Chapter 4
Teacher-Centered Versus Learner-Centered Design of Screen

Content precedes design.
Design in the absence of content is not design, it's decoration.
Jeffrey Zeldman

Abstract In context of the Metasystems Learning Design Theory there are eight didactical systems. Each of these systems includes some elements of the teacher-centered and/or learner-centered learning environments. In plus, for the effective learning outcomes should be taking into account the specific features of that didactical system that may solve the previous identified issue. Thus, the specific features of the teacher-centered environments are: visibility, accessibility, language, readability, learnability, usability and legibility. Instead of this, the learner-centered are focused on developing knowledge, competence or/and self-regulated skills. The goal of this chapter is to describe the specific features of user interface design for the teacher-centered versus learner-centered learning environments.

Keywords Teacher-centered learning environment · Learner-centered learning environment

4.1 Introduction

User interface, by definition, is the aggregate of means by which users interact with a particular machine, device, computer program, or other thing. Generally, this is a widely term used to define the design principles of user interfaces for machines and software, such as computers, home appliances, mobile devices, and other digital devices. In the paradigm of Internet of Things and services there are a diversity of digital the screens and effects everywhere. Thus, the main focus of digital devices is on maximizing the user experience.

However, a specific feedback-feedward mechanism 'controls' the efficiency of all interfaces, allowing or blocking the capacity of human to proceed data,

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information and knowledge. First, this mechanism was managed by various interface elements, viewed on displaying component as:

- *input control* (buttons, text field, dropdown lists, toggles and others);
- *navigational components* (e.g. search field, pagination, tags and others);
- *informational-communication* (progress bar, notification, message boxes, windows).

All these elements are managered by mouse. However, when the user use portable devices and multi-touch screens add the value of the human's finger or/and voice for input, some principles of the interface design were changed. The problem is that new user interfaces become less intuitive. The mouse and touch input are so different. For example, the roll-over effects, that have a good impact on desktop computers, are less important on touchscreens. Further arguments to think about the user interface design is the vast difference in screen sizes.

Each time a user does not understand content presented on a screen, he/she can look around at the other information displayed in front or besider of him/her. Obviously, the size of the screen limits how can information can be read at once, before narrowing or enlarging the screen or scrolling down or up. Thus, the humans' capacity for information-communication, (meta)cognitive and assessment processes is determined by the dimensions of the screen. In plus, the attention span are also affected. It was observer, the bigger the screen size, the larger the capacity of the communication channel between the human and the screen. Maybe from this effect on actual learning through reading some children are trying to 'enlarge' the printed page. They cannot more proceed the information on the printed page because of text' size, graphic design and so on.

On the other hand, once students have to take action and navigate to a different view that their teachers (either by scrolling, enlarging, switching pages altogether etc.), they will incur an extra memory load. They must apply not all the techniques for reading, but also must remember the specific actions (e.g. how to open or close the screen/program, how to find/disseminate information that they need), as well as the specific Apps or/and tasks's combinations.

Third, the smaller screen size of the tablets or/and smartphones make the provided content more difficult that desktop content. People usually 'use' working memory to keep information that may be available in future, but than, they doesn't authomatize knowledge to transform into a skill. However, the students may use the mobile devices not only for reading, but also to capture the image, to take a video, to download information or to send a message.

Fourth, the information that exists on digital screen are 'hyperlinked' with the information on other pages or/and environments. The simplest pattern is text plus animation or video games. If in the user interface design is used hyperlinks, the users should remember how to return back. This cause an extra load of the working memory and may be the reason of the distributive processing, and, therefore, to cause the attention' problem. As was noted by Harenberg et al. (2016), recent research demonstrate that video gaming can increase selective and distributive attention.

In a recent book Basar (2016, p. 159) describes about the plasticity of oscillatory behavior during the transition from the semantic memory to the episodic memory state. The preliminary results of transition between memory states emphases the fact that the reciprocal activation of the attention, perception, memory and remembering alliance is essential from the transition between two memory states. The problem is that digital screen easier activate the episodic memory that printed page, even it is displayed photos, animations, videos.

Fifth, the amount of information that actual students denote to a digital device is more than on printed pages. The attention capacity with a portable device is more different that on printed books/textbooks or computer display. In fact, the students are more interesting in a special device as a technological innovation, which on what Apps are installed and may be used for learning. They are more interested in looking on device, use as a phone or camera or, at least, to play a video game than to read a book or textbook. Does the digital content is important for learning, yet? If yes, how long is the average session duration on portable devices?

More specifically, for digital textbooks user interface design is the contact point of the author and his/her users. Nevertheless, who is the actual users and what design they need? In order to answer this question, we looked at the following definitions: (1) user interface design is the sum of information architecture; interaction design and visual design communications (Dragilev 2013) and (2) user interface design is a process that requires analyses of human performance and preferences, in particular the emotional and trust aspects of interaction (Dillon 2003, p. 457). In brief, the first definition views user interface design as a teacher-centered or goal-oriented approach. The second definition is focused on (meta)cognitive, affective, social and emotional aspects of self-regulated learning, e.g. this is the student-centered framework.

The student-centered interface design framework is a particular case of ‘user-centered design’, used to define a framework of processes (not restricted to interfaces or technologies) in which the needs, wants, and limitations of end users as a product, services or processes are given extensive attention at each stage of the design process. Therefore, the goal of student-centered interface design of digital textbooks is to anticipate what students might need to do for better results during learning or/and how to design interface elements that are easier to access, understand, and use in an affordable way for self-regulated learning.

