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An Integrated Teaching and Learning Assistance System Meeting Requirements for Smart Education

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Abstract There have been numerous attempts to heighten the effects of education over the course of history. Currently, many relevant studies are being carried out on such issues as utilization of recently developed Information and Communication Technology (ICT) for education, which has become a global topic; efforts are being put into this movement at the national level. However, the systems to assist the efforts are not yet sufficient. Through this research, in this light, the Structured Plug-in Integrated Teaching and Learning Assistance System was developed, which aims to achieve affirmative results from ICT on education. This system can provide the instructor, learner, and their parents with a real-time monitoring system, intelligent tutoring system, collaborative education mechanism, e-Portfolio system, and digital material production method. Further, the system can be realized in the form of a Structured Plug-in. The system has been used in six classes of 219 fourth-year students in Korean elementary schools to analyze the system's effects. In doing so, a questionnaire was developed and carried out on the students after the testing period. According to the results, the overall satisfaction level was 4.067 and the level of satisfaction on the content quality was 3.99, referring to 'satisfaction'.

Keywords Smart class · Teaching–learning · Future school · ICT

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1 Introduction

Changes in the IT environment of the world has resulted in the transferring of all educational materials to multimedia form [1]. Furthermore, E-learning is evolving as intelligent digital education and the optimized education solution for the new educational environment. In addition, the demands on utilization of Information and Communication Technology (ICT) for education are also increasing in order to evacuate from the unilateral and standardized delivery of knowledge via textbook [2,3]. Therefore, the education paradigm is changing into a cooperative, sharing, participative, customized, and self-initiated education [4–6]. This new movement has become a global issue from developing nations (which are targeting rapid growth through educational reform) to advanced nations, and more educational environments are under development combined with information technology. There are increasing demands for 'Smart-Education' in the E-learning market, which is also experiencing continuing and rapid growth.

It has been reported that 49 % of Korean people who are over three years of age and using the Internet have experienced E-learning. In particular, the utilization rates of those between 8 and 19 years old were the highest, accounting for 74.4 %. Further, an increasing amount of people over 40 years old are using education methods (such as E-learning) as an opportunity for life-long education [7]. 'Smart Education' is increasing the demands for interactive and participative education content, as well as a relevant system along with delivery of knowledge; the size of 'Smart Education' is expected to be around 3.5 trillion won ($3,500 million) by 2015 [8]. Gartner also predicts in its work '2010 Hype Cycle for Education' that tablet PCs, social mobile learning, and the market related to knowledge services are expected to be the main agents of the rapidly emerging market in 2–5 years [9]. Accordingly, a relevant 'Smart Education' system is required for efficient learning.

In this research, a Structured Plug-in Integrated Teaching and Learning Assistance (ITLA) system was developed for 'Smart Education', which can improve the effects of education by maximizing cooperative, sharing, and participative learning. In doing so, the characteristics of the learning environment and digital native as learners are reflected. Teachers and students can participate in the lecture through effective personalized and customized education. This system can connect content and services based on curriculum and the content's format, which is automatically customized to the characteristics of the device for various services. Further, the system provides an automatic content transferring system, which supports Internet screen, intelligent semantic searching tool, material producing system, and real-time learning evaluation system. The objective of all these is to provide an environment in which students can learn through personalized content anywhere and anytime, for self-initiating participation of students in lectures and a better environment for the teacher.

The rest of this paper is organized as follows: Sect. 2 provides background, Sect. 3 explains the structured plug-in ITLA system, Sect. 4 shows experimental methods and results, and finally, conclusions are given in Sect. 5.

2 Background

2.1 Smart Education

Ever since smart phones were launched in Korea, the mobile market has rapidly changed from feature phones to smart phones. As a result, the field of education is concerned with delivery of knowledge through smart devices. Such an issue is not only Korea, but also in other nations; the education mechanism that utilizes smart devices, along with cutting-edge ICT for education, is called ‘Smart Education’. This education mechanism can be seen as an integrated educational environment in which cooperative, interactive, participative, sharing, and intelligent learning are available through new forms of teaching–learning content, environment, and ICT [10].

