

Digital Media's Alteration Mechanism for Informal Learning

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Abstract: The main part of human learning happens en passant and mostly outside of an educational institution - called informal learning. Even pupils and students spend more time in front of digital media screens than in formal settings inside schools. Thus, their learning is strongly impacted by the use of digital media in everyday life. Current research, educational practice, and design of learning systems have their focus mostly on courseware and distance education for formal settings. The current study captures real-life learning episodes in the domains of cognitive, affective, and psychomotor learning using autovideography. Additional episodes are captured by the author applying participatory action research (PAR) in extensive field studies in different cultures. The episodes are analyzed, using different learning theories to develop a category system of alteration mechanism for informal learning using the approach of grounded theory. The main alteration mechanism identified is the extension of linear learning content to a multi-dimensional, perception sphere that is characterized by high interactivity and contingency. To utilize this alteration mechanism, one possible conclusion is that educators should neither stick to pure transfer of knowledge nor retreat to a facilitator, the latter of which is empty of content.

1 INTRODUCTION AND RESEARCH QUESTIONS

The main part of human learning happens en passant as a by-product of something else, mostly outside of an educational institution, and is naturally embedded in human life. It is non-intentional with no a priori objectives. We call this kind of learning *informal learning*. The 21st century is characterized by the advent of digital media and its ubiquitous use by humans as well as by machines to interact among each other. Young people spend, even during their life span with the highest share of formal education, more time in front of digital media screens than in formal settings inside schools. Better understanding of digital media's alteration mechanism should help to improve practice of informal learning by learners, methods of teaching, and envisioning and design of new learning environments. The aim of the study is *not* to tell educators how to better teach in the age of digital, but to have a better understanding of digital media's alteration mechanism to become capable combining different mechanisms to support learners in the best possible way. Therefore, the focus of the

present study is to understand the alteration mechanism of digital media which are used by people in their everyday life and not on dedicated courseware like MOOCs or systems for distance education. To broaden the perspective, which is currently focused on transfer knowledge from the teacher to the learner, deeper insights into basic characteristics of different learning theories and epistemologies are necessary.

To gain a better understanding for digital media's alteration mechanism on informal learning, we firstly capture real-life learning episodes via pictures, videos, and text annotations in the domains of cognitive, affective, and psychomotor learning. Next, we analyze the learning episodes through the 'glasses' of the two main learning theories of the 20th and 21st century, objectivism and constructivism, to identify basic alteration mechanisms. Finally, based on the analysis we develop a category system for those mechanisms.

2 INFORMAL LEARNING

2.1 Definition

Learning can be defined as acquiring new or modify existing knowledge, skills, competencies, and perceptions which lead to alterations in thinking, feeling, and behavior. Depending on the chosen definition of learning and its measurement only around 25 % of it happens in formal or non-formal settings. *Formal* learning is systematic organized learning within a formal learning system like universities or schools with learning specified objectives and degrees awarded by the system. *Non-formal* learning is similar but conducted outside of the formal learning system, e.g. in organizations for further education, vocational training settings, or youth organizations.

The predominant part of learning happens in *informal* settings. In these settings learning is not the main aim, it happens en passant as a by-product of something else, e.g. playing a game on the computer, competing in a bike race, or cheating during an exam. Very often the contexts for informal learning are day-to-day situations but it can also be a formal learning setting where informal learning is not intended. Normally, informal learning doesn't lead to a formal degree, whereby the formal acknowledgment of outcomes of informal learning is a widely-discussed topic. Informal learning can happen in different contexts: Family, school, work, leisure time, or social communities (Council of Europe, 2000; Ainsworth and Eaton, 2010; Harring, Witte and Burger, 2016).