Since 1970 a variety of tools, methodologies, models and instructions were proposed to make user interface design more easier and efficient. One of these is graphic design, which is communication design on the base on visual and textual content, focused on physical or/and virtual environments. Graphic design may include concepts and/or patterns from web design, interaction design, visual design, information architecture, instructional design of learning objects and learning design. However, this is not enough. The lack of transdisciplinary research focused on understanding how human’ brain has been accommodated to the diversity of the learning environments for learning and what filters use for this, provide the situation when digital screens are everywhere, but their effects is more less than is expected.

The big diversity of concepts and/or patterns may be associated with design of teacher-centered and/or student-centered learning environment, and, therefore with user interface design of teacher-centered or student-centered functions of digital textbooks. Thus, the main functions of the school textbook with reference to teacher are: information, communication on the base on immediate/delayed feedback and reference (as a storage of data, information and knowledge). In addition, the main functions textbook with reference to student are: (meta)cognitive, affective, emotional and social purchases as well as consolidation and evaluation of purchases.

What we see now is a big divergence with above-mentioned ideas. In practice, user interfaces design, ranging from early requirements of educational software obsolescence to adaptive textbooks, has become a time-consuming and costly process. Most used is Graphic User Interface (GUI), which allows only exploring provided content through icons and other visual indicators. However, this is not enough because technology allow developing digital textbooks as text, audio or video; the text can be embodied also by the use in various formats, like graphic, animation, virtual reality and others. In addition, digital textbooks can be developed easier developed collaboratively and/or be disseminated through various user interfaces of digital devices like text-based, graphical, voice, kinetic, tangible, multimedia, multi-touch interfaces. To understand these challenges, more research is needed to investigate correlations between user interfaces design of digital textbooks and user interfaces design of digital devices.

User interface design is one of the most important and one of the most difficult issues in designing of the affordable digital textbooks. First, it is the 'contact point' between the user and the digital screen. Second, this contact point has a more large extent regarding to diversity of the learning environments, both real and virtual. Third, the users' capacity to proceed information is rapidly changing. There is no doubt that all these challenges will generate new research questions and demand decisions regarding what user interface design is better for learning.

This chapter is confronted with fundamental questions in user interface design of textbooks for teacher-centered and student-centered learning environments. The following models were considered: *affordance based design* (aims to analyse the users' needs, consider the affordance requirements of learning tasks, and identify the affordances of artefact components) and *ecological interface design (*aims to create advanced user interfaces for complex socio-technical system). In plus, common features of the *instructional design* and *learning design* aim to strength the application of paradigm for affordable user interface design of digital textbooks.

4.2 A New Context for Learning and Design Principles

In context of MetaSystems Learning Design Theory the context of learning correspond to the actual paradigm. Thus, the modelled context for learning must be placed in the learners' context (e.g. the knowledge, skills, and attitude). However, there are, at least, two different approaches for understanding the learning context.

One refers on conscious learning in schooling and the second is the unconscious or the hidden context for learning, which are every time and everywhere. But, how to understand the data used to generate the content for interfaces?

There are two controversial concepts: *instructional design*, building on the system theory and on the work of Dewey, Pappert, Bruner, Anderson and Thorndike etc., used to describe the potential use of machines in the classroom and *learning design,* used to describe a method of instruction for a particular pedagogical session. As was noted by Scott et al. (2007) from the middle of 1990, the term *learning design* is associated with the design of learning utilised to facilitate learning. Does the learning design solved the issue of designing the hidden content for interfaces? If yes, why so many digital textbooks interfaces are so ineffective?

Designing of textbooks needs, also, to take into account the diversity of the digital screens and the human's capacity to work with information. In addition, designing a user interface for mobile devices is hard to do because some user interfaces are tiny, and some are larger. Today the learning designers are in the situation to design the textbook that should be affordable for reading on all devices. Different approaches to mobile design attempt to solve the problem of affordability in various ways. For example, if they are starting from the 4th industrial revolution principle of interoperability, then it is developed the idea of responsive design based on the relative priorities of the cells to be rearranged through a narrower communication.

Same content is available on various screens. However, the diversity of digital screens may affect the functionality of working memory. From one hand, the students have to work harder to keep more items in the memory, and from others—to understand how to work with the information provided on the screen. In the traditional way, the students only read the content of textbooks (text and exercise). They used notebooks to solve the proposed tasks by the teacher. Digital textbooks, however, integrate informational-communication, (meta)cognitive and assessment processes and are, mainly for self-regulated learning. Some students may be willing to spend the time and effort within the learning environment with interactive assessment, adaptive content or pedagogical agents, others will simply give up (or be forced to give up) if they do not find what they need after a reasonable amount of time.

If the digital textbooks are not integrated with the curricula or some learning standards the learning outcomes will be very different. Therefore, the difficulties we face when learning with digital textbooks can fluctuate dramatically. Digital learning can vary from very easy to impossible hard. Reasons are variations in purchasing of knowledge, skills or competence; developing of skills; differences in required time and effort to understand the content. For examples, two or more frames or patterns may appear to have roughly similar amounts of information, but differ in the effort required to achieve performance for different learners.

Learning requires a dynamic and functional mechanism. Two learning mechanisms, described by Sweller (1994, p. 296) as the *schema acquisition* and *the transfer of learning procedures from controlled to automatic processing* are only a small component of the complex structure of the generative competence, where the schema is only the cognitive construct that could be been extended and automatized. In addition, information-communication, (meta)cognitive and assessment processes may be also taking into account.

According to ISO standard 52075, the design is based upon an explicit understanding of users, tasks and environments; users are involved throughout design and development; the design is driven and refined by user-centered evaluation; the process is iterative; the design addresses the whole user experience and the design team includes multidisciplinary skills and perspectives.

