D-Move: Ten Years Experience with a Learning Environment for Digital Natives

Otto Petrovic

Institute for Information Science and Information Systems, Karl-Franzens-University of Graz,
Universitaetsstrasse 15/G3, AT-8010 Graz, Austria

Keywords: Digital Natives, Learning Environment, Learning Method, Delphi, Collaborative Learning, e-Learning.

Abstract: D-Move is a learning environment for Digital Natives, composed of different software modules and learning methods, mainly based on constructivist-connectivist learning theories. Digital Natives have the Internet as their mother tongue and probably require different learning approaches. D-Move started more than ten years ago with the aim to reach learning objectives in settings that are part of Digital Natives' everyday life. The article shows the results of three different phases: Text messaging, multi-channel support and finally, expansion by a Delphi-based research environment.

1 CHALLENGES FOR DIGITAL NATIVES' LEARNING ENVIRONMENTS

Digital Natives' mother tongue is the Internet and the digital language of computers (Jones 2011). They are born after 1980 and are raised with digital technologies. They are used to obtaining information quickly, possess a high amount of ad-hoc-communication, work and communicate in form of multitasking and use mostly interactive digital media. As a consequence, new challenges for learning environments evolve to support them. To design the learning environment D-Move we identified five key challenges:

Increasing Amount of Information

Digital Natives are faced with a much higher amount of information than their parents. Furthermore, distinguishing between important and less important information is becoming more and more difficult. Thus, only providing more information is viewed by Digital Natives not only as useless but even as harmful (BITKOM 2014). One important way to solve this is to move from pure consumption of broadcasted information such as in television or traditional lectures to self-directed acquirement of knowledge and competencies by acting in the real world (Klippert 1999).

Increasing Need for Authenticity

The strongly increased amount of information sources lead to greater difficulties in verifying the source of information. Search engines, used as the main information source of Digital Natives, deliver a vast amount of information but verifying them leads to discomfort and uncertainty. Thus, the need for authenticity of information sources increases. One strategy to reach this goal is to obtain the information and knowledge in real world practice or at least in learning environments that are perceived as being close to reality (Linten 2009).

From Lean Back to Lean Forward

More and more Digital Natives prefer lean forward media with a high amount of personal engagement and interactivity. They like to create content by themselves in form of pictures and videos, posts or comments and share them within their social media networks. Thus, they take over core competencies from traditional information sources like newspapers or television as well as lectures at a university (Tapscott und Williams 2008). This active role of Digital Natives in learning processes are based on co-production of learning content in highly engaged social processes (Lee und McLoughlin 2010, Alur et al. 2002). One outcome of this development is a high demand for lean forward functionalities of learning environments to co-produce and share learning content by the learners in real world settings.

High Importance of Peer Group

Peer groups with similar interests, age, background or social status gain importance in producing, acquiring and assessing learning content. Traditional authorities like parents, teachers or politicians are becoming less important as a main information source. This tends to result in more self-responsibility of learners for processes and content of learning and in an altered role of teachers from embodying the main source of information to being the moderator and enabler of learning processes by offering learning environments and connecting learners (Kuhlmann und Sauter 2008). Digital Natives are used to applying their own learning strategies, speed and locations (Handke und Schäfer 2012). The critical point of this trend is the spill-over to fact-based learning. To learn when Napoleon Bonaparte lived by asking peer groups can lead to an inefficient exchange of ignorance.

Increased Use of Digital Media

The use of digital media is very familiar to Digital Natives, because they grow up with them. Digital media are as intimate as face-to-face settings and much more familiar than the traditional media of their parents' generation like newspapers or television (Meyen, 2009). But recent findings show that in different groups of Digital Natives different digital media are more common than in other groups. For instance, Facebook is a main media for mature Digital Natives while Snapchat is much more common in younger age groups. The latter is as unfamiliar for mature Digital Natives as it is for their parents' generation. Thus, we have to distinguish the media usage between different groups of Digital Natives (Petrovic 2017). As changes in media usage always lead to social and cultural changes, they also affect the behavior of learners and as a consequence learning methods and processes (Hepp 2011).

Those five challenges for a learning environment to support learning processes of Digital Natives are *still the main requirements* for D-Move after more than ten years of experimental design, development, usage and evaluation. The main changes during that time are based on *technological innovations*, *changes in media usage* by the learners in their everyday life and *learnings from applying* D-Move.

