



Well Designed Digital Textbooks–Users’ Requirements

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Abstract. Using the example of recent German digital geography textbooks, this chapter aims to analyze which attributes well designed digital textbooks should include to meet today’s users’ attitudes, skills, and learning requirements. In this context, the term user describes, firstly, students and secondly, teachers. The focus is on conceptual and media didactic thoughts, motivational aspects and visual design factors, whereas subject education considerations and subject content are not elaborated on in detail. In doing so, this chapter analyzes theoretical approaches concerning the conception and design of learning effective and motivating digital textbooks. In addition, this contribution discusses theoretical approaches relative to empirical findings according to today’s students’ digital literacy skills, learning motivation, and user behavior in the specific context of digital textbooks. The analysis revealed that although today’s students extensively utilize digital devices and value digital technologies, their digital and visual literacy skills are still limited, which demonstrates the need for more instruction in how to utilize digital tools more effectively for learning and problem-solving. Moreover, the conception and the design of today’s digital educational media should not merely focus on technical features, but on carefully elaborated didactic concepts. These are concepts that integrate subject content with the capabilities of digital technologies fostering besides subject-specific knowledge, twenty-first century skills, such as digital literacy, information literacy, critical thinking, problem-solving, powerful concepts of analyzing, explaining, and understanding complex issues and relationships, and effective strategies to acquire new knowledge. This excludes unmodified or solely digitally enriched adaptations of existing printed textbooks, but it requires the development of new concepts, meaningful synthesizing of pedagogy, structure, design, content, and technology tailored to learning-fostering and motivating digital educational media.

Keywords: Digital textbooks · User requirements · Textbook design · Visual literacy · Motivation

1 Introduction

Textbooks—printed and digital—reflect the knowledge of a society (Bölsterli Bardy 2014) and are designed to enable students to learn effectively, whether it will be knowledge, attitudes, competencies or capabilities (Reints and Wilkens 2014). To enable today’s students to acquire knowledge efficient and effective by means of digital

textbooks, textbook producers are challenged by a number of new factors. These factors are multifaceted, interrelated and imply new requirements regarding the conception, design, and production of modern digital educational media.

Using the example of recent German digital geography textbooks, this chapter elaborates on three exemplary challenges concerning the conception and design of contemporary digital textbooks.

Firstly, the *pictorial turn*—postulated by Mitchell as early as 1992—is associated with a growing relevance of images for communication, meaning-making, and knowledge acquisition in our society (Mitchell 1992; Felten 2008). The pictorial turn affects the conceptual and visual design of current geography educational media in manifold manner. Particularly with the widespread use of digital imaging and new digital visualization techniques in recent years, a significant increase in number and types of visuals utilized in geography textbooks is apparent (Janko and Knecht 2014). Modern geography textbooks—digital even more so than printed textbooks—exceedingly utilize different types of visuals and visualizations to communicate subject content. However, numerous studies in image-text research revealed students’ difficulties with interlinking complex image-text relations and with decoding information from visuals (Hochpöchler et al. 2012; Mason et al. 2015; Schnotz et al. 2014).

Secondly, the digital shift in today’s society affects the geography textbook market with an increasing demand for digital educational media fulfilling requirements for teaching and learning geography in the twenty-first century. Digital learning environments are, by their nature, highly visual and provide information in different logic and visual structures to printed textbooks (hypertext versus linear, multimedia-based and interactive versus static). Therefore, users need visual, digital, and information literacy skills combined with and applied to subject-specific knowledge. In contrast, a recent study from the US indicates that competencies in utilizing digital technologies in an effective and critical manner are still insufficient amongst today’s students (Alexander et al. 2016).

Thirdly, technological innovations, such as digital textbooks, cannot be successfully implemented without considering the users’ attitudes, needs, and preferences because the motivational potential of digital technology itself is limited and the acceptance of digital educational media is determined by users’ subjective norms and perceived usefulness (Joo et al. 2014).

Though recent digital geography textbooks from major German educational media publishers are largely digitally enriched versions or digital modifications of existing printed textbooks, elaborated didactic concepts exploiting the potential of digital technologies for learning and teaching geography in the twenty-first century still remain a desideratum (cf. Behnke and Bagoly-Simó 2016). This is in line with Rodríguez Rodríguez et al. (2015, p. 102) who claimed that “[...] very few instructional and learning models exist for using digital textbooks”.