In use and development of digital textbooks, however, there are two main trends: teacher-centered and learner centered. If teacher directs the learning mechanism, that this is the teacher-centered mechanism, otherwise—this is learner-centered mechanism. The applicability of the user interface design principles for digital textbook design, first, depends on focus: teacher-centered interface design or user-centered interface design. Thus, teacher-centered interface design may be considered a framework of stages restricted to technologies in which it is important to follow the instructional objectives through stimulus, response and reinforcement. In contrast, in the learner-centered design a framework of activities or/and actions are not restricted to stimulus-response-reinforcement, but engage all students in a self-regulated learning process. The student may complete the provided content with own text, sketch, audio, video or animation.

Only one task is important for both cases: assessment, but this previous phase should be designed until the development or using digital textbooks, including open textbooks. There are some examples of questions for previous phase, as follows:

- What is the level of users' digital competence?
- What is (are) the user(s)' knowledge or skills level(s)?
- What difficulty of items are required?
- In which forms (open or/and closed) will be the students' answers?
- Which content does to be provided?

Therefore, these and other related questions are essential both for teacher-centered and learner-centered interface design. In designing is important to focus on a priori knowledge and skills, and to foster communication skills, taking into account the changing contexts for learning.

What is wrong with teacher-centered interface design? On the positive side, this approach has a long history in education and until it is a dominant vehicle for delivering knowledge on the base on curricula and instructional objectives. Practically, through the interface design of content is presented only the knowledge with details how to solve problems and, maybe, some interactive or adaptive tasks. On the negative side, however, the stimulus-response mode is the inadequate models of how students, with theoretical fundamentals based on theories of antiquity. This is inconsistent with current challenges of industrial revolution; e.g. nano-education, shifted communication methods, interoperability of contents, user generated content and others.

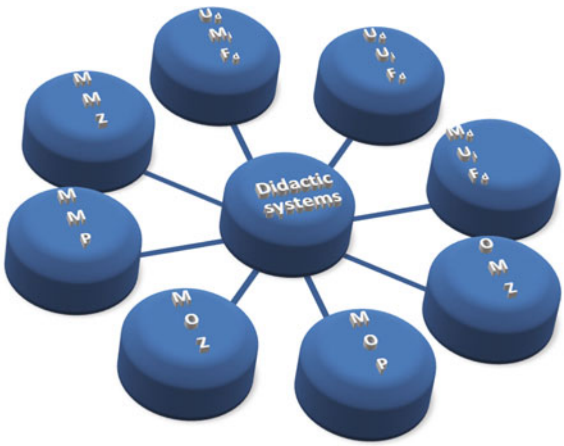

Fig. 4.1 Eight didactical systems

There is not empirical evidence that all teacher-centered interface design works well in all cases. There are, at least, eighth didactic models. If in the design is considered the criteria of communication, assimilation of knowledge and management of the learning process, than can be described eighth didactic models, as follows (Fig. 4.1).

Thus, the communication mode can be direct or indirect. In a direct communication style the truthfulness of knowledge are highly valued and to some extend are a higher priority that personal opinions or emotions. Saying *I don't know the answer* is considered a mistake since it goes to misunderstanding of the provided content. Problems are felt to be solved when the students know how to solve the academic problems or tasks. Open discussions are less encouraged, but are possible in an environment managed by the teacher. Instead, in the indirect communication style, negative information should be changed with the positive, and all tasks—with the solutions. In these situation, run away from the problem, which both parties usually knows the rules and recognize as such, are given, and in extreme cases are used a common strategy for learning (in our case it was the instructional dynamic and flexible strategy). All problems are felt to be solved more productively and, at the final stage, there are only solutions.

Moreover, either direct or indirect communication can be ensured through one (U_d and U_i) or more channels (M_d and M_i). However, the example of one channel can be printed text or audio text. Digital text refers to multi-channels or multimodal mode of communication. Digital 'extend' the features of the direct unimodal communication in favour of the multimodal communication. Thus, for example, a tablet for young children, encoded with the augmented reality drawings app, allow children to colour the characters that pop out of their books in real time. 3D printer has the potential to print the use interface in a new mode, used 'to synthesize' a three-dimensional object, previously modelled with the student(s). 3D glasses can be used to vision capacity of children through creating or enhancing the illusion of depth in an image. Does these technologies contribute to development of creativity or/and creative thinking?

Some ideas may come from the third criteria: management of provided knowledge. Thus, in the simplest mode the knowledge is communicated within a closed system (C_d and C_i) or in the open system (F_d or F_i). Digital textbooks within the closed system are developed on the base on educational system or state's conception, standards or/and methodology. In the open system there are only open standards, some tools and, maybe, design principles.

One more criteria will add other eight didactic schemas. Indeed, in the scientific literature could be found the Bespaliko (2002) description of the textbooks' diversity based on: aim, forms of learning environments, patterns and technology. If these four criteria are analysed on the bimodal diversity yes/no, than can be identified 16 types of the digital textbooks. Only on the aim level there are didactic, dogmatic, and declarative and monograph textbooks. The problem is that digital textbooks are developed as: *monographs* (e.g. eTextbooks, interactive textbooks, digital textbooks, adaptive textbooks etc.) and *dogmatic textbooks* (e.g. Cognitive Algebra).

