Chapter 5
Building a Smarter College: Best Educational Practices and Faculty Development

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Abstract In a smarter university/college, various matters should be interconnected for effective functioning. These include hardware, software, systems, institutional policies, including admission policy, curriculum policy, and diploma policy, faculty development, and information sharing. Our past practices of innovative smart education are highly evaluated and, as a result, financially supported by the Ministry of Education, Culture, Sports, Science and Technology, Japan, and National Institute of Technology, Gifu College (NIT, Gifu College). The efforts of smart education are being promoted at an accelerated rate. All of the faculty members are interconnecting the various matters. Active learning practiced at NIT, Gifu College is characterized by the use of educational systems with ICT equipment. From this point of view, in this chapter, active learning has almost the same meaning as smart education. Based on this idea, we describe various practices for building a smarter college.

Keywords Smart education · Smarter university/college · ICT · Active learning · Faculty development · Curriculum

5.1 Introduction

5.1.1 Globalization of Smart Education

Uskov et al. [1] proposed that "… a future smart university is expected to have distinctive features that go well beyond features of a traditional university, sufficiently taking in *Adaptation, Sensing, Inferring, Self-learning, Anticipation, Self-*

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Organization". These concepts are the core concepts of "smartness" that represent the foundation of smart education. In this chapter, it is clarified which concept among the smartness levels each content of smart education has.

Regarding a smart university, Hwang [2] describes the importance of the real-world learning environment, stating: "It can be seen that applying intelligent tutoring or adaptive learning techniques to real-world learning scenarios has become an important and challenging issue of technology-enhanced learning. That is, incorporating intelligent tutoring or adaptive learning techniques to context-aware ubiquitous learning has become one of the important issues of technology-enhanced learning" [2].

Coccoli et al. [3] state: "By 'smarter university' we mean a place where knowledge is shared between employees, teachers, students, and all stakeholders in a seamless way. … To cope with this reality, technology is no longer sufficient. We suggest that a paradigm change is necessary to transform a smart university into a smarter university, hence more efficient, more effective, and with a higher participation of both students and teachers, collaborating to achieve the common objective of better learning". Both the former and latter authors point out the importance of seeing our real society in addition to the technology, such as "the technology and the real environment" and "the technology and sharing knowledge among the university's faculty members" [2, 3].

Active learning (AL) encourages learners to actively and independently solve a problem. On such occasions, it is important to interact well with the other members within a group and a teacher as a facilitator. In smart education, various types of interactions are supported by ICT equipment, software, and other kinds of systems. Recording the interactions in the learning process will cause the system to send feedback or information helpful to learners and teachers in the form of a portfolio. For example, e-Learning using educational videos enables learners to do self-learning at home through the idea of flipped learning. Also, the use of ICT equipment and some kinds of systems for problem solving learning, such as flipped learning in class at a university/college, will effectively be able to bring out learners' active nature. Thus, AL becomes more finely tuned, more intelligent, and more effective when combined with smart education. At NIT, Gifu College, we are promoting this type of AL associated with smart education.

As globalization proceeds in the field of education, the increasing importance of the smart university concept is considered as a global standard. In 2013, Japan's National Institute for Educational Policy Research, which is under the Ministry of Education, Culture, Sports, Science and Technology (MEXT), proposed the "21st century competencies": in the future, Japanese students are expected to acquire, not only knowledge, but also the capability to find problems for themselves and solve them through thinking. The former Ministry of Education, now MEXT, substantially revised the standards for establishing universities in 1991 as the Japanese government promoted the decentralization of power and announced a policy to ease the restrictions.

5.1.2 Foundation for Smart Education in Japan

In the revisions, the related laws, including the School Education Act and the standards for establishing universities, were drastically amended. This allowed individual schools to flexibly develop unique education and research based on its own educational philosophy and objectives. This takes place while responding appropriately to the advancement of learning and the demands of society. The related legal revisions led to the elimination of the details of the standards including curriculum [4]. Under the revisions, the requirements of the standards were eased, but a policy in instituted that stated that universities themselves should assure quality of education and research. Consequently, universities were required to conduct self-inspections and assess the quality of their education and research.

As a result of these revisions, the number of private universities in Japan increased from 372 in 1990 to 605 in 2012. Also, the percentage of students who go on to a 4-year university increased from 25.5% in 1991 to 50.2% in 2009, surpassing the 50% line for the first time. In recent years, however, the university advancement rate has remained unchanged at approximately 50%. The total university enrollment also tends to decrease, following the decline in the number of high school students due to a declining birthrate in Japan. From a standpoint of both enhancing international competitiveness amid globalization and quality assurance of university education, MEXT announced "a University Reform Action Plan" in June of 2012. This clearly indicated its intention to exclude universities that cannot adjust to societal changes. The plan includes a policy to intensively provide subsidies to universities that improve the quality of education and promote the development of human resources focused on global outlook and/or contribution to the local community. They must also severely deal with universities that have problems with managing status and/or educational environment, etc. Also, because of the decline in the number of high school students due to the falling birthrate, MEXT has presented the following rough plan: universities are highly expected to promote the abolition of departments and graduate schools related to teacher training, humanities, and social science. They must also promote the abolition of their reorganization to fields with high societal demand.

In Japan, it is estimated that the number of 18-year-olds, which stood at 2.07 million in 1991, will continue to decline to 1.01 million in 2030. The declining number of children will cause the integration and abolition of universities in the future. Just as with the worldwide trend to positively introduce e-Learning and active learning (AL) into education amid increasing globalization, it is a natural tendency to introduce ICT-driven education and e-Learning in Japan under the present situation. MEXT is also strongly promoting the use of AL and e-Learning in elementary, secondary, and higher education. In order to develop an environment where school education appropriate for the 21st century can be realized, MEXT budgeted the amount required for attaining the targeted level in the Second Basic Plan for the Promotion of Education. This was endorsed by the Cabinet decision on June 14, 2013. Based on the "four-year environmental improvement program for

IT-based education (2014 to 2017)", 167.8 billion yen will be budgeted every year up to the fiscal year 2017, allotting 671.2 billion yen each year for four years.

5.1.3 Development to Smart Education in NIT, Gifu College

Colleges in the National Institute of Technology (NIT) accept junior high school graduates who have just completed compulsory education. We focus on applicants entering the best suited department by visualizing the educational content of each department and publicizing the differences among all the departments. This has made it possible to start specialized education at the first year and allow students to acquire university-level expertise, receiving a high evaluation from several external evaluation organizations, including OECD. As a success of the educational activities in NIT colleges, the graduates of departments have received a high evaluation from society whether through gaining employment after graduation or transferring into the third year at four-year universities. Those who have entered graduate schools after completing the advanced courses of NIT colleges have also received a high evaluation from the graduate schools they entered. Furthermore, the examinations conducted by the National Institution for Academic Degrees, Japan, and JABEE, such as the institutional certified evaluation and accreditation for the advanced course of NIT colleges, have recently pointed out the need to develop a curriculum while being more conscious of the specialized fields of respective departments. Accordingly, the research performances in his/her specialized field of the faculty of the departments of NIT colleges are screened more strictly than before. The sophistication and complexity of the technologies, society needs, globalization, global environmental issues, and the rapid progress of technological innovation have produced an idea that we should foster engineers with wide range of skills, though. Considering the social situation, NIT is promoting its educational and organizational reforms throughout the whole organization.