2 TEN YEARS EXPERIENCE WITH D-MOVE

D-Move is a learning environment for Digital Natives, composed of different software modules and learning methods to support Digital Natives to learn how to solve novel problems. These types of problems are characterized by Glaserfeld (1995): "The solving of problems that are not precisely those presented in the preceding course of instruction requires conceptual understanding …" Thus, it should support the building of 'strong intelligence', the big advantage of humans over computers. This is characterized by own intentions of the system based on self-reflection, emotions or social values and norms, the ability to enhance the problem-solving algorithm during run-time and finally, to modify their 'hardware' autonomously - in the case of a human being, the synapses of the brain - to better solve the problem (Luger 2008). The following aspects are mainly based on constructivism (Glaserfeld 1995, Foerster 1992) and connectivism (Siemens 2005) based learning theories. Those approaches suggest that humans construct knowledge and meaning from their experiences and their interaction with others within networks.

Since back in 2005 the basic aim of D-Move remains the same: *To learn how to solve novel problems in settings that are part of Digital Natives' everyday life.* This includes not only everyday life experiences but also the methods and media of communication and information sourcing which are familiar to a certain group of Digital Natives. Due to changes in available technologies and styles of communication among Digital Natives the implementation of D-Move ranges from text messaging in the early implementation to Snapchat Delphi in current implementations. D-Move is based on evolved learning methods and digital media used to meet the challenges of increasing amount of information, the trend from lean back to lean forward media, the increasing need for authenticity, the high importance of peer groups and the increased use of digital media. The author wants to stress that D-Move is *not an attempt to build the 'best' learning environment for Digital Natives*. On the contrary, Digital Natives call for different learning methods and environments - one of these could be D-Move (see also Dodero, J.M., et al. 2015).

2.1 Phase 1: The Early Years

The first instance of D-Move was designed back in 2005 by the author of this paper and implemented together with partners from six countries in a large-scale international research project supported by the European Union (Petrovic & Brand 2009). To fulfill the requirements shown above the learners were asked to identify and analyze real world phenomenon that are connected to certain learning

topics of the particular course. For this purpose, teams of five to six students were built and informed by text messages about a certain real world situation near the university. Their task was to go to this location, analyze the situation by using the methods learned in class and find similar situations at other locations. Text messaging was used to inform the students via an alert and to support communication between them. To document and comment the real world situation using text and pictures a basic blog system was implemented. Due to a limited time span between sending out the text alert and closing the blog, during which also a competition in which contributions of each team was evaluated, a close connection to real business settings was able to be obtained.

The main learnings from those early years, which still have high relevance for current learning environments, are threefold (Petrovic 2008, Petrovic 2008a, Petrovic 2008b). Firstly, there was a *huge difference in innovation openness among students*. Just a small share of the students was pleased from the beginning with the additional method of learning introduced in particular courses. They were asked at the beginning of the term who wanted to participate in the group with D-Move and who preferred the traditional classroom setting. The majority voted for the traditional setting. The factors influencing this decision were increased effort, unfamiliarity, unwillingness to spend spare time and additional costs incurred for traveling to the locations and for the communication via mobile phones. Secondly, there was a *high group dynamic among the students* in changing their willingness to adopt the new learning environment. After a dedicated statement of the lecturer about the differences between successful and less successful students regarding their openness for innovations, the first learners switched over to the group using D-Move. After those early adopters explained their reasons for changing their mind, more and more students wanted to be part of the D-Move group. In the end, very few were left over in the traditional group. Thus, in our experience traditional surveys exploring acceptance of future technologies that neglect those dynamic changes of mind can lead to wrong conclusions. The third main finding was the *resistance to merge private life with learning settings at the university*. This includes leisure time versus learning time at the university as well as using a very personal and intimate device like the own mobile phone for tasks at the university. Due to current increased tendencies to merge work time with leisure time, e.g. by checking e-mails or posting work related topics in social

media at home, this resistance is becoming less important in current implementations of D-Move.

2.2 Phase 2: Multi-channel Everyday Life Learning Environment

2.2.1 System Functionalities based on Learning Theories and Models

The next step in advancing D-Move was to enable multi-channel, multi-media and multi-device interaction between learners and also with lecturers. The driving force was the mobile Internet and social media, both of which have become ubiquitous in everyday life of Digital Natives. Because of the main aim of D-Move to offer a learning environment that corresponds to learners' communication in everyday life and their information sourcing, especially the technology platform of D-Move has changed.

