

Universal and Ubiquitous Learning in an ICT Society for Enhancing the Right to Learn

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Abstract: Our changing society requires us to renew our knowledge ceaselessly. In such circumstances, everyone must have the right to learn and to enhance his/her competence to serve society as well as his/her own interests. Ubiquitous devices, such as mobile phones and PDA, are effective and economical tools, both on campus and for distance instruction, to encourage creative outcomes from autonomous learning and collaborative working as well as to overcome the technology divide. Research methods have to change their feature from being a well-established discipline for accumulating knowledge into becoming a flexible framework to innovate instructional development for creating knowledge and designing universal learning by using these ubiquitous ICTs. I call this u-Learning. Autonomous u-Learning can be designed from the standpoint of a conceptual model called MACETO. This model is applied in the instances of university instruction on campus and is being implemented for distance learning.

Keywords: Ubiquitous ICT, Distance learning, Instructional designing, Research framework

Rationale of Universal and Ubiquitous Learning

Our rapidly changing society requires us to renew our knowledge constantly. The lifespan of knowledge is very short, scientific and technological expertise becomes quickly obsolete. This tendency is observed in both developed and developing countries. There is no difference in a way between industrial and agricultural societies, both requiring new knowledge for acquiring and keeping comfortable lives in the ever changing world while enlightening people to keep their dignity in global fluctuating economies. Unemployment can be always found in any society. People have to change their jobs several times during their lifetimes. Acquiring knowledge is therefore not a special requirement for so-called enlightened people only, but necessity for every citizen.

Knowledge has been provided through formal establishments, such as schools and universities, but its price is becoming higher and higher due to the shortage of expertise and the cost of human resources. People still expect knowledge acquisition from the well-established institutions and rush to these limited resources to acquire prestigious degrees. The present educational system in Japan both in schools and universities has effectively contributed to cultivating and disseminating a school-based, academic knowledge in the traditional styles of lecture and memorization. The presumption of this method is that the educated can then efficiently teach the uneducated in these same well-established institutions. Higher education, too, follows the conventional teaching styles, but also aims to introduce new disciplines in expectation of sure results for strengthening culture, science and technology, and economics. This framework of instruction has functioned well in a stable or slowly innovating society.

The situation, however, has changed drastically since Information and Communication Technology, ICT, was introduced in every institution, including the

elementary, secondary and higher levels as instructional media and means. Recent developments in ICT are expected to provide more and better opportunities for learning and to promote a general knowledge renewal. ICT enables us to provide large audiences with effective instruction while at the same time responding to personal needs, to cultivate a stronger interest in learning and a deeper comprehension of our surroundings. TV programs introduce us to entirely new worlds, strange and/or remote from our daily life. Computer simulations open new horizons in our recognition of the world. These high technologies contribute enlightenment to our world views and enrichment in our lives. Nevertheless, we are still suspicious about the equity of accessibility to knowledge acquisition necessary for renewing our professional competency, due to the technological divides between the haves and the have-nots.

When we try to create new solutions to problems or produce visible outcomes, we start from imaging them, to drawing sketches and making drafts, to materializing them and constructing the final solutions and/or products. In this process, we utilize paper and pencil, and even large sheets of paper for presentations. In the refining process of new ideas, discussions, critical reviews and consultations with peers and specialists are indispensable means for realizing productive and fruitful outcomes. Internet access and e-mail messages are also very powerful tools to accompany such discussions and consultations in our information society. In this working and learning situation, ubiquitous devices such as mobile phones and PDA are an effective and efficient technology to facilitate such interactive communication and review. In this context, these devices, available at everyone's hands, can be used to contribute to the development of universal learning and to overcome the ICT divide issues. This is the rationale for implementing a universal and ubiquitous learning, or u-Learning for

anyone, anytime, anywhere.