However, only didactic textbooks (with or without the intelligent technological support) have the potential to improve self-regulated skills of the learner. A small remarks should be added for guaranteed result: instead of the didactic process should be considered the mathetics solutions for the previously identified tasks. Thus, user interface design of didactic digital textbooks are based on the didactic model that embodies information-communication, (meta)cognitive and assessment processes. The mechanism that ensure the functionality of the didactic model is the *instructional interactive and dynamic strategy*. Therefore, according to Metasystems Learning Design Theory, the instructional/learning/assessment strategy should allow students to develop self-regulated skills and teacher(s), to observe the synergetic effect within the dynamic development of the learning environment.

The results of the international survey prove, on average, that students view in digital textbooks the potential to develop and to increase the ability for self-regulate learning. This idea is based on acceptance the massive open online courses (MOOC), in which students are intrinsic motivated to learn new things in an individual way, in special when the computer based environment is extended at the global level. This means that students are interested to view on their digital screens only the short videos, but also the interactive tasks with immediate feedback and peer-to-peer assessment projects. They are less interesting to read digital text on the screen.

Let us consider a learning scenario that goes beyond the delivery method of knowledge. For example, a student sits at a digital screen on which new material is presented dynamically. The other student receive only one module, e.g. the *Introductory* module. The first student reads and take notes, highlighting the most important concepts/passages or finding the meaning of some concepts. The second student receives the module 'divided' into small frames following by tasks, developed on the base on Bloom, Simpson or other taxonomies. This student should complete the provided content at the level of synthesis (according to Bloom' taxonomy). Displayed content includes also a hidden content developed within the core concepts techniques (a case of concept mapping method). During the learning process she/he will receive multiple tasks, will exercise in a computer-based assessment environment; will complete the content with animation, 3D simulation etc., build own sketch or add photo/video/audio registration, and will ask teacher for some help. Which of these two models are better for learning?

Indeed, the delivered model of knowledge with teacher speech, or digital text, pictorial, adaptive or dynamic content does not improve learning substantially. Some improvement is possible, when students have the good capacity of short-term memory or working memory, and he/she is motivated enough to learn in a traditional way. Usually teachers indicate these students to use, also, a special form of assessment&assignments for better results during formative or/and summative assessment. However, when learning is an analysed only as a dynamic system, it is easy to observe that the number of students who are motivated to learn decrease considerable.

Many external influences cause the improvement or rejection the presented information on screen. Moreover, multiple digital screens distributed everywhere; maybe, affect students' perception. Thus, students unconsciously opens/close the 'cognitive filters' to protect the brain from the irrelevant, non-useful and non-interesting information. The other, not less important reason for accepted the virtual context for learning may be considered design norms that require less thinking effort, personalisation, messaging, self-directed activities in a more coloured and more attractive instead of bored activities with the printed textbooks environment.

4.3 Essential Elements in Teacher-Centered User Interface Design

Teacher-centered design is more a didactic process than a product. However, in the traditional way the process consists of some methods or techniques for constructing the instructional process within the practical application of one model. Where there are effective principles or/standards that guide effective design, there is a certain amount of innovation and creativity in teaching/assessment processes. Whether or not the teacher-centered design is effective depends on the criteria used to define effectiveness.

By definition teacher-centered design focuses on teaching the knowledge. Theirs essential elements are visibility, accessibility, language, readability, learnability, usability and legibility.

Visibility is for setting up the instructional objectives and developing content to archive objectives through measurable outcomes. The most important indicator is what the student sees in the interface and how intuits the using of the interface. Therefore, good visibility is related on the things, objects, processes where everything is positioning in a way that can be easily found, used or intuit. The visibility property allows the author to show or to hide the text, rows or columns of a table while leaving the space. Thus, visibility is the property to see or to be seen.

Wang et al. (2004) describe that objective methods for assessing perceptual image quality traditionally attempt to quantify the visibility of errors (differences) between a distorted image and a reference image using a variety of known properties of the human visual system. Tan adds that poor visibility in due to the presence of some particles that have significant size and distribution in the participating medium. If the following is not taking into account, students involuntary will 'open' the cognitive filters to protect themselves. Thus, more research is needed to understand the functions, norms and correlations of design elements for visibility.

Korving et al. (2016) identify the relation between visibility and attention in weblectures. It was reported that students prefer weblectures with a visible lecturer to weblectures consisting of audio and slides only. Such preference is thought to be explained by the fact that selective attention is focused on relevant pieces of information in the process of understanding. Therefore, the visibility could be considered the degree in which a lecturer is visible in a weblecture. Focusing attention on an object, or thought, is considered to require attentional resources within the mind. More research is needed to understand the role of Gestalt principles and time.

Accessibility refers access to easy access to data, information and knowledge; intelligent tools or resource to find meaning of concepts. Some designers 'broke' the content into small pieces and offer students the possibility to interconnect pieces into a holistic whole. Others—design the interfaces that allow teacher to summarize various distributed contents into one. Lewthwaite and Sloan (2016) put the sign of equivalence between accessibility and permission, the interplay between operating systems and assistive technologies, browsing and other applications, the digital content and multimodal, flexible interactions. Accessibility requires a unique combination of theoretical understanding, as well as procedural and technical skills. It also draws from human-computer interactions, taking aspects of ergonomics and psychology to understand human characteristics and behavior, and disability studies, especially the factors that influence discrimination against people with disabilities and how discriminatory activity by individuals and organisations can be addressed.

According to Kumar and Owston (2016) there is a stringent need for innovative and assessable methods to ensure that students do not encounter any barriers in e-learning. Moore (2016) proposed to design inclusive features for simulations in chemistry in order to increase the accessibility of simulations both for teachers and for students, with and without disabilities. van Rooij and Zirkle (2016, p. 4) observe that in United States accessibility is governed by federal law, and, therefore, in all educational public institutions should be used the principles of the Universal Design, as follows: multiple modes of representation, multiple means of expression, and multiple means of engagement. The Universal Design norms enables creation of the accessible learning content for learners in all disability categories. Thus, the inclusive nature of the Universal Design and accessibility can enhance the learning experience of all learners.