As a result, this chapter aims to analyze users’ attitudes and potential requirements regarding today’s digital textbooks. Users of digital textbooks are, firstly, students and, secondly teachers. In conducting this analysis, this paper will examine the following questions:

- (1) How Digitally Competent and Visually Literate Are today's Students, Who Are Known as the *Net-Generation*?
- (2) Which Factors Affect today's Students' Acceptance of Digital Textbooks?
- (3) What Requirements Have today's Digital Textbooks to Meet to Be Effectively Utilized in Learning Contexts?

This chapter will focus on conceptual and media didactic thoughts, motivational aspects, and visual design factors, whereas considerations concerning subject education and subject content are not elaborated on in detail.

2 How Digitally Competent and Visually Literate Are Today's Students Known as the *Net-Generation*?

Today's students have grown up with gadgets constantly connected to the Internet (Boeckle and Ebner 2015). Therefore, Marc Prensky (2001, p. 1) coined the generation of today's students as "digital natives" and postulated they are "[...] native speakers of technology, fluent in the digital language of computers, video games, and the Internet". According to Barnes et al. (2007) and Prensky (2001), their *net savviness* resulted in different ways of learning and communicating than their predecessors' strategies. The *Net Generation* is described as highly information-competent, creative problem-solvers, experienced communicators, self-directed learners and critical thinkers who are able to effectively multitask with various digital tools (Veen 2006; Kirschner and van Merriënboer 2013). In this context, Daeid (2008) particularly emphasized the *Net Generation's* visual literacy, visual spatial literacy, and media literacy skills.

However, several studies questioned the claims made for the *digital natives* in terms of their ability to use technology for learning by arguing that the assumptions have been subjected to little critical scrutiny and lack of a sound empirical basis (Bennett et al. 2008; Comba 2011; Kennedy and Cook 2013). Furthermore, empirical evidence revealed that although today's students extensively utilize digital devices and value digital technologies, their digital and visual literacy skills are still limited (Kirschner and van Merriënboer 2013). A recent study from the US indicated that the digital divide is no longer about access to technology, but rather literacy in utilizing digital technology competently, effectively, and critically and, in particular, in utilizing digital technology to support students' own learning process (Alexander et al. 2016). This view is supported by studies revealing Wikipedia and Google as primary information research sources by today's students (Comba 2011) and thereby demonstrating that today's students' information literacy skills are still limited.

For learning contexts, it was determined that today's students utilize a limited range of technologies that focus on media consumption and communication (Schulmeister 2013). They are unaware of the enhanced functionalities of digital technologies useful for their own learning process, and they lack skills for improved information retrieval, critical information seeking and evaluation skills (Kirschner and van Merriënboer 2013). This is in line with Schulmeister (2013), who revealed that today's students utilize digital media mainly for entertainment and communication, whereas transfer from leisure media use to learning takes place only to a limited extent. Consequently,

Schulmeister (2013) questioned the existence of the *digital native* by arguing that students’ digital and visual literacy skills have not developed in the way that schools and universities necessarily expect it.

In addition, studies revealed students’ difficulties in decoding images and inter-linking complex image-text relations in educational media (Schnotz et al. 2011; Hochpöchler et al. 2012; Schnotz et al. 2014). They also determined knowledge acquisition from graphic visualizations as a highly complex process that represents a cognitive challenge to many students (de Vries and Lowe 2010; Bétrancourt et al. 2012; Boucheix et al. 2013). Therefore, it can be assumed that, notwithstanding the omnipresence of visuals in everyday life and educational media, today’s students face challenges when learning with visuals and image-text combinations. This might be essential for geography education, as geography is defined as a visual discipline as “[...] geography is unique in how it relies on certain kinds of visualities and visual images to construct its knowledge” (Rose 2003, p. 212). Likewise, studies revealed that solving information problems by means of digital media represents a cognitive challenge to many students (Miller and Bartlett 2012; Kennedy and Cook 2013; Kirschner and van Merriënboer 2013).

In summary, numerous studies demonstrated that today’s students are merely better equipped technologically than the previous generation, but remain mainly digital media consumers with a minority of them being visually literate, creative, and critical multimedia or web content producers (Ebner et al. 2008; Bennet et al. 2008; Kirschner and van Merriënboer 2013; Schulmeister 2013).

Consequently, it can be concluded that the challenge for today’s digital textbook users is not availability or access to digital educational media. The challenge are users’ limited capabilities to critically select and evaluate digital data and information and the lack of a deeper conceptual understanding of information practices (Roberts 2017). Today’s digital textbook users need an understanding of how these concepts may be applied across contexts and subjects (Roberts 2017). Therefore, students need to develop competencies to select, analyze, decode, and evaluate different information sources and information types (visual, verbal) related to and by means of subject content to utilize digital textbooks effectively and efficiently to support learning. For this purpose, today’s students need to develop critical skills that include cognitive, informational, creative, cultural and ethical, and social aspects (Scarcelli and Riva 2016). Therefore, students need more target-oriented instruction on how to utilize digital tools effectively for learning and problem-solving (Kirschner and van Merriënboer 2013).