Our past challenges such as advanced education using ICT equipment, e-Learning education under the credit transfer agreement practiced in a consortium, and developmental continuation of education constructed financially supported by the "Support Program for Contemporary Educational Needs (GP)" led to awards from several academic societies for education. Furthermore, NIT, Gifu College acquired the AP. While financially supported by MEXT for five years, we started to promote college wide educational reform at an accelerated rate for a smart college. And now, entering the third year of support, it has been decided that the period of our AP project would be extended from five years to six years. This will enable us to more fully develop items that were scheduled for the latter three years. This can further increase the quality assurance level of the graduating students. Our challenge of smart education is characterized by the practice of AL using ICT-driven equipment as well as some kinds of systems. Also, AL as described in this chapter is AL in a broad sense of the term, including project-based learning, learning-by-doing, adaptive learning, and flipped classrooms. We are practicing

smart education by using ICT-driven equipment and some kinds of systems. In short, the objectives of our AP project practiced during this period, are to have students acquire independent-minded, self-directive, and self-improvement minds as well as their ability through learning at college, holding the practice of AL, and the visualization of the learning outcomes as key words, while ensuring continuity after the completion of the project. The advancement and internationalization of the education of NIT colleges, which had been the education goals of NIT, Gifu College before the acquisition of the AP, are related to the AP themes of other fields.

5.2 Smart Education: Literature Review

5.2.1 Use of Data Mining

The wide use of the Internet has caused an explosive increase in the amount of information available to society. It has also caused a tremendous increase in the amount of information learners can access and, accordingly, provided them with a greater range of interest and choices. On the other hand, it is becoming difficult for teachers to meet all the needs of all learners. This is because teachers are limited in knowledge beyond their lectures. By automatically supplying learning materials, distributing reference materials, collecting reports, and conducting tests using ICT, though, we will be able to build an educational system which responds to the learner-centered personalized needs. Also, analyzing big data will make it possible to create a system related to smart education. This is where teachers will support learners to match each student's ability.

Technology to extract knowledge is developing rapidly; it is conducted by exhaustively applying some kinds of data analysis techniques. Statistics, pattern recognition, and artificial intelligence by use of data mining can all be used to deal with such large amounts of data [5–7]. Data mining analysis of learners' study history/portfolio of, for example, LMS, will make it possible to give feedback to students and teachers. This corresponds to "sensing" when it comes to smartness levels. Relational databases and its operation language (SQL) appeared in the 1980s, making it possible to perform dynamic data analysis on demand. Data volume increased explosively in the 1990s and provided a spark for people to use data warehouses for data accumulation. This trend created an idea of using data mining as a way to deal with massive amounts of data in a database. It was then slowly applied as a way of statistical analysis, the search technology in the field of artificial intelligence, and so on. In the 2010s, a variety of practical services using big data analysis, where data mining is conducted with an enormous quantity of data, have appeared and are provided.

5.2.2 Data Processing on Students' Physiological Responses

By gathering students' data, in addition to giving feedback to learners and teachers based on the analysis of data from LMS and so on, research is being conducted where, after measuring learners' automatic biological information, the result of data analysis is fed back to learners and teachers [8–10]. Here, we find research to evaluate educational materials with an entirely new approach. This is where students' physiological responses are employed to evaluate the quality of digital educational materials scientifically and objectively, not by questionnaires or forms of the same nature. This kind of coping using biometrics corresponds to "sensing" of the smartness level. The authors measured the physiological responses of both students learning with interactive educational materials and students learning with non-interactive educational materials based on blood-flow engineering. They then explained the difference between them. The data analysis was based on bioinstrumentation data. By incorporating the data into a system, we will be able to directly provide feedback to the students as well as the faculty. Thus, we will provide a smart education environment. For example, when the operational bioinstrumentation system detects that the students are inactive, a teacher can immediately provide feedback by giving them appropriate or different educational materials. Besides, as a different method for utilization of the measured results of automatic biological reactions, the system will be able to analyze where and how learners have setbacks in light of their pattern of learning. It can then provide detailed advice to them for dealing with their setbacks. This matter corresponds to "sensing" of the smartness level. Asanka et al. [11] took a look at how this can utilize eye blinking and a learner's attitude.

5.2.3 Challenges in Education in a Virtual World

Problem-based learning (PBL) in a virtual world has some challenges. The following references are worth noting in regards to the measurement of the eye blinking in a virtual world and a learner's attitude. Barry et al. [12] shows that the introduction of a virtual world like metaverse into education will make it possible to realize smart education where distance in space is followed by techniques. We can create an environment where students feel as if they were learning in the same classroom through metaverse as an educational environment, even though they really are distant from each other [13, 14].

5.2.4 Application to Smart University

At NIT, Gifu College, we are advancing the above-mentioned research. Their research results have already been introduced into smart education classes. Their practical realization will make it possible to introduce smart education, specifically, to mostly shift individualized instructions by teachers to each student to ICT. This will bring a substantial change to future models for education and the role of teachers. In knowledge-acquisition learning, through an integrated management system where an ICT environment and a software environment are associated each other, each student studies by him/herself or with the support of a teacher. In class, students take advantage of information, have problem consciousness, seek a solution, and present his/her idea. Teachers play a role as a guide for learning. Specifically, they act as a facilitator who motivates students for learning and activate a discussion. They also need flexibility to deal with learners' diverse interests as well as their different desires to learn. These are regarded as the embodiment of future education, which MEXT and the ruling party suggested, and are the guidelines that universities/colleges all around the world aiming for "smart universities/colleges", including NIT, Gifu College, should follow.

5.3 Goals and Objectives of Smart Education

5.3.1 NIT, Gifu College's Transformation into a Smarter College

On April 1st, 2004, the National Institute of Technology (NIT) in Japan was inaugurated to manage 55 national colleges (KOSEN) including NIT, Gifu College [15]. In Japan, almost all prefectures have one KOSEN. It is an institution of higher education with a unique feature that the campuses exist throughout Japan. In 2014, ten years after its foundation, the Institute has developed the third-stage medium-term programs and goals where the promotion of AL, which would highly contribute to the realization of smart college using ICT-driven equipment, is described. On the other hand, NIT, Gifu College, a higher education institution celebrating its 53rd birthday in 2016, has been working on unique challenges related to smart college since before the NIT in Japan was inaugurated. For more than fifteen years, NIT, Gifu College has been developing ICT-driven educational content to cultivate students' voluntary learning. Also, we have developed a system to give incentives for voluntary learning and its evaluating method.

MEXT's "Support Program for Contemporary Educational Needs (GP)" once sponsored our activity. These implementations led to use receiving several awards from academic societies for education. Our ICT-driven education that has been practiced for the past fifteen years was highly evaluated. As a result, our program was selected as a project of the AP by MEXT in 2014. Our AP project began college-wide smart education and was funded by MEXT for six years.

5.3.2 Curriculum

The acquisition of the AP has triggered the introduction of students' voluntary learning into the classes of all teachers; this previously had been performed only in a few classes. In our AP project, we will introduce AL into all the formal subjects at NIT, Gifu College. We also visualize the learning outcomes of both non-curriculum and AL of curriculum, based on the practical engineering credit system. Though AL includes various kinds of activities, such as flipped learning, they correspond to "adaptation" of the smartness level. In addition, AL places emphasis on thinking for oneself and solving problems. These matters are related to "self-learning" of the smartness level. We will promote active educational improvement and the visualization of the learning outcomes by doing the following:

(1) to consolidate in a server and distribute both educational content for teachers. This ensures the educational quality based on Model Core Curriculum (MCC) established by the National Institute of Technology and learning assistance content for students.
(2) to improve the classroom ICT environment.
    (a) projectors with an electronic blackboard system,
    (b) wireless LAN environment,
    (c) terminal environment, and
    (d) systems and software environment.

