

Interactive Content in E-Learning Environments: An Overview

Philipp Klein

TU Wien

1040 Vienna, Austria

e01326251@student.tuwien.ac.at

ABSTRACT

E-Learning is a relatively new learning trend that has gained a lot of popularity in recent years. Especially the restrictions caused by the COVID-19 pandemic boosted its usage. Currently, there is a wide range of online platforms that offer e-learning courses for a wide variety of topics and subjects. Those courses are available for everybody through the internet and provide easy access to materials from the comfort of peoples' homes. Furthermore, the unsupervised approach of e-learning courses enables the creation of flexible content. The learner determines the pace and time of learning. New digital technologies create opportunities to include more engaging content in e-learning through a variety of methods like interactive content. Especially environments that build upon the constructivist learning theory, regard interactivity as an essential part of learning. The main goal of this approach is to provide better and more sustainable learning experiences. This paper examines the concept of interactive content in e-learning environments by giving an overview of interactivity and its goal to create more engaging e-learning materials. It describes the underlying learning theory in detail and gives a classification of interactive learning content in e-learning courses with the Guerra Scale. Furthermore, this paper investigates the integration of interactive materials as well as their benefits and risks. The last section gives an outlook of interactivity in e-Learning environments and describes trends in building engaging content, like virtual reality.

KEYWORDS

e-learning, interactivity, gamification, interactive content, interactive learning, gamification, serious games, learning, learning theories, constructivism

ACM Reference Format:

Philipp Klein. 2021. Interactive Content in E-Learning Environments: An Overview. In *Interactive Content in e-Learning*. , 12 pages.

1 INTRODUCTION

E-learning has gained a lot of popularity over the last few years and experts predict that the e-learning market will continue to grow. Some estimates argue that the US market alone will hit US\$325 billion by 2025 [10]. Thus more and more people are learning on online platforms. Those platforms are usually built on self-paced and unsupervised learning. Since students in e-learning courses usually have no direct contact with a human teacher or instructor it is important to make them as intuitive and self-explanatory as possible. Otherwise, students can become frustrated and lose interest to finish courses. It can also effect students' motivation to further investigate the topics by themselves. This current trend towards self-education through e-learning platforms shows the impact e-learning has on our current education system. It also highlights the necessity to include engaging content and materials in those courses.

In the past, transmitting information and knowledge was usually done by teachers in classrooms. Learning happened in a physical space where students and human instructors can interact with each other. This is often called the "sociocultural" approach of learning or "social constructivism" [30]. The methods of such classrooms can range from frontal teaching to more interactive approaches. But the widespread use of digital tools such as the internet introduced new ways of learning that often lack student-teacher interaction [3]. As the growing market of e-learning platforms suggests, learning with digital instructors is becoming more popular as a huge number of people have access to a variety of virtual classrooms and learning environments. Today, e-learning courses are available on a wide range of topics on different

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

Seminar Media and Human-Centered Computing, Winter Semester 2020/2021, TU Wien

© 2021

platforms. Among the most popular providers on the internet are sites such as Udemy¹, Skillshare², edX³, and Coursera⁴. These offer an extensive amount of courses on subjects like design, marketing, multimedia production, programming, health, social sciences, and many more. But there are also more specialized learning platforms like Codecademy⁵. Those platforms focus on a specific target group and topic, in this case, programming and technology. Furthermore, universities, like Harvard, and other more traditional education institutions built their own e-learning platforms to reach people from all over the world⁶. This allowed them to bring their formerly locally restricted university courses to an unlimited number of recipients. All those providers have to compete in the e-learning market. Thus it is important to provide high-quality courses and engaging materials for students to be a successful platform in this area. One way to create such materials is through the use of interactivity to transmit knowledge [3].

While learning has been around since the beginning of humankind e-learning is a relatively new field. Overall, e-learning has no clear definition and it is a very diverse area that can have many different forms and formats. In the most general sense, it has been described as the usage of digital technology in learning environments. This definition does not exclude the usage of digital technologies in classrooms or face-to-face teaching methods. E-learning environments, where students and teachers interact in a physical, face-to-face format, are often called “blended learning”. This subset of e-learning allows instructors to use the possibilities created by digital technology to enhance student-teacher interaction as well as the interaction between students among themselves. It can make the classrooms more engaging and foster a dialogue while learning. Yet, most people connect the term “e-learning” with learning through the internet or other digital tools. This paper does not focus on blended learning or similar approaches. It discusses interactive content that uses unsupervised learning materials. Section 2 gives a more in-depth discussion about the different definitions of e-learning concepts and their delimitation.

First, this paper defines the terms learning and e-learning and how they are connected as well as distinct features of both. Afterward, it describes the integration of interactive content in e-learning environments and how they affect user engagement. It discusses what interactivity is, its psychological foundations, and what problems it tries to solve. Since digital technology and therefore its usage in e-learning are

rapidly changing areas it gives an outlook of future interactive technologies. It discusses trends that might have an impact on digital learning environments, especially the usage of virtual reality in education. Furthermore, this paper describes the opportunities created by interactivity and what challenges designers, developers, and content creators have to face. The restrictions in education had a huge impact on learning in traditional environments. Since this forced many to use e-learning, the impact of the COVID-19 pandemic on e-learning briefly is discussed as well. For example, during the lockdown teachers had to switch to remote or online learning environments.

2 DEFINING LEARNING AND E-LEARNING

Theories of learning have been researched in the past thoroughly and scientists created three main theories on how we learn. They are called “Behaviourism”, “Cognitivism”, and “Constructivism”. Section 3 gives more details on those approaches and describes how they differ in their perception of learning.

Learning

Today, there are many definitions of the term “learning” since the different psychological approaches focus on other aspects of the learning process and its results. Depending on the learning theory different things are emphasized in a definition but in general, learning can be described as a “gaining of knowledge or understanding, or the acquisition of a skill or behavioral tendency through study, instruction, or experience” [34, p 2]. In neuroscience, learning is the creation and rewiring of neural connections in our brains [11]. It is something that happens automatically every day and does not stop happening in our life whether we are aware of it or not.