3 Which Factors Affect Today’s Students’ Acceptance of Digital Textbooks?

Users’ attitudes towards a digital learning medium are of vital importance, because *well-designed textbooks* have the potential to make learning more fun, lasting, and meaningful (Morgan 2014). They may actively engage learners’ cognition in many ways, for example through visual processing, analytical thinking, posing questions, problem-solving, testing hypotheses and verbal reasoning (Morgan 2014), but only if they are accepted by their users and utilized effectively and efficiently. Which attributes

that *well designed* digital textbooks may ideally characterize will be summarized in the conclusion. User acceptance of a textbook is linked to motivational aspects, which, amongst other factors, interrelate with design components.

Motivational concepts and design are relevant factors in the conception of digital learning environments because the motivational potential of digital technology itself is limited. The acceptance and utilization of digital educational media is determined by users' subjective norms and perceived usefulness (Joo et al. 2014), whereby motivation is one key factor. Therefore, at first, a selection of theoretical approaches from literature on motivational factors relevant to the development of digital learning environments will be briefly introduced, followed by studies from pedagogical psychology concerning the design of learning-effective and motivating multimedia learning environments and approaches from visual communication and information design.

Ryan and Deci's (2000) self-determination theory reveals three intrinsic motivational factors effective for learning, which are useful to consider in the development of digital learning environments: competence, autonomy, and relatedness. Competence relates to the construct of self-efficacy. Autonomy (in learning contexts) is described as the ability to strive towards one's own goals, interests, and aptitudes. Relatedness is described as the experience of interacting with and being connected to others (Hense and Mandl 2012; Fotaris et al. 2016).

Malone and Lepper's (1987) Taxonomy of Intrinsic Motivations for Learning includes aspects from self-determination theory and aims to provide a model on how to design intrinsically motivating learning environments. The model is derived from successful principles of game play and is divided into internal motivational factors, such as challenge (goals, outcome, feedback), curiosity (foster learner's inquisitiveness) and control (in terms of self-efficacy and autonomy), as well as intrinsic motivational factors, such as co-operation (working together to achieve a goal), competition (competing to achieve a goal), and recognition (making achievements visible for others) (Kapp 2012).

John Keller (1987, 2010, 2012) developed the ARCS motivational design model for learning. It includes a synthesis of several motivational concepts and theories, amongst others, the expectancy-value theory (Wigfield and Eccles 2000)—which presumes that students' learning motivation is determined by their beliefs about how well they will do on the learning activity and the extent to which there is personal value in the knowledge presented—and intrinsic motivational theories, such as Ryan and Deci's (2000) self-determination theory. Keller provides a theoretical model based on empirical evidence aimed at creating motivating learning environments.

The ARCS model is clustered into four categories: attention (A), relevance (R), confidence (C), and satisfaction (S). Each category is divided in subcategories. Each subcategory is elaborated on by practical examples (see Keller 1987, 2010, 2012). Attention (A) refers to the interest displayed by learners in taking on the concepts/ideas being taught. Relevance (R) aims to establish the relevance of the instruction to learner goals. Confidence (C) relates to building confidence with regard to realistic expectations and personal responsibility for outcomes. Lastly, satisfaction (S) refers to making the instruction satisfying by managing learners' intrinsic and extrinsic outcomes (Keller 1987, 2010, 2012).

Recent studies from pedagogical psychology investigated cognitive and affective aspects of multimedia learning with the aim of integrating emotion, motivation and attitude into cognitive processing models (Park et al. 2014). The theoretical background builds on Moreno’s (2006) cognitive affective theory of learning with media (CATLM), which is an extension of Mayer’s (2005) cognitive theory of multimedia learning (CTML). CTML supplements by twelve principles of instructional design (e.g., multimedia principle, redundancy principle, signaling principle etc.) how people learn effectively from static or dynamic images and written or spoken text in combination. Moreno (2006) extended Mayer’s (2005) CTML by adding motivational and affective aspects, self-regulatory skills and learner characteristics (Park et al. 2015). In this context, the emotional design hypothesis assumes that visually appealing learning materials support learners’ cognitive processing (Mayer and Estrella 2014). Studies examining learning-fostering design principles revealed that *well-designed* learning materials may promote positive emotions and comprehension (Plass et al. 2013; Park et al. 2015) and reduce the perceived difficulty of learning tasks (Um et al. 2012), which consequently may foster the acceptance of a digital textbook.

