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## Preface

The central questions this book is addressing are, what are the effective digital resources for contemporary teaching and learning? and How such resources can be designed, developed, classified, used, and reused?

Countries around the world have been transforming and modernizing due to cultural, political, social, scientific, economical, and other conditions created by emerging technologies. Technological development has been rapid; however, this, to a large extent, also has been too fast for educational institutions to fully understand and create timely responses. Governments around the world are investing in education and support of educational modernization, and initiatives of their education authorities emerge to focus on the transformation of pedagogical practices away from traditional teacher-centered to modern learning-centered approaches empowered by the contemporary technological developments and practices. For traditional, teaching-centered educational practices, the goals of teaching are to transfer curriculum content to learners, prepare learners to score highly on examinations, and develop knowledge in a specific discipline that they would use and practice throughout their life. These are no longer holding the ground, and societies for today and the future need people who have deep conceptual foundations of disciplinary knowledge required for them to make sense of developments and solve problems and, at the same time, be prepared for lifelong learning and challenges that emerge in front of all of us now and in the future.

However, one of the key problems for drives to modernize education in line with the technological development is somehow limited ability of many educators and education policy-makers to transform their own traditional expectations, understanding, and mind-sets of what is teaching and learning, and how technology plays important roles in that process. It is strongly emerging, as recognized by the authorities and researchers, that changes are essential in (a) what we teach, that is, in the curriculum design; (b) how we teach, that is, in the pedagogy; and (c) how we evaluate learning, that is, in assessment, as essential conditions for effective technology integrations. These, in turn, impose a need for changes in the resources we design and use in teaching and learning, including those digital resources for learning. We need to think differently about the design and use of digital resources for learning than it has been done so far in the context of traditional teaching and learning. Speed and form of learning achieved in the traditional educational

practices simply are no longer sufficient to enable individuals and societies to be in line with developments and demands. In this sense, an organizing idea of this book is that there is an unavoidable transformation of teaching and learning, influenced by broader changes and needs of contemporary societies, and this imposes a demand for rethinking what are effective digital (and non-digital) resources for learning. In a nutshell, this book is not only about digital resources for learning (which are seen as one of the tools for changes), but also an attempt to promote the modernization of teaching and learning.

**Important**

One of the key problems for drives to modernize education is somehow a limited ability of many educators and education policy-makers to transform traditional expectations, understanding, and mind-set of what is teaching and learning, and how technology plays important roles in that process.

There has been widespread absence of understandings of what are effective digital resources for contemporary learning, their connection to a curriculum, and their design and learning uses. Often, technologies and digital resources are taken simply as instructional medium for the transfer of explicit information to passive learners, or as specific media types, such as digital videos, animations, simulations, and slide presentations. Before articulating effective design and strategy use of resources for contemporary and modern teaching and learning practice, we need to have a curriculum approach that will enable these. Once more, the goal of education should be that learners accumulate lifelong lasting knowledge foundation (conceptual knowledge primarily) and skills needed to utilize these in dealing with challenges successfully (e.g., in continuous learning, problem solving, design, and innovation). There is a need for the curriculum to embrace a new approach, not the traditional one focusing on information and a single dimension of what will learners know, but a multidimensional approach that integrates all aspects of knowledge content, knowledge use, and emerging literacies and skills. Traditional curriculum models such as Bloom's Taxonomy (see Bloom et al. 1956) and even variations and revisions such as those proposed by Anderson et al. (2001) and Krathwohl (2002) might not sufficiently address the needs of such a need. Without an appropriate curriculum in place that emphasizes important components, there will not be any change in traditional teaching and learning for twenty-first century education. The proposed curriculum model for modern education in this book emphasizes three components or directions:

- *Knowledge content dimension*—where, in addition to declarative and procedural knowledge, more attention is given to the development of conceptual knowledge shaping disciplinary specific thinking and decision making (theoretical thinking);
- *Knowledge use dimension*—disposition to make intellectual uses of knowledge content to solve problem(s), continuously learn, and create innovation; and

- *New literacies and skills dimension*—which creates conditions for effective participation in intellectual activities and engagements, and use of modern tools in the contemporary world.