Research Procedure for u-Learning

The deep introduction of technology into education often depends heavily on sophisticated ICT, especially multimedia and broadband. In this case, designers' attention and interests tend to focus solely on the technology, not on the learning itself. If we approach universal education from the high tech standpoint, it is almost impossible to overcome the ICT divide surrounding economically deprived people. These high tech and low tech concepts are not a dichotomy, but two extremes which can be linked seamlessly for disseminating universal education. In this context, we should take into account the potential of ubiquitous, inexpensive information technology and take the first step from the standpoint of knowledge creation and problem solving to overcome technology divide issues. In my u-Learning project, I started the instruction mainly with printed materials and mobile phones. Textbook-based instruction does help us focus our efforts critically on the design technology for students' creative and active involvement in learning. Adaptation of a simple hardware reveals the essential and appropriate technology for critically effective and economic instruction.

There are four relation possibilities between teaching and learning: 'we teach and students learn' 'we teach but students do not learn' 'we do not teach but students learn' and 'we do not teach and students do not learn'. In our instructional development, we are trying to develop the third assumption for an autonomous learning suitable to distance learning. This approach requires a well thought out strategy in order to develop appropriate instructional materials.

In a web-based and computer mediated learning project, most developmental trials start from the implementation of ICT, especially multimedia and broadband technology in the conventional classroom situation. On the other hand, if we start from discussion and communication with peers and fellow instructors in institutions but at distant workplaces, we find that ubiquitous communication devices, mobile

phones and PDA, are also useful tools to enhance knowledge creation and refinement inside and outside the classroom, even in distant homes.

New trials often require entirely new, innovative solutions unfamiliar to our own and others' experiences. Even if we adopt ubiquitous facilities the instructional development should follow a systematic and scientific procedure to make the development more effective and acceptable by other experts in instructional development.

Figure 1 shows four possible approaches to designing un-experienced instruction: practical syllogistic derivation from educational norms to actions, application of scientific findings, learning from others' experiences, and intuitive and creative ideas enhanced by tacit knowledge accumulated from our previous experiences. We start to generate intuitive and creative ideas by referring to the tacit knowledge emerging from our past experiences. The concern in this paper is to develop a research method for formulating explicit knowledge in the forms of figurative and iconic representations, as well as statements and propositions as formal knowledge for accumulating our experiences in the form of knowledge easily communicable and systematically revisable.

Figure 2 shows the procedure used to conduct material development and research on u-Learning, mainly depending on an empirical approach rather than a science-application approach. There are two possible approaches: one from synthesis and another from analysis. Novice teachers prefer to start by making images and then refining them into figurative and/or iconic models. In this process, discussion and critiques are essential to improve their initial ideas and clarify feasible plans. On the other hand, experienced teachers are strongly recommended to start by analyzing their own teaching. They are accustomed to teaching in unilateral lecturing and feel it difficult to reorganize their teaching style from teacher dominant to learner centered. After several trials, however, they can begin to express their recognition about the lessons and describe their empirical laws in the form of statements and judgmental propositions,

