What is “Educational Informatics”? A Google search for educational informatics reveals a burgeoning interest in the subject, with an increasing number of higher education courses, research groups, and institutes being established in the area. However, such a Google search will also reveal that there is much imprecision in the term educational informatics, which is commonly used simply to signify the application of information and communication technology (ICT) to education.

This book seeks to establish a more rigorous definition of—and an integrated conceptual framework for—educational informatics. It is not simply about the blend of ICT and education, although this is a central pillar. Rather, it represents the integration of three major areas of research and development, namely: ICT, education, and library/information science. While it is a relatively new field of endeavour, at the same time it builds on, integrates, and extends existing areas of work. It is thus relevant to these existing areas as well as representing a new area of research and development in its own right.
Educational informatics is defined here as:

*The development, use, and evaluation of digital systems that use pedagogical knowledge to engage in or facilitate resource discovery in order to support learning.*

This definition indicates that educational informatics is about computer-based systems that support people’s learning. This support may be given *directly to learners* themselves—or *to teachers* whose role it is to help people learn. However, educational informatics systems also “engage in or facilitate resource discovery.” *Resource discovery* is used here to embrace the seeking or encountering of any informational materials that may be useful to learners. It thus includes both information that has been carefully structured to create formal learning resources, and less structured informal information.

The volume and diversity of such resources available via the World Wide Web (the Web) are growing rapidly. Search engines like Google are increasingly becoming a first port of call for many students faced with an essay or other learning task—as it is for many people who are seeking the answer to some question or problem outside the context of any formal educational course. Much useful information may be located in response to a search. However, carefully constructed learning resources are also becoming increasingly available via the Web. They may be located in specialist repositories available only to particular users, or available freely to all—for example, open educational resources (http://www.oercommons.org/) such as Massachusetts Institute of Technology (MIT)’s *OpenCourseWare* (http://ocw.mit.edu/index.html) and the United Kingdom Open University’s *OpenLearn* materials (http://openlearn.open.ac.uk/).

However, a tool that enables people to search for resources does not necessarily fall within the definition of an educational informatics system. To do so requires that it “uses pedagogical knowledge,” which is used broadly here to mean “knowledge of teaching and learning.” Thus pedagogic knowledge includes not only knowledge of teaching in the traditional sense (i.e., knowledge used by educators in order to help others learn), but also the sort of “self-teaching,” or “meta-cognitive” knowledge, that people need in order to engage in autonomous and self-regulated learning outside any formal educational institutional context.

As we will see in this book, the types of pedagogic knowledge used by educational informatics systems may be of varying types and levels of complexity—from education-specific metadata, through pedagogic ontologies to academic argumentation structures. The techniques used by educational informatics systems for processing such knowledge also varies, from complex inference mechanisms designed to discover learning resources which match individual learner’s needs and characteristics to devices designed to enabled learners to become aware of and use their powers of
meta-cognition. In the former case, the system is using pedagogical knowledge to engage in resource discovery. In the latter case, it is using pedagogical knowledge to facilitate resource discovery, that is, to help learners search more effectively. Thus, educational informatics integrates the notions of learning and resource discovery. It is distinct from educational computing in that it integrates, as essential ingredients, a central concern of library and information science, namely: how to seek and discover information from large, diverse collections of sources such as databases, libraries, and of course, the Internet.

Educational informatics adds a library/information science perspective to the notions of personalised and autonomous learning. Within education, there is a long history of attempts to devise computer-assisted learning (CAL) systems that provide a level of personalised learning. These range from relatively simple early branching devices to more recent intelligent tutoring systems (ITS) and adaptive hypermedia systems (AHS). Autonomous learning has also been a prominent concern in education over many decades, being manifested in a number of vogues including resource-based, independent, project-based, and inquiry-based learning. Such forms of learning have emphasised the type of relatively autonomous information seeking of more traditional concern to library and information science.

Educational computing systems such as CAL, ITS, and AHS have provided relatively highly “pedagogically mediated” access to information—but until recently, typically to a relatively small set of information sources customised for a particular system, and not readily available for sharing or reuse. Conversely, the information retrieval (IR) systems developed within library and information science to support information seeking and resource discovery have typically provided access to very large diverse, remotely distributed, shared sets of information sources, but have offered no pedagogical mediation.

However, relatively recent developments mean that information systems are decreasingly restricted by the need for such a trade-off between (1) diversity, volume, openness, and shareability of information content, and (2) the level of pedagogical mediation provided by the system. These developments are being enabled in large part by the emergence of: (1) metadata standards relating to how information sources and combinations/aggregations of them should be described, thus enabling the discovery of shareable reusable resources by educators; (2) standards specifying how they should constructed as “learning objects,” enabling sharing and reuse via their integration into different learning environments; (3) standards enabling the interoperability of ontologies; and (4) standards specifying how procedures can be shared in the form of Web services.