Hence, the three components are emphasized, and this proposed approach to the curriculum design is called the ‘3D curriculum.’ The traditional classroom practices are insufficient to achieve curriculum outcomes integrating these three dimensions. The traditional practices focus primarily on the content knowledge dimension, while knowledge use is given attention to a limited extent. However, even in this context of the learning of curriculum knowledge content, the traditional practices are limited, as they are effective mostly with the learning of declarative and procedural aspects of content knowledge, while the development of conceptual knowledge is left to happen spontaneously. Traditional teachers naively equate knowledge with information to be transferred, and mostly are unaware, or lack understanding of the importance and meaning of conceptual knowledge. Information transfer can hardly achieve conceptual knowledge, and intellectually challenging activities are essential for deep thinking, generalizing, abstracting, and conceptual changes to occur. Traditional practices need to be replaced by ‘learning-centered’ practices that focus on activities engaging learners in knowledge content development, knowledge use, and the development of new literacies and skills. Activities must be central to learning, and teachers’ primary roles should be the design and facilitation of such experiences for learners.

How do digital resources for learning fit in with this proposition? Digital resources for learning are representations of the curriculum knowledge content (declarative, procedural, or conceptual) that, at best, are designed to be effectively useful within learning activities. This central proposition will be unpacked in this book in the chapters that follow. Currently, there is absence of literature that provides any useful classification of digital resources for learning. This book is changing such a situation by providing an in-depth discussion of different forms of digital resources for learning, expanding the traditional conception of digital resources as information containers, and includes categories supporting the 3D curriculum, enabling knowledge use, as well as the development of new literacies and skills. Digital resources for learning are discussed and classified into a distinctive taxonomy in this book, including five definite types corresponding to different forms of curriculum content knowledge (declarative, procedural, and conceptual), as follows: presentation resources, information displays, conceptual representations, practice resources, and data displays. Each of these types of digital resources is discussed separately in various chapters of this book. It is emphasized that their design should enable effective learning within learning activities where, in addition to the learning of knowledge content enabled by these resources, knowledge use and the development of new literacies and skills are achieved. Particular emphasis in this book is given to conceptual representation as a special form of digital resource designed to support conceptual knowledge development.

**Important**

There is a need for the curriculum to embrace a new approach, not the traditional one focusing on information and a single dimension of what will learners know, but a multidimensional approach that integrates all aspects of knowledge content, knowledge use, and emerging literacies and skills.

Traditionally, digital resources for learning have been designed as a replacement to a teacher in a context of information transfer, thus mostly supporting traditional educational practices. The main idea there is that there are representations in the world which correspond to representation in our minds, and learning involves copying external into internal representations. At least, that has been the case with most of the learning objects, computer-based courseware, computer-based tutorials, computer-managed instruction, and even many of the most contemporary produced MOOCs. At best, such resources can support the learning of declarative and procedural knowledge; however, their effectiveness for the development of conceptual knowledge is limited, and if concept learning occurs, it is accidental rather than intentional. In the ideas presented in this book, only presentation resources are suitable for such traditional purposes. A design approach underlining the development of such traditional resources is known as the ‘instructional design,’ and an instructional designer’s task is to articulate the best possible approach to information transfer through the application of affordances of representational media and determine how content is to be presented to learners through a specific medium (technology in our context). Norman (1988) defines affordances as ‘the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used’ (p. 9). For Barnes (2000), a teacher’s use of new technology in teaching and learning is carried out with a belief that this technology will afford learning in some way. Similarly, designers of digital resources for learning will design these resources by leveraging affordances of representational technology with the belief that these will support learning. Key affordance of representational design for learning are affordances of visualization and interactivity. Various aspects of these affordances are unpacked in this book.

