

Chapter 2

Technology and Knowledge in the Classroom

Abstract Development of ICT in the last few decades; together with the rise of social constructivist approach to learning, has largely influenced education in the twenty-first century. For example, the global pedagogical standard of the twenty-first century is shifting from knowledge transmitting approach to knowledge building approach. This paradigm shift stems from the emergence of social constructivist approach to teaching and learning, which became popular in the US in 1990s and into the 2000s. In addition, the development of ICT, especially the Internet is transforming the role of educational institutions. This chapter will look at how literacy can be integrated in such environment to empower learners and to help them in knowledge building practices.

Knowledge Building Process and Social Constructivism

Today it is possible to learn using ubiquitous environment as a result of widespread broadband Internet connections. Participatory media, such as social networking services (SNS) also became available. Video streaming technology is used to support a new teaching and learning environment. Today, one can access information easily using the Internet. Educational institutions, especially universities worldwide are increasingly exploring ways to make meaningful use of its physicality, meaning that, the classroom is becoming a place where students discuss, engage, create, and collaborate with others. This tendency is creating new possibilities and endeavors for educational institutions such as Open Education and Flipped Learning. Also, teaching and learning in classroom incorporate more approaches that support learner-centered activities, creativity, and cooperation.

While more traditional theories of learning such as behaviorist and cognitive view of learning from individualistic perspective, social constructivists view learning as construction of meaning, and knowledge through social relations and interaction. For instance, in a broad sense, behaviorist would define learning as individual's changes in behavior. Cognitive view would define learning as

individual's acquisition of knowledge and assimilation or alteration of cognitive schema. However, social constructivists claim that knowledge is built through communication with others, and that learning inevitably involves interaction. According to social constructivists learning to take place both inside and outside formal educational settings. Learning is inseparable from social context. This is one of the fundamental perspectives of a social constructivist.

Social constructivist approach of learning and teaching goes back to Vygotsky's work on zone of proximal development first published in Russia in the 1920s which became influential much later in the US especially from 1990s until today. Vygotsky left a pioneering work focused on social aspect of learning. In particular, Vygotsky's theory of zone of proximal development significantly affected generations of educators in thinking about social interaction and learning. Vygotsky paid attention to the development stage of children's higher order thinking and looked at how much she or he can solve a problem by him or herself, as opposed to how much she or he can achieve with a support of a fellow or guiding adult. Zone of proximal development refers to this gap between the two suggested developmental levels, what one cannot independently reach today, but can be reached with the help of others, becomes tomorrow's development level of higher order thinking. The gap between what a child can do by him or herself, and what he or she can do with the help of others is always present in the course of a child's development; in this sense, Vygotsky considered social scaffolding as an important aspect in the learning process.

Based on his work, Lave and Wenger (1991) developed the theory of legitimate peripheral participation, which focuses on the social process of learning. Lave and Wenger (1991) view knowledge as being distributed within a community of practice and not necessarily owned by one individual. Learning occurs as participants become able to function as a full member of the community where he or she belongs. Knowledge and expertise needed for participation in a given situation is dependent upon specific social contexts. Lave and Wenger (1991) look at different community of practice from anthropological viewpoint and explain how knowledge is handled, created, and transmitted within different community. In a community of practice, different members exist and participate. Initially, when newcomers participate in a community, they start off from the peripheral position of the community for example as an "apprentice." However, as the newcomer learns to participate fully and become a legitimate member of the community, they become old timers and experts. By participating more in the community, they learn to play in fullness the designated roles as full-fledged participants. It is at this time that a marginal participant becomes a legitimate participant. Lave and Wenger (1991) called this process as legitimate peripheral participation. Learning is a social process that also transforms ones' identity as a community member. In such context, it is by interacting socially that the newcomers learn new skills and acquire knowledge of the community and knowledge necessary to become a full participant in the community is distributed among the participants of the community of practice.

One suggestive ethnographic case Lave and Wenger (1991) introduced that exemplifies learning process in community of practice is the apprenticeship of Vai tribe tailors in Africa. In a Vai tribe, in order to become skilled tailors, children start

living beside the master as the apprentices. So-called act of “teaching” is almost nonexistent in this context. In the process of becoming experts, and gaining independence, children acquire necessary skills of a being a tailor. All learning and teaching occur by participating in the social context of the community. The children, in the process gain the knowledge of being a tailor, and eventually gain an identity of an independent tailor.