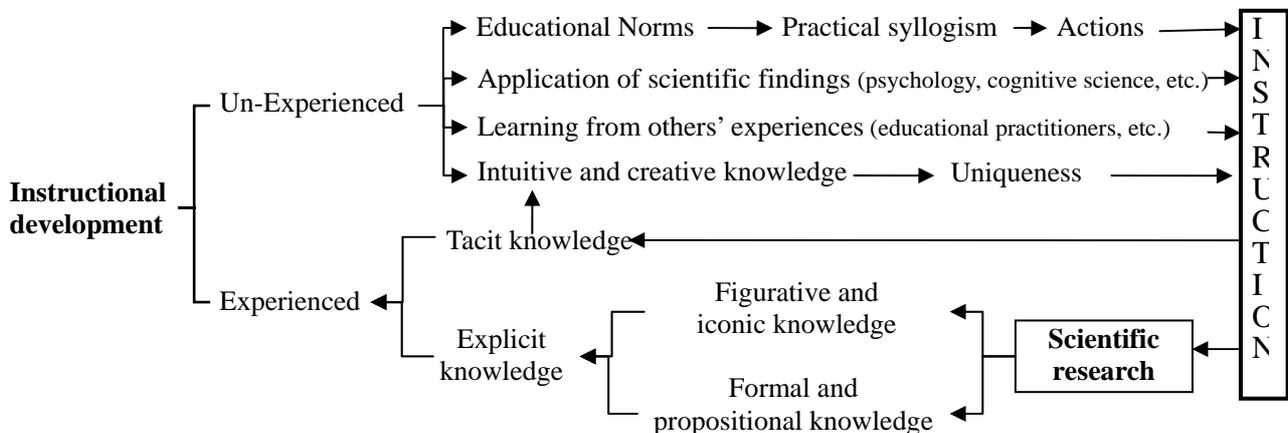


Figure 1 Empirical approach for u-Learning development

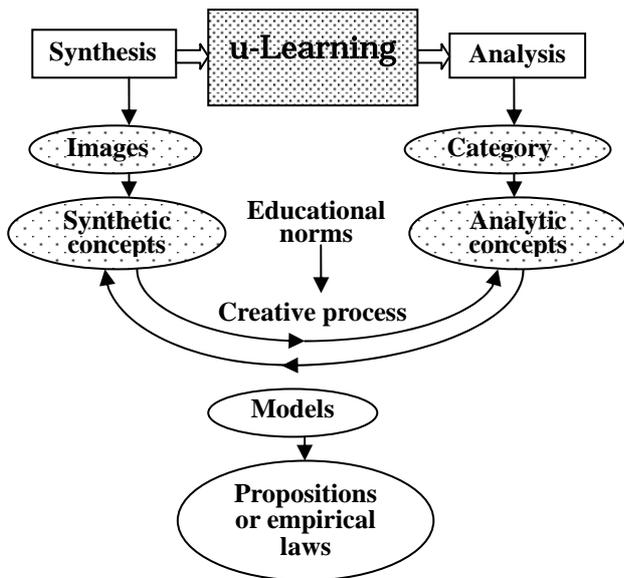


Figure 2 Empirical researches on u-Learning

sometimes after having conducted lessons by themselves. The author makes a greater effort to develop design technology than information technology in education, believing strongly in the potential for fruitful and creative outcomes from collaborative team work.

Collaborative team work is essential to ensure fruitful and creative outcomes from u-Learning. The Japanese lower educational system is still sharply competitive among candidates aiming to go to the higher educational stages: from elementary to secondary to higher education. Students' learning heavily deviates towards exam preparation and forced competition with their peers. Collaborative team work in a learning atmosphere is not well cultivated and difficult to realize, even at the university level. To overcome such a distorted and maligned attitude, the following five principles are emphasized in classes as an example of the educational norms.

- Autonomous learning
- Collaborative work
- Contributions to team work
- Responsibility to the team
- Respect for other people

Universal education rather than selective streaming, and a smooth articulation between different stages of educational life are urgent issues to be tackled in our rigid schooling system. Ubiquitous ICT and collaborative working are expected to be very effective for solving these problems.

Practical implementations

Active learning can be realized by integrating structural models of instruction rationally. The structural model MACETO consists of six components: Meaning, Activities, Contents, Environment, Tools and Outcomes. The six components are classified into internal and external conditions for autonomous learning. The major aim of instruction for universal education is to provide autonomous learning for enhancing one's

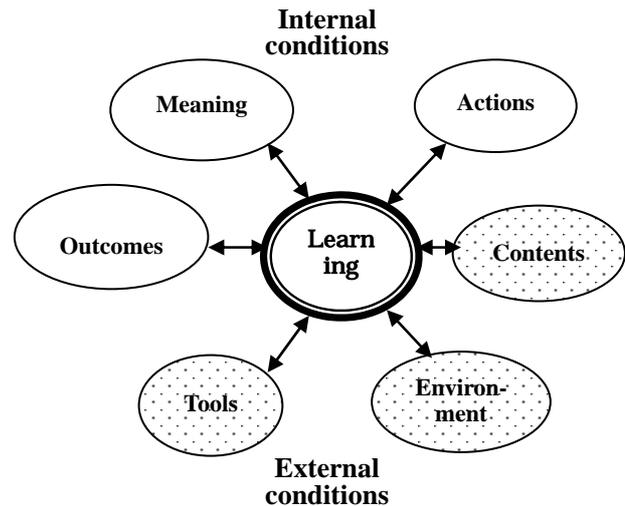


Figure 4 MACETO model for instructional designing

competence and knowledge in spite of any different conditions in the learning environment. Instructional design starts from understanding the learners' interests and intentions, while taking into account the meaning of learning; it then proceeds to planning learners' activities and anticipated learning outcomes.