In summary, informal learning is characterized by:

- Non-intentionality
- Absence of structure
- Absence of a priori set objectives,
- Occurrence in day-to-day situations outside of educational institutions
- Absence of a reward in the form of a formal degree
- Ongoing, pervasive, and natural connection with life

2.2 Domains of Learning

As shown below in the section on methodology used in this study, real-life learning episodes are captured in the form of videos, pictures, and annotations by learners. The first step of analysis is assigning them to certain learning domains. For the purposes of this study, considered learning domains are based on the well-established and widely discussed taxonomy of

learning objectives by Benjamin Bloom and his colleagues (Bloom, Englehart, Furst, Hill and Krathwohl, 1956; Krathwohl, 2002) However, as informal learning has per definition no a priori defined learning objectives, we focus more on outcomes than on objectives and use the notation of *domains*.

The focus of learning in the *cognitive domain* is on the ability to recall facts, methods and processes. Bloom and his colleagues identified six categories of cognitive learning outcomes with different levels of difficulty, in that the first must be mastered before the next. Learning in the *affective domain* (Krathwohl, Bloom and Masia, 1973) focusses on perceptions, attitudes, emotions, values, and norms. Learning in the *psychomotor domain* concerns physical coordination and movement in relationship with cognitive and affective processes. Examples are handwriting, doing sports, operating a complex machine like a car, or playing a computer game.

2.3 Informal Learning from an Objectivist Point of View

To find different alteration mechanism of digital media for informal learning we study their impact in real world learning episodes. As those episodes, like every real-world phenomenon, are very complex, we must reduce complexity by using a certain point of view, which is a dedicated 'lens' in form of a theory of learning. Many of those theories were generated during the last decades and centuries. They should explain how people learn and act as a 'lens' for observations in the field. For the purposes of this study we will look at informal learning through the lens of objectivism and constructivism and their related subcategories. For an in-depth analysis of these theories as well as their relationships to epistemology see (Harasim, 2017).

The *objectivist point* of view posits knowledge as existing objectively beyond our minds, as finite truth. It is based on the dualism of one's own mind and the world around it. The focus of *behaviorist learning theories* how particular behavior is changed by certain learnings. *Cognitivism* tries to overcome those limitations of behaviorism by understanding the 'black box' of the human mind. The focus of cognitivist learning theories is to understand mental processes to promote learning effectively.

2.4 Informal Learning from a Constructivist Point of View

Constructivism refers both to a learning theory (how humans learn) and to an epistemology (the nature of knowledge). It postulates that humans construct their own knowledge of the world by experiencing and interacting. Thus, knowledge is dynamic and changing, constructed and negotiated in social context, rather than something absolute and finite. The role of the teacher no longer is to transfer his knowledge to the brains of students effectively but to help them build their own knowledge by creating supporting environments. Glasersfeld (1995) emphasizes, that memorization and rote learning are *not* useless. But to solve problems that are not exactly presented during instruction the student requires conceptual understanding and the ability to rearrange memorized facts as well as abstract building blocks and to relate them to other already learned processes to fit the challenges of a novel problem situation.

Collaborativist learning theory is based on constructivism and emerged with the advent of networked computers. The basic assumption is that computer networking creates new opportunities to share multiple perspectives, to foster reflective thinking skills, and to build multidimensional and multidisciplinary understanding instead of the emphasis on one 'correct' answer, by interacting with others using online environments.

An example is the significant increase in the use of self-monitoring devices which create content in form of vital and performance data and share it with millions of peers on fitness platforms like Strava (www.strava.com) and Garmin Connect (connect.garmin.com). Increased awareness of exercise and nutrition as well as self-responsibility for one's own fitness and health are resulting learnings (Petrovic 2017b). Figure 1 shows the analyzing process of such a learning episode within the current study.



Figure 1: Analysis of road biking in South Korea considering different learning domains.