E-Learning

E-learning is a subset of learning that uses digital technologies to promote knowledge gain [11][19]. It has been around since the beginning of computer technology. Especially the introduction of personal computers and smartphones resulted in a vast development and usage of e-learning environments and technologies [24]. In the early days of e-learning different media have been used to create and distribute learning materials. For example, CDs with e-learning software were a popular method to bring digital content to students. After the internet gained popularity, most consumer-oriented e-learning environments are now available through the web. This shows that e-learning is not static as it is heavily influenced by technological development. Thus, Kaceti and Semradova state that the concept of e-learning is not clearly defined as it is a very broad area and used in various contexts [19]. Like mentioned, a variety of media is available

¹<https://www.udemy.com>

²<https://www.skillshare.com>

³<https://www.edx.org>

⁴<https://www.coursera.org>

⁵<https://www.codecademy.com/>

⁶<https://online-learning.harvard.edu/>

in e-learning environments. All of them are considered as tools to provide e-learning content for consumers. However, as technological progress continues to change rapidly those methods change as well and different digital tools are being used through the last decades. Thus it is difficult to come up with a final definition of the term “e-learning” that considers future technological advances as well. But in a general sense, Kacetl and Semradova argue that e-learning is the usage of digital “methods that can effectively influence the learning process and which present the learning content of various kind to users, i.e., those who are educated, among other things, through collaboration software and WBC (web-based-courses)” [19, p 1323]. Another definition by Clark and Mayer describe e-learning as “instructions delivered on a digital device that is intended to support learning” [8, p 7]. Although both definitions are rather similar they emphasize different aspects of e-learning. While [19] focuses on the content and argues that e-learning is the presentation of information for knowledge gain in a digital way, the central argument in the definition from [8] is the usage of digital devices to convey information. I would argue that e-learning is a combination of both definitions. It is the transfer of instructions in a digital format through digital devices or hardware. Those devices can range from desktop or laptop computers to tablets or smartphones.

Blended Learning

Blended learning is a similar concept that is becoming more popular recently as well. It describes the teaching and learning process that combines both, physical face-to-face learning and e-learning [19]. In this approach, a variety of activities, including face-to-face instruction, live e-learning, and self-paced learning try to use the benefits of e-learning and traditional learning formats.

Asynchronous and Synchronous E-Learning

Clark and Mayer argue that e-learning can be present in two different temporal forms [8]. It can either be asynchronous or synchronous. In asynchronous e-learning, learners consume the content in a flexible and self-paced schedule upon demand. This means that students have to actively proceed with the e-learning courses to succeed. Asynchronous e-learning tries to promote self-regulated learning opportunities for students [22]. Synchronous e-learning on the other hand is present when instructors guide through the materials at a fixed time. Teachers educate the students one time only with the usage of digital tools, for example, the internet. This creates a fixed schedule that has to be followed by the students as well as the teachers.

Benefits and Risks of E-Learning

Some of the most common benefits of e-Learning include flexibility which creates the ability to adapt to the individual learning process. This is especially present in asynchronous e-learning. Furthermore, e-learning can improve the clarity of instruction as well as promote course integrity, individualization of the learning process, and feedback.

A study conducted by Wan et al. investigated the effectiveness of e-learning for different people [35]. In this study, 383 students were tested on the influential factors that influence e-learning experiences and learning outcomes. While they argue that many aspects have an impact on e-learning experiences, their work mainly focused on the learner’s experience with information and communications technology (ICT) and its effect on learning outcomes. They found out that virtual competence has a significant effect on learning outcomes. In their work, they define virtual competence as a learner’s experience with ICT usage. However, this virtual competence is a complex area since different types of experience exist. For example, people that were more experienced in seeking information and communicating via ICT had higher levels of virtual competence. However, their results did not show direct positive effects of ICT experience on e-learning outcomes but suggest that positive effects can be indirectly achieved through higher virtual competence. Thus they argue that virtual competence is an important preceding factor that influences learning outcome.

3 PSYCHOLOGICAL FOUNDATIONS

The psychological foundations of learning are often described as learning theories and can be divided into three different approaches [2][30]. In general, they characterize how students perceive and process information to build up knowledge.

Behaviorism

One of the earliest concepts of learning is called “Behaviorism” [2][30]. It describes the concept that learning in the brain happens within a black box. In this box, learning is seen as a reflex to stimuli. The most important thing for substantial learning is to find the stimuli that activate this reflex. Researchers that follow this approach are only interested in producing an outcome that can either be right or wrong. By changing stimuli that precede a response, the response itself, and the stimuli that follow a response the behavior, in this case learning performance, can be explained. Nowadays this concept is considered outdated and is criticized by most experts.

Cognitivism

The second learning theory is called “Cognitivism” and considers the internal processes of the learner. In contrast to

behaviorism, the human brain is no longer a black box with input and output. It tries to understand the things that happen after the information is presented and regards human thinking as the processing of information. There are a lot of similarities between computers and humans according to cognitivist theories. Thus it is the main psychological foundation for developing artificial intelligence [2]. According to Baumgartner cognitivism no longer tries to find one correct answer in a response to stimuli but rather to discover methods and processes that allow sustainable learning that produces one or more correct answers.

Constructivism

The last learning theory is called “Constructivism” and builds the basis for interactive content in learning environments. Today this theory is widely popular among scientists and considers the experiences and personalities of individuals as central parts of a learning process. This theory argues that we, as humans, build or construct our reality through external stimuli. Those stimuli are then processed and put into perspective with previous individual experiences. Therefore, everybody creates and perceives his or her own reality and no objective description of reality exists. Reality is considered as something interactive that combines both, observer and observed. The main difference to cognitivism is that in constructivism a feedback loop with past knowledge is used to construct meaning out of external stimuli. In cognitivism past experiences are not such central parts of learning. Baumgartner argue that constructivism sees learning as an active process in which people use their relationship to previous situations and experiences to construct new knowledge [2]. The learning process is no longer only determined by stimuli and response but rather by all experiences and attributes that make up an individual [2][30].