All members of a community of practice; both newcomers and experts, play vital roles in defining the knowledge formation process. In addition, skills and expertise of each coexist with the skills and expertise of the other participants. Knowledge is dispersed to various participants working within the purpose of a community, and skills of each person are utilized by following the social rules of the community involved.

Competency-Based Education and Electronic Student Response System

With emphasis and expansion of social constructivist approach to teaching and learning, classroom activities are shifting toward pedagogical construct that allows students to participate actively in classrooms through activities, such as discussions, debates, and collaboration. Curriculum is also changing from acquisition-based (knowledge transmission) to competency-based (knowledge building). In knowledge building education, classroom can become a place of sharing new thoughts and building common ground. Making school into a place to learn how to handle information and build knowledge as opposed to a place to merely acquire new skills and knowledge is important.

Also, student to instructor discussion is taking on a key significance in a social constructivist-oriented classroom. Acquisition-based education do not allow active interaction between students and the lecturer. For instance, a typical lecture format courses do not allow for interaction to occur. Today, to deal with this issue, electronic student response systems are used in many Japanese universities (Vogel et al. 2009; Iinuma et al. 2010).

The use of electronic student response systems goes back to the 1960s and 70s. During that time, electronic response systems used in large lecture halls allowed students to provide immediate feedback to multiple questions and to show student understanding (Judson and Sawada 2002). However, in the last two decades, there has been a shift away from the technology being the catalyst of student achievement. There is more of an emphasis on using electronic response system to foster active participation for knowledge building activities. Today, electronic response systems take on different formats. For example, the new generation of mobile wireless devices, notebook personal computers, and web-based systems enable a wide variety of student to instructor interaction to occur inside and outside classrooms. Participatory media such as SNS is also creating new ways teachers and students interact.

Participatory Culture, Technology, and Learning

People around the world create and distribute messages via online and interpersonal network at ever-accelerating rate. Our world is being transformed by knowledge building culture in which people collaborate, organize and build information using the internet. Jenkins (2006) mapped the rise of “participatory culture” in contemporary society. Participatory cultures are characterized by “relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing one’s creation, and some type of information mentorship whereby what is known by the most experienced is passed along to novices” (p. 7). Learning in participatory culture therefore relates to learning that occurs in community of practice. Lave and Wenger (1991) explains that novices learn in a community of practice by becoming a legitimate participant in a given community. It is also added that participatory culture “is also one in which members believe their contributions matter, and feel some degree of social connections with one another” (Jenkins et al. 2009, p. 7). This notion of belonging to a social connection and being part of a community relates to learning which occur in community of practice. The characteristic of participatory culture; however, differ in the fact that the culture in question exist and depend at least partly in relation to the online community.

According to Delwiche and Henderson (2013) there are four distinct phases to the rise of participatory culture. Phase one was 1985–1993, when the global communication landscape emerged. This is the phase in which ARPANET, which was the precursor to the civilian Internet grew on college campuses in the US. Phase two was 1994–1998 when the American public began paying attention to the Internet. These years witnessed the birth of web-based electronic mail (1994), Yahoo (1994), Amazon (1994), eBay (1995), and Google (1996). Phase three is considered to be 1999–2004, when web publishing became available. User-friendly publishing system such as Blogger (1999) was born. During these years, MySpace (2003), Flickr (2004), and Facebook (2004) emerged. Phase four is 2005–2011, when ubiquitous connection became the norm. As a result of widespread broadband Internet connections, video sharing site YouTube (2005) was introduced. The iPhone (2007) and the iPad (2010) played a part in this phase, making the mobile phone into handheld computers equipped with ubiquitous capabilities.

Today, users can experiment easily with video editing, digital publishing as well as digital art creation. Participatory media, such as blogs, wikis, video blogs, and social network services are also being used to foster various interactions both inside and outside classrooms. Rheingold (2013) coins participatory media as “social media whose value and power derives from the active participation of many people. Value derives not just from the size of the audience, but from their power to link to each other, to form a public as well as a market” (p. 218). He also claims that the present structure of the participatory media is still unsettled.

Participatory Media and Literacy

From social constructivist viewpoint, if you look at a place where learning occurs, you will notice that learners interact not only with others but also with various artifacts, such as language, images, new tools, and technology. It is apparent that learning cannot take place without the mediation of such artifacts. Knowledge is always constructed through the mediation of such artifacts. From social constructivist point of view, artifacts play a major role for learners to connect with “the other.” It is in this process, that the learner share and generate new knowledge. It is not in the technology but in learning how to use information and technology to create a new value, that one becomes empowered.