D-Move can be characterized by learning theories that form the basis, the learning methods used and features of the technical platform. D-Move is mainly based on *contructivist-connectivist learning theories* (Brunner 2009, Siemens, G. 2005). Constructivism suggests that humans construct knowledge and meaning from their experiences. New information is linked to prior knowledge; as a consequence, mental representations of the reality are subjective. From a connectivist point of view, learning occurs distributed in different networks, is socially and technologically enhanced and is based on recognizing and interpreting patterns within those different networks. Both approaches are central starting points for the functional design of D-Move. In contrast to learning based on case studies, the learning content is not only as close as possible to reality but the real world experiences of learners form the learning content. Additionally, the media and the kinds of social interaction used in learning are the same as used by learners in everyday life. To reduce the time gap between learning certain facts or methods in classroom teaching and applying them in real life, D-Move supports both styles of learning and bridges them.

Regarding the used *learning methods* D-Move mainly supports approaches that help gain experiences and observations in real life. Different ethnographic methods like participant observation, field protocols and picture- and video-based documentation are implemented to observe social interaction as well as interaction of humans with technical artifacts in vivo. Also, cooperative learning is supported to enable learning by interaction with peer groups (Anderson et al. 1996).

The *features of the technical platform* can be classified into front end and back end features. One central design requirement was the support of multi-devices to collect, assess, enrich and share observations in the field and to interact with other learners as well as with lecturers. To support many different smartphone types with varying screen sizes, computing power, local storage and network speed, D-Move can be fully utilized by *standard web browsers* preinstalled on common smartphones, tablets and desktops. The installation of a dedicated client application is not necessary, which strongly enlarges the range of supported smartphones as well as the willingness of the learners to use D-Move on their own private devices. Additionally, *native apps* which run on the client device can be used for special functionalities to collect, assess and share observation data in the form of text, pictures and video. The implemented interfaces allow the learners to use familiar standard apps such as Facebook, WhatsApp, Snapchat or Instagram as well as dedicated apps for ethnographic field work to interact with the back end of D-Move. This multi-channel, multi-device, multi-media approach supports the central requirement of being as close as possible to the ‚natural' communication behavior of the learners.

The *backend features* of D-Move are based on an *information repository* to store collected data in the form of text, pictures and videos in combination with annotations made by the learners and interaction content with peer groups and lecturers. The content of the information repository is delivered from the front end via interfaces to the *data integration module* that supports online and offline data transfer. The latter is useful for fieldwork with no, poor or too expensive online connectivity of the front ends used. The *data manipulation module* supports basic content editing, annotations of collected data in the form of text, pictures, voice and videos as well as classification of collected observation content by adding metadata and tags. The *sharing and interaction module* enables collaborative learning by using interfaces with widespread social media to support common communication patterns of Digital Natives. It also offers proprietary sharing and interaction features for situations where a separation of learning oriented and private communication is preferred. The *storage module* offers a space to distribute learning material among learners and to share documents, pictures and videos generated by the learners to document their observations. The *access control module* allows the governing of rights to read and modify data from other learners.

A main paradigm of the development of D-Move is to implement, parameterize and use *standard software* as far as possible instead of developing the system from scratch. Despite the advantages of time, costs and quality a central goal is still to offer tools that Digital Natives are familiar with. On the other hand, as mentioned above recent findings show that different groups of Digital Natives call for different front ends to collect observation data (Petrovic 2017). This approach also allows for the inclusion of future front ends that are not yet known today but may possibly be used by millions within some years.

Figure 1: Collecting and annotating observation data in the front end to transfer it for storing, editing and sharing using the back end.

2.2.2 Example of Applying and Evaluating D-Move in Phase 2

The following case shows the use of D-Move in a Master Course on the diffusion of innovations (Rogers 2003) and technology acceptance models like TAM (Davis et al. 1989) and its successors. In the first phase, the lecturer gave *theoretical input* in a traditional course setting to 25 master students. The second phase included the *fieldwork* based on D-Move. Students started by developing concepts to perform the fieldwork to identify critical acceptance issues in innovative approaches for last-mile-logistics like pickup-boxes, click-and-collect or same-day-delivery (Petrovic et al. 2013). The students made videos of customers using innovative technologies for parcel delivery and conducted on the spot interviews regarding the customer's experience immediately after use of the technology. Afterwards, they analyzed both results in regards to the underlying acceptance model. The main findings were annotated graphically and textually directly inside the recorded video using the information repository of D-Move. The students' final step was to *summarize the findings* in a report, which was also uploaded to D-Move. In a *presentation* attended by all students they explained their findings in detail and discussed differences between the observed delivery technologies as well as their experiences in

applying the different technology acceptance models.