In Korea, there are numerous ongoing studies and policies to improve educational efficiency and lead the world’s education at the national level [10]. The size of the ‘Smart Education’ market of Korea is expected to reach 3.5 trillion won ($3,500 million) by 2015 [8], and the relevant industries of ‘Smart Education’ (including software, hardware, content, and e-books) would be more activated. The ‘Smart Education’ market is rapidly growing. However, its focus has mainly been on infrastructure and smart devices only, without much concern on its ultimate goal of educational effectiveness and efficiency. Through this research, accordingly, structured plug-in ITLA System has been designed and developed to achieve the ultimate goal of ‘Smart Education’.

2.2 Related Works

As research on content conversion and an automatic transmission system that supports Inter Screen continues, SK Telecom is providing the ‘multi-screen video encoder’ service, which is technology for processing various video content and sending it to TV or mobile devices, and for balancing the quality of video by providing services for watching various TV programs simultaneously in different sizes, in line with the era of N-Screen [11]. The ‘eStream PRESTO’ of Xinics provides integrated solutions for support services, from recording offline presentations and education status to an edition for high-quality multi-media and streaming services on the Internet [12].

The studies on smart education materials include “Lecture Maker” of DaulSoft, which is for the recycling of various multi-media subjects, Powerpoint, Flash, and HTML documents, and for direct editing of content using a special editor. Therefore, the user can save video lectures as well as content for interactive online education [13].

The “Qrobo” of semantic, which is part of the studies on content searching and customized semantic engines, is a search engine based on semantic technology that can provide search results through various search engines. This technology uses methods including automatic analysis of the characteristics of documents on semantic, automatic analysis of words on ontology, automatic tracing of tagging, and analysis of word-related issues of ontology [14]. The “[IN2] Hybrid Classifier (HBC)” of Saltlux is a hybrid automatic classification engine based on technology, which classifies unset documents in to set ones. This can categorize themes automatically according to mechanical learning based on statistics to expand the range of classification, as well as secure accuracy through classification, based on the definition of rules of each classification to provide structure, in which there is continuous improvement and supplementation. These can enable the efficient operation of content and the establishment of infrastructure [15].

The study on plug-in software that supports smart device learning includes ‘T Smart Learning’ of SK Telecom. This is the first smart education platform on an education platform, which is based on 12 education facilities and tablet PCs. Such technology tries to provide optimized education services for each individual person, and supports interactive learning by utilizing the mobile radio communication network of SK Telecom. Further, it provides education courses and methods according to the level of education and tendency of each individual, thereby helping learners study on their own level through a customized learning plan [16]. The “Olleh TV School” of KT provides various content for grades and skill aptitude, which supports preparation, revision, and self-initiated learning through school IPTV; in addition, it can be utilized for regular classes, special classes, after-school learning, self-study, and weekend/caring classes [17].

In research on real-time education monitoring system, the media solution center of Samsung Electronics provides 'Smart School Solution', which is an interactive learning support system, utilizing Galaxy Tab 10.1 and an electric board. Also this system can provie service to help the monitoring of the electronic board and students using smart devices [18]. The screen for SchoolCap lecturer is sent to the learner's screen for real-time learning, and enables a teacher to monitor the PC screen of learners in order and at the same time. Further, this technology fosters learning by providing various functions including remote control, Internet restriction, and file transmission [19].

3 Structured Plug-in ITLA System

3.1 Service Architecture

The Structured Plug-in ITLA System can provide an integrated education process based on new smart content services, which can provide 'Smart Education' for both the teachers and students. Further, it can help cooperative, sharing, and participative classes by utilizing learning support methods in the smart devices of the teachers and students. In addition, it is the next wave of classroom learning system that can provide customized learning content for each student through student's profiling.

The major service scenarios are as follows: above all, content providers register learning content such as videos, PPTs, and e-books into content management systems. Further, the instructor prepares class and curriculum, and makes digital material by utilizing the registered contents. The instructor can teach students by using digital material prepared by electric board and smart device, and the students can use the material after schooling. In addition, all learning results are stored in digital records, and the material or learning content are automatically recommended to the level of students according to the stored data. Also, parents of the students can monitor the learning data of the students.