It is likely that those who know what to do with the participatory media to learn, inform, advocate, and organize who remains empowered. Both literacy and ICT access are prerequisite for full participation in the information society and participatory media has become important part of ICT access. It is important to explore literacy in participatory media and how technology mediates the meaning making process. Literacy and the use of participatory media can be seen as part of a social practice that can lead to empowerment of the learners

As Warschauer (2004) mentions, literacy and ICT access differ in many aspects. For instance, organizational content of literacy are books, magazines, newspapers, and journals; while for ICT access, they are websites, email, instant messages. Receptive skill of literacy is reading. On the other hand, for ICT access, they are reading and multimedia interpretation, searching, and navigating. In addition, while the productive skill of literacy is writing, for ICT access, they are writing and multimedia authoring and publishing. Similarly, for participatory media that emerged recently, receptive skills of literacy is navigating, searching, and multimedia interpretation, and the productive skill of literacy are multimodal in nature. Table 2.1 shows an example list of skills that can be used in participatory media. These skills are just a few examples and there may be combinations and others to be added. Also, these skills can be compared reading and writing skills. I have defined these skills as participatory media literacies for convenience sake. Especially, skills or literacies related to video creation and streaming is one aspect unique in the area

Table 2.1 Participatory media skills and literacies

	Productive “writing” skill	Receptive “reading” skills
Participatory media literacies	Multimedia authoring, e.g., images, moving images, writing	Searching and reading
		Navigating and reading
		Linking and sharing
	Digital publishing, e.g., images, moving images, writing	Multimedia interpretation and enjoyment, e.g., video contents, audio contents
	Video creation	Assessing credibility of information
	Audio creation	

of participatory media. The result of broadband Internet connections and ubiquitous environment has made easy creation and distribution of video content, and this is changing education.

Video Delivery and Information and Communication Technology

The transition from knowledge transmission to the knowledge building education has widespread and forced universities to become more open to the public. While knowledge is considered open to public, building of knowledge process is retained for legitimate participatory members of the academic community, i.e., the students and faculty members. This trend was already seen in 2002 with the spread of the largest public open courseware Open Courseware the Massachusetts Institute of Technology (MIT). Open Courseware was an attempt to deliver video lectures through the Internet to provide content for free to the public.

Globally, universities around the world today deliver lectured video content to the public for free using the YouTube Channel. MOOCs (Massively Open Online Course) also utilize such online video lectures. This is one example of how the purpose of attending a university has moved away from merely acquiring new knowledge to participating in a social context of the academic community to learn to become active participants in creating new knowledge.

Video Distribution and Knowledge in Education

Delivery of video lecture content is supported by video streaming technology. Universities record lectured video content and distributes them through streaming technology online. These contents can be accessed by anyone with access to the internet and can be utilized for distance learning, learning for the disabled, as well as for informal learning. In addition, video streaming delivery raises various possibilities for distance collaborative learning used with video conferencing. For instance, in medical institutions, sharing content of a patient's CT scan or 3DCG online and having a video conference can help the communication between doctors as well as educating interns. Different lecture recording systems exist today. Figure 2.1, shows one example of such streaming delivery technology.

Until very recently, most lecture recording systems on market were expensive. However, this is changing rapidly. Recording system that allows creations of video composition for instant streaming delivery is available. Older systems tended to have problems synchronizing video content of instructor speaking with lecture material, such as audio and PowerPoint Slides. For instance, in order to create such videos, one had to record the lecture and composite the lecture materials separately. This procedure was time consuming and was labor intensive.



Fig. 2.1 Lecture recording system

However, in recent years, progress of the lecture recording technology made it possible to record, composite and distribute video lecture content online through streaming delivery at low price with high quality and high frame rate. Because of high quality and high frame rate of the video content, it became possible to include high spec digital content on the lectured video. The new type of lecture recording system that is going on market worldwide also reduces the burden of the instructor and creation of educational video content has become easier than before. Today, for example, presentation content of an instructor's portable Android or iPad can easily delivered to the recording PC which then can instantly be merged and recorded with the live video data of the instructor using IPWeb camera.