Baumgartner argue that, depending on the used learning theory, different points of view regarding learning exist. In behaviorism, learning is an authoritarian teacher-student model where suitable input or stimuli result in a “correct” output. In cognitivism, this authoritarian structure is broken up and students work on problems mostly independent from their teachers. Here the teacher acts as a tutor that accompanies the learning process and only helps if necessary. Constructivism goes a step further and considers individual and personal experiences in a learning process as well. Students have to work out the problem statements in complex situations by themselves. Teachers act like coaches, rather than all-knowing instructors. They work with students cooperatively and accompany them in their learning process as more or less equals [2].

Learning Styles

Another important part of learning theories is the individual differences in the most effective learning styles, which is often described as the meshing hypothesis. According to this hypothesis, optimal learning requires environments and formats that are tailored to a student’s preferred learning style [28]. For example, some people prefer words over pictures or speech. This preference determines the most effective way of learning for individuals. However, a literature review by Pashler et al. found results that contradict the meshing hypothesis. However, they argue that not all learning styles have been tested comprehensively (for example auditive learning) and they “do not claim that the same kind of instruction is most useful in all contexts and with all learners” [28, p 116]. In general, they think that learning styles do not play as an important role in the process of learning as considered previously. Thus, they argue that other educational practices are better suited to promote effective learning. One of those practices can be the usage of interactive content in learning environments.

Constructivism and Interactivity

Like already mentioned, e-learning and especially interactivity builds upon the constructivist learning theory. This refers to the conception that learning is an active process where the student has to interact with information to link it to previous experiences. It considers knowledge as the “production of meaning” [26, p 2651]. Bodner described the constructivist learning model as “knowledge [that] is constructed in the mind of the learner” [4, p 1]. A similar description regarding the constructivist approach knowledge building by Robinson et al. argues that in constructivism “knowledge is constructed by learners as they attempt to make sense of their experiences” [30, p 33]. This allows students to immerse themselves in complex problems and an therefore active construction of knowledge. Most interactive contents create such environments and learners can explore the subjects by themselves. As already mentioned, this cooperative and accompanying nature of instructors and instructions is a characteristic of constructivism as well.

4 WHAT IS INTERACTIVITY?

Whenever two or more entities exchange information they interact with each other. Thus in the broadest sense interaction is simply the exchange of information. The term “interactivity” has been shaped by communication technologies and today researchers associate interactivity mostly with such communication technologies [20]. However, Kioussis argues that interaction always implies some form of feedback. In the context of e-learning and other digital environments this feedback is usually linked to digital technology such as

computers [20]. In his work Kiouisis states that there is no clear definition of interactivity. Some researchers focus on the message that is conveyed while others focus on the technological tools in their definitions [20]. But in a narrower sense interactivity is the communication process where participants have control over, and can interact with the content through digital technology. This allows them to construct new knowledge by themselves.

The usage of interactive materials in learning environments is not a new concept that only emerged with the introduction of e-learning. Supporting meaningful and long-lasting (inter)active learning through interactive content is one of the key concepts of the constructivism learning theory. E-learning that follows one of the other two psychological concepts regarding learning theories thinks that interactivity does not provide notable benefits in learning environments. Especially in behaviorism the black box in the brain does not consider learning as something interactive. As this theory only focuses on the learning results that follow stimuli, it does not perceive interactivity as a tool that can enhance learning experiences. I would argue that interactivity is often neglected since learner motivation and engagement is not a fundamental part of behaviourism. It views learning as input and output rather than as a process that's happening in the brain. Cognitivism, on the other hand, does consider internal processes while learning. But it does not perceive knowledge as something "constructed". This construction of knowledge is a fundamental part of interactivity regarding learning. Thus Reich argues that interactivity in education is following the constructivist learning theory as students construct their knowledge by themselves. This usually happens through active interplay with the materials [29]. However, Berge argues that there is no real "interaction with content" since content itself can not interact, hold a dialogue, or answer back [3]. Thus he argues that "interaction about course content can only occur within the students' own heads as they dialogue within themselves while attempting to construct meaning, answer questions, or find the appropriate places to integrate incoming information into their existing schema" [3, p 185]. Based on the statement by Berge I would propose the following definition of interactive learning in e-learning environments: Interactive learning in e-learning refers to the construction of knowledge within learners' heads as they get in an internal dialogue to construct meaning. If we consider this definition, interactive content refers to the usage of digital technologies that enable such a dialogue and therefore interactivity. Those technologies allow learners to "learn by doing", a concept that is described in more detail in Section 6.

Furthermore Berge argues that "an instructor or designer who views teaching and learning from a constructivist philosophy creates a context for learning"[3, p 181]. In his view,

in an environment that follows a constructivist teaching approach, and therefore includes the usage of interactivity, learners can become more engaged in projects, that involve problem-solving, and other learning activities. If we apply this argument to e-learning, engagement with the learning materials through interactive content encourages intrapersonal interaction or reflection. This highlights the importance of interactivity in constructivist e-learning environments as this dialogue within learners' heads is regarded as the foundation of knowledge construction. In traditional classrooms, the teacher acts as an instructor that builds this learning environment for the students. Thus, the content and materials build upon the teacher's understanding of the content and personal learning styles of students are often neglected. Therefore, interactivity in those contexts is not as important as an internal dialogue of students. Another difference is that interactivity usually addresses multiple learning styles. For example, students can build up knowledge through interactive content. This content is usually designed as a combination of multiple media, like text, audio, or visual materials. Although the learning styles or meshing theory is not fully supported by research (as described in Section 3) the usage of multiple media is, in general, a well-established way of teaching.

To sum up, interactivity in the context of this paper consists of two parts. First, the message that is being conveyed through interactions of content and learner. Second, the usage of digital devices and tools that enable such interactions. Interactive learning happens when the construction of knowledge within learners' heads supports internal dialogue with those two dimensions. Learners are encouraged to construct meaning in a reflective, self-reliant way. Thus, interactivity is heavily influenced by the constructivist learning theory. The most important benefit of interactive content in e-learning is the possibility to create more engaging learning materials. In the end, this fosters more substantial knowledge gain. Reich argue that "educators must recognize that their interaction with learners includes great demands not only in practical application/implementation but also in theoretical reflection" [29, p 7]. This statement supports the argument that interaction mainly focuses on the reflection of the presented information by learners.