Language of the digital textbooks interfaces is based on well-written texts in an academic way. However, there are not unique requirements of what language (e.g. teacher(s) or student(s)) to use. What is clear is that is not possible to opt out of using the technologic language instead of the academic language. On the other hand, it is impossible to ignore the technology for summarisation and dissemination of the content. First, the sentences should be simple, but with the possible 'extensions'. For example, student(s) receive the content and can complete this content with own text, video, video at the level of his/her understanding. From the other hand, the last know-how needed to deal with technologized forms of language is *multiliteracies*, since digital technologies. Therefore, rather that attempting to distinguish common features between printed and digital content and how to implement emotions in digital content, more important is to identify some conventions from earlier technologies.

The other issue is that digital screens, instead of printed, allow multiple forms of communications: direct and indirect, synchronic and asynchronic. These challenges change the nature of context for learning. Now, using digital devices it is easier to find any information. Thus, if student will have the option to choose between knowledge or skills, he/she will choose the second option. The worst thing is that in teacher-centered learning environment, the interfaces is not designed for learning, but for teaching and assessment.

The last, but not less important thing is that with digital interfaces may operate simultaneously in physical and symbolic spaces, learning or working simultaneously in different time zones, using typing and instant messaging instead of writing; swiping a screen or trackpad instead of turn the pages, speaking in a videoconference instead of presenting the portfolios. These actions require other meaning of language for design, because in the first case this is the language of activities, and in the second—the language of actions.

Usability defines how effective and satisfying it is for user to interact with the information presented on the screen. Challenges the way in which digital textbooks were situated as "supplementary" to an printed textbook can be considered a significant step toward the study of the learning design affordability. How quick and efficient can learner performs the assigned activities within the digital textbook environment? Is their same requirements for designing digital textbooks for a sustainable learning environment?

Many researchers note about the changing behaviours and perceptions of information during digital learning, like learner's culture, behavior patterns, learning styles, and motivation to learn. Some others proposed to use feedback in order to keep the communication patterns; to design relevant and consistent tasks and the efficient space for answer; to provide intuitive interfaces and to prevent errors by informing students of the specific features; to facilitate communication with the author of the content; to provide adaptive interfaces used for all in an efficient way. In plus, is important to keep the minimalist design in order to answer the question: What issues will be solved? Thus, the usability norms is when the

Table 4.1 Usability versus learnability within digital textbooks use and development

	Usability	Learnability
Definition	Extend on which a digital textbook can be developed and used to achieve the specific goals: efficiency, operability, attractive, memorability and untestable by the user, helpful to avoid errors, designed to safeguard the health	Intuitive interfaces, comprehensive input and output, as well as instructions readiness and messages readiness (when it is applicable). But, a learnable user interface can be very cumbersome for experienced users
Aim	To make possible for users to archive their goals when using the digital textbook as a pedagogical resource or tool for learning. Can the users accomplish their goal?	How easy is it for a user to learn how to use digital textbooks? How intuitive is interfaces to learn or to self-evaluate the knowledge?
Effect on the user	The more usable is the digital textbook, the more possible it is for a user to continue using the resourse/tool efficiently over long periods	The more learnable the digital textbook is, the less time the user takes in order to understood how to do a specific task withoud previous training and using any documentation

designed interface is equivalent to perceiving interface. The term ‘usability’ defines the degree of which the system can be used and with which it promotes learning and can be associate with the *learnability*, e.g. its efficiency, functionalities and others.

Learnability in teacher-centered learning environments refers on how well the designed activities enable obtaining guaranteed learning outcomes. To objective of learnability is to learn. Thus, the context with ambiguity of data provided by diversity of learning environments and the content, both in printed and digital forms, causes a contradictions regarding *what to learn* and *how to learn* for better memorisation, understanding and others. The differences between usability and learnability, according to international standards are, as follows (Table 4.1).

Some experts have classified learnability as an active component of usability (Cino and James 2016). According to ISO 9126-1 and 4 learnability is a subsystem of usability, along with understandability, operability, attractiveness and usability compliance. The learnability is a matter of how the possible futures making different hypotheses correct branch off from one another through time. The more complex the temporal entanglement of the futures satisfying incompatible hypotheses, the more difficult learning will be. Learnability is governed by the topological complexity of the possible hypotheses and computable learnability depends on their computational complexity.

Reliability is another concept that indicate to disposition to acquire new knowledge or skills over a broad range of relevantly possible environments. Reliability studiers are very diverse. For example, Topaloglu et al. (2016, p. 350) have equated software applications developed for web 2.0 with readable and writable web as well as with the possibility to develop information in a digital form and to share information around the world. Thus, the question comes up: To what purpose and why do teachers use digital textbooks? If the answer is: for teaching in an innovative way in a teacher-centered learning environment, than the reliability could be considered an equivalent of composing some distributed contents in a holistic one.

Solvability in a teacher-centered learning environment refers on an opportunity to develop an adequate strategy and prove that this strategy succeeds/not succeeds in the relevant sense. However, if the issue of solvability will be investigated from the cybernetic point of view, then it is used the algorithmic way. According to Gadouleau et al. (2016), the solvability problem asks whether the demands of all the destinations can be simultaneously satisfied by using linear network coding. The guessing number approach converts this problem to determining the number of fixed points of coding functions f: An → An over a finite alphabet A (usually referred to as Boolean networks if A = {0, 1}) with a given interaction graph, that describes which local functions depend on which variables.