5.3.3 Creation of an Environment for Smart Education

We think it's vital for first year students to become accustomed to AL in order to understand its meaning and to experience and master the skills of creating new things by themselves and/or with friends in classes over a short time period; of course, these are true for students in upper grades as well. We are now developing the supporting system of students' voluntary learning; all of the teachers learn how to use the electronic blackboard system, the LMS server, tablet PCs, and software for creating teaching materials.

5.3.4 Development of Educational Materials

When starting this AP project, we consulted with some senior graduates of NIT, Gifu College. Each has worked long and/or is currently working in Japanese industries as leading engineers. There is emphasis on the knowledge and skills that they think are important for when students enter the industry after graduation. Specifically, in the 2014 questionnaire, they picked up forty-five important items

among those included in MCC and recommended visualization of educational outcomes of these items. More specifically, they suggested subjects, keywords, related matters, backgrounds, reasons, motivation, the introductory level, the intermediate level, the advanced level, and familiar products and cases in use, using diagrams as well as texts when needed. From this academic year, we will create the learning content and learning support content of each item based on the suggestions of the graduates. We will also create the content while being conscious of the learning level of respective content and the relations among the subjects.

5.3.5 *Promoting and Visualizing Smart Education*

It is important to construct both hardware and software interdependently in order to realize smart education: the introduction of equipment and the advances in technology of classroom environment in terms of hardware as well as the systematic analyses of the constitution of educational content, the establishment of the related education system, and the creation of the educational content that goes along with the system in terms of software.

The aim of our AP project is to promote students' active way of learning by practicing AL [16–27]. Therefore, we are creating an environment for practicing ICT education useful for AL and developing teaching materials based on MCC established by the NIT to ensure educational quality [15]. The AP project of NIT, Gifu College is composed of two themes, Theme I and Theme II. We are now promoting both Theme I, which is the promotion of AL, and Theme II, which is the visualization of the learning outcomes. As for the initiatives for Theme II, we are visualizing the educational and learning outcomes of NIT, Gifu College for off-campus people. It also examines them every time NIT, Gifu College undergoes accreditation by evaluation organizations such as the National Institution for Academic Degrees and Quality Enhancement of Higher Education and the Japan Accreditation Board for Engineering Education (JABEE) [28, 29].

In our AP project, we are proceeding with:

(1) the improvement of educational methods by introducing AL into all classes of the formal subjects of NIT, Gifu College, and
(2) the construction of a system where the educational and learning outcomes are visualized, evaluated, and examined quantitatively under the practical engineering credit system, or a point system where educational outcomes are visualized as independent learning outcomes.

Theme I, the promotion of AL, acts as a catalyst for accelerating the improvement of educational methods of respective subjects, encouraging teachers to improve their teaching methods as well as content, and cooperating with other teachers concerned. The efforts made by respective teachers are shared and visualized through our faculty development (FD) and debrief sessions. This is helpful in

spreading the efforts within NIT, Gifu College. Theme II, the visualization of the learning outcomes, focuses, not only on the learning outcomes of respective subjects and the improvement of the educational outcomes, but also on the students' independent learning process toward the objectives from entrance to graduation. Under Theme II, we also visualize the process of developing the ability necessary to acquire competencies, such as cooperativeness and humanity as well as literacies of planning, independence, etc., so that students can attain their objectives.

5.4 The Creation of the Environment: Methods and Outcomes

As described earlier, NIT, Gifu College is leading the way in the promotion of AL among all the National Institutes of Technology. More precisely, we are improving the environment for AL including ICT-driven equipment, e-Learning and teaching materials and promoting educational practice with them as the AP, funded by MEXT for five years.

In the academic years of 2014, 2015, and 2016, we introduced projectors with an electronic blackboard system into all 25 classrooms for all five years of all the five departments through bids at the expense of the AP budget. Furthermore, the wireless LAN device was set up for use in the 25 classrooms so that the introduced LMS systems, such as Moodle and Blackboard, could be used in classes. STORM Maker, software for making teaching materials, was introduced to develop teaching materials to store in the LMS. The special characteristic of STORM Maker, which has an automatic voice synthesis function, simplifies the process of making content that is based on materials. Therefore, we can easily create teaching materials with voice for e-Learning with the work of entering character, without recording narration voice. Both male and female voices can be synthesized, depending on the use and characteristics of teaching materials. Moreover, we introduced 163 Tablet computers (Toshiba), 50 notebook PCs (Fujitsu) and 20 Microsoft Surfaces. All of them were introduced for lending and being set up to connect to all the access points of the wireless LAN for e-Learning in classes.

5.4.1 The Foundation for Introducing AL

As the actual performances that have led NIT, Gifu College to a hub for promoting AL, there are two pillars:

(1) The practice of ICT-driven education performed mainly in the multimedia educational building.
(2) The practice of the credit transfer system education using e-Learning.

5.4.1.1 The Practice of ICT-Driven Education Performed Mainly in the Multimedia Educational Building

The first pillar is the practice of ICT-driven education performed mainly in the multimedia educational building. In NIT, Gifu College, from 2001 until the present, ICT-driven education has been practiced in the multimedia educational building where the fourth-year classrooms of all five departments reside. The installation of ICT-driven equipment for teachers, as well as desktop personal computers for all students with desks having a storage feature for locking away each personal computer, made it possible to perform ICT-driven education in all classes (Fig. 5.1).

ICT-driven equipment was introduced into teachers' workspaces as well as students' workspaces in every classroom. Since the ICT-driven education system has been introduced, ICT-driven education can be applied in various subjects, including social studies, languages, science, and engineering. Every student can use his or her own personal computer and enjoy multimedia education at his or her own will. In NIT, Gifu College, ICT-driven equipment of the multimedia educational building has been internally budgeted for replacement every five years. In 2016, we introduced new ICT-driven equipment useful for AL. This will be mentioned later.

5.4.1.2 The Practice of the Credit Transfer System Education Using E-Learning

Additionally, supported by the "Support Program for Contemporary Educational Needs (GP)" since 2004, we developed the content and system for e-Learning. Also, the program to provide two different kinds of consortium with lectures by using the e-Learning system has successfully been continued until today. When studying by e-Learning, students are supported by e-mail and teachers face-to-face. They are supposed to study the content within the server for themselves, though. Their studies with simulation software, interactive software, videos, texts, etc.

Fig. 5.1 ICT-driven equipment installed in the fourth-year classrooms

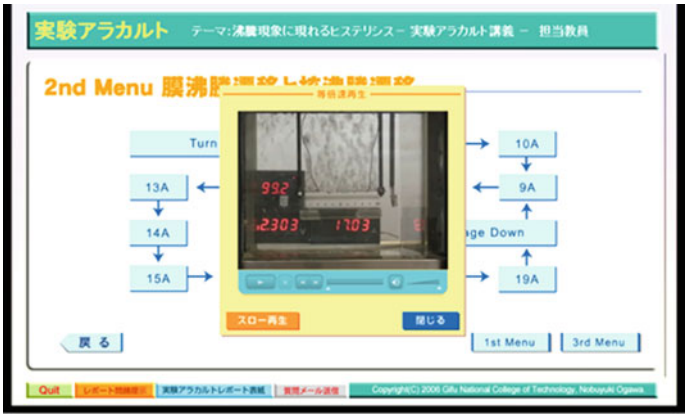

Fig. 5.2 An example of a presentation using the e-Learning system

correspond to "self-learning" of the smartness level. The number of NIT colleges participating in the consortium is increasing year after year. To this day, nearly half of all of the NIT colleges have already participated in the consortium (Fig. 5.2).