After finishing the course, an *evaluation* was carried out to analyze the impact of D-Move on learning process and learning outcome compared to traditional paper-based case study learning. The evaluation covered five constructs: Activation, emotion, satisfaction with the learning process, perceived learning success and satisfaction with D-Move. Compared to paper-based case study learning, the environment shows a high degree of activation. It also shows that the learning environment evokes stronger positive emotions for students. In terms of satisfaction with the learning process, D-Move was viewed as strongly positive. The students appreciated the freedom to discover things themselves ($\mu = 1.7$), the use of independent judgment ($\mu = 1.7$), the possibility to reflect observations ($\mu = 1.6$), the demand for individual initiative ($\mu = 1.4$), and the feeling of being actively involved ($\mu = 1.6$). Also for the items of perceived learning success positive results were obtained. This includes the ability to understand relationships ($\mu = 2.1$) and to apply newly acquired knowledge ($\mu = 2.1$). The overall satisfaction with D-Move was also perceived positively. For a detailed presentation and discussion of the results see Petrovic 2016.

Table 1: Evaluation results for D-Move applied in a course on diffusion of innovations and technology acceptance by comparison to case study teaching.

Construct	Item	α*	µ**
Activation	Energetic activation	0,84	1,7
Emotion	Interest	0,58	2,0
	Surprise	0,95	2,5
Satisfaction with the learning process	Free space	0,74	1,7
	Personal judgment		1,7
	Reflection		1,6
	Personal initiative		1,4
	Involvement		1,6
Perceived learning success	Correlations	0,55	2,1
	Practical application		2,1
	Know How		2,4
	New knowledge		2,2
	Media competence		1,7
Satisfaction with the learning environment	Sharing options	0,78	1,4
	Location independence		1,7
	Traceability		1,4
	Usefulness		1,4
	Transferability		1,4

Scale: 1.. much better, 5.. much worse, * α Cronbach's Alpha, ** µ Mean value

2.2.3 Learnings in Phase 2

Several applications of D-Move during phase 2 leads, among others, to three main learnings. Firstly, compared with conventional paper-based case study learning, *learning process and outcomes were perceived by the learners as superior*. Thus, D-Move is an alternative to traditional case study teaching. As D-Move was always implemented together with classroom lectures, findings on the acquisition of fact-based knowledge cannot be deduced. Secondly, the main part of students' workload is performed outside the classroom during the field observations or in form of document preparations at home. This leads to *conflicts with traditional regulations for courses* like grading on the basis of individual performance, necessary time spent in the classroom and additional work for lecturers for the technical setup of the learning environment and the support of students outside the classroom. Thirdly, an important advantage of D-Move is the *support of different front ends* with the same back end. This allows the alignment of the front end to collect, assess and share data to the latest communication patterns of different groups of Digital Natives; also to future, to this day still unknown tools used by millions in some years. At the same time, the logic to support different learning methods, strategies, activities and sequences that are embedded in the back end can remain stable to a large extent. This allows the carrying out of long-time studies in regards to the acceptance of the system and its impact on learning success.