Readibility refers on the quality of writing that makes text easy or difficult to read and understand. The readability of text can be measured and improved. There are many tools and tests that can analysed the readability of the text. If the text is written in MS Word, the simplest way is to use the tool embodied in this program. For testing the readability it is used *Flesh Reading Ease*, *Flesch-Kincaid Grade Level*, *Gunning-Fog Index and others*. *Therefore*,

(1) Fresh Reading Ease test rates text on a 100-point scale, so that the higher the score, the easier it is to understand the document. The good readable text is when the score is between 60 and 70. The formula for the Flesch Reading Ease score is:

$$206.835 - (1.015 \times ASL) - (84.6 \times ASW), \; where:$$

ASL = average sentence length (the number of words divided by the number of sentences) and ASW = average number of syllables per word (the number of syllables divided by the number of words).

(2) Flesch-Kincaid Grade Level test aims to identify the readability of content at the school level. The formula for the Flesch-Kincaid Grade Level score is:

$$(0.39 \times ASL) + (11.8 \times ASW) - 15.59, \; where:$$

ASL = ave sentence length (the number of words divided by the number of sentences) and ASW = ave number of syllables per word (the number of syllables divided by the number of words).

In addition, many online tools allow testing the readability of the digital content. For example, using '*Readability Test*' can be calculated and interpreted the readability of digital textbooks, providing the website address.

Legibility is for quality of screen being clear enough to read. Ornamental fonts and text in all capital letters are hard to read, but italics and bolding can be helpful when used correctly. Large or small body text is also hard to read. Screen size of 10–12 pixel sans serif and 12–16 pixel serif is recommended. High figure-ground

Table 4.2 Topographic readability versus legibility

	Readibility	Legibility
Definition	The way in which words and groups of words is arranged in a way that allows the readers eye to access the content easily and in a way that makes sense	The way of how a typeface is designed and how well one individual character can be distinguished from another
Specific features	*Spacing Height* (e.g. additional spacing placed before or after a paragraph) *Line Height* (e.g. if the line height of one paragraph is set to 2em and a paragraph is 1.5em, the first paragraph will require more paragraph spacing and probably more margins around it) *Size* (e.g. 13px or 0.813em at smallest) *Measure* (e.g. around 70 characters) *Letter spacing* (e.g. add generous letter spacing to subheads or phrases of uppercase text) *Good type contrast* *Successful hierarchy of contents digestible parts*	*Naturally open counters* (e.g. more words with o, e, c etc. help to define character is the most easiest way) *Individual letter shapes:* – large x-height can improve legibility – character shapes affect legibility *Serif typefaces:* lighter typefaces are usually more legible than heavier weights *Transparent type*: – content to be more important than the container

contrast between text and background increases legibility. Dark text against a light background is most legible (Table 4.2).

Affordability is the extent to which digital screen is affordable. Some digital screens is for presenting data, information or knowledge, others is for learning. In the first case, the students read the information, but in the second—need to spend time and effort to go through the content linearly or sequentially before they read any particular piece of information. Sometimes students may willing to spend the time and effort, but sometimes—not. How to facilitate the affordability of the digital screens for learning?

If one believes is important to offer direct access to content, making sure that navigation is easier. But, according to Barab and Squire (2004, p. 3), design-based research suggests a pragmatic philosophical underpinning, one in which the value of a theory lies in its ability to produce changes in the world. If so, we, as teachers, are in the core of global challenges for the sustainable development of students for better accommodation and relevant decision-making regarding the future of local and global world environment. In plus, textbooks designed for mobiles do take into account the limited channel capacity and make sure that students will learn. Mobile apps could add affordability of these textbooks, as apps around special tasks have built.

Alternatively, simply offering the indirect access through observing the student's behavior and helping them to develop own potential during learning. For this issue, some designers recommend to take into accord the interdependencies between

Table 4.3 Interdependencies between learner's need to learn and medium for learning

	Learner's need to learn	Medium
1.	Remembering a small amount of verbal information	Auditory medium
2.	Retaining information over longer periods of time	Textual information
3.	Learn information more effectively	Pictorial mode
4.	Recall and recognize spatial relations in a story	Concept mapping
5.	Understanding motion-based information	Animation/video
6.	Difficult information, i.e. abstract concepts	Tool for exercising concepts
7.	Communicating verbal information	Textual information

learner's needs to learn and medium features that makes learning easier, as follows (Table 4.3).

There are many ideas how to develop rapid and intuitive user interfaces for learning. Google develops one of these apps, known as Primer. Nam (2015) has observed that only 3 % of people want to learn something new and spend own time during learning. Learning has several barriers to entry: you need to figure out what, where, how you want to learn, and then you need the time, money, and energy to follow through. In her opinion, digital screens designed for learning needed to be intuitive and inviting in order to overcome all factors that keep people from learning. Initially, the focus group has divided into three categories: *passive* (those who are looking around and browsing), *active* (that have more that an idea about what they want to learn) and *curious* (looking to learn something new, but not sure what). Then it was designed prototypes. There are three of the most important elements:

(1) *Dashboard*, e.g. lesson parks, letting users pick from three random lessons and others.
(2) *Lessons* with the rhythmically guide the user through the content.
(3) *Activities* with the three types of interactions that appears at different types, e.g. Quick Starts appear early in each lesson; Mid-Lesson Activities appear during the lesson; and Do This Nows come at the end.

This is an affordable model of the teacher-centered interfaces for learning.