3 DIGITAL MEDIA AND ITS FUNCTIONS

3.1 Definition

For the scope of the present study, media should be defined as *means or channels of communication between humans, machines and humans, or among machines, creating a dedicated perception sphere for the participants of the communication process*. We do not see media just as mean to transport a certain part of reality, but to communicate certain views on reality perceived by the creator of the communication content. Because of this, media are not a substitution for reality, but a means to communicate individually perceived reality. The content of this communication process builds a sphere for the participants of the process to interpret the content individually (Pietraß, 2016). Primary media functions

The focus of the present study are digital media's alteration mechanisms for informal learning. Thus, the center of analysis are *not* empirical findings on changes in different learning settings caused by digital media or recommendation for using digital media in the context of informal learning, but *enabling factors* for such changes facilitated by digital media. The difference between those two perspectives is the *actual use* of digital media by humans or machines. This allows firstly, to better understand the reasons for observed changes in learning and their relationship to digital media and secondly, to envision and design new learning environments. The starting point of the intended category system of alteration mechanisms are *primary media functions* which are properties of media to support handling of the communication content (Keil-Slawik and Selke, 1998; Selke, 2008).

Create and delete allows to produce and delete communication content e.g. symbols like letters, pictures, videos, drawings, or models. An example of using this primary function at the level of secondary function is the ability to make pictures and videos with omnipresent smartphones. Normally, the creator of a content assumes its permanency until someone delete it. Thus, deletion is a related function of media. Examples of digital medias alteration in deletion are Snapchat with its value proposition of deletion after some seconds or contrary, the violent discussion on the 'right to be forgotten' in the universe of digital media.

Arrange and link facilitates the organization of communication content. By arranging, the content is grouped together in spatial proximity within a certain perception sphere. Examples are digital documents

stored in the same folder or organic results of Google search. Thus, arranging is not a characteristic of the content itself as the spatial proximity is generated by human intervention or software algorithm without changing the content entity. Linking implies a reference within the communication content to some other to show relationships. Therefore, it is a property of the communication content. Examples of using that primary function are hypertext links or recommendations on e-commerce sites. Arrange and link are the core functions for creating a perception sphere, contrary to a single linear information entity. Thus, arrange and link is one of digital media's most powerful alteration mechanism for informal learning.

Transmit and access comprises the exchange of information content between humans, humans and machines, or directly between machines without human intervention as discussed in the context of internet of things (Petrovic, 2017c). A core characteristic of transmit is the existence of a certain addressee of the communication content. Therefore, transmit leads to push communication in one-to-one, one-to-many, many-to-one, or many-to-many settings. Examples for using that alteration mechanism on the level of secondary media functions are sending emails or making video calls. Contrary to transmit, *access* doesn't require any intervention of communication content's creator after creation. Others access the content in the perception sphere in a pull mode based on their access rights. Examples are the access of web sites or the use of social media groups.

3.2 Types of Digital Media

After the widespread use of the personal computers and the launch of the Internet in 1989 followed by the rise of social media around 2004, settings like computer based training and intelligent tutoring systems, followed by MOOCs (massive open online learning), PLEs (personalized learning environments) and ALS (adaptive learning systems), and online communities of practice became part of learning processes (Harasim, 2017, Kindle-Position 4178). As all those systems are designed and used explicitly to support formal learning, they are not in the focus of the present study, as it deals with informal learning and its core characteristic of *not-intentionality*. In the present study, the focus lies on digital media used by learners in their everyday life, e.g. popular social media sites, online games, or browsing the World Wide Web. Figure 2 shows the use of popular forms of digital media and compares it with traditional media. There are different potential criteria to build a

typology of digital media, for an extensive review see (Salaverría, 2017).

The focus of Figure 2 is on media whose content is generated by humans, like online press. Currently, software agents, often called *bots*, strongly gain in importance for all primary media functions mentioned above. They can be embedded in other software, act invisibly to human users, and create, arrange, and transfer communication content automatically without human intervention. Further types of communication content generated by machines are performance and vital data in the field of self-monitoring captured by sensors (Petrovic, 2017b) or results of search engines and recommender systems. All these examples support the notion that digital media is used for communication between machines and humans..

