Empirical Approach for Designing Universal Learning with Ubiquitous ICTs: u-Learning for Enhancing the Right to Learn

NISHINOSONO Haruo
Bukkyo University
Kyoto, Japan
(nisinohr@bukkyo-u.ac.jp)

Abstract: Our changing society requires us to renew our knowledge ceaselessly. In such circumstances, everyone has 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 efficient and economic 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 should change their feature from being a well established discipline for accumulating knowledge to being 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 standpoints of both structural and procedural models. These models are applied and implemented in three instances of university instruction.

Keyword: Ubiquitous ICT, Distance learning, Instructional designing, Empirical approach

Rationale of Universal and Ubiquitous Learning

Our rapidly changing society requires us to renew our knowledge continuously. Recent developments in Information and Communication Technology, ICT, are expected to provide more opportunities for learning and to promote a general knowledge renewal. The present educational system both in lower schools and universities has effectively contributed to cultivating and disseminating a school-based, academic knowledge in the traditional styles of lecture and practice. The presumption of that approach is that the educated can efficiently teach the uneducated in well-established institutions. Higher education also follows the conventional teaching styles, aiming to introduce new disciplines in expectation of results in strengthening culture, science and technology, and economics. This framework of instruction has functioned well in a stable or slowly innovating society. The situation has changed drastically however since ICT was introduced in every institution, including the elementary, secondary and higher levels as instructional media and means. ICT enables us to provide large classes with instruction responding to personal needs, and to cultivate a stronger interest toward learning and a deeper comprehension of our surroundings substantially as well as virtually. TV programs introduce entirely new worlds, strange and/or remote from our daily life. Computer simulations open a new horizon in our recognition of the world. These high technologies contribute an enlightenment in our views of the world and an enrichment to our lives. Multimedia display, broadband communication and Video On Demand, VOD, are supposed to be ultimate instructional media for distance learning.

On the other hand, when we try to create new solutions to solving problems or produce visible outcomes, we start from imaging them, then 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, large sheets of paper for presentation, and recent technological tools such as word-processors, spreadsheets, presentation software and other utilities to represent intuitive ideas and to elaborate on them in depth as well as extensively, all thanks to the sophisticated ICT. 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 mailings are also very powerful tools to accompany such discussions and consultations. In this working situation, ubiquitous devices such as mobile phones and PDA are also an effective and efficient technology to facilitate such interactive communication and review. In this context, these devices seem to contribute to the development of universal learning and overcome any 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

In a web-based learning project, most developmental trials start from the implementation of ICT, especially multimedia and broadband technology, in the conventional instructional situation, and proceed to the information delivery required for institutionalized learning. On the other hand, if we start from discussion and communication with peers and instructors in the conventional situations, we find that ubiquitous devices such as mobile phones and PDA are also powerful tools to enhance knowledge creation and refinement within and out of the class, even in distant homes. In the process of formulating solutions and/or products, the well established disciplines and
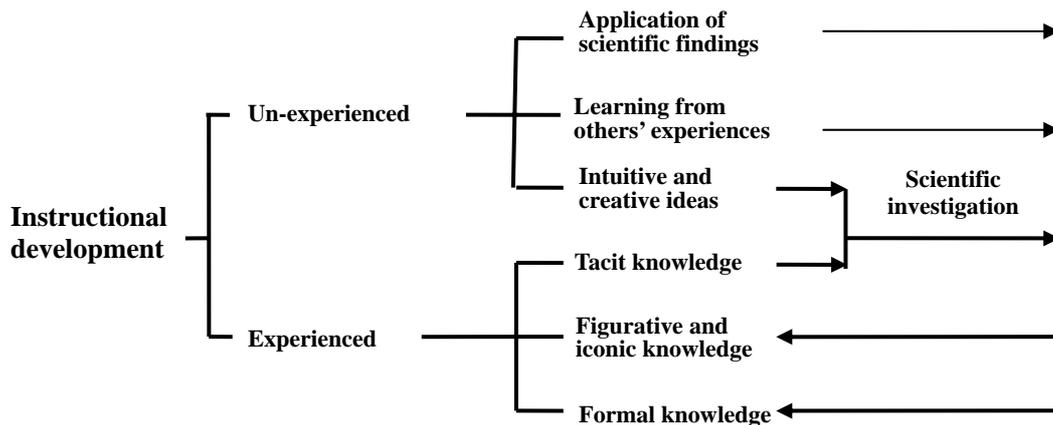
Figure 1 Empirical approach for u-Learning development