Theoretical approaches for learning effective textbook design principles can be also found in visual communications and information design. Wertheimer’s (1923) Gestalt theory summarized visual perception principles, such as figure-ground, proximity, similarity, and closure, which are today well-established media design principles. Furthermore, several of Wertheimer’s (1923) visual perception principles, such as signaling and proximity are included in Mayer’s (2005) CTML. Information designers, such as Edward Tufte (1990), Robert Horn (1999), and Rune Pettersson (2016) developed concepts to visualize and communicate complex information (data or ideas) in a clear, memorable, and understandable manner that attracts curiosity and attention (Knemeyer 2006; Smiciklas 2012; Uyan Dur 2014). According to Pettersson (2016), information design comprises analysis, planning, presentation, and understanding of information—its content, language, and form. Therefore, *well-designed* information material will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements (Pettersson 2016).

In sum, theoretical approaches from motivational theory and motivational design can be utilized for the conception of digital textbooks, such as how to provide subject content in a motivating, learning-fostering manner or in the conception of interesting, engaging tasks. Learning fostering approaches from visual communication, information design, and pedagogical psychology could be applied in the visual design of digital textbooks. These principles can be utilized to foster users’ acceptance of a digital textbook because, according to Joo et al. (2014), they affect factors closely linked to design, usability, and motivation, such as subjective norms, perceived self-efficacy, perceived ease of use, and perceived usefulness. These, again, affect users’ attitudes to digital textbooks. However, the acceptance and efficacy of a digital textbook may be also influenced by resource style, learner interests, learning objectives, and learner characteristics (Ainsworth 2006; Schnotz et al. 2011).

4 What Requirements Have Digital Textbooks to Meet to be Effectively Utilized in Learning Contexts?

A recent analysis revealed that digital geography textbooks from German major educational media publishers are largely digitally enriched versions or digital modifications of existing printed textbooks (Behnke and Bagoly-Simó 2016). An analysis of digital textbooks for Spanish language from Spain reached a similar conclusion by stating that “[a]lthough an attempt was observed to incorporate e-textbook elements, the structure and teaching models implicit in the material were those of a paper textbook” (Regueria Rodríguez and Rodríguez Rodríguez 2013, p. 192). Bruillard (2015, p. 523) came to similar conclusions in France: “[...] the digital textbooks offered in France are mainly improvements of paper textbooks, including new features, with an economic model still in line with paper products”.

However, unmodified adaption of printed textbooks into digital versions may result in a paradigm called *chocolate-covered broccoli* (Bruckman 1999; Deterding 2015). For unmodified adaptations of printed textbooks into digital versions this means to *sugar cover* well-known subject content, organizing structures and teaching models from paper textbooks with digital technology without developing new didactic concepts, structural features and subject content utilizing the specific benefits of digital textbooks, such as connectivity, adaptability or immediate elaborated feedback. This might be one reason for the low acceptance of digital textbooks among learners (Behnke 2018). Hence, digital textbooks will not be accepted by users and are neither learning-effective or motivating solely through their digital technology or features, such as extraordinary 3D graphics or complex multimedia animations because the motivational potential of digital technology itself is limited. To be accepted and utilized, digital textbooks need to augur clear added value beyond printed textbooks.

However, digital textbooks have the potential to become effective tools in learning and teaching because of their motivational, communicative, and technological potential if the digital technology is meaningfully integrated in learning environments (e.g., by embedding a problem-based learning approach, motivational design, emotional design, and playful elements by coupling them with effective pedagogy) (Kapp 2012; Boeckle and Ebner 2015; Fotaris et al. 2016). Motivational factors and motivational design strategies should not only be meaningfully embedded in subject content and elaborated didactic concepts, they should also consider usability and specific requirements of the visual design of digital learning environments.

Reints and Wilkens (2014) identified three characteristic key factors for digital textbooks: adaptability, multimodality, and interactivity. These factors can be largely aligned to motivational design theories, such as Ryan and Deci’s (2000) self-determination theory. Adaptability, described as the ability to adapt the format, content, and learning tasks of a textbook to the level of the learner and, thus, enabling flexible learning pathways, can relate to factors of autonomy and competence from self-determination theory and thus, self-efficacy. Reints and Wilkens (2014) define interactivity as a key factor that includes the possibility of communication and connection to other learners, and it is, thus, included in Ryan and Deci’s (2000) motivational factor of relatedness.