Knowledge and Flipped Learning

Development of technology such as the lecture recording system has created new possibilities to design activities in classroom. Flipped classrooms and flipped learning is one of them. Flipped classroom exchanges the timing of a more traditional lecture and activities given to the students as homework by delivering the recorded lecture as an online educational material as homework, and to have the students engage in activities during classroom period (Baker 2000). Flipped classroom offers an example of how the new technology can be used to reconfigure the classroom meetings. Transmission of knowledge occurs outside the classroom

and creates opportunity for knowledge building activities in the classroom. For example, this can be done by concentrating more on having the students work with authentic materials, allowing more time for collaboration, facilitating discussion, giving students time to reflect, and creating ways to give students more scaffoldings to build a meaningful learning community. Development of streaming delivery technology and lecture recording system offer us a new choice of how and when to deliver and share knowledge within the classroom.

Many studies exist on flipped classroom that utilize video lecture for online educational materials. Baker (2000) conducted flipped classroom in a graphic design class. Flipped classroom was administered in order to diminish time for lecture in the classroom, to focus the class time for understanding and application of what one learned through the lecture, to have the students actively think for problem solving, and to provide opportunities for the students to learn from other members of class. As a result, Baker (2000) maintains that motivation of the students increased. They were also better able to think more critically. Similar study was done by Lage et al. (2000) where flipped classroom was conducted in an economics class. In this study, 10 min video lecture was given for students to watch as homework, and during the class period, students participated in group work and experiments. According to Lage et al. (2000) when they administered a survey, students preferred flipped classroom as opposed to a regular class.

However, it appears that initially, there was confusion in the literature between the term “flipped classroom” and “flipped learning” (FLN 2014). What is often defined as “school work at home and home work at school” is overly simplistic, and does not cover the range of engagement within flipped classroom using flipped learning (FLN 2014). The governing board of Flipped Learning Network (FLN) composed a formal definition of flipped learning in March 2014. According to FLN, Flipped learning is defined as a “pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter” (FLN 2014). Much research is still needed to investigate how to integrate technology to support successful flipped learning. Four pillars of F-L-I-P released by FLN (2013) are helpful in giving educators a direction for successful flipped learning. It suggests that teachers must incorporate into their practice: flexible environment, learning culture, intentional content, and professional educator.

It may be important to note that flipped classroom may not necessarily lead to successful flipped learning. The effectiveness of flipped learning depends on how well the instructor can arrange the learning space considering the needs of the students by providing flexible environment, intentional content, and to foster learning culture. Studies on flipped learning are divided between effective and noneffective results. For example, somecase, students were not as pleased by flipped classroom

and were confused by the class. In the study of Takaoka et al. (2011) in which when flipped learning was introduced to introductory programming class, many students dropped out. On the other hand, a flipped classroom in medical education increased students confidence in clinical research since flipped classroom allowed students to interact with many colleagues for discussion (Kadono et al. 2012).

Case Study on Flipped Learning Using Video Streaming Technology

There are many different experiences with flipped learning in several k-12 schools and higher education (FLN 2014). At Niagara Fall High School (NY), math teachers Ed Venry and Amy Kilmer flipped their classes in 2013 to use class time for more applied activities and individualized instruction. Venry and Kilmer recorded lectures and posed them on online collaborative platform. They supplied the students with guided notes to complete while watching the video outside of class time. The students then worked on “homework” problems in class where teachers were able to help. The students’ performance on Regents Examinations (a New York State standardized test) improved compared with the previous year.

Flipped learning model has been applied to middles school as well. At Ashland Middle School (MA) flipped learning model has been applied to French class. Ellen Dill compared the performance of two seventh grade classroom in 2012. In the flipped class, students watched video lectures outside of class and participated in project-based learning and workbook assignment in class (FLN 2014).

In higher education, instructors at many universities including, University of British Columbia, the University of Memphis, University of North Carolina, Chapel Hill, Texas A&M University, Capital University, Georgia Institute of Technology and Harvey Mudd College have started incorporating elements of the flipped learning model into their classes (FLN 2014). For example at University of British Columbia (BC), Introduction to Modern Physics was conducted using flipped learning approach. At University of Memphis (TN) flipped learning was applied in Preparation for General chemistry, and suggests that flipped learning may have a positive impact on student performance. The flipped classroom has also been evaluated in the nursing program at Texas A&M University. The students were provided with videos and lectures to watch outside class instructions, so that, class time can be used for case simulations and activities related to the real world situation. Over three semesters, students in two health-nursing courses were taught with different modalities. Students were either taught in a flipped learning class, traditional lecture class, or traditional lecture plus video lecture. On average, students in the flipped classroom scored slightly higher on course examinations than students in either traditional lecture or traditional lecture plus video lecture section. At Capital University, flipped learning model was conducted in an undergraduate statistics course for social science major (FLN 2014).