Hypothesis: If we can arrange internal conditions meaningfully, students would overcome externally difficult conditions and work hard autonomously.

Why should we specify and realize the meaning of learning before deciding instructional contents? The present education in schools, even in universities, emphasizes the importance of instructional contents, deviating towards a teaching crammed with factual knowledge. If we start from the analysis of instructional contents first, it is almost impossible to reach a common agreement among educators on the range and scope of the contents. On the other hand, our information-rich society provides us with the most up-dated knowledge, requiring us to refresh ceaselessly our professional competence in order to fulfill our responsibility as members of society. Autonomous learning proceeds from asking the meaning of learning, then moves to specifying the problems, planning learning activities and clarifying outcomes at the first stage, and then working out the contents at the second stage. In this context, we start by identifying learners' competencies to be cultivated, providing authentic themes relevant to the present changing society, and stimulating intuitive and creative knowledge to solve problems rather than letting them absorb factual knowledge easily accessible through the Internet.

Innovation in school and university education is urgently needed for changing instruction from a teacher-led one to a learner-planned one for coping with our ubiquitous ICT society. The outcomes from autonomous learning are also the products of institutionalized education; they result in individual

satisfaction as well as serving national interests as their ultimate goals. It is very crucial to find an authentic theme suitable to enhance the learners' interest and motivation while contributing to solving problems in society. After clarifying those internal conditions, designers proceed to the arrangement of external conditions to encourage the learners and enhance their learning. This model is utilized to describe the instructional design in its initial stages and thereby to clarify the whole structure of the course.

The second stage of instructional development is to produce modules that provide learning events which are equally accessible for every learner. Printed materials, mobile phones and PDA are most convenient and economic media among students in this information age. Printed materials are portable anytime and anywhere and convenient for content reviewing. The mobile phone facilitates learners to communicate with each other anytime, anywhere. PDA can display documents, videos and simulations in natural motion and color. A software product named 'C-learning' developed by Netman Co. provides us with instructional functions such as storage of instructional materials, bulletin boards, testing, exercises and consultation by e-mail in mobile phones as well as PCs entirely compatible to each other (except the attachment of files in mail via mobile phones). A similar system named 'campus 3' developed by Interlect Co. Ltd. is also a suite of tools for conducting ubiquitous learning through mobile devices, including a management system for instructional materials and computers on teachers' desks.

In this circumstance, teachers are expected to develop their professional expertise, accumulate their experiences and communicate with their colleagues and professionals, even at a distance.

Hypothesis: Our experiences with instruction are accumulated tacitly as well as explicitly, of which explicit knowledge can be described in a set of iconic figures and propositions to be easily communicated among instructional professionals for enhancing the Right to Learn.

We try to develop learning events utilizing printed materials, and then confirm their validity by observing learners' activities and products through testing, discussion on the bulletin boards, consultation by e-mail and reading submitted reports. Such judgmental reasoning is described in the form of figurative and iconic representation and judgmental propositions, and stored in a database with the intention of being referred to later or accessed by others. Therefore, the outcomes from those lessons based on the MACETO model are four fold: visible products such as reports and/or work, students' enhanced competence, instructional materials for the course and empirical knowledge concerning instructional development.

Cases of implementation

In this u-Learning project, a theory for instructional development is expected to emerge from our practical experiences in a local situation, not through foreign literature, to develop an instructional system suitable to local needs and individual interests. The author conducted relevant courses at the undergraduate level: 'Introduction to Instructional Technology', 'Instructional Analysis and Design', and 'Introduction to Informatics' to confirm the validity of the MACETO model and procedure for scientific investigation. Figure 5 shows scenes from one class, and instructional materials combined with printed materials and mobile phones. In these mobile phones, bulletin boards, questionnaires, e-mailing and group management systems are provided. To achieve such systematized instruction, it is indispensable to pursue a procedure of integrating synthesis and analysis of instructional development.

Case I: The first trial in full-time course

The first case study was carried out for studying the feasibility of team working and use of mobile phones.