2.3 Phase 3: Expanding D-Move by a Research Environment

2.3.1 Enhancements

In this phase a research environment to gain insights into Digital Natives expands D-Move. Following the contructivist learning theory mentioned above, learners develop their own views and opinions on certain aspects of social interaction and use of technical artifacts while engaging in the real world. Additionally, following the connectivist learning theory, they share their views and opinions in social networks and learn from changes in their patterns. The learning support of D-Move can be also used for insights into Digital Natives' behavior and their attitude to certain phenomena in the world of digital. Due to *combining research with everyday life,* the validity of results can be higher than in artificial settings of controlled experiments or surveys based on recalling instances of the past or 'try to imagine'
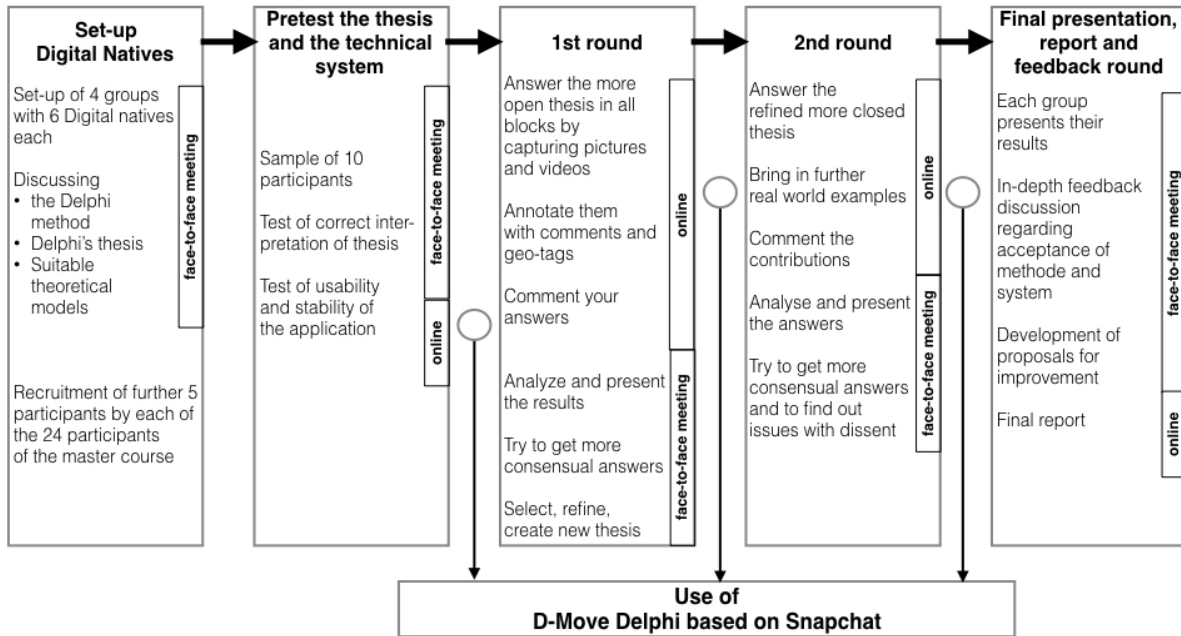
Figure 2: Method used by D-Move Delphi to gain insights into Digital Natives.

questions. Regarding the identification of trends and future developments Digital Natives are not only test persons for a survey but also experts in the world of digital. They will create future innovations and will form the majority of the population that will use them in the future.

To exploit Digital Natives' role as experts thoroughly the Delphi method is implemented using D-Move. The main steps of the Delphi method in empirical research are: Formulating theses about current or future issues, obtaining experts' opinions, aggregating these opinions and presenting them to the experts and finally, starting a second round to obtain consent/dissent to these issues (Loë 2016). The features of the technical platform and the learning methods used as described above remain unchanged in this phase. The module *D-Move Delphi* is added to support the interaction between learners as well as with lecturers following the Delphi process shown in Figure 2. For a detailed description of D-Move Delphi and its evaluation results see Petrovic 2017.

2.3.2 Example of D-Move Delphi's Results

Figure 3 shows a sample result of the first Delphi round regarding the future role of self-monitoring for health and fitness from Digital Natives' perspective. This chart, using means of info graphics, shows how familiar the participants are with this topic of the Delphi together with data on the demographic build-up of the 134 experts

participating the Delphi. Based on experts' opinion on Delphi thesis gained in the first round, in a subsequent face-to-face meeting topics are identified with strong dissent/consent and are discussed in depth. After summarizing the results, a 2nd round starts as shown in Figure 2. Charts as indicated in Figure 4 assist the participants in identifying thesis with high dissent to be discussed in a face-to-face meeting. They are also used to prove if consent finding was successful after round 2.
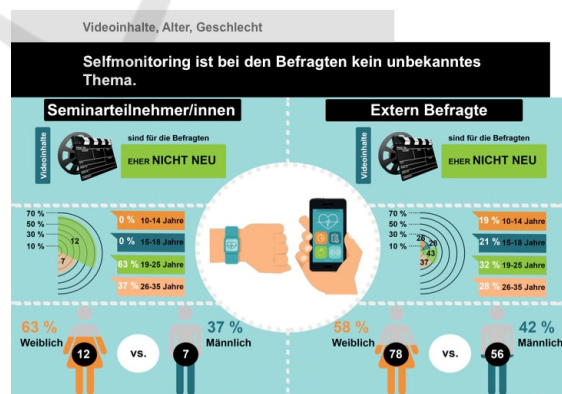