4.4 Information Is Information, not Matter or Energy

'Information is information, not matter or energy'. This famous words of Wiener, written in 1948 for '*Cybernetics*: *Or the control and communication in the animal and the machine*' today is more important than even. We found this quote important for understanding challenges of the actual living and learning design. Does information, mater and energy are connected or not? This is the question of this paragraph.

We live in a globalized world in which ‘reversing global climate change, protecting biodiversity, restoring the health of our oceans, developing sustainable food systems, accelerating the shift toward clean, renewable energy—require fundamentally new ways of thinking and acting’. In such a word, teaching, assessment and learning practice are ‘integrated’ with context, content, core competencies, and habits of mind. Some of these practices could be extended on the base on innovative instructional strategies.

Can anybody learn something if he/she doesn’t have a vital energy?

Can anybody learn something if he/she doesn’t have a vital energy? Does the human has a potential energy? What are the correlation between potential and kinetic energy? How important is to use multisensory cues for changing potential into kinetic energy? Is this process reversible or irreversible? What interface design is the most important for deeper learning: those that organize information into memorable ‘chunks’ or those that enable students in a dynamic self-directed learning process? Some of the answers to these questions could be found in the following article signed by Li et al. (2016, p. 65), as follows:

> Human beings’ brains are one kind of high energy storage battery. Life is one procedure of studying. In the times of big data, the social network is incredibly growing, intelligence is increasingly increased, update periods of knowledge are becoming shorter and shorter, and new ideas and new knowledge are coming endlessly. Virtual learning, due to its advantages of quickly recharging brains, is being loved by people of all ages and levels. Nevertheless, community resident virtual learning autonomy requires cultivation.

It is a verified fact that everything is energy in motion, even the children growing, reading, writing, recalling, emotions, memorisation, running, thoughts and decision-making. All learning activities require energy. How about physiological actions or/and unconscious physiological functions, especially the role of the unconscious affective reactions to deeper learning? Indeed, there are various forms of energy important for learning: potential, mechanic, quantic and others. But, not only the energy is important for learning (Fig. 4.2).

Therefore, energy is the condition for all the mechanic activities/actions, like focusing attention on digital reading, walking during self-regulated learning, running away from classrooms and many others that students use to learn or to avoid learning something new. Does these activities are initiated or activated by data, metadata, information or knowledge provided or rapidly disseminated on/with digital screens? Maybe yes, because digital screen instead of printed page are working on/with energy. More research is needed to understand all these complex and interconnected mechanisms, processes and stored data on the base on digital screen.

The energy is at the head of the ancient medicine and cosmology. From the one hand, the energy is vital for maintain all physical, mental and emotional activities and actions of human body. Everybody ‘vibrates’ at some energetic frequencies during his/her life. The brain’s potential energy of processing data, metadata, information and knowledge characterise the *learning style* (Keefe 1987; Reid 1987; Riding and Sadler-Smith 1997), which associated with intellectual ability,

Fig. 4.2 The human body during learning

personality and achievement motivation, as was observed by Busato et al. (2000, p. 1057).

On other hand, digital interfaces attract people by 'default' rather than by deliberate choice. This is a kind of a new energy with the potential to motivate for sustainable understanding of the world, either real or virtual. What are the correlations between the brain and body' energy? Does the body energy is so important for identification, sorting, summarising things or patterns of the real world for decision-making? How important is the physical activity immediately after learning activity? Does sleeping improve deeper learning? These and many other questions should be answered before the scientists will be able to provide the adequate definition of what learning is?

Over the years, numerous studies of learning style and its multiple correlations with intellectual ability and educational outcomes show that learning style is a distinctive feature of learning preferences. Thus, according to Neuhauser (2010), the person who need people as a source for regenerating his/her energy is extroverted, whereas those who prefer solitude to recover energy may tend toward introversion. In plus, extroverts find their energy is sapped when they spend too much time along. Introverted people loss energy from being around people for long periods of time, particularly large crown. However, as was noted by Carl Jung, there is no such thing as a pure introvert or extrovert. According to Hans Eysenck, the differences between introverts and extroverts is a result of the extent (e.g. arousal) to which minds and bodies are alert and responsive to stimulus. In sum, several studies indicate difference between introverts and extroverts as correlations between arousal, learning, and memory (Eysenck 1976; Eysenck 2012; Swickert and Gilliland 1998).

Research has actually found that there is a difference in the human potential and capacity to learn in terms of how the information is processed and how the genetic makeup differs for extroverts and introverts. In turn, people learn from one another via *feeling* (e.g. learning through feeling); *recognizing* (e.g. patterns and meta-patterns); *memorization*, (e.g. artefacts). Learning achievements have reinforced within digital learning environment, thanks to availability of the immediate feedback. The drill and practice techniques is not yet a fashion in learning, even in learning mathematics, chemistry, physics. The affordance of learning through *repetitive practice,* when students receive small tasks for memorisation, should be investigated in an innovative manner. The learning, as repetitive actions, is characterized by time, effort, energy and intellect.

It is true that in a digital society, learning become more and more complex. Initially, it was observed that learning is effective when students are engaged in process and that active engagement in the learnings process promotes *mental activity*. The mental activity helps students retain new information and develop some *thinking capacities*. Therefore, it was proved that an effective learning process is individual, group based or collaborative. However, this is not enough for success in a digital society. In a powerful real-digital learning environment is required a mechanical-quantum energy for learning. The quantum energy is a result of *deeper thinking*.

The postmodern paradigm of learning should penetrate life deeper enough to answer essential questions of humanity and offer solutions for sustainable learning. Complicated problems cannot be solved at the same level as easy problems. For example, if the specific objective of learning is recalling the adding of numbers, then it is used immediate feedback. Thinking about learning from the paradigm of the human well-being is bound to give as a scare from the perspective of the understanding user interface design for a dynamic equilibrium of human life with the patterns of the UNIVERSE. To address an innovative learning paradigm it is required a new level of thinking about learning in general.