5 ENGAGEMENT THROUGH INTERACTIVITY

Motivation and engagement are among the most common problems of e-Learning from a student's perspective. Both can have a huge impact on learning performance and results. If students do not finish e-learning courses it is usually due to lost interest or motivation to continue. This happens because of a lack of engagement with the subject, material, instructions, or teachers within learning environments. But

engagement is a complex area in e-learning since it is influenced by a wide range of different factors [27][25][33]. But no widely agreed-upon definition of engagement exists. It can be used differently depending on its context. However, most literature describes it as something that draws us in and holds our attention [27]. This creation and holding of attention are influenced by single parts of learning environments as well as the concept of an e-learning environment as a whole. For example, media presentation, perceived user control, choice, challenge, feedback, but also aesthetics, interactivity, and student interest determine engagement levels of learners [27][25][33][14]. Some researchers argue that engagement in learning is a single variable that is measurable as the learning results or through gained knowledge. But O'Brien see engagement as a process that consists of four stages. First, the point of engagement is where learners initiate engagement with content. Alternating periods of engagement or disengagement followed. In the end, re-engagement happens in ideal situations [27].

In general, engagement is something that is desirable in learning environments. Therefore, it should be carried out carefully when creating e-learning content and materials. Engagement encourages learners to continue with courses and therefore supports effective learning in the long term.

Engagement in E-Learning

Doherty and Doherty see engagement in e-learning as something that is connected to the property of materials [14]. It is determined through the learners' attentiveness and interactions with the platform. Thus engagement in e-learning environments is both, the result of learning and the means or mode of learning [14]. This means that in order to create engaging interaction in e-learning it is crucial to provide high-quality learning materials. Therefore, creators of e-learning content need a well-considered design and integration of interactivity.

The argument for different forms of engagement in e-learning is supported by Morgan-Thomas and Dudau. According to them, two forms of engagement in e-learning exist [25]. First, students can be engaged with the e-learning platform itself. Here they claim that engagement is created through the structure of the e-learning environment. For example, the quality of materials, aesthetics of the platform, or modes of learning. Second, engagement can be created through learners' interest in the subject. If students are interested in a subject it is easier to build and hold up engagement. Otherwise, it is much harder to engage students in a subject as they do not enjoy working on it.

However, a study conducted by Barana and Marchisio focused on the integration of interactive learning environments to empower engagement in mathematics [1]. Their research showed that engagement is linked to self-regulation

and persistence and that cognitively engaged students are less likely to stop with their learning. The students that were initially less engaged had the biggest increase in engagement through the integration of interactive learning elements. Although this study has been conducted in a blended learning environment it can be adapted to pure e-learning environments as well.

This contradiction between the arguments from Morgan-Thomas and Dudau and Barana and Marchisio shows that engagement is a very complex area in e-learning. While some argue that the creation of engaging content is much harder for students less interested in a subject others argue that those students have a bigger effect on their engagement and therefore benefit to a larger extent from engaging content. However, it is very difficult to compare different studies and practical research on engagement since different topics might have a big impact on outcomes. For example, it might be more difficult to motivate students to engage with subjects such as mathematics than it is with biology.

6 INTERACTIVITY IN E-LEARNING

Interactivity is a fundamental part of e-learning and present in almost all successful e-learning environments. It promotes engagement, understanding, and the construction of knowledge. However, modern information and communication technologies are a prerequisite for the creation of interactive learning environments [37]. Thus, the integration of interactivity is especially appealing for designers, creators, and developers of e-learning materials and courses.

Synchronous and Asynchronous E-Learning

As already mentioned in Section 1 there are two different approaches to e-learning regarding time, namely asynchronous and synchronous e-learning. I would argue that this has a major impact on the form and extent of interactivity in e-learning environments. To my knowledge, there is currently no literature that explicitly discusses the implications of those two types on interactive content in e-learning environments. However, the implemented approach of interactivity determines what people are confronted with in e-learning. I would argue that interactivity in synchronous e-learning is more challenging to design and implement as both, the student and the teacher, need to communicate without a delay and give feedback to each other immediately. In this case, it does not matter if the instructor is a human or an artificial teacher. The student expects to be able to interact with the instructor as it is crucial for non-frustrating interactive content. In asynchronous interactivity students and instructors are also in dialogue but with temporal delay. This delay might be intended to foster reflection of the learner. As Doherty and Doherty argue slower forms of interaction, and

therefore asynchronous, promote understanding through reflection.

Supervised and Unsupervised E-Learning

As mentioned, e-learning environments can either be asynchronous or synchronous. However, I would add another characteristic for interactive content in this area, namely supervised or unsupervised interactivity through human teachers. While interactive content in a constructivist point of view is most likely performed by the student in a self-reliant way, exceptions may exist where students and instructors work collaboratively and communicate with each other. In some cases, instructors may be present while students have to work on problem statements by themselves. In a constructivist learning environment teachers give guidance but support individual learning through the construction of knowledge. This would be an example of a supervised learning environment. A synchronous format can be video calls, chats, or other immediate dialogue between student and teacher with the help of technology. Asynchronous, supervised learning happens in the form of dialogue in forums or if teachers give feedback to assignments. Since no human instructor is present in unsupervised learning, interactions with the learning environment are most likely synchronous since digital technology allows to interact with students immediately. However, some exceptions may exist where students have to wait for a response from the system. For example, due to time constraints of assignments.

Examples of Interactive Content

Since interactivity in learning environments has gained a lot of popularity new and innovative ways to present interactive content and integrate interactivity in e-learning are being developed constantly.

A possibility to categorize content in e-learning according to its interactivity is through the usage of the so-called “Guerra Scale” [37][7]. This scale contains ten levels of interactivity that can be implemented in e-learning environments. Each step adds increases complexity, functionality, time for processing, development effort, and needs more attention by content creators. Table 1 shows the scale and gives examples of (interactive) content in each layer and step.

The definition of interactivity given in Section 4 state that interactive content fosters exploration. Although no precise definition of interactivity exists, it requires at least some form of feedback for the learner. Interactivity in the sense of the definition given in Reich starts at layer 6 of the Guerra Scale. Whereas layer 7 is required for interactivity according to [3] and Kiouisis. I would argue that interactivity in a very broad sense starts at layer 4 of the Guerra Scale. However, it can also be argued that some forms of interactivity are present in earlier stages as well. A more detailed definition

of interactivity argues that learners need to have control over and can interact with the content. Thus, interactive content in e-learning would need to be at least in layer 7 of the Guerra Scale.