Although there is a long history of development relating to adaptive and intelligent CAL systems, more recently such systems have incorporated the notion of Web-based resource discovery via standardised metadata (relating to learners as well as information and learning resources) and ontologies. Such systems are capable of providing relatively high levels of pedagogical mediation in relation to informa-
tion presentation and access to support personalised learning, based on access to a much greater volume and diversity of potential information sources and learning resources.

However, educational informatics is also concerned with the question of how we may facilitate autonomous Web-based learning by providing increasing levels of pedagogical mediation to information seeking and retrieval in response to individuals’ relatively free exploration of the Web in pursuit of their own “personal learning goals.” This represents a convergence of the “learning objectives” often associated with formal educational situations and the more autonomous “information needs” associated with library and information science.

How This Book is Organised

Chapters I-VI of this book are organised to reflect the main components making up educational informatics. Recall that educational informatics is defined here as:

*The development, use and evaluation of digital systems that use pedagogical knowledge to engage in or facilitate resource discovery in order to support learning.*

Chapters I-VI explore the key concepts included within this definition (and italicised previously). *Learning* is explored in Chapters I and II. Chapter III focuses on educational issues including pedagogical knowledge, while Chapter IV introduces resource discovery. Digital systems are the subject of the next two chapters, which describe ICT-based systems and approaches designed to support education (Chapter V) and resource discovery (Chapter VI).

Chapters I and II explore the basic processes entailed in learning—support of which is the goal of educational informatics systems. Chapter I introduces basic processes of learning that we all share. Chapter II focuses on the ways in which different people may use these basic processes in very different ways, often with very differing results in terms of the quality of resultant learning. Chapter I begins with some basic definitions. Learning is the processing of information in order to generate new knowledge. At a fundamental level, learning begins even before we are born, developing rapidly after birth as we try to make sense of the world around us. As we get older, a significant part of our learning may take place in the classroom, and the information processed may include that supplied by teachers, textbooks, and other learning resources. As we progress, we may experience increasing levels of autonomy in finding the information that fuels our learning both within formal educational environments which emphasise, for example, project-, problem-, and inquiry-based learning.
Learning also takes place, however, outside the context of formal education, and as part of our everyday life we seek information in order to answer questions and to help us solve our problems. The information processes discussed in Chapter I underlie all of these types of learning, and they form the basis for a model, which is developed as the book progresses, and which seeks to provide an integrated conceptual framework for educational informatics. This framework brings together key aspects from the fields of education, ICT, and library/information science, which form the three pillars of educational informatics.

But before going on to explore each of these pillars in detail (in Chapters III, IV, V, and VI), Chapter II focuses on a dimension of learning that is very important in the design of learning experiences and activities, and of systems designed to support learning. This dimension relates to human “individual differences.” Although to an extent we all share common physiological and psychological components and processes, these may be developed and deployed very differently by different individuals. Thus we are to a degree all the same, and to a degree all different. Different individuals may bring to the learning process very different kinds and levels of prior knowledge. They may also bring with them very different motivations for, confidence in, and styles of learning. All of these factors may affect how information might best be presented to them by teachers, and how systems might best be designed to support them in their learning. Chapter II explores such differences and extends the framework introduced in Chapter I to take account of them.

While Chapters I and II discuss theories of how people learn, Chapter III sets these in the broader context of different views relating to what they should learn, and why. Educational philosophies are concerned with the purposes of education. Differences in such philosophies map, to an extent, onto differences in learning theories to form broad perspectives on how teaching and learning should be organised—for example, behaviourist, humanist, cognitive, constructivist, and social constructivist. Such perspectives greatly affect views on how learning may best be brought about via appropriate teaching approaches and exposure to appropriate learning experiences and activities. Achieving this is the goal of “learning design,” which is also discussed in this chapter. Learning design is sometimes loosely referred to as instructional design. The difference between these two terms is explained, as is the choice of the former in this book.

Increasingly, learning designers are able to share, repackage, and reuse learning resources—and learning designs. However, to be effective on a large scale, this process requires agreement on standard ways of describing them. For example, imagine a teacher searching the Web to find learning resources on a particular topic, suitable for a particular age range. If he or she is to find an appropriate resource, then that resource must be described using words which either match—or can be linked to—the words he or she uses when searching.

Chapter III discusses such standard descriptions in the form of educational metadata. However, at a more complex level, if learning designs are similarly to be shared and reused, then agreement is also needed on standard ways of expressing more
complex aspects, such as structural features and inter-relationships between elements of design. Such structural specifications are handled by ontologies, and the Educational Modelling Language (EML) enables the creation of such ontologies. The EML is also introduced in this chapter, which goes on further to develop the conceptual framework introduced in Chapters I and II.