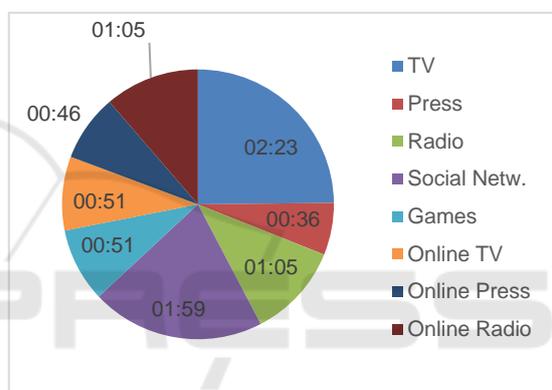


Figure 2: Daily media consumption in hours, n=153.501, age 16-64, 36 countries around the world (source: globalwebindex 2017). Other online activities like browsing and e-commerce not included.

4 FINDINGS FROM THE FIELD

4.1 Research Question

The main aim of the present study is to better understand the alteration mechanism of digital media for informal learning. This broadened understanding can help improve practice of informal learning by learners as methods of teaching, and to envision and design new learning environments. Therefore, the research question is: *What are digital media's alteration mechanism for informal learning?* It's not the aim to find representative results for a certain population or to evaluate a certain technical system. Thus, the methodology applied is selected by its added value to gain insights into digital media's alteration mechanism on learning and not its

representativeness for a certain population, as is often the goal of quantitative methods.

4.2 Methodology

The methodology used for capturing learning episodes in the field *by learners themselves* in form of video, pictures, and annotations is based on autovideography and photovoice (Goo Kuratani and Lai, 2011; Woodgate, Zurba and Tennent, 2017; Wang and Burris, 1997). Additional learning episodes are captured by the author using participatory action research (PAR) in extensive field studies, also applying videography. To analyze those data qualitative content analysis and grounded theory (Charmaz, 2014) is applied. Subsequently to ten years of preceding studies with several hundreds of participants as shown in (Petrovic, 2017a) 50 learners in two master courses grouped into 10 teams were asked to capture real-life informal learning episodes with their own smartphones in form of pictures, videos, and text annotations and to send them to a blog for immediate sharing with other participants of the study. Previously, the main characteristics of informal learning and different learning domains were presented and discussed and the learners received the task to study basic literature on both topics. Also, the aims, the methodology, and the procedure of the study were presented and discussed. After capturing and analyzing the learning episodes they were presented to the research team. Both, the

captured material in form of pictures, videos, and annotations as well as the *analysis* by the learners themselves represented the input data for the research team. Additionally, the research team also captured some learning episodes to fill gaps in data for certain learning domains as mentioned by learners such as 'I have liked to capture ...' (see Figure 1 for an example).

The whole analyzing process of the learning episodes was performed with the software MAXQDA. The *first step* of the research analysis was to assign the learning episodes or certain parts of them to one or more learning domains. For this, the learning episodes were analyzed according to the main characteristics of cognitive, affective, and psychomotor learning. If single parts of the learning episode were related to different learning domains, those parts were marked and assigned within MAXQDA separately. The *second step* was to analyze the learning episodes once with the 'glasses' of objectivist and in a second run with those of a constructivist point of view together with their related learning theories. The focus of that analysis was to identify alteration mechanism of digital media in the three different learning domains. As a starting point, the identified alteration mechanisms were categorized based on a tentative category system deduced from theoretical concepts. According to the methodological approach of qualitative content analysis and grounded theory the category system was further developed iteratively during the process of analysis. Same or similar alteration mechanism where grouped together and groups of mechanism were assigned to main groups. During this process, the research team looked out for coherent mechanisms, plausible relations between them, and aimed to reach an exhaustive category system. The main guideline during the whole analysis was the additional value of categories concerning the research questions.