NIT, Gifu College has been strongly promoting ICT-driven education and e-Learning. As described above, in a broad sense, we have been practicing AL for a long time. Also, like other colleges, NIT, Gifu College has been practicing AL by PBL for the instruction of practical experiments for the past years. Under the groundwork of the above-mentioned AL, NIT, Gifu College began to strongly promote AL. This includes flipped learning for classroom lectures in 2012. The states of our practice, both before and after the acquisition of the AP, are described below.

5.4.2 AL Before the Acquisition of AP

5.4.2.1 The Learning Environment of AL at NIT, Gifu College Library (2nd Floor)

From this point forward, we will describe the learning environment of AL that was developed in a room on the 2nd floor of the library of NIT, Gifu College. In order to do flexible education of AL, it is important that the equipment in the classrooms is flexible.

As shown in Fig. 5.3, considering these points, NIT, Gifu College has developed a learning environment by installing some custom-made trapezoidal tables. These can be combined in various forms according to the type of group work required, in addition to movable downsized whiteboards for group discussion in the 2nd floor room of the library. During breaks between classes and after school, students can

Fig. 5.3 The learning environment of AL in NIT, Gifu College's library

use the classroom freely. They can have an active discussion using freely arranged desks for completing a report or studying for an exam.

5.4.2.2 Best Practices of AL

NIT, Gifu College is presenting a plan to introduce AL into all classes of NIT, Gifu College and establish it within the term of the third-stage medium-term programs and objectives. In 2012, NIT, Gifu College started AL with flipped learning in the classes of some subjects underlying engineering. More specifically, these classes were mathematics, physics, chemistry, applied physics, and applied mathematics. These subjects took a central role in promoting AL in NIT, Gifu College.

In AL, where the utilization of knowledge is important, such class activities as group discussion, debate, and group work, are effective. Also, cooperative learning done in groups and presentations are indispensable.

In order to do flexible education of AL, it is beneficial that the equipment of the classrooms to be used is versatile. In 2013, considering these points, NIT, Gifu College developed ICT environment by installing electronic blackboards, tablet computers, a file server for teaching materials, and the like in the laboratory classrooms of applied physics, and chemistry.

Fig. 5.4 ICT installment in the laboratory classroom of applied physics

The classroom has also been used for classroom lectures of applied physics and applied mathematics and a new type of flipped learning where classroom lectures, practical experiments, and ICT-driven education are combined has been practiced (Fig. 5.4).

5.4.3 AL After the Acquisition of AP

5.4.3.1 ICT-Driven Equipment Introduced by the AP Funds

So far, at the expense of the AP budget, we have introduced 163 Tablet computers (Toshiba), 50 notebook personal computers (Fujitsu) and 20 Microsoft Surfaces. Besides this, the following four items were introduced through bids for the purpose of developing various systems for smart education with ICT-driven equipment. The name of the company written at the end reveals which company won a bid and is in charge of constructing a respective system:

(1) an electronic blackboard system that uses ICT (Kameta Inc.),
(2) software for making teaching materials, STORM Maker (Otsuka Shokai Co., Ltd.),

(3) lease and maintenance operations of wireless LAN switch (Nippon Telegraph And Telephone West Corporation), and
(4) LMS server (Moodle) and DB server+FileMaker (Nippon Telegraph and Telephone West Corporation).

We believe that it's vital for freshman students to become accustomed to AL in order to understand its meaning as well as to experience and master the skills of creating new things by themselves and/or with friends in classes over a short time period; of course, these are true for students of the upper grades as well. Therefore, in 2014, when our AP project started, we replaced the blackboards in the back of the first-year classrooms of all five departments with whiteboards and introduced Epson-manufactured projectors. Each has the function of electronic blackboard that is described in the above item (1).

In the 2015 academic year, we introduced the same ICT environment into the second and third classrooms of the five departments. Moreover, in the 2016 academic year, we are planning to introduce the same ICT environment into the fourth and fifth classrooms of the five departments. Thus, the same projectors with the electronic blackboard functions will have been installed into all classrooms of all departments.

The introduced electronic blackboards make it possible to draw and write on its whiteboard with a dedicated electronic pen without connecting a personal computer. Digital data of drawing and writing can be recorded and stored in a file server connected to the network. Moreover, the linkage function of a tablet makes it possible for teachers to arbitrarily select students' tablets up to 50 units from the teachers' tablet and display them on up to four screens. Using the projector control toolbar displayed on the projection screen of the electronic blackboard, teachers can easily select and control students' tablet screen by operating on the screen (Fig. 5.5).

It was basically left to respective departments in which personal computers the assigned licenses are to be installed. The assignment of software for making teaching materials, STORM Maker, is as follows: Two licenses for the departments of liberal arts and natural science, respectively. Three licenses for the specialized five departments, respectively.

The special characteristic of STORM Maker is that we can easily develop content based on materials. It contains the functions to create original Power Point material with animations, write an article on it using the notebook function, and automatically translate original educational material into educational material with a movie using the speech-synthesis function. (Figure 5.6) The software makes it possible to automatically synthesize voice from text, which corresponds to "adaptation" of the smartness level.

AL, which makes students learn on their own initiative, will help them gain a deeper understanding. It is considered important that students present their knowledge and opinions in a positive manner through presentations, discussions,

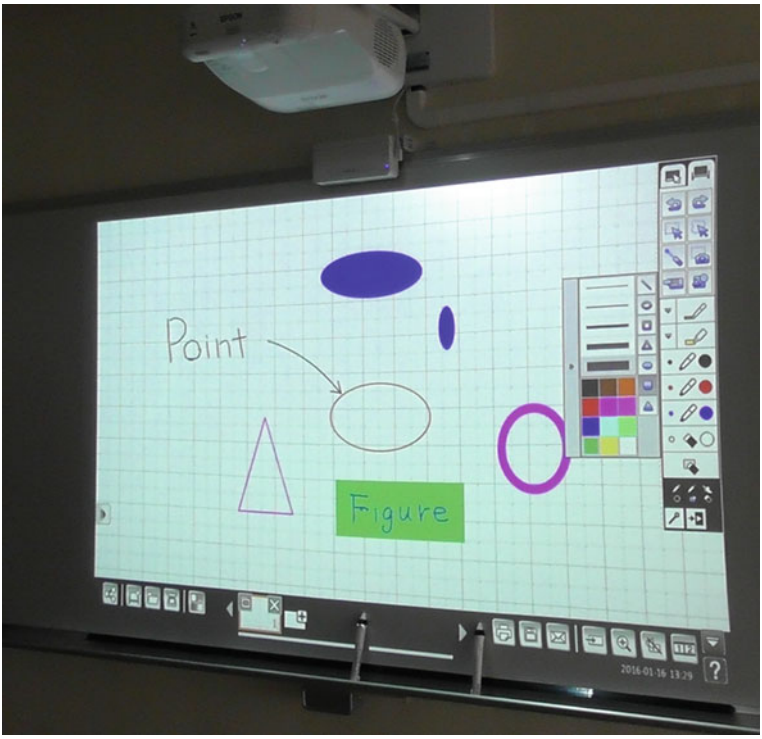

Fig. 5.5 Drawing on an introduced electronic blackboard with an electronic pen

and debates. The intention of the software is not only for teachers to make content, but also for students to make content for future use. In addition to the fact that students' creative activities can also be considered AL, the teaching materials they produce are practiced in classes of AL. When students make educational materials, teachers are hoped to facilitate their content. Doing so will assure the quality and quantity of the teaching materials and increase the quality of AL where students do content creative activities.