scientific findings such as cognitive science, educational psychology and other disciplines are not necessarily effective for solving problems in instructional development. Entirely new trials often require new innovative solutions unfamiliar to our own previous experiences as well as to others' experiences. Figure 1 shows three possible approaches to designing un-experienced instruction: application of scientific findings, learning from others' experiences, and intuitive and creative ideas enhanced by tacit knowledge accumulated from previous experiences. We start to generate intuitive and creative ideas by referring to the tacit knowledge emerging from our experiences. The concern in this paper is to develop a research method for formulating explicit knowledge in the forms of figurative and iconic knowledge, and statements and propositions as formal knowledge.

In the u-Learning project, the author started the study with instruction mainly of printed materials and mobile phones. The recent introduction of technology into education tends to depend heavily on sophisticated ICT, especially multimedia and broadband. In this case, designers' attention and interests tend to

focus solely on the technology, not on learning itself. Textbook-based instruction helps us to 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.

We have to plan and implement the instruction well before meeting the responsibility of providing a universal education at first hand. ICT is developing very fast and improving its potential in two directions: one toward a more sophisticated but expensive technology, such as multimedia and broadband, and the other toward a sufficiently powerful and inexpensive technology, such as mobile phones and PDA. If we approach universal education from the high tech standpoint, it is almost impossible to overcome the ICT divide among economically deprived people. These high tech and low tech concepts are not a dichotomy, but two extremes which should be linked seamlessly for disseminating universal education. In this context, we should take into account the potentials of ubiquitous, inexpensive information technology and take the first
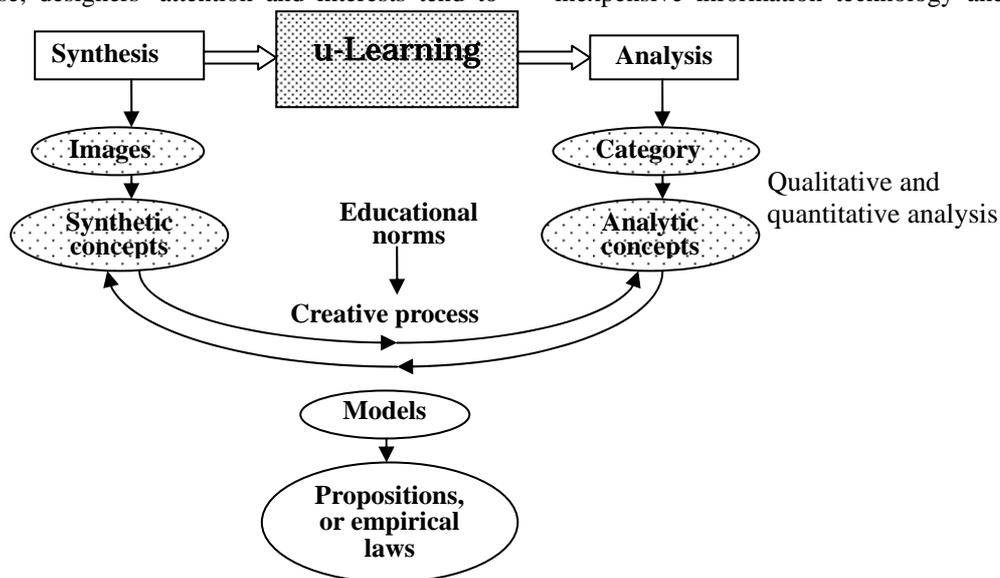

Figure 2 Procedure of empirical research on u-Learning

step from the standpoint of knowledge creation to overcome technology divide issues.   Figure 2 shows the procedure used to conduct 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 models.   In this process, discussion and critiques are essential to improve initial ideas and clarify feasible plans.   On the other hand, experienced teachers are strongly recommended to start from analyzing their own teaching, because they are so accustomed to teach in unilateral talking and feel it difficult to reorganize their teaching style from teacher dominant to learner centered instruction.   After several trials, however, they can express their recognition about the lessons and describe their empirical laws in the form of statements and judgmental propositions, 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 a fruitful and creative outcome from collaborative team work among participants.

Collaborative team work is essential to ensure fruitful and creative outcomes from u-Learning. The Japanese educational system is still 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 strong competition with their peers.   Collaborative team work in a learning atmosphere is not well cultivated and hard to realize even at the university level.   To overcome such a distorted attitude among students, the following five principles are emphasized in classes as an example of the educational norms illustrated in Figure 2.