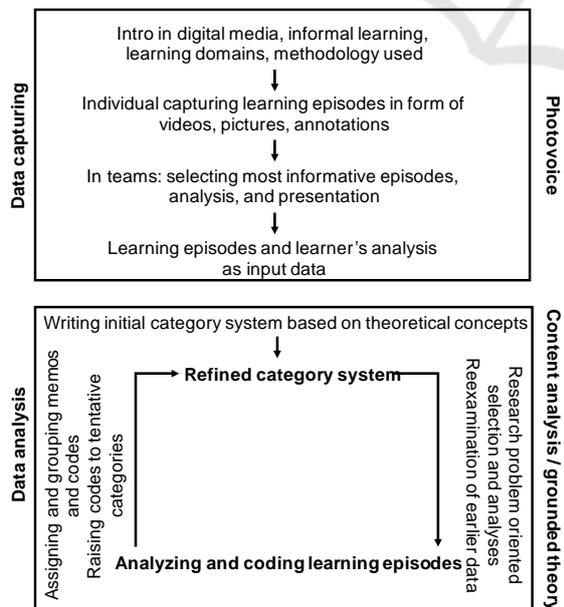


Figure 3: Methodology used to gain insights into digital media's alteration mechanism.

4.3 Findings

Table 1 shows digital media's core alteration mechanism for informal learning as found after several iterative cycles between analyzing and categorizing captured learning episodes on the one hand, and theoretical views from learning theory and epistemology on different learning domains on the other hand. This categorization is neither exhaustive nor mutually exclusive. In traditional media like printed newspaper the three domains of *create and delete, arrange and link, and transmit and access* to a great extent form a linear step-by-step sequence of

activities, ranging from writing an article by an editor to reading the newspaper by the reader. In a perception sphere including digital media this is not the case. An activity in one domain immediately triggers mechanism in another one, whereas this alteration initiates further mechanism. Simultaneously, one communication activity is mostly impacted by different related alteration mechanisms at the same time. The resulting interdependent communication contents form the perception sphere. Communication content is not only *created* by humans or machines explicitly in form of dedicated entities, but also by *arranging and linking* them and the dynamics of its structure. A certain browsing behavior creates a new perspective on communication content and thus, it leads to altered content within the perception sphere. Relations between content in form of spatial proximity like search results or semantical proximity due to linking create new content and become important parts of the perception sphere. Also, the behavior in *accessing* creates new content, e.g. due to traced user behavior and deduced recommendations such as ‘most read’ or ‘other users also looked at ...’.

The alteration mechanisms in Table 1 are enabling factors for higher degree of freedom in shaping content nodes and relationships within a perception sphere where informal learning happens. They shouldn't be seen as totally new capabilities or as inevitable improvement or deterioration of informal learning due to the advent of digital media.

Table 1: Digital media's alteration mechanisms for informal learning.

Domain of alteration mechanism	Alteration mechanism
Create and delete	1. Medialization 2. Omnipresent means of production 3. Real time reach 4. Copy-ability without loss and marginal costs 5. Traceability 6. No doubtfulness of deletion
Arrange and link	1. Divisibility 2. Multi-perspectivity 3. Associativity
Transmit and access	1. Efficient transmission 2. Immediacy 3. Searchability 4. Interactivity and Contingency 5. Ubiquity

4.3.1 Create and Delete

Medialization means the representation of a certain communication content via a digital media instead of by the physical environment. A learning episode found in the psychomotor domain was playing tennis with Nintendo's Wii in front of a screen instead of on a physical tennis court. This medialization leads to a medial difference (Pietraß, 2016) between the physical environment and the learning environment including digital media. Therefore, the learning environment doesn't represent the physical environment but becomes a new perception sphere with its own information content, linkage, forms of access (swinging the virtual tennis racket), and social rules. For the learner, it is 'reality' like playing on the court, but a different one. From a constructivist point of view, both realities are created by the learner himself. Nintendo's game designers have that in mind and don't try to imitate the physical game perfectly but exploit digital media's alteration mechanism. A further lucid learning episode found was remote control a flying drone. The medial difference to a human which cannot fly is so big that together with the alteration mechanism of multi-perspectivity sustained affective learning is stimulated, particularly considering values and norms. Informal learning happens more and more in environments which are created by humans and machines instead by evolution respectively God's design.