The wireless LAN device was set up for use in all 25 classrooms every year (from the first to the fifth year) in all five of the departments. The system was developed by providing two access points for the wireless LAN in each classroom and by controlling them using MAC addresses to prevent injustice access. The same setting was conducted for more than 163 tablet computers (Toshiba). They can be connected to all of the access points for the wireless LAN of 25 classrooms. Therefore, though tablet computers are stored in the storage cabinets near the first-year classrooms, they can be used in other classrooms as well. More specifically, more than 160 tablet computers (Toshiba) were introduced so that we could use them in four classrooms at the same time. All of them were set up for connecting to all the access points of the wireless LAN of the above-mentioned 25

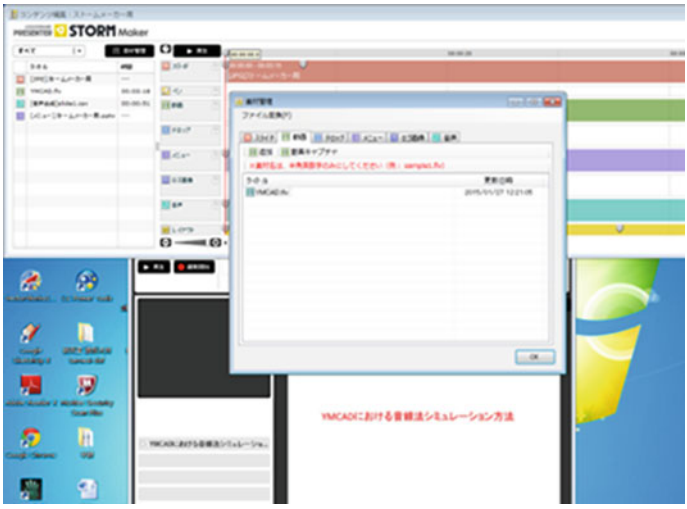

Fig. 5.6 A screen of materials selection for making educational materials using STORM maker

classrooms. Though tablet computers are stored near the first-year classrooms, they can be used in the classrooms of the second, third, fourth and fifth years by simply carrying them. In NIT, Gifu College, we are promoting AL while utilizing two kinds of LMS; LMS (Blackboard) of started by NIT, Japan and LMS (Moodle) introduced by the above-mentioned AP. LMS can be used in classes by using equipment we introduced. It can also be used at home. When learners use it for his/her own learning, LMS corresponds to "self-learning" of the smartness level. The same goes for the 50 notebook computers (Fujitsu) and 20 Microsoft Surfaces we introduced. They can be used in every classroom with the wireless LAN system.

The LMS server was introduced so that personal computers and tablet computers within and outside the campus, as well as smartphones, could obtain access. This enabled students to access it at home in addition to in the classroom. The use of these kinds of mobile devices corresponds to "adaptation" of the smartness level. In the 2014 academic year, students used the LMS server for conducting student evaluation while teachers used it for submitting a report on AL. "DB server +FileMaker" will be used for DB processing to visualize the learning outcomes and visualization itself.

"DB server+FileMaker" will be used for DB processing to visualize the learning outcomes and visualization itself. It will also be used in an effort to visualize students' learning activities performed outside the formal curriculum. Moreover, we intend to build a "student analytics system" by using LMS and a DB server we introduced, which corresponds to "inferring" of the smartness level.

5.4.4 *Replacement in the Multimedia Educational Building*

In NIT, Gifu College, ICT-driven equipment of the fourth-year classrooms of all five departments, which we mentioned in "4.1 The foundation for introducing AL", has been replaced every five years since it was first introduced. In the fourth replacement done in the 2015 academic year, we changed each of the fourth-year classrooms of all five departments into a flexible classroom environment. Now, using tablet/notebook computing bought using the AP budget allow the practice of AL. These connect to the classroom wireless LAN. The expenses needed for the replacement were not from the AP budget, but from NIT, Gifu College operating cost. Additional costs were covered by MEXT as well as the NIT. We expected, however, that the change of the fourth-year classrooms into a flexible classroom environment for practicing AL with tablet/notebook computers would make it almost impossible to practice programming/CAD. Before that, the students were learning these by using high-specification desktop computers with high memory capacity, high-speed arithmetic processing capacity, and advanced drawing performance. These were installed in the fourth-year classrooms. In order to deal with this situation, we increased the number of the computer rooms of the Information Processing Center from 3 to 5 in the replacement (Fig. 5.7).

Through the replacement of the Information Processing Center, the following were introduced and distributed into 5 computer rooms: 242 Client PCs (DELL: OptiPlex 3020 SFF), 4 Servers (DELL: PowerEdge R430), 1 NAS (Dell Storage NX3230), 10 Printers (Canon Laser Beam Printer Satera LBP8710), and 5 Document Cameras (EPSON: ELPDC12).

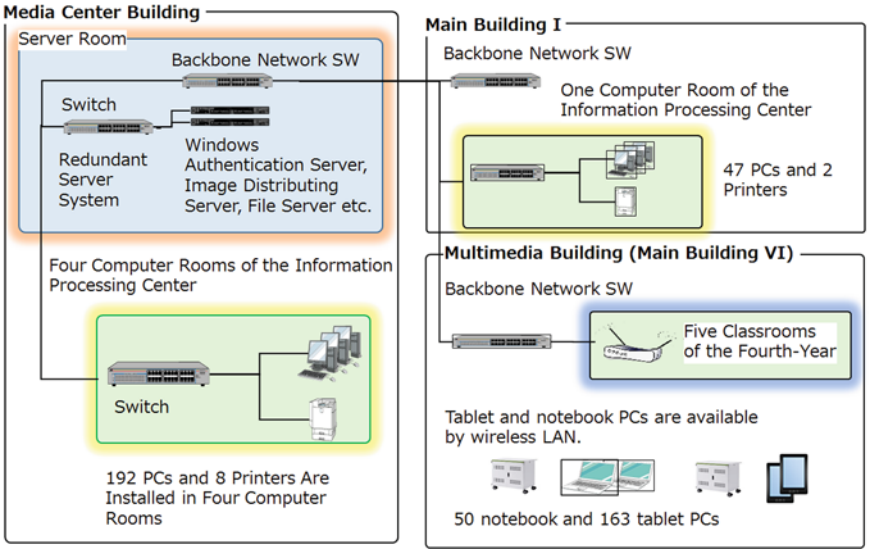

Fig. 5.7 The whole image of the computer rooms of the information processing centre and related facilities after the replacement

For the sake of managerial convenience, the system we introduced was set up as "thin client" and incorporated in the server system. Moreover, clients were set up to be under the same server system and work in the same way with the notebook PCs bought with the AP budget. This made it possible to conduct a smart management of software introduced in clients. For example, though software systems such as Adobe and CAD are managed under the license server, the connection of the license server with the "thin client" system will make it possible to use software with appropriate licenses in appropriate client PCs. We built a system where the server automatically shuts down in the event of a power outage. This corresponds to "self-organization" of the smartness level. The server system was designed to be load-balanced in addition to a doubling for redundancy. This also corresponds to "self-organization" of the smartness level.