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

Universal education rather than selective and smooth articulation between different stages of educational experience are urgent issues to be tackled in our educational system.   Ubiquitous ICT is expected to be very useful for solving these problems.

Practical implementations

When we start our project by implementing various technologies aiming at an effective instruction, we have to prepare different frameworks for those different technologies.   For instance, the radio-TV education requires a specific framework and techniques quite different from those for CAI, Computer Assisted Instruction.   However, if we start from the learning itself, the strategy for specifying instructional objectives, for clarifying instructional strategy and arranging learning experiences comes first, while providing a learning environment comes second.   This
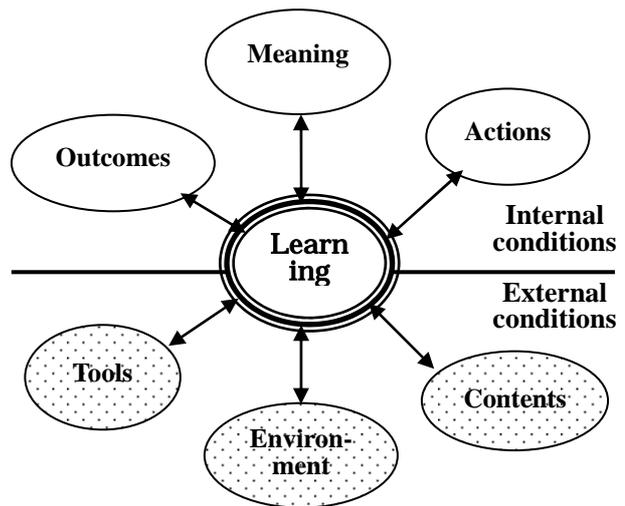

Figure 3 Structure model MACETO

approach underlies the model illustrated in Figure 3 which has emerged from the author's long experience in instructional technology.   (I have referred to and modified Gagne's model of internal and external factors (Gagne et al. 1979, 1992)).

Active learning can be realized by integrating the structural and procedural 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 competence and knowledge in spite of different conditions of 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.

Why should we realize and specify the meaning of learning before deciding instructional contents? The present education in schools, even in universities, emphasizes the importance of instructional contents and deviates towards teaching crammed with factual knowledge.   At the same time, our information-rich society provides us with the most up-dated knowledge, requiring us to refresh ceaselessly our professional competence relevant to daily life 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, learning activities and outcomes at the first stage, and then working out the contents at the second stage.   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 contents.   In this context, we should start by identifying learners' competencies to be cultivated, arranging authentic themes relevant to the present changing society, and stimulating intuitive and creative knowledge to solve problems rather than having 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. The outcomes from autonomous learning are also products of institutional 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 and contribute 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 for providing learning events accessible to 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 review. 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 phone).

Referring to figurative and iconic models and instructors' empirical laws, we try to develop learning events utilizing printed materials, and then confirm their validity by observing learners' activities and products through functions of testing, discussion on the bulletin boards, consultation by e-mail and report submission. Learning materials to elicit learning experiences can be described in the form of a process model named ITISCA: Intention of instructional developers, Taxonomy of instructional objectives, Individual/team/ cohort learning, Sequencing of learning activities, Contents and Assessment scheme.

Lessons
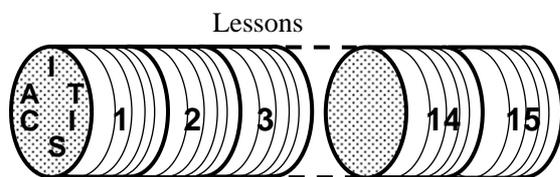
Intention of instructional developer
Taxonomy of instructional objectives
Individual/team/cohort learning
Sequencing of the module
Contents of learning
Assessment criteria if necessary

Figure 4 Procedure model ITISCA

The Process model ITISCA is applied to develop segmental instructional modules for generating specific learning events during the course. For each lesson, students receive three to seven modules, each of which has usually one to four pages intending to generate different learning events. Each module has unique and specific characteristics and is described in terms of ITISCA. The university course 'Instructional Technology' is composed of about sixty modules, of which some are compatible to modules applicable to other courses. They are all stored and managed by an Access package for common use by developers.

