.
While steps 3–6 are enumerated sequentially, developing in parallel can be useful because identifying relevant filters and constraints requires a negotiation back and forth between resource elements and learner resources as well as consideration of the role of potential MAPs. It is not a matter, here, of trying to incorporate steps 4–6 into the Ecology of Resources model generated at Step 3. It is, rather, a matter of identifying relevant resources and asking the following questions at each step.

**Step 4: Identify potential resource filters**

Filters can act as constraints or opportunities, each of which can have positive/negative qualities (see Table 2). For example, learners who want to learn more about the Milky Way might attend the Planetarium Show where they will learn about the Milky Way as part of a particular scheduled show. The show as a resource is filtered by time (show times, length of narrative/visuals about Milky Way) and by rules (no audio recording or photography allowed) which means that the learners must remember or record in a different way what they are seeing/hearing. It is also filtered by ambiance (a darkened room) where lack of light acts as a constraining filter on their ability to make written notes, and by opportunity — if, for example, learners have mobile phones, they could save text notes using the backlighting filter in the phone. The act of listening to the narrator and the presence of the audience acts as a constraining filter on the learner’s ability to use available MAPs as *in situ* resources. Some of these issues could be addressed in the design process by, for example, considering the use of GPS sensors.
which ‘push’ information to learners’ mobile phones at various locations, or, for example, learners could opt to receive additional digital information about specific knowledge concepts (e.g., the Milky Way via Bluetooth to their mobile phone). All of these act as potential filters in the learners’ interactions with their contexts.

Table 2: Resources and Filters

<table>
<thead>
<tr>
<th>Resources (can also be potential MAPs)</th>
<th>Filters (can be positive or negative)</th>
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<tbody>
<tr>
<td>Astronomy, Planetarium show, interactive exhibits, simulations, models, digital information screens, information about the universe, galaxies, stars, black holes, Milky Way, film or video clips, audio commentaries, Planetarium learning workshops, Planetarium shop</td>
<td>Milky Way, design and layout of exhibit space, content/relevance/organisation of exhibits, access (to show, exhibits, workshops, shop), Internet connectivity, network connectivity, language, location, Planetarium rules, time</td>
</tr>
<tr>
<td>Learners, staff from learning centre, peers, researcher-designer, Planetarium show narrator, museum guides, Planetarium ticket collectors, shop assistants, other museum staff, other learners/visitors</td>
<td>Relationship, accessibility, time, location, existing knowledge, environment, confidence, opportunity, group/community rules</td>
</tr>
<tr>
<td>Mobile phones, batteries, memory cards, voice recorder, digital still image camera, digital video camera, combined still image/video camera, headphones, mp3 player/iPod, DVDs</td>
<td>Connectivity, Planetarium rules, copyright, power, storage capacity, technology skills, availability, quality, ambiance (e.g., light levels, sound levels)</td>
</tr>
</tbody>
</table>

Step 5: Identify the learner’s resources
What are the resources brought to the situation by the learner? For example, some possible resources in the this case study were co-ordination, curiosity, motivation/interest, existing knowledge, problem-solving skills, decision-making skills, planning skills, technical skills, learning models, learning styles, relationships, social skills, collaborative skills, communication skills, and self-esteem.

Step 6: Identify potential more able partners
Who or what are the MAPs and what role might they play? For example, a range of potential MAPs can be identified in the scenario of the learner at the Planetarium who wishes to learn more about the Milky Way. The MAPs would include the narrator at the Planetarium show, the learning mentor from the learning centre who traveled on the trip, peer learners, and technology.

The stated purpose of the Ecology of Resources framework at Phase 1 is to identify and model a particular design need. Through the various iterations in Steps 1 and 2 and the subsequent review and revision of these resources in Step 3 and Steps 4–6, a subset of resources which were sufficiently scoped and relevant to the stated focus of attention for Phase 1 were produced to enable progress to Phase 2.
Phase 2: Identify Relationships and Filters

The aim of Phase 2 of the Ecology of Resources design framework is the identification of relationships and interactions that might influence the ways in which the resources, filters and MAPs may or may not be appropriated to act as forms of assistance for learners. The resources identified in this example are organized into groups according to the category elements and the relationships between the elements. Figure 3 illustrates a sample Ecology of Resources model of a learner’s trip to the London Planetarium incorporating resources and filters based on the preliminary output generated at Phase 2. The model also incorporates arrows that highlight the relationships between these resources and filters.

Figure 3: Ecology of Resources illustration for the Planetarium visit example

This Ecology of Resources model is still quite broadly framed but can nevertheless be used and reused to consider scenarios and options and to explore the learner’s potential interactions with resource elements. The relationships and filters framing available resources and potential MAPs can be made more explicit. Opportunities for cross-location activities can also be generated and made visible. Mapping a learner’s interactions in this way can provide a preliminary model for considering ways of developing effective scaffolds in both the learning process and the design process. Each of these resources and filters can influence any of the others and it is perhaps only with this understanding that the value of the Ecology of Resource framework really starts to
become apparent and the interdependency of the component parts of the learner’s context begins to emerge.

**Phase 3: Identify Scaffolds and Adjustments**

The research of this case study was largely exploratory and focused on supporting learners’ decision-making processes about appropriate and effective technology use to support their learning. Phase 3 therefore focused more on identifying, for future iterations, potential scaffolding opportunities. For example, an adjustment to the rules framed by copyright has been made in relation to the Exhibits hall, thus permitting learners to use their technology to capture data about their interests in astronomy, which they are later able to share with others, via Flickr, for example. A further example adjustment to this scenario could be made by making *in situ* provision within the Planetarium for visitors to share digital data captured in this way online, such as via a shared visitor website.

**Conclusion**

In this paper we have discussed the nature of the concept of context and have suggested that it is the role of the abler participants in a society to scaffold the construction of a narrative for those who are less knowledgeable or less able: the learners. Through this process the learners at the centre of their contexts internalize their interactions and develop increased independent capability and self-awareness. The Ecology of Resources model and its associated design framework offers a way to talk about learners holistically — to sensitize us to the range of interactions that constitute their contexts. It frames a participatory design process that enables us to identify the assistance that could be available to learners, the ways that learners’ interactions might be filtered, and the situations where scaffolding might be used.

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**References**


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