Title of the course:

Introduction to Instructional Technology
Participants: 228 students

Duration: one semester, 15 weeks, during the spring term, 1999

Facilities: ordinary lecture hall and small computer laboratory equipped with 40 terminals.

In this first trial, by using printed texts and mobile phones, the effort for implementing the course was mainly concentrated on confirming the feasibility of instructing students in team work and writing reports at the end of course. The 228



Figure 5 Scenery of a Class

students were divided into 6 groups, each group into 6 teams composed of 6 or 7 students. Each team studied quite independently and shared their experiences within their group, but not with other groups. They used mobile phones out of class to discuss their concerns in the earlier half of the course, but not so much in the later half, mainly due to the increasingly independent study of each student. From this trial, we confirmed the students' active involvement in collaborative learning and the high retention ratio in a full-time course for one semester.

Case II: Affluent facilities in full-time course

Title of the course: Instructional Analysis and Design
 Participants: 76 undergraduate students
 Duration: one semester, 15 weeks, during the fall term, 2000
 Facilities: one computer laboratory with 98 terminals, enough to accommodate all students

This trial aimed to confirm the effects of computer use for producing creative consequences. The instruction followed almost the same texts used in the first case as stored on a computer network. Students could share textbooks, Internet accessibility, resources and easily exchange their products. In spite of such affluent facilities, however, there was no remarkable quality superiority in comparison with the products of the first case. It revealed that the availability of one terminal per student does not produce more unique outcomes at the initial stage of creation. Open discussions and critiques seem to be more needed than the availability of computers.

Case III: Effect of communication among students

Title of the course: Instruction of Informatics
 Participants: 20 undergraduate students
 Duration: one semester, 15 weeks, during the spring term, 2003
 Facilities: Computer laboratory equipped with 40 terminals and software entirely compatible to PCs and mobile phones.

This class was divided into four teams; students' activities in the classroom and their communication through mobile phones were continually under observation. Their task was to propose an instructional plan for a whole course of informatics at the high school level, to create a curriculum and lesson plan for the instruction of information technology. Each team proposed one imaginary curriculum of 'Basic Informatics' with the intention of introducing innovative lessons to overcome the present passive and monotonous high school lectures.

Critical and urgent issues to be solved in higher education are to provide instruction for promoting students' active involvement in learning and creative participation on and off campus. The first solution to this issue is to provide students with opportunities to participate in active discussions and collaborative team working among themselves. Discussion through mail

via mobile phones indicates the involvement out of classrooms and the computer laboratory. From our observation of their involvement, the team that was more active in discussion produced more unique plans for the lessons. It was still very difficult for students to transform their framework from a teaching dominant style to a learning centered one. More time was required to discuss issues, change their framework of instruction and revise original ideas continually.

Case IV: Implementation in correspondence courses

Bukkyo University has a correspondence school with a 50 year history and accommodating 20,000 students at the moment. We plan to implement a new instruction method using ICT for meeting more the interests of distance students. There are several alternative media available for the revision of courses. A combination of ubiquitous ICT and conventional text-based instruction is one such alternative for the future implementation of popular distance learning. The above mentioned trials suggest to us a framework for conducting a feasibility study on new distance learning programs. Self-learning materials require of us continuous and repeated revising of learning materials. If we can develop such self-sustained materials in the full-time courses and then apply them to the correspondence courses, the cost of instructional development will be quite reasonable for improving the quality of instruction in both. A similar assessment scheme for learning outcomes can be applied to both in order to overcome the misunderstood and lowly estimated social divide between the two.

Theory of instructional development for u-Learning at Higher Education Levels

Article 26 of the Japanese National Constitution and UNESCO's 1985 Declaration of the Right to Learn provide a philosophical background for realizing universal and ubiquitous learning, or u-Learning. Our national constitution maintains that all people have the right to receive education equally corresponding to their ability. In spite of this declaration for the equity, Japanese education has developed based more on the national interests and less on individual abilities and needs. But we cannot waste the talent of any child within the national education scheme. Changes from a selective and competitive educational system to a universal cooperative learning system are urgently needed for the future society.