From the standpoint of the sustainable development, digital textbook is not digitalised/digitised version of printed textbook. Thus, there are no ultimate answer of what is the most effective methods for learning with textbooks. This mean that learning designers should move beyond the paradigm or develop instructional, assessment of learning model according to this paradigm. The provided 0model should be focused on solving the special task(s).

4.5 Essential Elements in Learner-Centered Interface Design

Learner-centered interface design refers on decide upon the look of a learner-centred learning environment that is vital for sustainable development and in which student(s) is central or became the central of own lifelong activities and/or actions for better adaptation in the local/global, or/and real/virtual challenges. He/she contribute to everyday decisions in the most rational way. Therefore, the learner-centered interfaces are developed together with the teacher during the learning process. Two remarks are important here, as follows:

– *By teacher*, we understand not only a person who teach, but also each of the resources, tools, phenomena, events, emotions, experience abroad into a on-formal or informal environments, which make learning possible.
– *By learning process*, we understood not only a component of a well-defined didactic process, but also the conscious and/or unconscious activities or/and actions of the brain which influence the behavior, during the assessment and thinking processes.

The most essential elements of the learner-centered learning environments are *core concepts* and interconnections between core concepts. The idea to use core concepts for learning design is proved by many transdisciplinary studies, including Fermi–Pasta–Ulam recurrence problem of non-linear systems; Pappert description of mathetics and so on.

Learning is both conscious and non-conscious, linear and non-linear. During learning is changed non only the synapses in the brain, but also the human body, the information, both mechanical and in forms of quantum waves that provide signals for learning and leaving. Maybe, digital screens form a special energetic cloud that 'make harder' for them learning in a traditional classroom or/with classical blackboard?

Theoretically, the formula for student's learning strategy can be described as Y = D (X), where Y represent either a pedagogical or didactic goal; X—personal goal and D indicates the own strategy for learning used to transfer the pedagogical/didactic goal into a personalized goal. The limitation of formula is in formative self-assessment methodology. This idea is based on the assumption that computerised assessment exploits the feature of the digital content to be automatized through including into an interactive feedback and/or feedward loops and to be managed through a knowledge management model. From this perspectives, the nucleus of generative structure of competence operates as follows:

(1) The knowledge structure provided in the digital or multimodal content acts upon the human cognitive system at the level of goal-oriented influences and based on intellect, emotion, and energy at integrated (meta)cognitive, affective and psychomotor levels of competence.
(2) The incorporated tasks initiate the processes that are involved in acquiring the learning outcomes in transitory processes from the most current psycho-pedagogical state to the potential psycho-pedagogical state. The transition is equal to initial and final levels.

All psych pedagogical mechanisms of each learner are involved in these processes.

Into the dynamic and flexible instructional strategy all teaching, learning and assessment processes that lead to learning outcomes represent a hierarchical dynamic and flexible construct, developed by each student that are guided by a

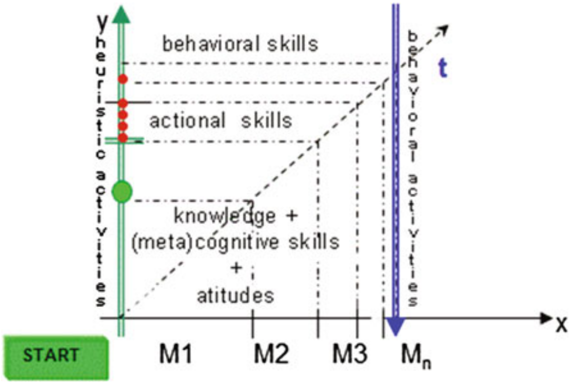

Fig. 4.3 The instructional dynamic and flexible structure

professional teacher. This is possible because the structure of content is generated from an initial knowledge graph structure, which includes only interdependent concepts. Each author of digital textbook can build the structure with interdepended concepts, if he/she will use *concept mapping as* a technique for representing concepts in knowledge graphs.

The methodological dimension is represented by the way, in which the didactic process is integrated into functional structures that assure the efficiency of communication/information, cognitive activity and assessment processes. The proposed model is to consider the first phase equivalent to the first module, the second phase-to the second module etc. Therefore, the digital content of the first module incorporated from the reproductive (the content is recalled from the memory) to productive tasks (the learner synthesis a new definition, concept etc. or construct own content following concept mapping). The number of modules depends on complexity or difficulty of concepts, but, in any case, it will serve as a fundament for designing *learning tasks* and solving it in powerful learning environments. The graphic representation of "transfer" from pedagogical/didactic aim into a personalized aim is reflected into an instructional dynamic and flexible strategy, that reflect also the system of presentation the instructional content into electronic textbook (Fig. 4.3).

The instructional dynamic and flexible structure shows an example of strategy that ideally follows the principles of learner-centered learning environments. The content of digital textbook is divided into *modules*. There are two possible models to present digital content: *inductive* and *deductive*. Students learn effectively with either inductive or deductive methods. The content of each module is structured around information framework with formative assessment tasks and concept mapping tool. In time the number of *algorithmic activities* tasks, focused on reproductive skills, decrease in favour of *heuristic activities*. In an algorithmic method, the student is presented with all data for problem-solving, context and procedures are described. The learner's decision is based on understanding and reproduction of presented algorithm. However, during heuristic activities step-by-step procedures of learning are not provided or explained explicitly.

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