Traditional media requires rare and expensive means of production like presses, broadcasting stations, and complex logistic systems. Means of production of digital media are *omnipresent* in form

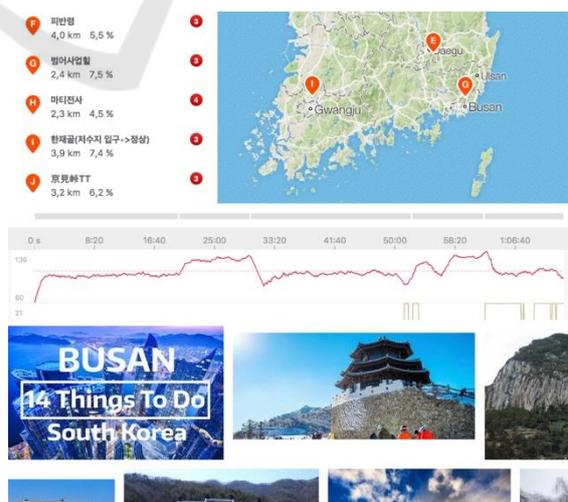


Figure 4: Tracing a bike ride opens informal learning opportunities on local history, culture and geographic.

of smartphones, personal computers, computerized things of daily life, and the Internet. The ubiquitous use of digital media leads to continuous informal learning, largely independently from intentions, structures, and activities of the formal education system and its teachers. That means, that learning happens more and more independent from traditional authorities like parents, teachers, or publishers.

Digital media's omnipresence together with its efficient transmission of communication content leads to an increase in *real time reach*. For example, immediately after writing a blog post it can be read by thousands and millions of other people as well as by machine based agents. This works similarly for real time sharing of performance and vital data on fitness platforms as shown in Figure 1. No layouting, printing, physical distribution, and scanning to make the content readable by machines is necessary. Therefore, informal learning can utilize more content with promptness as core value. At the same time, also the critical analysis and embedding in one's own point of view, often seen as the opposite of promptness, can lead to informal learning processes based on digital media. Both promptness and in-depth analysis happen in the learning episode shown in Figure 1. Informal learning gains more degrees of freedom by combining different alteration mechanisms and doesn't solely suffer changes induced by digital media.

While creating communication content, it can be copied without loss in quality, with no or extremely low marginal cost, and without much time needed. This *Copy-ability* leads to a significant increase in content in form of text, pictures, video, and linkages between them, and consequently leads to a strongly extended perception sphere for informal learning. Growing demands concerning learning in the affective domain is a consequence for learning, particularly in the field of receiving including awareness and willingness to hear and give attention to a certain issue. This alteration mechanism could be a fruitful connecting point between informal learning and formal settings with teachers – not only by 'teaching' media literacy but mainly by building a scaffold to learn informally in the fields of awareness and willingness during daily life behavior.

Traceability is mostly seen as an alteration mechanism for the domain of transmission and access. But it also strongly alters the creation of content. Every activity with digital media is traced, whether someone wants that or not – otherwise digital media wouldn't work technically. Google's organic search results as important communication content are strongly based on the search behavior of humans

and machines. Tracing user behavior enables recommendations on e-commerce sites as personalized news feeds. Whereas the tracing is always done by machines, its object can be the behavior of humans, for example clicking patterns, or of machines, such as web crawlers which generate around a third of the Internet traffic. The results of tracing can be analyzed and used by humans or automatically by machines like the personalized arrangement of content by Facebook, which permanently creates new content. The consequence of that alteration mechanism for informal learning is more communications content on the one hand and an increased richness of it on the other hand. As shown in Figure 4, tracing vital and performance data from one's own bike ride or from live tracking shared by peers on platforms like Strava, Garmin Connect, or Komoot opens possibilities for informal learning on geographic characteristics of the environment, recommended sightseeing opportunities, or historical and cultural insights into cities along the route. This alteration mechanism can bridge psychomotor activities with informal learning within the cognitive and affective domain.