In university education, one course lasts for 15 weeks per semester. Each lesson is composed of three to seven modules for 90 minutes in total, each of which corresponds to a specific learning experience. Sequencing those experiences rationally during the course aims to compose a reasonable process to elicit creative and visible outcomes. Such judgmental reasoning is described in the form of figurative and iconic knowledge and judgmental propositions, and stored in a database with the intention to be referred to later or accessed by others. Therefore, outcomes from those lessons are four fold: visible products such as reports and/or works, students' enhanced competence, instructional materials for the course, and empirical knowledge concerning the instructional development.

Cases of implementation

In this u-Learning project, a theory for instructional development is expected to emerge from practical experiences. The author conducted three actual courses at the undergraduate level: 'Introduction to Instructional Technology', 'Instructional Analysis and Design' and 'Instruction of Informatics'.

Case I
Title of the course: Introduction to Instructional Techno-
logy
Participants: 228 undergraduate 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, 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 by using printed texts and mobile phones. (This feasibility study on learning using textbook and inexpensive devices is urgently needed to implement new distance learning at Bukkyo University which has a 50 year history and 20,000 students in the correspondence education department.) The 228 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 each group, but not with other groups. They used mobile phones out of class to discuss their concerns in the earlier half 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 a high retention ratio (89.9 percent) in full-time course for one semester.

Case II

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

This trial aimed to confirm the effects of computer use for producing creative outcomes. The instruction followed almost the same texts as stored in 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 case I. It revealed that the availability of one terminal per student does not produce a more unique outcome. Open discussions and critiques seem to be more needed than the availability of computers.

Case III

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

This on-going class is divided into four teams; students' activities in the classroom and their communication through mobile phones are continually under observation. Their task is 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 proposes one imaginary curriculum of 'Basic Informatics' with the intention of introducing innovative lessons to overcome the present passive and monotonous 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 is more active in discussion produces more unique plans for the lessons. It is still very difficult for students to transform their framework from teaching dominant style to learning centered one. More time is required to discuss issues, change their framework of instruction and revise original ideas repeatedly.

Theory of instructional development for u-Learning

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 of national education, Japanese education has developed based more on the national interests and less on individual abilities and needs. However, a recent demographic survey showed a steady decrease in the population of children with only 1.32 children born by one female during her lifetime. Therefore, we cannot waste the talent of any child within the constricted national education concept. 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 decision making for materializing realistic instruction. The conventional theory already conceptualized and well established is not necessarily applicable to a specific situation and 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 such as mobile phones and PDA and the most convenient medium of printed materials.

Application software such as word processing, presentation software and spreadsheet are widely used in schools and universities. New information and communication technologies have the potential to innovate the instructional framework from knowledge transfer models to knowledge creation models. This is due to the universal accessibility of the most recent and advanced knowledge on a global scale and with facilities easy to operate, creating elaborate original ideas and then refining the outcome. An innovative framework of instruction is indispensable to transform the students' passive attitudes to courageous and adventurous creation.

In the process of developing courses for undergraduate students, there are three possible approaches to apply a rational procedure for instructional development; 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 the behaviorism and constructivism. Actual instruction is too complex to manage from a single concept and 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 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 shown in the Appendix as examples.

Conclusions

Mobile phones and PDA so familiar to students are still out of bounds as educational instruments. Using mobile phones is entirely one part of their daily life and they cannot forget them at home or anywhere else. On the other hand, instruction has become too difficult to tackle by teachers 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 imaginative and creative, to develop scientific procedures to pursue a rational reasoning for instructional development in the professional disciplines. 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 in the real 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.

References

Gagne, Robert M., Leslie J. Briggs (1979): Principles of Instructional Design, 2nd ed. Holt Rinehart and Winston

Gagne, Robert M., Leslie J. Briggs, Walter W. Wager (1992): Principles of Instructional Design, 4th ed., Harcourt Brace Jovanovich College Publishers

Nishinosono, Haruo (1978): *Two Symbol Systems for Designing the Instructional Process*, Educational Technology Research Vol.2, No.1, Tokyo

Nishinosono, Haruo (2002): *Instructional Development for Knowledge Creation in Large-scale Classes*, Proceedings of SITE2002, March 18-23, 2002, Nashville, Tennessee, pp.2558-2562

Polanyi, Michael (1983): The Tacit Dimension, Gloucester, Mass. Peter Smith

(Appendix)

Some instructional propositions emerged from the u-Learning projects. (5 propositions 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 previous 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 students 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 results 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 results in a reliable but mediocre outcome 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 of groups, encourage active participation and let them recognize their responsibility towards self-reliant learning.
- To make learning meaningful, it is effective to start the lesson from one's own earlier experiences which are relevant to instructional contents.