5.5 Validation of Research

5.5.1 Faculty Development

As described earlier, NIT, Gifu College has established the system of associating hardware with software. It also created an educational environment for smart education. All teachers are practicing it; however, operation of the system depends on human factors. In other words, even though using the same instrument/system in a variety of types of smart education can be practiced, it depends on how teachers use them. We consider it important to share information among faculty regarding these matters. A teaching example of a teacher can provide the faculty with helpful ideas. Sharing information in good examples among the faculty will promote the practice of smart education at a college-wide level, leading to a true smart university/college.

It is necessary to consider the following two things when practicing AL according to the MCC curriculum:

(1) How to use the e-Learning system and ICT-driven equipment, and
(2) Educational methods of AL and e-Learning.

Teachers have different degrees of knowledge and skills regarding these two items. This means it is important to improve the teachers' knowledge and skills through FD in order to promote AL and e-Learning within NIT, Gifu College. In later paragraphs, we will describe the upward spiral of ICT-driven education through FD in NIT, Gifu College.

In the 2014 academic year, we established the office for promoting AL as a college wide organization and since then have been practicing AL. The office members consist of the representative teachers of all the departments including Mechanical Engineering, Electrical and Computer Engineering, Electronic Control Engineering, Civil Engineering, Architecture, liberal arts, and natural science. This

makes it possible to exchange information smoothly between the office and each department. This system will be maintained in the future. Also, the members of the office learn the newly introduced e-Learning system, ICT-driven equipment, and the approaches of AL in advance. Each member then conveys new information to his/her department. Moreover, the office is playing a leading role in promoting AL by implementing the following two kinds of FD activities at every faculty meeting: (A) teaching methods of AL and (B) How to use the e-Learning system and ICT-driven equipment. In NIT, Gifu College, we regard "teaching methods of smart education and AL" and "the use of ICT-driven equipment" as important cores. We also have the idea that a variety of AL can be practiced by combining teaching methods, the e-Learning system, and methods of using ICT-driven equipment. Actually, some teachers, inspired by the FD sessions held at faculty meetings, have created and practiced their own methods of AL.

Table 5.1 shows the FD sessions related to e-Learning and ICT-driven education held in NIT, Gifu College in the 2015 academic year. Since the beginning of the 2016 academic year, we have been holding the FD sessions under the two new subjects: one is an integrated subject of "teaching methods of smart education and AL" and "the use of ICT-driven equipment", and the other is a newly born subject, "the FD sessions where examples of AL performed within college include field works". It has been decided that, in this academic year and from the next academic year, the FD sessions will be held continuously. This is so that the teachers will be able to acquire more advanced skills. By doing so, trainers can conduct detailed instructions and respond to different teachers with different skills.

It is important to enhance teachers' skills for teaching and student counseling/guidance along with systematic curriculum to make college wide organizational deployment of education work more effective. It is necessary for each teacher to improve, not only his or her teaching ability, but also his or her skills of using ICT-driven equipment in order to practice education based on e-Learning and AL. This requires the improvement of the coordinated training system, sharing and publicity of model education examples, and the system of properly evaluating teachers' education examples. Also, it is necessary to introduce the system of teacher evaluations and student counseling/guidance conducted within a campus (peer review). In NIT, Gifu College, we consider it important to do continuous improvement performed by sharing and evaluating the education examples that, we believe, make high-quality e-Learning and AL penetrate within the college. These methods work well by both a shared understanding of the objectives of the curriculum and the curriculum itself by teachers and the effort for improving teachers' skills for teaching and student counseling/guidance. Considering the importance of organizational deployment of education curriculum, it is necessary to hold organizational workshops (FD) concerning the objectives of the curriculum, education content, and methods. It is important to keep in mind that the characteristics and creativity of education should not be impaired.

Table 5.1 The content of the FD sessions of NIT, Gifu College held in the 2015 academic year

Dates	Type of activity performed for promoting AL	People that the sessions targeted (headcount)	Results, expected effect	Problems	Measures against the problems described in the left column
Faculty meetings: Apr. 1, Jun. 3, Aug. 5, Sep. 18, Nov. 18, Feb. 10, Mar. 14	NIT, Gifu College, collegewide level (FD on the teaching of AL and ICT-driven equipment)	All teachers (about 80 people)	The FD lecture sessions are effective because they are held when all teachers get together	There are different needs because the teachers have different degrees of skills	A wide variety of subjects are treated
The FD meetings: May 7, Oct. 14	NIT, Gifu College (collegewide level)	All teachers (about 80 people)	Useful lecture by visiting lecturers	General topics, not concrete content	Concrete content is treated at FD regarding AL conducted at faculty meetings
(1) May 26–28 workshop of blackboard (basic) (2) Jun. 1–3 workshop of blackboard (intermediate) (3) Jun. 8–10 workshop of blackboard (advanced)	NIT, Gifu College (collegewide level)	All teachers (about 80 people)	To acquire how to use blackboard (basic, intermediate, advanced) and practice AL in class)	Some teachers cannot attend workshop because of other school affairs. The teachers have different degrees of skills	The same content was presented for three days, considering the teachers' schedule. The participants were free to select the level among three (basic, intermediate, advanced)
Workshop of moodle was held three times in Jun.	NIT, Gifu College (collegewide level)	All teachers (about 80 people)	To acquire how to use moodle and utilize it in class	Some teachers cannot attend workshop because of other school affairs	The same content was presented for three days, considering the teachers' schedule
Jul. 23 (Akashi) Oct. 14 (Gifu) Dec. 3 (Kyoto) Mar. 1 (Maizuru). The 2015 AL promotion study team of the third block	The third block committee members of AL promotion study team (the colleges that belong to the third block)	The number of colleges that belong to the third block multiplied by two committee members of each college	NIT at Akashi and Gifu Colleges, leading colleges of AL, are supposed to lead the other colleges within the third block to the positive practice of AL	Each college has a different perspective and degree of penetration of AL, which makes it difficult to have a common understanding of AL	To respond to diverseness among colleges, first, it is necessary to assess the position of each college by conducting a survey of the teachers who belong to the third block

(continued)

Table 5.1 (continued)

Dates	Type of activity performed for promoting AL	People that the sessions targeted (headcount)	Results, expected effect	Problems	Measures against the problems described in the left column
Sep. 24: workshop of projectors which have the functions of electronic blackboards and tablet PC (the fosterage of trainers: for the members of AL promotion WG)	For the members of AL promotion WG of NIT, Gifu College	For the members of AL promotion WG (seven people)	How to use projectors which have the functions of electronic blackboards and tablet PC. How to conduct AL classes using equipment	The teachers have different degrees of skills	Workshop for the members of AL promotion WG was held, for fostering trainers who would instruct the faculty members. The instructions for teachers by trainers are supposed to be conducted within each department
Sep. 25, 28, 29: workshop of projectors which have the functions of electronic blackboards and tablet PC (for all teachers)	NIT, Gifu College (collegewide level)	All teachers (about 80 people)	How to use projectors which have the functions of electronic blackboards and tablet PC. How to conduct AL classes using equipment	The instruction of how to use equipment is insufficient for actual use.Some teachers cannot attend workshop because of other school affairs	In the workshop held at a classroom of each department after school, teachers actually operated projectors, which have the functions of electronic blackboards and tablet PC
Sep. 1–4: workshop of cybozu (collaborative software)	NIT, Gifu College (collegewide level)	All teachers and college staff	To acquire knowledge of procedure/ methods for managing various information within college	Some teachers and college staff cannot attend workshop because of other school affairs	The same content was presented for four days, considering the teachers' schedule

5.5.2 Feedback on Smart Education

5.5.2.1 Teachers' Feedback

The teachers practicing AL have shown the following good points and other comments.