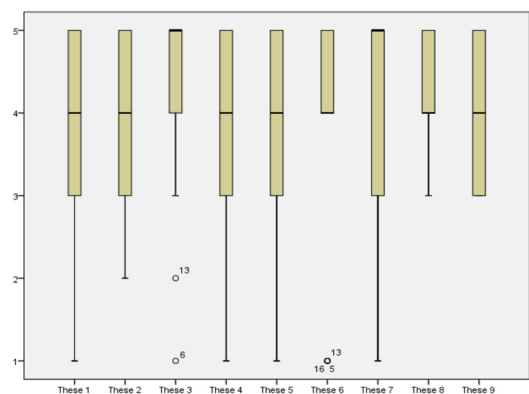Figure 3: Sample result of D-Move Delphi in round 1.

Figure 4: Topics with high degree of dissent/consent to be discussed in a face-to-face meeting.

2.3.3 Learnings in Phase 3

Although phase 3 and its Delphi module has just been implemented and used tentatively, early learnings can be deduced. Firstly, to understand Digital Natives' behavior and views using the Delphi method together with D-Move's technical features is *remarkably useful for gaining insights* into current and future phenomena in the world of digital. Secondly, on the contrary to other university-based empirical research settings like experimental research or traditional surveys, *recruiting students* is not a disadvantage in regards to representativeness but because of their role as experts poses even an advantage. Additionally, as D-Move is run every year with different Digital Natives, also long-term studies showing changes over time are possible. Thirdly, a methodological challenge has to be solved. As D-Move Delphi is being enhanced constantly, its functions as a research instrument also change over time. Thus, special attention has to be turned to *risk of inferences* between change in the instrument and conclusions from its results.

3 CONCLUSION AND FUTURE DEVELOPMENTS

After more than ten years of designing, developing, using and evaluating D-Move there are a lot of findings - please see the list of references. In a nutshell, the main finding is the high usefulness to *obtain learning aims* and simultaneously a *high acceptance* by learners. This can be attributed to the alignment of learning theories and learning methods used together with implemented technical features, the everyday life communication behavior and media usage patterns of Digital Natives. This

requires continuous development, especially regarding implemented front ends due to the very high innovation dynamics of Digital Natives. Secondly, *D-Move Delphi* as the latest module implemented is *very promising*. The enrichment of a learning environment with research features, especially using the Delphi method with Digital Natives as experts, allows for new research insights as well as long-term studies. A third learning is that D-Move should not be used as a substitute but as a supplement to classroom teaching. However, the findings show also that the additional use should *not be based on traditional learning methods* with their associated learning theories - like broadcasting the lecture via a video stream. We learned also that the use should not occur on a side-by-side basis according to learn-and-apply-logic. Rather a *tight integration* between classroom and everyday life learning is necessary, *switching from one to the other mode often*. As D-Move is based on constructivist-connectivist learning theories and not on stimulus-response-models of learning, there are limitations regarding representatives and validity as broadly discussed in the mentioned literature and in methodological work on qualitative research in general.

There are two main future development streams of D-Move. Firstly, the continuous enhancement of learning methods based on constructivist-connectivist learning theories together with technical features to support them. The main aim is to enhance the *seamless integration* in Digital Natives' everyday life using front ends that are most common in a certain target group. Those future activities are based on the research paradigm of design science with its close loops between development of technical artifacts and their evaluation (Hevner 2004). A strong emphasis will be put on the enhancement of D-Move Delphi to gain insights into Digital Natives' opinions and attitudes. One vision is to open D-Move like an omnibus survey for market research regarding current trends and future innovations among Digital Natives. Also, long-run studies on changes in Digital Natives' communication and learning patterns, on an inter-cultural scale too, will be conducted.

REFERENCES

Alur, P., Fatima, K., Joseph, R. 2002. Medical Teaching Websites: Do They Reflect the Learning Paradigm? In: Med Teach, Vol. 24/No. 4, pp. 422-424.

Anderson, J. R., Reder, L. M., Simon, H. A. 1996). Situated Learning and Education. In: Educational Researcher, Vol. 25/No. 4, pp. 5-11.