Gamification and Serious Games. One of the most widely used forms of interactive content in e-learning environments is gamification. According to Deterding et al. it refers to the “the use of game design elements in non-game contexts” [13, p 9]. Since its introduction in 2001, this definition of gamification has become one of the most widely used ones today. It gives a clear idea of what gamification is and how it looks like in practice. In their work [13] argue that gamification only covers the usage of game elements but never full-grown games. According to them, game design elements are present in five different levels [13, p 12]:

- Game interface design patterns (e.g. badges, leaderboards, or levels)
- Game design patterns and mechanics (e.g. time constraint, limited resources, turns)
- Game design principles and heuristics (e.g. enduring play, clear goals, variety of game styles)
- Game models (e.g. the creation of aesthetics and challenges; sparking fantasy and curiosity)
- Game design methods (e.g. playtesting, play centric value-conscious design, value-conscious game design)

Gamification uses at least one of those game elements but never all of them. A so-called “serious game” is present if all five game design elements are present. Often a clear distinction between the usage of gamification and a full-fledged serious game is difficult as interactivity blurs the border between gaming and merely interacting with content. However, in the context of this paper both add interactivity to e-learning environments and try to engage the user in similar ways. Today, it is more common to simply use game elements and therefore gamification in e-learning platforms. Because serious, full-fledged games are more comprehensive and therefore time-consuming for learners. This is especially problematic if a game addresses only a small part of the subject on an e-learning platform. The most widely used game elements on e-learning platforms are “game interface design patterns” such as achievements, badges, points, leaderboards, or levels. For example, learners can get achievements if they complete a chapter from an e-learning course.

According to Rodrigues et al. gamification in a programming learning environment is working since it improves students’ intrinsic motivation [31]. However, they argue that students’ previous experiences with programming affected the duration and level of gained motivation through the integration of game elements. As already discussed, interactivity and therefore gamification and serious games can create

Table 1: Guerra Scale

Guerra scale	Characteristics	Examples
GS1	Simple, static elements where interactivity is limited to scrolling	PDF documents, Images
GS2	Users can jump to relevant sections with integrated hyperlinks	Hyperlinks within text, image, or documents
GS3	Dynamic feedback either at end of throughout the interaction with content	Dynamic feedback to tests, quizzes
GS4	Simple movement of text and images to demonstrate more complex content	Presentations with animations
GS5	Usage of multimedia elements	Multimedia content such as audio and video
GS6	Integration of user input	Single wiki pages, text upload
GS7	Introduces community and online discussions	Chats, forums, wikis, workshops, Q&As
GS8	Real world processes in realistic e-scenarios	Simulation
GS9	Inclusion of real time instructions and guidance from professionals	Real life coaching
GS10	Full immersive environments in which user has near total control	Virtual reality

more user engagement. Something that is supported by the work of Rodrigues et al..

Development and Implementation of Interactive Content

The integration of interactive content in learning environments follows the “learning by doing” approach since its core concept is to motivate students to actively work with the learning materials. Students have to think about what they do and how they approach the tasks. It fosters exploration of a subject where concepts are being “constructed” during working on the problem statement. It is often argued that this “learning by doing” is one of the best ways to learn new things and gather knowledge [11][32][30][15]. Especially scientists that follow the constructivist learning theory argue that the most effective way to learn is through experience. It allows students to connect their previous experience with the learning material in an (inter)active way. According to Robinson et al. students are explorers in a constructivism e-learning environment through the usage of educational technologies [30]. They argue that the most effective learning experiences use complex and meaningful activities for the construction of knowledge rather than repetition of facts alone. Thus, when developing interactive content, the learner should be motivated to actively “do” things.

Robinson et al. argue that “students activities that represent engaged learning, are authentic, worthwhile, and involve constructivist principles while employing educational technologies as tools for learning” [30, p 36]. As already

mentioned in Section 3, interactivity uses the constructivism learning theory and fosters learning by following a “learning by doing” approach. As already discussed in Section 5, interaction is a fundamental and well-established way to create engaging content in e-learning environments. Thus, if designers and developers use the constructivist nature of interactivity regarding engagement within an e-learning environment it is possible to create such authentic and worthwhile learning experiences, mentioned by Robinson et al..

However, Schank argue that it is difficult to develop a “learning by doing” approach in general [32]. According to him, some subjects are more suitable to learn in an interactive way than others. He thinks “learning by doing” is not our normal form of education for two main reasons: First, it is difficult to implement as interactive “doing devices” are often not related to the subject and students have no way to build upon their experiences. For example, it is hard to learn literature or history by doing. Second, it is critical to understand what the subject that is being learned actually is and how it can be taught interactively. Otherwise, the student has not learned what the instructor was teaching. Instead, he or she focused on something else or nothing at all. However, Schank based his arguments on more practical skills, like driving or cooking, rather than classical knowledge that can be conveyed on e-learning platforms. Thus his work is not fully applicable for the integration of interactivity in e-learning environments. But it shows that it is difficult to implement and needs to be thought out carefully. It can foster learning and create engagement. But, if carried out badly,

it can demotivate students and lead to frustration without learning.

Like mentioned, engagement is a useful concept of e-learning environments as it creates a connection with a topic within an e-learning environment. It draws and holds our attention to specific areas and therefore fosters learning. Doherty and Doherty argue that engagement is “not only utilitarian but also driven by enjoyment, gamification, escapism, and fun” [14, p 99:20]. In their opinion, one of the fundamental parts of building and holding engagement of users is the students enjoyment of the content. This enjoyment can, for example, be created by humour, gamification or other methods. Engaging content can challenge learners and promote their curiosity, fantasy, and personal control. Thus it is important to enable exploration when developing interactivity as this is one of the key concepts of interactive content. In the end, the goal of implementing interactivity is to provide effective and fun e-learning experiences.