Moreover, future concepts for digital textbooks should consider usability, meaningful ways to involve learners in the creation and customization of learning content (Prensky 2005; Kapp et al. 2014), concepts to document and control students’ own learning process but also learning fostering visual design, as form and content are related (Uhrmacher 2009).

Therefore, among others, the concept of gamification provides suggestions on how to implement playful elements in digital textbooks to foster motivation and learning. Gamification is the application of game-based dynamics and activities to an educational effort (Kapp 2012). Examples for game-based dynamics are creating desirable goals at different levels and providing specific immediate feedback. Examples for game-based activities are decision-making, problem-solving, exploring unknown places and objects, role-play or decoding, analyzing and sorting information. One key factor in gamification are tasks and activities designed to foster repeated attempts, and continuous improvement to attain a learning objective (Kapp et al. 2014) simultaneously fostering students’ perseverance, motivation, and perceived self-efficacy—vital factors for successful learning according to intrinsic motivational theories. In particular for geography as highly visual and spatial discipline, digital textbooks provide features and gamification activities to design engaging and multifarious learning tasks and subject content addressing different knowledge types, such as declarative, conceptual, procedural, and affective knowledge (Kapp et al. 2014) or factual, conceptual, procedural, and metacognitive knowledge according to the revised version of Bloom’s Taxonomy (Krathwohl 2002).

Learning-fostering visual textbook design is characterized by clarity, coherence, consistency, and aesthetics. This is in accord with LaSpina (1998), who argued that good textbook design provides visual guidance through its content by means of a well-articulated layout in which clarity and complexity are not mutually exclusive. Consequently, how clearly, aesthetically, and coherently information in digital textbooks is provided, has become a crucial factor for successful knowledge acquisition from textbooks. Design, then, can be crucial for learning with textbooks; a design that harmonizes with the textbook’s content and has learners and their needs in mind may facilitate their understanding of the meaning of information provided (Holmqvist Olander et al. 2014). The presented theoretical approaches should be analyzed, tailored to respective learning contexts, subject content, and the target user group, then selected and meaningfully embedded in subject content and didactic concepts mediating twenty-first century skills, such as digital literacy, information literacy, critical thinking, problem-solving, powerful concepts of analyzing, explaining, and understanding complex issues and relationships, and effective strategies to acquire new knowledge (Maude 2015).

In sum, digital textbooks need to differ from printed textbooks in terms of design, usability, content, didactic concepts, and features that support learning. Only digital learning applications auguring clear added value beyond printed textbooks, fulfilling the needs and learning objectives of today’s users, and designed with regard to users’ capabilities and motivational factors, will be widely utilized (Schulmeister 2013). This view is supported by the expectancy-value theory (Wigfield and Eccles 2000).

5 Conclusions

Requirements for digital textbooks are in many aspects different and even more complex than printed textbooks because of their technological features and possibilities. Therefore, unmodified or solely digitally enriched adaptations of printed textbooks to digital textbooks fail to meet the user requirements of today's digital educational media. Today's digital textbooks require the development of new concepts synthesizing pedagogy, structure, design, and content tailored to learning fostering and motivating digital educational media. Thus, the conceptualization of today's digital educational media should not merely focus on technical features or on providing subject content, but on carefully elaborated didactical concepts that integrate subject content with—for the respective learning context useful—digital features, such as interactivity, connectivity, customization, differentiation or immediate feedback. Additionally, digital media should utilize playful elements and multimedia features in a meaningful manner, considering motivational theories and, therefore, users' needs and attitudes. In addition, to meet more users' requirements, the development of digital textbooks should include prototyping, usability tests, and user surveys—all proven instruments to design digital applications fulfilling users' needs and attitudes.

Consequently, in this specific context, the term *well-designed* digital textbook describes an elaborated structural and didactic concept that meaningfully integrates subject content and learning tasks that address various knowledge types with technical features, playful elements, and motivational design. The visual design is focused on learning-fostering principles from educational psychology, information design, and visual communication including comprehensibility, clarity, usability, and aesthetics.

Therefore, the design, content, structure, and didactic concepts of digital geography textbooks need to be further developed to meet the learning requirements of today's curricula and allow today's students to gain twenty-first century skills and knowledge necessary to develop their capabilities “[...] to become self-fulfilled and competent individuals, informed and aware citizens and critical and creative ‘knowledge workers’” (Uhlenwinkel et al. 2016, p. 2).

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