Flipped learning model has also been successfully applied in a graduate school setting. At University of North Carolina at Chapel Hill, flipped learning model was used over 3 years in Basic Pharmaceutics (a first year pharmacy school course) by Dr. Mumper. In 2011, the course was taught in traditional style; in 2012 flipped learning was used. The graduate students watched video-recorded lectures outside of class and spent class time for more interactive activities. Average final exam scores increased significantly (FLN 2014).

In another example, video streaming technology was used for flipped learning at a graduate level class in Tokyo University of Technology. In this instance, the students were asked to read journal articles for homework to prepare for the weekly discussion. Most of the journal articles are in written in English. However, in this case, all students were Japanese. Usually, instructor did not spend time in class to help the students understand the English journal by explaining the key terms as well as background information of the paper due to time constraint. Using lecture recording system, the instructor easily create a short video that captures and merges the video of instructor giving the lecture and the instructor's iPad or notebook PC as she maneuvers the screen. In this case, the instructor explained the content of the journal article and difficult English terms so that the students can come to class prepared. The lecture video was uploaded onto YouTube for the students to watch before they attend the class for discussion. Figure 2.2 is a picture of the actual video file that was used in flipped learning at a graduate level class. By having the students watch the video and read the article, the students can come better prepared to class to discuss about the journal article more deeply.

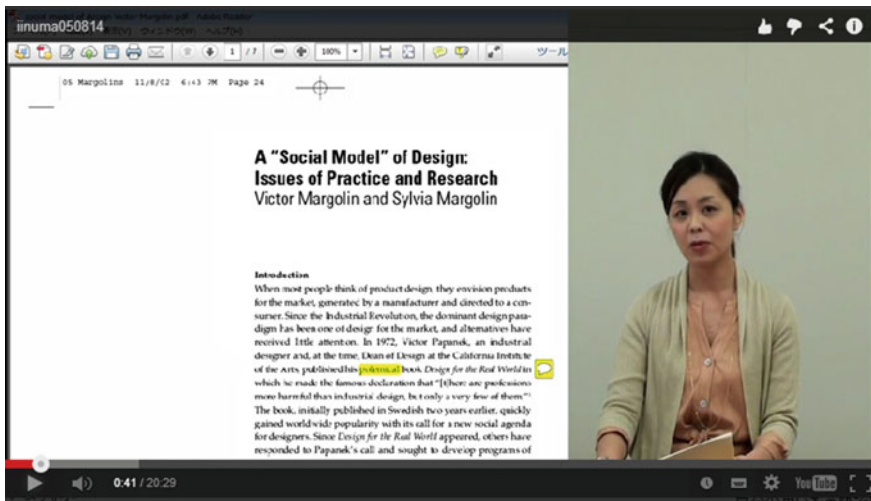


Fig. 2.2 Video streaming for flipped learning

At the end of the study, a survey was conducted and the result showed that all students viewed the video materials and most of the students felt it to be helpful (Matsuhashi et al. 2014).

Recommendation for Teachers Using Participatory Media

Participatory media can successfully be integrated into learning and teaching with careful planning. As the cases of flipped classroom show, designing the whole learning environment is possible today with the use of technology. Educators can physically rearrange their teaching and learning spaces to support the learning experience and incorporate variety of learning models. Educators can deliberately shift instruction to a learner-centered approach using different technology to maximize classroom time for active learning to take place. Table 2.2 is a list of some activities that teachers of secondary to tertiary level of education can integrate into their teaching. These activities are just few ideas and not limited to the list for there are many more possibilities. When designing learning and teaching space, it is helpful to think of which aspects of participatory media, productive or receptive skills are suited for certain lessons. For example, creation of a video report using a free video editing software maybe suited for a social science class if the teacher wants the student to gain productive skills in video creation.