Cosmin and Mustea argue that the most important form of interaction in online courses is the interaction between the student and the content of the course [9]. This highlights the importance of implementing high-quality interactive and engaging material that fosters learning. For Cosmin and Mustea, student-teacher interaction is only the second most important part of e-learning. In their opinion, student-student interactions should be prioritized in the end [9]

Benefits and Risks

Like mentioned, the overall goal of interactive content in e-learning environments is to create more engaging content. Interactivity promises to elevate user engagement and therefore create more enjoyable learning experiences. In the end this should result in better learning results and more sustainable knowledge gain of learners. Zhang investigated the effects of interactivity in e-learning environments through experiments [38]. They confronted groups of people with highly interactive e-learning environments, less interactive e-learning environments, or traditional classroom environments. Their results suggest that more learner-content interaction improves learning performance and learner satisfaction. In interviews that were conducted after the experiments, most participants in the fully interactive e-learning group stated that they enjoyed the interactivity and flexibility in their e-learning environments. According to Zhang there may be multiple explanations why interactivity in e-learning creates engagement and therefore beneficial effects for learners [38]. They argue that, in contrast to traditional classrooms, e-learning enables the student to control the learning environment. In physical teaching, this physical control of the learning process is instructor-based and therefore a sequential process. Thus the pace and content of the learning environment follow the instructor and not the student. This

enables the implementation and creation of learner-centered activities. However, it is important that the learners in the study by [38] were adults. They argue that such learners are more committed to learning when they are interested in the subject. Thus the target group of the e-learning environment greatly influences the type of interactivity.

Interactive content in e-learning environments is sometimes implemented as fast interactions between the user and the system, especially in some gamification contexts and serious games. However, according to constructivism the learner needs to construct meaning to build knowledge. Thus time is necessary to reflect upon the consumed content. One critique of interactivity and especially gamification is that those fast-paced interactions do not sufficiently inspire reflection and therefore the construction of knowledge [14]. In contrast, effective learning environments foster such reflections. However, Doherty and Doherty argue that designers sometimes even avoid opportunities that make users reflect upon their actions and behavior. They argue that this is due to the desire to create the most engaging content without considering learning outcomes. But in the end this can lead to unwanted side-effects of interactivity in e-learning environments. Thus, slower forms of interaction are often more suitable to promote complex cognitive processes such as understanding [14].

Other possible risks of the integration of interactivity in e-learning environments include so-called “overjustification” [16]. This concept describes the psychological effect of extrinsic rewards on intrinsic motivation. Glover and [23] mention and discuss this effect in their work [16][23]. Extrinsic motivation describes rewards or motivational forces that are not relevant for the task, like money or deadlines. Behavior, driven by a personal reward, rather than an external reward is called intrinsic motivation. Overjustification can especially be a problem with the usage of gamification as extrinsic motivation through leaderboards or achievements can decrease intrinsic motivation when interactivity is implemented carelessly.

Since the internet is mostly used to provide e-learning courses, addiction is another potential risk, especially if serious games or gamification are used in the courses. Although the long-term effects of gamification are not fully understood, the combination of both, game and internet addiction, can be a problem within e-learning systems. Those two elements can encourage addictive or compulsive behavior if certain personality traits are already present.

“Is motivation actually a problem?” is the fundamental question for Glover, regarding gamification in learning systems [16]. He argues that “incorporating game-mechanics with an educational activity or process is non-trivial and cannot replace good learning design” [16, p 2004]. Thus gamification and in a broader sense interactivity is only a tool

to make learning more engaging. It can create additional learner engagement but badly implemented interactivity can result in demotivated and frustrated students. In the end, it is important to provide high-quality content within e-learning environments that also rely on other aspects, not only interactivity and enjoyment.

7 TRENDS AND OUTLOOK

As briefly shown in Section 6 virtual reality provides the most interactive content in e-learning environments. However, this field in e-learning is not very widespread in learning environments yet. But, it is a promising way to create interactivity through new technologies.

The umbrella term “virtual reality” contains mixed, augmented, and virtual reality. Those provide the most immersion of learning content and are on the top layer of the Guerra Scale. Virtual reality can be characterized as the usage of technology to create or add virtual, non-physical worlds and objects for its users. Currently, there are three main subsets of virtual reality that describe similar concepts but slightly differ in execution [17]. First, virtual reality itself refers to the usage of head-mounted displays or headsets to create environments where the user enters a virtual, non-physical world. It is the most immersive form as no interaction with real-world objects (apart from controllers) is happening. Augmented reality on the other hand creates an overlay of digital information on real-world elements. Here the user does not enter a virtual environment but rather adds virtual objects to the existing reality. Mixed reality describes something similar but combines digital with real-world items. In mixed reality, users interact and manipulate physical and virtual objects. Those technologies do not only promote learning through handling virtual objects on a screen but create the most immersive and intuitive learning experiences. Their foundations are built upon the already mentioned idea of “learning by doing” from Section 3. While traditional learning by doing approaches in e-learning try to create engagement through interactive content, virtual reality takes it a step further as students get an immersive experience through interactions with objects that feel more physical to them.

These technologies are rather young and new ways to integrate and use them in different fields are being developed continuously. Over the last few years, the market size and revenue of them grew steadily, something that is expected to continue [18]. Especially, COVID-19 restrictions are likely to boost its development. As they become more integrated into our daily lives these technologies will have a huge impact on our world. Although many argue that virtual reality technologies are most likely to be used in gaming they can also change and improve learning environments [12]. For example, new smartphone technologies allow developers to create better augmented reality applications that

can enhance our reality with additional information. This is already being used as an interactive, intuitive, and exciting way to promote learning in museums [36]. Furthermore, applications of virtual reality and similar technologies have already been discussed since the early 1990s [24]. This shows that those technologies were already considered as helpful interaction methods in learning environments since their early development days. Current trends support those ideas [12]. However, Curcio et al. argue that the usage of virtual reality might be challenging for fields such as social sciences as they are currently almost exclusively used in learning environments of natural sciences [12].

To sum up, the integration of more virtual content in learning environments will most likely continue to grow and learning will become more immersive in the future. People will use virtual reality to attend courses online and be completely embedded in those virtual learning environments as those technologies can create a more engaging and immersive experience for students.