In the past, there have been several widely used instructional design models, and the most popular among them remains ADDIE (Analyze, Design, Develop, Implement, Evaluate), the systematic design of instruction model developed by Dick and Carey (1978, 1985, 1990, 1996). It is understood that the instructional design emerged as early as in the 1940s from a military organization’s practices of designing systematic instruction. Underlining it is the instructivist tradition of what constitutes learning. Instructivism is based on behaviorist learning theory, and it refers to a teacher-directed, carefully developed, instructional planning, sequencing, and delivery, with the purpose of transfer of curriculum content information to passive learners. For a learner, there is little space for active self-discovery, knowledge construction, and reflection. Thus, the central focus of instructivism is on transfer of the curriculum contents (with the aid of media as it is the case with

digital resources), rather than on learning activities, as it should be in the context of pedagogical practices supporting modern education. Since these initial days, the instructional design has changed very little, even though that, in particular over the last 20 years, we have gone through significant development in technology and the transformation of teaching and learning. The same old thinking about teaching as a transmission of curriculum information from a teacher, or a source, to a passive learner continues to be dominant when decisions about how learning technologies are to be designed and used are determined by many designers, publishers, and educators.

**Important**

Design of digital resources for learning must focus on how people learn with the utility of such materials in their learning activities. These activities engage learners to work on tasks and experience processes of knowledge construction and use, while developing new literacies at the same time.

Even though, more recently, the visual and interactive capabilities and affordances of education technology have progressed significantly with the development of powerful processing and video display architecture, mobile technologies, and software tools, very little advancement has been done overall in the way how digital resources for learning are conceptualized, designed, and used.

There is an urgent need to define possibilities and articulate strategies that can be useful to teachers, designers, publishers, and researchers in their drive to modernize education in line with the contemporary developments. We need to think of a suitable design and structure of digital resources that would support declarative, procedural, and conceptual knowledge developments, as well as activities where knowledge is used, and where new literacies and skills for today and the future are developed. Instead of relying on instructional design as an underlining idea for the design of digital resources for learning, we need to start adopting and using what in this book is called ‘learning design.’

Learning design places central emphasis upon a learning activity that creates experience and opportunity for learners to construct and use knowledge and, at the same time, develop literacies and other skills for twenty-first century participation. Digital resources for learning, in their most effective format, are tools used in these learning activities; they are not a replacement to a teacher, and they do not explicitly teach and transfer curriculum content. Rather, these enable, facilitate, and mediate learning activities and empower learners. This thinking brings about the fact that the central role of a teacher is no longer planning of instructional sequences; rather, it is the design of learning activities, that is, the learning design. Recently, learning design has been explored in the context of contemporary pedagogies such as constructivist learning environments (e.g., Cetin-Dindar 2016; Kwan and Wong 2015), problem-based learning and problem solving (e.g., Jonassen 2011; Savery 2015), engaged learning (e.g., Pipere 2016), active learning (e.g., Chiu 2016;

Chiu & Cheng 2016; Lee et al. 2016), and conceptual change approaches (e.g., Azevedo 2015; Deck et al. 2016; McNeil 2015). Underlining these is a set of foundational learning theories and models, such as the following:

- *Constructivist learning environment* (Jonassen 1999). In this view, learning should be arranged around activities and occur in an environment that supports knowledge construction, as opposed to knowledge transmission. Knowledge construction is a process where students individually construct their understanding of the content of the curriculum based on exploration, social engagement, testing of understandings, and consideration of multiple perspectives.
- *Problem solving* (Jonassen 2000). For Jonassen, learning is most effective when it occurs in the context of activity that engages students to solve ill-structured, authentic, complex, and dynamic problems. These types of problems differ significantly from logical, well-structured problems with a single solution. These types of problems include dilemmas, case studies, strategic decision making, and design, all of which require learners to engage in deep thinking, examination of multiple possibilities, deployment of multiple theoretical perspectives, uses of tools, creation of artefacts, and exploration of possible solutions. Students learn by solving complex problems rather than by absorbing ready-made rules, information, and procedures.
- *Engaged learning* (Dwyer et al. 1985–1998). Dwyer, Ringstaff, and Sandholtz conducted a longitudinal study to investigate the most effective adoption of Apple technology in a student-centered learning environment (i.e., The Apple Classroom of Tomorrow). These scholars argue that technology must serve as a tool for learning, which supports engagement in activities, collaboration, and deep learning. Central to their work is the concept of ‘engaged learning,’ which is critical in making students more active in their learning and uses of technology.
- *Problem-based learning* (PBL) (Savery and Duffy 1995). Savery and Duffy propose PBL as an optimal design model for student-centered learning. Similar to those above, PBL builds upon constructivist philosophy and contends that learning is a process of knowledge construction and social co-construction. One of the features of PBL is that students actively work on activities which are authentic to the environment in which they would be naturally used. That is, students construct knowledge in contexts which reassemble those in which they would use that knowledge. Creativity, critical thinking, metacognition, social negotiation, and collaboration are all perceived as a critical component of a PBL process. One of the key characteristics of PBL is that teachers should not primarily be concerned with the knowledge students construct, but should focus, more attention to metacognitive processes (awareness of one’s own thinking and learning).
- *Rich environments for active learning* (Grabinger and Dunlap 1997). Similar to Savery and Duffy, Grabinger and Dunlap propose PBL as a highly effective educational intervention. However, in their approach, further attention is given to the context of the environment in which PBL occurs, considering the further