- A group solved a problem by their freewheeling thinking.
- It seems that group work made students consider how to make use of their knowledge and that one student's idea stimulated the other participants.
- Students coped flexibly with the new method.
- At the beginning of a class, I had students expect a solution. With the passage of time, the final solution began to appear like fog clearing away. In some cases, the solution was the same as the initial expectation and, in other cases, it wasn't. In all cases, most students seemed to have interest in the process.
- Some students could submit a task, which shows what they had learned through homework and classwork in a wonderful way as soon as a class ended.
- Students were requested to complete common answer sheets by teaching one another among the group members from the step of preparation; however, they didn't perform research beforehand or teach one another. Those who could solve a problem for themselves continued to do so at their own pace. Those who couldn't solve a problem, though, didn't even ask questions. They didn't initiate a discussion for completing a common answer sheet for the presentation.
- I hoped to get common answer sheets, which are almost the same level within a group soon after the class ended; however, there seemed to be little difference between the sheets of the students who work hard and the sheets of the students who don't work hard.
- The situation where the students teach one another among the group members makes it possible for a teacher to contact them individually based on their level of understanding.
- Few students fall asleep during the time. And we can urge sleepy-looking students to sleep beforehand.
- Group work itself is effective and the instruction that a representative of a group writes on the blackboard led several groups to a discussion on how they arrange their thoughts in order to present their ideas in a simplified way. Also, the class was very stimulating for a group idea which was given low evaluations at the beginning yet turned out to be very useful in the process of treating handling advanced content.

5.5.2.2 Students' Feedback

The teachers that practiced AL have shown the students' attitude. Most of them are positive.

- When I told the students the development processes of all groups, they acted as a stimulus and the students worked harder in competition with the other groups.
- Group work activated the class and created a condition where the students made a lot of remarks.
- A student who was not interested in the activity at first (i.e., not knowing the aim and what was going on) began to have interest in the activity as the class advanced and his level of understanding deepened. Finally, he seemed to be satisfied with the result.
- The students who followed a teacher's lecture didn't actively ask questions about the content of the presentations by the other students. Also, they seemed to be unsatisfied when their teacher didn't give explanations.
- The students who don't work hard habitually in class didn't make a preparation and take part in a discussion. Also, they relied on the other students at the time of presentation and submitting a report. In short, they didn't change their attitude.
- Nearly every time, more than a few students in the class fell asleep during a lecture. They seemed uninterested in the content of the lecture. Today, however, they tried to solve a problem through discussion with fellow group members. They seemed to have more motivation than usual. Seeing them, I thought that most students could understand the problem. Today's trial seemed to be successful.
- I think some students increased their interest in mathematics. They were doing calculations rather amusingly.
- At the beginning, they were solving a problem silently in an unfamiliar situation, but they began to exchange their ideas soon after.
- An hour or so after the class started, some students began to talk in whispers through lack of concentration.
- Some students may not have taken part in the discussion, but most students seemed to do so actively.
- Most groups made an active discussion. The description of their ideas on the blackboard was useful for processing them.

5.5.2.3 Teachers' Comments

Some teachers presented their comments, including the future feedbacks and problems, after they practiced AL.

- The tasks that require students to think for themselves and solve problems in a group setting are helpful for making their knowledge useful. It will stimulate and activate problem-solving skills and communication skills.
- It is important to improve AL by providing feedback following its trial.
- Many teachers are hoping to learn the content of the advanced examples of AL (flipped learning). We are planning to hold a workshop where an extramural lecturer will make a lecture with the aim that we will spread AL in NIT, Gifu College.

- If we let students take the initiative, from beginning to end in AL class, they will be at a loss for what to do first. I think that teachers should teach basic knowledge. It might be an idea that students learn basic knowledge preliminarily as homework, but it is unreasonable to carry out the idea considering the fact that students have different degrees of ability.
- When students made presentations, the teacher tried correcting mistakes and making comments. But some students didn't pay attention to the teacher, remaining unfocused on studying.
- If students perform preparation, group work, and presentations seriously, I think their studies proceed smoothly.
- It was difficult to make the students concentrate on a new method as I instructed. I think it is important to make them have an idea that they must study at their own initiative and employ Teaching Assistants.
- They made few discussions within a group. Questions and answers were not active at the presentation. These are probably because of their poor communication skills.
- It was effective in one class, but not effective in the other class. I am thinking of increasing time spent doing group work and getting cooperative work on track in the latter class. There may be some students who want to solve a problem individually, but I am thinking of leading those diligent students to teach other students voluntarily.
- It is difficult to know students' reactions in an ordinary class, but it is possible to check the level of understanding of each student, as a teacher gets a direct response from each student in an environment where students can speak freely.
- Since the time a teacher speaks unilaterally decreases sharply, students and observing parents might be mistaken into believing there is insufficient effort on behalf of the teacher. Therefore, a teacher should always walk around the classroom during a class, monitoring students as they work.
- I think how to solve a problem is difficult. I think it necessary to continue the method and produce results, but I have not grasped the direction yet.
- Group work is very effective. Only a question will develop into a deep thinking activity. But it takes some time. So, a teacher must consider the balance of the method with the progress schedule.

5.6 Discussion

5.6.1 A Summary of Smartness Levels

In this chapter, we describe our practice of smart education in NIT, Gifu College. Smart education was classified based on its smartness level. In each section, we wrote our efforts related to respective smartness levels [1]. The key concepts are as follows:

(1) Adaptation: software for synthesizing automatic voice, mobile device access designing, flipped learning, etc.;
(2) Sensing: feedback on learning history, coping with physiological responses, coping with learners' setbacks;
(3) Inferring: a system that visualizes students' learning activities performed outside the formal curriculum;
(4) Self-learning: learning materials such as simulation software, interactive software, videos and texts; LMS; active learning which urges learners to think for themselves and solve problems;
(5) Anticipation: an automatic registration of student information data operated by combining some systems, a mail system as a crisis measure; and
(6) Self-Organization: a system where the server automatically shut down in the event of a power outage; load-balancing in addition to a doubling for redundancy.

5.6.2 Curriculum in Smart Education

A true smart university/college is where smart education is practiced at a university/college-wide level. In order to realize this situation, it is important to share information on smart education among the faculty and hold the FD sessions on related matters in addition to a smart system environment mentioned above. More specifically, this is a system environment of smart education created by associating hardware and software. Also, it is necessary to create university/college educational concepts, including admission policy and diploma policy, and the education system of respective departments based on the educational concept, in consideration of smart education. Moreover, it is necessary to prepare the curriculum based on a common viewpoint in relation to the practice of smart education.

Though the education of the NIT, which NIT, Gifu College belongs to, is highly evaluated by various domestic and overseas quarters. The NIT is intended to pursue the sophistication of its education, centering on the improvement of ICT environment. Taking world movements into consideration, the respective NIT colleges have improved its educational content. This led to certification by some examination bodies such as JABEE; however, before the release of Model Core Curriculum (MCC) by the head office of NIT on March 23, 2012, there was no uniform standard regarding curriculum for all NIT colleges. Through the trend of the revisions to standards for establishing universities directed by the Japanese government, the NIT started working to establish MCC ahead of universities after conducting a hard survey of the current situation of curriculum, afterwards, repeatedly conducted investigations, and published MCC in 2012.