Impact of COVID-19 on Learning Environments

In early 2020 the Coronavirus forced schools and universities worldwide to change much of their face-to-face learning environments to remote or online learning. Many people were no longer able to attend their usual learning facilities and had to adapt to e-learning. This rapid change showed many problems with e-learning environments, mainly the lack of online teaching infrastructure, the inexperience of teachers, and inequality of resources among students[5]

The European Commission Joint Research Centre argues that the impact of the closure of universities and schools made students less motivated to engage in learning activities [6]. Although this is most likely caused by a combination of a lot of different factors that are unrelated to learning itself, the lack of in-person contact had huge negative effects on students. In combination with the arguments from Carrillo and Flores it can be derived that our e-learning system was not prepared for such a situation. Moreover, it highlighted many problems with e-learning environments. It also indicated that, although e-learning may play a crucial role in future education, it can not fully replace classrooms and physical face-to-face learning environments, as they also foster social interactions with other students.

8 FURTHER RESEARCH AND LIMITATIONS

This paper gave an overview of e-learning and interactivity in e-learning. Overall the creation and integration of interactive content is a very complex topic that needs to be done carefully. It can either boost learner engagement or make them less engaged. Interactivity can influence the learning outcomes of e-learning environments as they build the foundation of learning in constructivism. However, Kaceti and

Semradova showed that students are usually aware of the risks of e-Learning [19]. Therefore a critical confrontation with possible problems of e-learning is happening. Overall many prefer a physical interaction with teachers in their learning process. In interviews with teachers and students, they discovered that the lack of personal contact may hinder students' motivation to study. Thus interactivity in blended learning needs to be further investigated, as it can utilize the benefits of both, physical classrooms and digital learning tools. In general, the usage of technology and e-learning alone does not necessarily produce a better learning experience and outcome [2]. It is necessary to create a well-designed concept and framework regarding the usage and creation of such technologies.

New interaction methods like mixed, augmented, and virtual reality will most likely become important tools for digital learning in the future. They promote more physical experiences than traditional interactive content since they challenge students to interact with learning material more actively. But Lindgren et al. argue that the usage of these technologies in learning environments is not fully understood and needs more in-depth research.

The concept of supervised versus unsupervised learning environments, introduced in Section 4, is already included in different forms in e-learning. However, further research can help the understanding of its benefits and risks, especially in synchronous and asynchronous learning environments. This might be helpful for future implementations of interactive content that use those ideas to create engagement through interactivity.

9 CONCLUSION

E-learning has become an important method to gain knowledge over the last decades. It creates virtual learning environments where students use digital technology to foster learning. This approach is usually following the constructivism learning theory as students actively “construct” knowledge. This happens through the connection of presented information with a students previous experiences. As opposed to behaviourism and cognitivism, constructivism highlights the importance of interactivity in a learning process. Therefore a goal of e-learning is to make learning more enjoyable and therefore engaging. In the end, when developing constructivist e-learning environments interactive content is crucial for learning.

As mentioned, the major goal of the usage of interactivity in e-learning is to create more engaging courses and material. This paper defined engagement as creation and holding of attention. Engaged learning therefore happens if students are drawn into the learning environment and

immerse themselves into the content. According to constructivism, interaction can create such immersive learning experiences. However, no final definition of interactivity exist since the way students can interact with content and people change rapidly. However, good interaction in e-learning consists of two important parts. The first part is the message that is being conveyed through the communication between content and learner. Second, through the digital devices that are being used to transmit those messages. Examples of interactivity are interactive videos, wiki pages, simulations, and forums. Two widely used applications of interactive content are called “Gamification” or “Serious Games”. Depending on their implementation they foster learning through the usage of game mechanics. Their goal is to employ the engaging character of games in learning environments. Furthermore, new technologies like virtual reality devices expanded the range of interactive content recently as they allow new ways to create immersive experiences.

Interactive content in e-learning generally follows a “learning by doing” approach since students actively interact with content. This is an important part of creating understanding and fosters reflection within learners' heads. However, learning by doing is hard to implement as negative side-effects can be triggered through badly integrated interactivity.

As digital technology is changing rapidly, new generations create new opportunities for content creators. Emerging tools enable different and more engaging forms of interaction. However, the development and implementation of interactive content in e-learning environments is an rapidly changing area. Often it acts as an early adopter of new technologies. For example, the usage of virtual reality technology is becoming more and more popular within learning environments.

REFERENCES

- [1] Alice Barana and Marina Marchisio. 2020. An interactive learning environment to empower engagement in Mathematics. (2020), 20.
- [2] Peter Baumgartner. 2003. E-Learning: Lerntheorien und Lernwerkzeuge. *Österreichische Zeitschrift für Berufsbildung (ÖZB)* 21, 3 (2003), 3–6.
- [3] Zane Berge. 2002. Active, Interactive, and Reflective eLearning. *Quarterly Review of Distance Education* 3 (Jan 2002).
- [4] George Bodner. 1986. Constructivism: A Theory of Knowledge. *Journal of Chemical Education* 63 (Oct 1986). <https://doi.org/10.1021/ed063p873>
- [5] Carmen Carrillo and Maria Assunção Flores. 2020. COVID-19 and teacher education: a literature review of online teaching and learning practices. *European Journal of Teacher Education* 43, 4 (Aug 2020), 466–487. <https://doi.org/10.1080/02619768.2020.1821184>
- [6] European Commission Joint Research Centre. 2020. *The likely impact of COVID-19 on education: reflections based on the existing literature and recent international datasets*. Publications Office. <https://data.europa.eu/doi/10.2760/126686>
- [7] Lim Kin Chew. 2007. Digital Content Framework. *Fourth International Conference on eLearning for Knowledge-Based Society* (2007), 8.