aspects of components and complexities that such an activity requires. In particular, emphasis is placed upon making students more responsible, willing to provide initiatives, reflective, and collaborative in the context of dynamic, authentic, and generative learning. This approach also emphasizes the importance of the development of lifelong learning skills (one of the important skills for twenty-first century learning).

- *Technology-based learning environments and conceptual change* (Vosniadou et al. 1995). In this view, the central role of technology is to support students' conceptual changes and concept learning rather than simple knowledge/information transfer. Students construct mental models and other internal representations via attempts to explain the external world. Students often bring prior misconceptions to learning situations. Therefore, learning activities ought to be designed to correct such misconceptions. Technology will scaffold not only the presentation of effective external representations of conceptual knowledge, but also the externalization of internal representations so that teachers can gain insight into students' knowledge and understanding. Taking a more constructivist perspective, technology resources will serve the role of mediator in learning activities.
- *Interactive learning environments* (Harper and Hedberg 1997; Oliver 1999). In order to serve the complexity required for learning, Oliver proposes that a learning module must contain resources, tasks, and support. For full learning to take place, a task must engage students to make purpose-specific use of resources. The teacher's role is to support learning. These integrated components will lead to interactivity essential for learning to occur. Harper and Hedberg strongly emphasize a constructivist philosophy and argue that technology itself should provide an environment where learners can interact with tools and each other. Similar to Jonassen (2000), Hedberg supports problem-based approaches as the most effective educational intervention.

### **Important**

This book is providing an in-depth discussion of different forms of digital resources for learning, expanding the traditional conception of digital resources as information containers, and includes categories supporting the 3D curriculum, enabling knowledge use, as well as the development of new literacies and skills.

- *Collaborative knowledge building* (Bereiter and Scardamalia, in press). Knowledge building is a theoretical construct developed by Bereiter and Scardamalia to provide interpretation of what is required in the context of collaborative learning activity. Personal knowledge is seen as an internal, unobservable phenomenon and the only way to support learning and understand what is taking place, and to deal with the so-called public knowledge (which represent what a community of learners know). This public knowledge is

available to students to work on, expand, and modify through discourse, negotiation, and collective synthesis of ideas. Digital resource for learning should serve as the representation of the public knowledge.