The alteration mechanisms of copy-ability, efficient transmission, and real time reach lead to *no doubtlessness of deletion*. Immediately after its creation, the communication content can be disseminated widely within the whole Internet and other networks with or without human intervention. Due to the impossibility of knowing the number of indistinguishable copies of certain content and their current storage location, it's hard to imagine that somebody can guarantee the full removal of certain communication content. That is the root of the discussion on 'the right to be forgotten', started by Mayer-Schönberger (2011) and that was taken up by the European Commission. This alteration mechanism expands possibilities for informal learning as it extends the perception sphere with content, which otherwise would be deleted or disappeared. On the other hand, it can also inhibit learner's willingness to share opinions and personal data, and thus, also opportunities for one's own and other's informal learning shrink.

4.3.2 Arrange and Link

Divisibility offers the possibility to split communication content into any number of packages for re-arranging and separate sharing. A widespread example is play lists for audio and video files. This alteration mechanism can be directly led back to technical implications of digitalization, specifically

discretization of signals. It facilitates micro learning, using small packages of learning content ‘on-demand’, e.g. while using a certain software product. These packages are context sensitive and personalized taking into account the learner’s actual need in real time – often resulting from a quick Google search. Consequently, en passant micro learning in the sense of informal learning increasingly replaces formal learning in traditional seminars on using certain software.

Multi-perspectivity allows the arrangement of communication content, or certain parts of it, in spatial proximity to other content. Because of this changed context, the content gain added value which can be used for informal learning. An example is displaying blog posts arranged by author, date, certain predefined topics, or tags. In a broader sense, also individual browsing after querying a search engine creates a unique perspective on existing content. It’s unlikely that another user searching for the same item in the same content will apply the same browsing sequence. Thus, every user generates its own perspective depending on its clicking and browsing behavior. That multi-perspectivity results in alterations in the cognitive learning domain, for example by finding different applications of a certain mathematical formula. Therefore, the learner can gain a deeper understanding and can bring his knowledge from the low level of recalling the formula to applying it for different problems.

Associativity is best known by hyperlinks embedded in communication content and by recommender systems. Because of this embedding, the content itself changes and gains a new quality. This alteration mechanism is closely related to multi-perspectivity and both are core building blocks of digital media’s alteration mechanism for informal learning. It not only leads to alterations in the cognitive learning domain as shown in the example above, but also in the affective learning domain. Associativity helps the learner to explore communication content triggered by a sudden perception, desire, emotion, or just by chance. Thus, he can gain awareness for a new issue, explore it immediately, and induce different valuing of a certain domain. For example, someone hears streamed music from a certain musician on a Tablet or PC, learns that the artist changed his name several years ago, searches in Google to find out why, and ends up reading about a different religion largely unknown to him so far. At the same time, this is an example for wander off the point caused by associativity and how hard it can be to stay attentive and concentrated on what you are doing at the moment. Thus, we speak in

this study of ‘alterations’ and not ‘improvements’ for informal learning.

The alteration mechanism of arrange and link facilitates the shift from a mostly linear, self-contained content like a book or a movie to a multidimensional and open perception sphere. *Therefore, associativity is probably the most important alteration mechanism for informal learning.*

From the perspective of social systems theory, that perception sphere is an autopoietic system, characterized by a high level of contingency (Luhmann, 1996). Its participants are not only humans but also machines controlled by algorithm, equipped with self-learning capabilities based on artificial intelligence. In those algorithms functionalities are embedded that are similar to learning in the affective domain, making changes in giving *attention* to a certain issue, for example by an adapted search strategy. Examples for alterations in *responding* are automatic generated Likes or blog posts, and highly personalized intelligent agents for changing *habitual behavior*. Currently, those algorithms try to catch up to human intelligence which is ‘strong’ particularly because of three capabilities: defining its own problem to be solved, specifying and adapting the problem-solving algorithm by itself, and modifying hardware during the process of problem solving, like changes in synapses of the human brain. When machines and its embedded algorithm achieve that goal and its algorithm are no longer programmed by humans but by machines themselves, the point of Singularity is reached (Kurzweil, 2005).