Chapter III focuses primarily on formal, mediated learning, that is, learning designed and delivered by teachers. However, as we will see towards the end of that chapter, even within such mediated contexts, learners may be allowed varying types and levels of autonomy, particularly within project-, problem-, and inquiry-based learning designs. A key element of such autonomy entails learners engaging in their own resource discovery—seeking information and resources for themselves, whether from libraries, intranet-based repositories of learning materials, or the open Web. This may be contrasted with situations in which information and resources are largely prescribed or recommended for them by teachers. Resource discovery is also a key component of autonomous, self-regulated learning taking place outside the context of teacher-mediated education.

Resource discovery within both contexts—formal education and autonomous self-directed learning—is a central concern of library/information science, and this area of research, practice, and development is the focus of Chapter IV. The chapter begins by introducing key techniques, tools, and standards developed within the library/information science community to enable and facilitate resource discovery, including cataloguing, metadata, classification, thesauri, and ontologies. The chapter goes on to explore the nature of information needs, and models of how we go about trying to satisfy them through information seeking and information encountering. The relationships between information seeking and learning, and between knowledge behaviour and information behaviour are also discussed. The conceptual framework, which was presented in evolving form in each of the previous chapters, is then further extended in order to integrate the notions autonomous information seeking and encountering with those associated with mediated learning already introduced in the previous chapter.

ICT is the third pillar of educational informatics. Chapter V focuses on ICT-based tools, techniques, and standards developed to support resource discovery—whether by teachers looking for learning materials to support them in their learning design, or learners seeking information and resources in an autonomous self-directed way outside the context of any formal course of study. Chapter VI explores ICT tools, techniques, and standards to support learning. This exploration covers developments in CAL and ITS and goes on to discuss learning management systems and virtual learning environments, the notion of learning objects and the move to an ethos of inter-operability, sharing, and reuse. The ability to share and reuse learning resources created by others on a widespread scale across networks builds on the developments outlined in the previous chapter.

Chapter VI goes on to review more general ICT-based developments including mobile and ubiquitous computing; virtual and augmented realities; and so-called...
“Web 2.0” developments. Although more general in the sense of not being specific to education, these developments have a major impact on the way learning can be designed and delivered. The chapter explores the educational affordances they offer and ends with further development of the integrated conceptual framework to take account of ICT-related issues.

Building on these foundations, Chapters VII and VIII introduce a number of examples of educational informatics systems in detail. Chapter VII focuses on educational informatics systems primarily from an individual learner perspective. Examples include adaptive systems designed to search learning object repositories for materials appropriate to individual learners in terms of their personal needs and characteristics, and systems which attempt to discover resources not only from such specially structured repositories, but also the unstructured open corpus Web. These systems engage in resource discovery on behalf of their users. However, research is also described, which seeks to facilitate rather than directly engage in resource discovery. The goal is to enhance learners’ own powers of resource discovery through the use of “meta-cognitive enabling devices” linked to retrieval systems.

Chapter VIII is concerned with collaborative and community-based learning aspects of educational informatics systems. The limitations of current metadata schemes in accommodating a range of pedagogical approaches—in particular those entailing participation and knowledge creation perspectives on learning—are discussed, along with attempts to devise alternative schemes. A number of educational informatics approaches are introduced, which exploit collaborative aspects of learning. These include systems which derive metadata to describe learning objects from learners’ interactions with these objects. User-centric metadata is attached to learning objects as they are used by different learners. The resulting data can then be analysed using data-mining techniques in order to discover patterns, which may be useful in a variety of ways, including helping learners find learning resources suitable for their own particular needs. Systems are also introduced that map argumentation structures inherent in academic argumentation and debate in the form of “knowledge charts.” These are supported by ontologies relating to different forms of argumentation.

Chapters IX and X explore a number of key themes to emerge from this review of research and development within educational informatics and discuss what may lie ahead as the field of educational informatics develops. Chapter IX focuses on the limitations of much educational informatics research in terms of “real-world” needs. It discusses the need to overcome the limitations in our knowledge of learning, learning design, and the design of ICT-based learning support systems so that we can improve our own learning, the design of other people’s learning, and the design of learning support systems that will work effectively in the real world. The chapter goes on to explore limitations in the extent to which digital systems can support higher order creative thinking processes and discusses the importance of helping learners to develop their own meta-cognitive and “learning to learn” skills.
Chapter X focuses on a number of themes that emerge from an analysis of the research and development presented earlier in the book and discusses how research and development in educational informatics might effectively be progressed. Issues are explored that relate to the generation of different types of “evidence” on which we can build, and how we can make sense of conflicting perspectives and interpretations. The conceptual framework developed throughout the book is further extended to include key issues arising from these explorations. Finally, possible future trends are discussed, including the potential for enhanced teaching and learning as the Web continues to develop.