- *Situated learning* (Brown et al. 1989). Brown and colleagues build upon the activity theory perspective to emphasize the central role of an activity in learning. An activity is where conceptual knowledge is developed and used. It is argued that this situation produces learning and cognition. Thus, activity, resources, and learning should not be considered as separate from a learning design. Learning is a process of enculturation where students become familiarized with the uses of cognitive tools in the context of working on an authentic activity. Both activity and how these tools are used are specific to a culture of practice. Concepts are not only situated in an activity, but also are progressively developed through it, shaped by emerging meaning, culture, and social engagement. In Vygotsky's terms, concepts have history, both personal and cultural. A concept can only be understood and learnt at a personal level through their uses within an activity. Active tool uses and an interaction between these resources and activity lead to an increased and ever-changing understanding of both, the activity and the context of tool use, and the tool itself. Tool use might differ between different communities of practice, so learning how to use a tool specific to a particular community is a process of enculturation. How a tool is used reflects how the specific community sees the world. Concepts also have their own history and are a product of sociocultural developments and experience of members of a community of practice. Thus, Brown and colleagues strongly suggest that activity, concept, and culture are interdependent, in that 'the culture and the use of a tool determine the way practitioners see the world, and the way the world appears to them determines the culture's understanding of the world and of the tools... To learn to use tools as practitioners use them, a student, like an apprentice, must enter that community and its culture' (p. 33). Hence, learning is a process of enculturation, where students learn to use a domain's conceptual tools in an authentic activity, and digital resources for learning should serve as such tools.
- *Inquiry-based learning supported by technology*. Work under this general idea includes practically oriented frameworks and design guidelines for building technology-based learning modules, such as the Quest Atlantis (Barab et al. 2005), MicroLessons (Divaharan and Wong 2003), ActiveLessons (Churchill 2006), and WebQuest (Dodge 1995). Similar to the previously discussed theoretical work, this approach elevates the importance of learning activity as critical for an effective educational intervention. Learning begins with an inquiry or a problem (supported with a multimedia presentation) being presented to students in an interesting way. The learners are then assigned to a task(s), provided with a template to assist them in the completion of the task(s), directed to Web-based and other resources to assist them, and collaborative tools such as discussion platforms. Most often, students use digital resources in completing



their tasks and are directed to submit outcomes via electronic means. As a design model, these approaches make a significant step in directing teachers to move away from the traditional, content-driven, teacher-centered use of technology.

**Important**

A learning activity and development and uses of conceptual knowledge should emerge as central to teaching and learning. Digital resources alone are not sufficient for full achievement of learning outcomes; rather, a learning activity is the mandatory condition.

What can be observed from all these ideas is that a learning activity and development and uses of conceptual knowledge should emerge as central to teaching and learning. Later on, in this book, an entire chapter will be dedicated to the discussion of an activity-based learning, with more specific emphasis on the activity-theoretical perspective (e.g., Engeström 1987). Overall, the proposed approach to digital resources for learning in this book strongly aligns with contemporary theories and research and is a strategy for transforming traditional teacher-centered teaching to a learning-centered paradigm. Articulating a learning design upon these theoretical ideas leads us to an important conclusion that digital resources alone are not sufficient for the achievement of learning outcomes; rather, a learning activity is the mandatory condition in this context. In this book, a specific learning design model is introduced. That model is called the ‘RASE’; on the basis that it includes four key components: resources (R), activity (A), support (S), and evaluation (E). Design of a learning experience should focus on an activity (e.g., problem solving, projects, and inquiries) that engages learning in knowledge construction through intellectual uses of resources serving as mediating tools (inducing digital resourced for learning). A teacher’s role during the implementation of a learning design is that of a facilitator supporting learners, although this should gradually fade out to allow learners to take more responsibilities and develop skills for supporting their own (lifelong) learning. Outcomes of an activity produced by learners must be formatively evaluated, and recommendations for improvements integrated in their final learning outcomes. Although the move called ‘learning analytics’ is attempting to automate evaluation, for now, and likely in the future, this will not be effective through technology alone, and the involvement of teachers and communities of learners is essential for effective evaluation.

In this book, particular attention is given to two affordances of contemporary representational technologies: affordances for (a) visualization of information, data, and ideas through the design and arrangements of colors, lines, shapes, images, symbols, etc.; and (b) interactivity as a means for providing learning with tools for manipulation and exploration of information, data, or ideas through the use of sliders, buttons, clickable areas, text inputs, etc. It is argued that these affordances empower the design of digital resources for learning, maximizing representation

through multimodalities, and, in particular, making possible for complex concepts to be represented in a format that can be effectively useful in the context of learning activities. Furthermore, this book examines the design and delivery of digital resources for learning via mobile technologies. In the final chapter, emerging representational and interactive technologies are explored, and some proposals on how these might influence digital resources for learning are provided. The chapters include activities carefully selected and designed to facilitate the understanding and learning of ideas presented in this book. Throughout the book, numerous examples of digital resources for learning, mostly designed by the author, are provided and discussed. The author hopes that these will be useful and inspirational to teachers, publishers, and designers of educational resources and that the ideas presented will lead to positive changes in teaching and learning practice, as well as to open possibilities for effective research questions to be explored.

Hong Kong

Daniel Churchill

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