- [8] Ruth C. Clark and Richard E. Mayer. 2016. *e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*. John Wiley & Sons.
- [9] Herman Cosmin and Anca Mustea. 2016. The Development of Interactive Content. *Conference proceedings of eLearning and Software for Education (eLSE)* 03 (2016), 75–78.
- [10] Coursify. 2019. E-Learning Market: Trends and Forecast 2019 - 2025. <https://blog.coursify.me/en/e-learning-market-forecast-2019/>
- [11] Jay Cross. 2004. An informal history of eLearning. *On the Horizon* 12, 3 (Sep 2004), 103–110. <https://doi.org/10.1108/10748120410555340>
- [12] Igor D. D. Curcio, Anna Dipace, and Anita Norlund. 2016. Virtual realities and education. *Research on Education and Media* 8, 2 (Dec 2016), 60–68. <https://doi.org/10.1515/rem-2016-0019>
- [13] Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. From Game Design Elements to Gamefulness: Defining Gamification, Vol. 11. 9–15. <https://doi.org/10.1145/2181037.2181040>
- [14] Kevin Doherty and Gavin Doherty. 2018. Engagement in HCI: Conception, Theory and Measurement. *Comput. Surveys* 51, 5 (Nov 2018), 99:1–99:39. <https://doi.org/10.1145/3234149>
- [15] Richard Felder and Rebecca Brent. 2003. Learning by doing. *Chemical Engineering Education* 37 (Sep 2003), 282–283.
- [16] Ian Glover. 2013. Play As You Learn: Gamification as a Technique for Motivating Learners. 1999–2008.
- [17] Lauren Goode. 2019. Get Ready to Hear a Lot More About “XR”. *Wired* (May 2019). <https://www.wired.com/story/what-is-xr/>
- [18] Katharina Jochum. 2020. 2021 wird das Jahr der Virtual Reality. *Inside IT* (Oct 2020). <https://www.inside-it.ch/de/post/2021-wird-das-jahr-der-virtual-reality-20201022>
- [19] Jaroslav Kacetl and Ilona Semradova. 2020. Reflection on blended learning and e-learning – case study. *Procedia Computer Science* 176 (Jan 2020), 1322–1327. <https://doi.org/10.1016/j.procs.2020.09.141>
- [20] Spiro Kiousis. 2002. Interactivity: a concept explication. *New Media & Society* 4, 3 (Sep 2002), 355–383. <https://doi.org/10.1177/146144480200400303>
- [21] Robb Lindgren, Michael Tscholl, Shuai Wang, and Emily Johnson. 2016. Enhancing learning and engagement through embodied interaction within a mixed reality simulation. *Computers & Education* 95 (Apr 2016), 174–187. <https://doi.org/10.1016/j.compedu.2016.01.001>
- [22] Rebecca M. Logan, Cynthia E. Johnson, and Jeremy W. Worsham. 2020. Development of an e-learning module to facilitate student learning and outcomes. (Oct 2020). <https://doi.org/10.1016/j.teln.2020.10.007>
- [23] Elisa Mekler, Florian Brühlmann, Klaus Opwis, and Alexandre Tuch. 2013. Do points, levels and leaderboards harm intrinsic motivation? An empirical analysis of common gamification elements. <https://doi.org/10.1145/2583008.2583017>
- [24] Teresa Middleton. 1992. Applications of virtual reality to learning. *Interactive Learning International* 8, 4 (Oct 1992), 253–257.
- [25] Anna Morgan-Thomas and Adina Dudau. 2019. Of Possums, Hogs, and Horses: Capturing the Duality of Student Engagement in eLearning. *Academy of Management Learning & Education* 18, 4 (Mar 2019), 564–580. <https://doi.org/10.5465/amle.2018.0029>
- [26] Robert Neimeyer and Heidi Levitt. 2001. *Constructivism/constructivist methodology*. Elsevier Science, 2651–2654.
- [27] Heather O’Brien. 2016. *Theoretical Perspectives on User Engagement*. 1–26. https://doi.org/10.1007/978-3-319-27446-1_1
- [28] Harold Pashler, Mark McDaniel, Doug Rohrer, and Robert Bjork. 2008. Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest* 9 (Dec 2008), 105–119. <https://doi.org/10.1111/j.1539-6053.2009.01038.x>
- [29] Kersten Reich. 2007. Interactive Constructivism in Education. *Education and Culture* 23 (Jan 2007). <https://doi.org/10.1353/eac.2007.0011>
- [30] Rhonda Robinson, Michael Molenda, and Landra Rezabek. 2008. *Facilitating Learning*. Routledge, 27–60. <https://www.taylorfrancis.com/chapters/facilitating-learning-rhonda-robinson-michael-molenda-landra-rezabek/e/10.4324/9780203054000-8>
- [31] Luiz Rodrigues, Armando Toda, Wilk Oliveira, Paula Toledo Palomino, Anderson Avila-Santos, and Seiji Isotani. 2021. Gamification Works, but How and to Whom?: An Experimental Study in the Context of Programming Lessons. 184–190. <https://doi.org/10.1145/3408877.3432419>
- [32] Roger C. Schank. 1995. *What We Learn When We Learn by Doing*. <http://cogprints.org/637/>
- [33] Mark Simpson and Sheila Bolduc-Simpson. 2018. Interactivity: Engaging Video Activities In Online Courses. (Aug 2018). <https://doi.org/10.5281/ZENODO.1403941>
- [34] Jan Visser. 1999. Overcoming the underdevelopment of learning: A transdisciplinary view. (Jan 1999).
- [35] Zeying Wan, Yinglei Wang, and Nicole Haggerty. 2008. Why people benefit from e-learning differently: The effects of psychological processes on e-learning outcomes. *Information & Management* 45, 8 (Dec 2008), 513–521. <https://doi.org/10.1016/j.im.2008.08.003>
- [36] Rafal Wojciechowski, Krzysztof Walczak, Martin White, and Wojciech Cellary. 2004. Building Virtual and Augmented Reality museum exhibitions. In *Proceedings of the ninth international conference on 3D Web technology (Web3D '04)*. Association for Computing Machinery, 135–144. <https://doi.org/10.1145/985040.985060>
- [37] Lina Yordanova, Nadezhda Angelova, and Gabriela Kiryakova. 2015. INTERACTIVE MODELS OF E-LEARNING FOR ACTIVE LEARNING. *ARTTE Applied Researches in Technics, Technologies and Education* 3 (Dec 2015), 336–343. <https://doi.org/10.15547/artte.2015.04.008>
- [38] Dongsong Zhang. 2005. Interactive Multimedia-Based E-Learning: A Study of Effectiveness. *American Journal of Distance Education* 19, 3 (Sep 2005), 149–162. https://doi.org/10.1207/s15389286ajde1903_3