Instructional development requires very complicated considerations and well thought-out decisions aimed at materializing realistic instruction. The conventional theory already conceptualized and well established is not necessarily applicable to a specific situation or target population, especially in the case of adopting the innovative ICT into the conventional framework of instruction. In these circumstances, we have to start from any ad hoc theory and continually refine it as the project progresses. The basic philosophy of u-Learning is to enhance

universal and ubiquitous learning with or without electronic technology. Even in Japanese society affluent with information technology, there is still some reluctance to introduce technological gazettes into classrooms. The u-Learning project aims to introduce ICT in education where a large number of students are studying on and off campus with a limited number of PCs, but sufficient mobile devices and with the most convenient medium of printed materials.

Conclusions

In the process of developing courses for undergraduate students, there are four possible approaches for applying a rational procedure for instructional development; practical syllogistic derivation from educational norms to actions, application of scientific findings, learning from other's experiences and refinement of intuitive and creative ideas as illustrated in Figure 1. There is heated discussion among instructors on the validity for the instructional design based on behaviorism and constructivism. Actual instruction is too complex to manage from a single concept. It is impossible to cover the whole process by only one specific scientific standpoint. Learning from other designers and practitioners is always very fruitful. At the same time, we face many entirely unfamiliar situations, but nevertheless have to conduct our instruction. We cannot wait for knowledge from scientific meetings or information from others' experiences. In many cases in daily teaching, we start from our intuitive ideas and confirm their validity empirically. Can we theorize this process for scientific investigation?

As shown in Figure 1, the author starts from the intuitive and creative ideas referring to tacit knowledge hard to express verbally but certainly embedded in his own experiences. We may express them in the form of figurative or iconic representations easier than strictly logical statements. Young students are quite familiar with expressing their ideas in non-linguistic ways. Taking advantages of such familiarity, students start expressing their original ideas, discussing the issues and refining them towards final concrete outcomes, or products of instructional materials, models representing the instructional situation, and logical statements and propositions convenient to revise later or communicate with their peers in written form. In this process, ceaseless communication and critiques among students are indispensable to encourage their active involvement. The author collected his experiences from the above mentioned courses in the form of statements or judgmental propositions or empirical laws. A few are shown in the Appendix below.

Mobile phones and PDA so familiar to students are still out of bounds as educational instruments. Using mobile phones is entirely one important part of their daily life, they never forget them at home or anywhere else. On the other hand, instruction has become too difficult to tackle by teachers working alone.

They need to help each other, obtain public support and communicate intimately with students, colleagues and the citizens in the community. Ubiquitous equipment is a very powerful tool to facilitate mutual communication and, in this sense, to contribute to a truly universal education. However, it requires us to become more imaginative and creative, to develop scientific procedures in pursuit of a rational reasoning for instructional development in our professional discipline. Starting from ambiguous but intuitive and creative ideas, we can refine them and express our ideas rationally and then contribute to the scientific development of instructional design technology. Thanks to the recent technological development in qualitative and quantitative analysis, we can easily investigate the validity and relevance of empirical knowledge during real classroom instruction. For this purpose, we need to develop a scientific procedure to clarify our experiences and refine them to be able to communicate with each other in the international world.

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(Appendix)

Many instructional propositions emerged from my u-Learning projects. 4 out of 65 are listed here.

- The transformation from image to key concepts, graphic presentations and modeling is indispensable but hard to achieve in student teachers with any success. Modeling requires a great leap from the initial step.
- Realization of autonomous learning requires cultivating the students' heightened attitude towards learning. To cultivate such an attitude, it is effective to require repeatedly the same behavior of filling in the framework sheet (MACETO format) before they can organize learning by themselves.
- Alternative strategies of degrees of freedom in learning:
 1. When we increase the degree of freedom in learning and give more initiative to the students, learning outcomes in a wide range from excellent to poor in quality and quantity.
 2. When we decrease the degree of freedom in learning and give less initiative to the students, learning outcomes in a reliable but mediocre payoff of both less excellent and less poor quality.
- To manage a large group of students to learn autonomously, it is effective to form groups and clusters within the groups, to encourage active participation and to help them understand their responsibility towards self-reliant learning.