From my own personal experience it is highly recommended to pair a more traditional literacy skill along with the use of ICT in classrooms such as writing or reading into the activity. Kleifgen (2013) argue that within different semiotic systems such as sound and images, language is the primordial source of human communication. Linguistic mode, spoken and written, remains central in human communication and remains the main way in which we communicate, learn and create knowledge (Kleifgen 2013). Therefore, it is important that teachers, when using ICT such as the participatory media, become aware of the productive and receptive skills necessary for users of the specific mode of communication, but also

Table 2.2 Participatory media in education and literacy skills

<i>Ideas using productive “writing” skills and participatory media</i>
Plan and write logs to create video reports on a topic
Write scripts and create video interviews
Use SNS to test marketing strategies and write a report
Create website and write articles on local social issues
<i>Ideas using receptive “reading” skills and participatory media</i>
Interpret video reportage found on YouTube and read a newspaper article on the same topic
Watch video lecture outside class and read supplementary notes
Research using Google Scholar and read articles found online
Share ideas using SNS and read other members’ ideas on a given topic

make sure to combine linguistic mode into the learning exercises to incur deep thinking. For example, as Table 2.2 shows, if the teachers decides to have the students interpret a video reportage found on YouTube on a certain political topic in class, she or he may want to have the students read a newspaper article on the same topic and make a deeper analysis on how a certain political event is expressed in different media. Adding linguistic mode, spoken and written along the use of participatory media will help students become critical thinkers.

References

- Baker, J. W. (2000). The “classroom flip”-using web course management tools to become the guide by the side. Paper presented at the 11th International Conference on College Teaching and Learning, Jacksonville.
- Delwiche, A., & Henderson, J. J., (2013). “Introduction: What is participatory culture?” In: A. Delwiche & J. J. Henderson (Eds.), *The Participatory Cultures Handbook* (pp. 3–10, Chap. 1). New York, NY: Routledge.
- FLN. (2014). Extension of a review of flipped learning. Retrieved from <http://www.flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/Extension%20of%20FLipped%20Learning%20Lit%20Review%20Review%20June%202014.pdf>.
- Iinuma, M., Nakamura, T., & Chiyokura, H. (2010). Development and application of the on-line student response system in a university lecture class setting. *The Journal of Information and Systems in Education*, 9(1), 69–75.
- Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. New York: New York University Press.
- Jenkins, H., Clinton, K., Purushotma, R., Robinson, A. J., & Weigel, M. (2009). *Confronting the challenges of participatory culture: Media education for the 21st Century*. Chicago, IL: John D. and Catherine T. MacArthur Foundation.
- Judson, E., & Sawada, D. (2002). Learning from past and present: Electronic response system in college lecture halls. *Journal of Computers in Mathematics and Science Teaching*, 21(2), 167–181.
- Kadono, N., Tsugihashi, S. et al. (2012). Kyoiku jissen kenkyu rinsho kennkyu ni kansuru blended eikaku gakushu program no kyoiku koukasokutei no kokoromi. *Medical Education*, 43(3), 205–210.
- Kleifgen, J. (2013). *Communicative practices at work: Multimodality and learning in a high-tech firm*. Bristol, UK: Multilingual Matters.
- Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education*, 31, 30–43.
- Lave, J., & Wenger. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.
- Matsuhashi, T., Iinuma, M., Nakamura, T., Mizutani, E., & Chiyokura, H. (2014). Daigakuin ni okeru hantenjyugyo no jissen to hyoka. In: *Proceeding of the 39th National Conference of JsiSe, National Conference of Japanese Socieity for Information and System in Education*.
- Rheingold, H. (2013). Participative pedagogy for a literacy for literacies. In A. Delwiche & J. J. Henderson (Eds.), *The Participatory Cultures Handbook* (pp. 215–219, Chap. 1). New York, NY: Routledge.
- Takaoka, U., Osawa, Y., & Yoshida, J. (2011). e-Learning gakushu rireki womochiita dropout choko sha souki chyushutsushiuhou no teian kensho oyobi kongo no kanousei. *Journal of Information Processing Society of Japan*, 2(12), 3080–3095.

- Vogel, D., Kennedy, D., & Chi-Wai Kwok, R. (2009). Does using mobile device applications lead to learning. *Journal of Interactive Learning Research*, 20(4), 469–485.
- Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide*. Cambridge, Massachusetts: The MIT Press.
- 角館直樹, 次橋幸男, 他: 教育実践研究臨床研究に関するブレンデッド型遠隔学習プログラムの教育効果 測定の試み. 医学教育, Vol. 43, No. 3, pp. 205–210 (2012).
- 高岡詠子, 大澤佑至, 吉田淳一: “e-Learning 学習履歴 を用いたドロップアウト兆候者早期抽出手法の提案” 検証および今後の可能性. 『情報処理学会論文誌, Vol. 2, No. 12, pp. 3080–3095 (2011).

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