5.6.3 MCC in Smart Education

MCC is intended to clarify the model of a practical, creative engineer. NIT colleges are fostering and the policies of educational content and methods assure the quality of education in itself. They further promote the educational reform and improvement with individuality and characteristics of respective NIT colleges. In the schematization of NIT education, in addition to showing "Core (a minimum standard)", the minimum skill level and content to be studied for all the students of NIT, and "Model", a guideline for further advancement of NIT education, is presented to respond to more advanced social requests. The curriculum is promoting both "Model" and "Core", so the name "Model Core Curriculum (MCC)" is used. For "Model", in addition to only presenting the method of thinking, it is important to share pioneering challenges performed in some colleges among all NIT colleges and introduce them into the other colleges based on the realities of respective colleges. For this purpose, NIT colleges are complementing MCC by sharing education examples of engineering design created on a periodic basis. MCC doesn't indicate concrete curriculum itself organized and practiced by school as a narrowly defined curriculum. It represents students' attainment targets, or outcomes, as a guideline for curriculum organization. The way of thinking conforms to domestic and international trends and, when it comes to aiming to achieve the targets, respective NIT colleges are indicated to devise a way to combine various educational activities such as concrete subjects, practical studies of every kind, and extracurricular activities based on their own conditions and policies. MCC never uniformly determines concrete subject names or content.

5.6.4 ICT Managed Classification of MCC in the Promotion of Smart Education

MCC is organized from the viewpoint of the advancement of NIT to respond to social needs. The direction of NIT is as follows:

(1) The fostering of engineers who can be active internationally in response to the globalization of society and industry,
(2) The fostering of innovative human resources who can contribute to the sustainable social progress, and
(3) The expansion into the composite, integrated fields that respond to the needs of the local communities and industries.

MCC clearly specifies the targets for students to attain from the viewpoint of 10 items: mathematics, natural science, art and social science, basis of engineering, Specialized Engineering Categorized by Field, Engineering Experiments and Practical Skills Categorized by Field, Substantiation of Specialized Skills, Versatile Skills, Attitude/Orientation, Comprehensive Learning Experience, and Creative

Thinking Power. The teachers are proceeding with the following work and integrating them with each other in order to meet our targets, following the curriculum created based on MCC:

(1) Improvement of lecture and teaching method (Ex. group work, workshop-type learning),
(2) Cooperation among teachers,
(3) Improvement of educational evaluation and checkup method (Ex. interview and oral examination, portfolio of students and teachers),
(4) Development of teaching materials, and
(5) Activities of Faculty Development (FD) and Staff Development (SD).

In order for NIT, Gifu College to be a higher education institution that contributes to local industries, it is essential to have a viewpoint of industry-college-government cooperation, as well as regional cooperation. The Targets of MCC are to be attained by combining the students' attained level with various kinds of methods and subjects. This is cooperated among teachers. The students' attained level is evaluated by what and how far they have learned. In MCC, the students' attained level has been established in accordance with the dimensions of cognitive processes of the Bloom's Taxonomy (cognitive domain) Table (the revised edition):

(1) Knowledge-Memory Level (to be able to remember, recognize, recall related knowledge)
(2) Comprehension Level,
(3) Application Level (apply knowledge, theory and information for applied cases and problem-solving, execute, practice),
(4) Analyzing Level,
(5) Evaluation Level (to be able to judge based on criteria and standards, adjust, find, observe, verify, criticize, judge), and
(6) Creativity Level (newly construct elements to organize the whole, to be able to newly reorganize elements, produce, plan and design, create).

The study targets were established for each item of MCC, which will be linked with the ICT systems such as e-Learning, the syllabus system, and the portfolio system. For example, in the item of "Natural Science" (Large Classification), there exists the item of "Physics" (Middle Classification) as one of the many items. In the item of "Physics" (Middle Classification), there exists the item of "To be able to synthesize and resolve forces" (Small Classification). The item of "Physics" doesn't mean the subject of physics itself, but represents collectivity of the attainment targets regarding physics-related fields. When trying to make students rise to the "(3) Application Level" in the upper years, with respect to the item of "To be able to synthesize and resolve force", the curriculum of the department is supposed to organize with the following in mind: In the curriculum of a construction-related department, for example, students are expected to rise to the "Knowledge-Memory Level" in physics class of the early years, so that they can solve problems of

"synthesis and resolution of forces". On the other hand, they are expected to rise to the "Application Level" in the structural dynamics class of the upper years so that they can perform practical calculations of load when lifting heavy goods. Which subject of curriculum each item of MCC corresponds to and how far it is taught is checked and managed by the syllabus, e-Learning, and portfolio systems.

By combining the syllabus system with the e-Learning system and adding the MCC check system function to the combined system, these systems work in conjunction with each other, developing a system with an automatic registration function. This kind of system corresponds to "anticipation" of the smartness level. As another example of this, NIT, Gifu College has a mail system as a crisis measure. In the case of a typhoon, for example, the system immediately and automatically provides the students with a notice as to whether school will be closed or not.

5.7 Conclusions

MEXT grants support promoting of university reform with the aim of activating Japanese higher education and contributing to the development of highly skilled personnel. It is intended to develop educational and research projects working on leading educational reform in Japan by introducing competitive support. Our efforts made for more than 15 years include the following: ICT-driven education, e-Learning, distance education using e-Learning under the credit transfer agreement practiced in a consortium with more than 20 colleges and universities within the prefecture, distance education using e-Learning under the credit transfer agreement practiced in a consortium with about 30 higher education institutions such as NIT colleges, universities, graduate universities, and the Open University of Japan.

In that process, NIT, Gifu College applied for and successfully acquired the "Support Program for Contemporary Educational Needs (GP)" of MEXT (three-year financial support) in 2004. Also, in 2014, our application was picked up as a project of the AP by MEXT with three-years of financial support. Moreover, this year, it was decided that the period of our AP project would be extended from five years to six years. Therefore, we are going to continue our research and education on advanced practices until the academic year 2019.

Making use of subsidies from MEXT necessary for the projects to promote educational reform of NIT colleges, NIT, Gifu College is promoting college wide AL, as well as visualization of education from the viewpoint of both students and teachers. Here, in this article, we described our efforts to visualize extra curriculum education for promoting AL. In NIT, Gifu College, we consider it important to visualize, not only feedback by means of visualization of education, such as e-portfolio in formal curriculum, but also efforts in extra curriculum education.

The efforts encourage students to act based on their own ideas, help students acquire generic skills, active nature, initiative, independence, and cooperativeness. In our AP project, we visualize the outcomes of extra curriculum education by

analyzing, classifying, and grading them. Moreover, we created a relational database system in order to visualize each student's data with ease.

Making effective use of the budget granted by the central government during the extended period, we will strongly introduce beneficial approaches related to students' activeness. Also, we are strongly promoting the FD sessions for the use of AL for all NIT colleges, as per an attempt to expand NIT, Gifu College's efforts. Moreover, we are developing the improvement of a learning-support ICT environment, including the Learning Management System (LMS) with Blackboard into the efforts of many NIT colleges for expanding it among all NIT colleges. Based on the above, we added the following three items to the original plan of our AP project:

(1) research on students' abilities conducted by using progress reports on generic skills and the provision of individual portfolio,
(2) the great expansion of the Learning Commons environment in NIT, Gifu College. which the universities aiming for smart university are promoting,
(3) the support of the FD programs regarding the use of AL, LMS, etc., and
(4) more accelerative promotion of the reduction of the burden on NIT, Gifu College's staff and effective use of our educational resources, mainly by introducing a terminal management software and human resources, to provide support; we added this item because of the ICT environment, which is not fully utilized now due to lack of manpower.

The above-mentioned additional four items were highly evaluated by MEXT. It was determined to extend the period of our AP project from five years (the initially scheduled period) to six years.

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