4.3.3 Transmit and Access

Efficient transmission as an alteration mechanism is widely discussed and facilitates the transmission of more communication content, without loss of quality, and with no or very low time delay and marginal costs for half of mankind. It’s also discussed comprehensively from a theoretical point of view, like in economic theories including transaction cost and principal agent theory. It has its origin directly in the technical capabilities of digitalization and is the basis for other alteration mechanism. Therefore, its alterations for informal learning are discussed in connection with other mechanisms.

Immediacy is the counterpart to the alteration mechanism of real time reach as discussed above in the section on the domain ‘create and delete’. The time lag between the creation of a certain communication content and learner’s awareness for it

shrinks or disappears entirely. More and more content with high promptness become available. Because of disintermediation of intermediaries like journalists, publishers, or teachers also authenticity of communication content can increase. For a fruitful use of that authenticity in relation with a strongly increased quantity of communication content, competencies out of the affective domain like awareness, giving attention, responding, valuing, and organizing must be further developed. This need can become a valuable trigger for informal learning processes.

Searchability is mainly based on the alteration mechanism of medialization, traceability, and efficient transmission. It facilitates search for a certain content, relations to other content, for meta information like author, date and place of creation, or certain tags. The search can be triggered by humans or by machines; also the results can be used by both. Because of the alteration mechanism of efficient transmission, the search can be done with no or very little time needed and marginal costs within huge quantities of communication content. From a constructivist point of view, search results are not a characteristic of the underlying communication content but they *are* the content. Only the results of transmit and access can be perceived by humans and by machines. Therefore, search and access tools are not neutral means for better use of the perception sphere; instead they are very significant content creators within it.

Interactivity is characterized by the relation of certain communication content to several previous ones (Rafaeli, 1988). Also, interactivity is enabled and used by human and machine based participants of the perception sphere and creates new communication content within it in relation with the alteration mechanism of associativity. *Contingency* means, that the outcome of a certain interaction is open in principal (Luhmann, 1996). Thus, it is the content for learning also. Interactivity and contingency together with arrange and link create the most *significant* alterations for informal learning and lead to a strong decrease of learning control by traditional authorities like educators, parents, or publishers. Simultaneously, for the learner, it creates numerous new opportunities to construct own knowledge as core characteristic of learning from a constructivist point of view.

Ubiquity means, that communication content is available anytime and everywhere. The perception sphere for informal learning is no longer limited to communicating participants like human teachers, textbooks, natural environment or smartphones and

gaming consoles. It includes more and more everyday objects like a pair of glasses, watches, refrigerators, LED Lamps or sensors for vital and performance data as discussed above in the context of Internet of Things. As informal learning often happens en passant during everyday life, ubiquity highlights the importance, especially for teachers, to look beyond digital media dedicated developed for learning, like courseware or distance education.

5 CONCLUSION AND FURTHER RESEARCH

Digital media extend learners' perception sphere strongly, and therefore the opportunities for informal learning. The discussed alteration mechanisms lead to everyday life environments with high interactivity and contingency in contrast to linear, predefined content mostly used in formal learning settings. Today, educators have their focus mostly on digital media supporting their teaching, like courseware or distance education, turning a blind eye to the main part of students' learning – the informal part. To fully utilize digital media's alteration mechanism, educators should neither stick to pure transfer of knowledge nor retreat to a facilitator role, the latter of which is empty of content. Utilizing digital media's alteration mechanism, he can head for being a renowned source of knowledge *and* to focus the interaction process, introduce appropriate concepts of the discipline, and help to reach intellectual convergence. Without this convergence, because of fully individualized learning styles and contents, social cohesion will shrink as people can no longer communicate among each other due to the lack of mental connectability.

Future research will cover a deeper analysis of captured learning episodes to further refine and evaluate the category system of alterations. Also, capturing learning episodes in additional cultural areas is planned to better understand differences in alterations for learning *despite* a globalized world. Finally, the alteration mechanism will be deepened on selected learning domains and digital media, for example on the affective domain and self-monitoring.

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