BITKOM 2014. Keine Angst vor der Informationsflut aus dem Netz. Berlin.

Bruner, J. S., 2009. The process of education. Harvard University Press.

Davis, F., Bagozzi, P., Warshaw, P. 1989. 'User acceptance of computer technology - a comparison of two theoretical models', Management Science 35(8), 982–1003.

Dodero, J.M., et al. 2015. ,Learning Technologies and Semantic Integration of Learning Resources', IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, Vol. 10/No. 1, pp. 11-16.

Foerster, H. von 1992. Lethology, A Theory of Learning and Knowing, vis é vis Undeterminables, Undecidables, Unknowables. In: Kristina Hooper Woolsey (ed.) Full Spectrum Learning. Apple Multimedia Lab, Cuppertino, pp. 88–109.

Glasersfeld E. von 1995. A constructivist approach to teaching. In: Steffe L. P. & Gale J. (eds.) Constructivism in education. Erlbaum, Hillsdale: 3–15.

Handke, J., Schäfer, A. M., 2012. E-Learning, E-Teaching und E-Assessment in der Hochschullehre: Eine Anleitung. München.

Hepp, A., 2011. Medienkultur. Die Kultur mediatisierter Welten. Wiesbaden.

Hevner, A.R., March, S.T., Park, J., Ram, S., 2004. Design science in information systems research. MIS Q. 28, 1, p. 75-105.

Jones, C., 2011. The Net Generation and Digital Natives: Implications for Higher Education. The Open University, Walton Hall, Milton Keynes.

Klippert, H., 1991. Handlungsorientiertes Lehren und Lernen in der Schule. In: arbeiten und lernen/Wirtschaft. 1991, v 4, p 7–16.

Kuhlmann, A. M., Sauter, W., 2008, Innovative Lernsysteme: Kompetenzentwicklung mit Blended Learning und Social Software. Berlin.

Lee, M. J. W., McLoughlin, C., 2010. Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching. Hershey.

Linten, M., 2009. Auf dem Weg zur Informationskompetenz: Portale und Datenbanken als Gegenpart zu Google & Co. Bildungsforschung.

Loë, R. C., Melnychuka, N., Murraya, D., Plummerb, R., 2016. Advancing the State of Policy Delphi Practice: A Systematic Review Evaluating Methodological Evolution, Innovation, and Opportunities, in: Technological Forecasting and Social Change, vol. 104, p. 78-88.

Meyen, M., 2009. Medialisierung. In: Medien & Kommunikationswissenschaft, 57. Jg./H. 2, S. 23–38.

Petrovic, O., Kittl, Ch., Edegger, F. (2008): Learning by Pervasive Gaming – An Empirical Study. Ruy, H.; Parsons, D. (Ed.): Innovative Mobile Learning Techniques and Technologies. Idea Group Publishing; S. 60-80.

Petrovic, O., Kittl, Ch., 2008a. Pervasive Games Education, in: Proceedings of the Euro American Conference on Telematics and Information Systems (EATIS 2008), Brasilia.

Petrovic, O., Edegger, F., Kittl, Ch., 2008b. Entwicklung und Evaluierung einer Interaktionsplattform für massentaugliche Pervasive Games, Wirtschaftsinformatik, n. 4, p. 282-291.

Petrovic, O., Brand, A. (Ed.), 2009. Serious Games on the Move. Springer Verlag, Wien.

Petrovic, O., Harnisch, M., Puchleitner, Th., 2013. Creating an end-to-end information flow to enhance last-mile logistics, in: Proceedings of the 2013 International Conference on Advanced Information and Communication Technology for Education (ICAICTE 2013, China), p. 780-783.

Petrovic, O., 2016. Design, Development and Evaluation of a Field Learning Video Blog, in: Proceedings of the 12th International Conference on Mobile Learning, Vilamoura, Algarve, Portugal, p. 51-58.

Petrovic, O., 2017. D-Move: A Mobile COMMUNICATION based Delphi for Digital Natives to Support embedded research, in press.

Rogers, E., 2003. Diffusion of Innovations, 5th Edition. Simon and Schuster.

Siemens, G., 2005. Connectivism: A Learning Theory for the Digital Age, International Journal of Instructional Technology and Distance Learning, Vol. 2 No. 1.

Tapscott, D., Williams, A. D. 2008. Wikinomics, How Mass Collaboration Changes Everything. New York.