Figure 1 Indicates the scenario of learning model for a class to which the Structured Plug-in ITLA system has been applied. The e-Portfolio System (EPS) classifies instructor and students. Further, the instructor can use Real-Time Learning Monitoring System (RTS), Mind Map Collaboration System (OKMMS), Smart Digital Textbook Creating System (SBMS) and

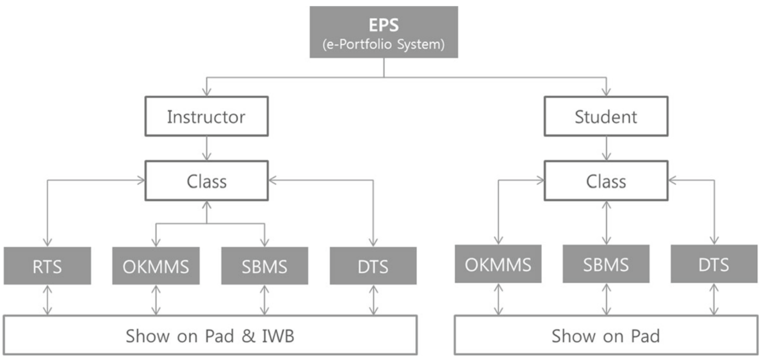

Fig. 1 Scenario of lesson model

Drawing Tool System (DTS) from an interactive white board and pad. In addition, students can select the class and use OKMMS, SBMS, and DTS from the pad.

e-Portfolio System (EPS) can provide student's profile such as learning date, learning contents, test score. Also, teachers, students, and parents can access EPS using PC and smart devices. RTS can provide real time learning monitoring to teacher. RTS collects student's attention, comprehension, and learning activity results from quiz, drawing tool, questionnaire. OKMMS is a mindmap drawing tool. Teacher and students can draw mindmap on OKMMS at same time. And DTS is a drawing tool. Teacher and students can use these systems in classroom and home using PCs and smart devices.

3.2 Application Architecture

Structured plug-in ITLA system provides various systems including DTS, RTS, Intelligent Tutoring System (ITS), SBMS, Contents Retrieval, and Semantic Search Engine in the form of a plug-in. Figure 2 indicates the entire application architecture.

The Structured ITLA System is a type of plug-in that can be built into various systems by user requests. Abbreviations for each systems are as follows: DTS, Real-time Learning Monitoring (RTS), ITS, Contents Retrieval and Symantic Search Engine (CS), Parent Supporting System (PSS), Multi- Language Management System (MLM), SBMS, Curriculum Management System (STBS), Statistics System (ST), Smart Device Learning Plug-in SW (SDPI), Inter Screen Supporting (ISST), Inter Screen Online Education System (IS), Message Center (MC), OKMMS, Moodle LMS (MLMS), International Standard and Non-Standard Contents Management System (IMSNONS).

This system enables various systems through the integration of various systems. Therefore, it is a plug-in for establishing a new system by combining the systems that the user prefers. e-Portfolio (EPS) and Integrated Plug-in System (IPS) are essential systems consisting of ILE (Base System). The other systems are divided into essential systems for EPS and others,

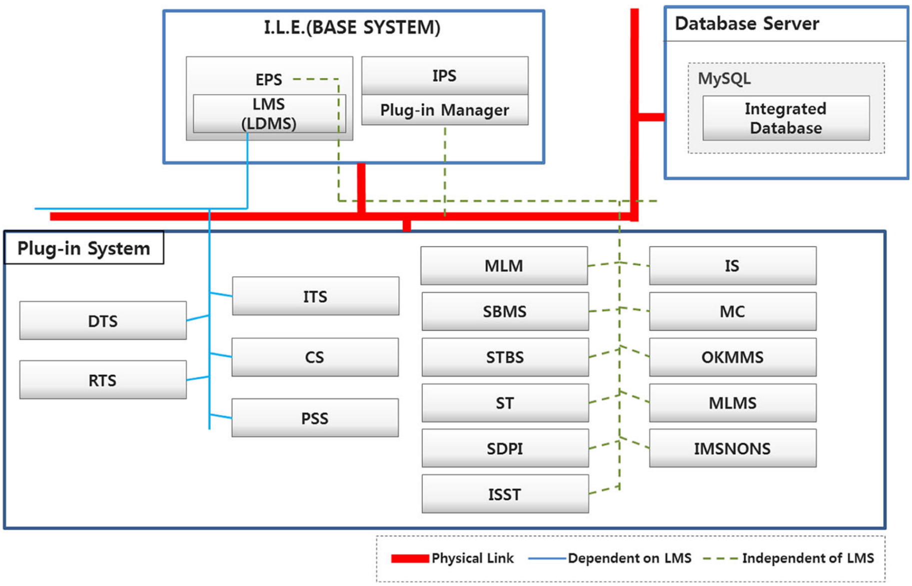

Fig. 2 Structure of structured plug-in ITLA system

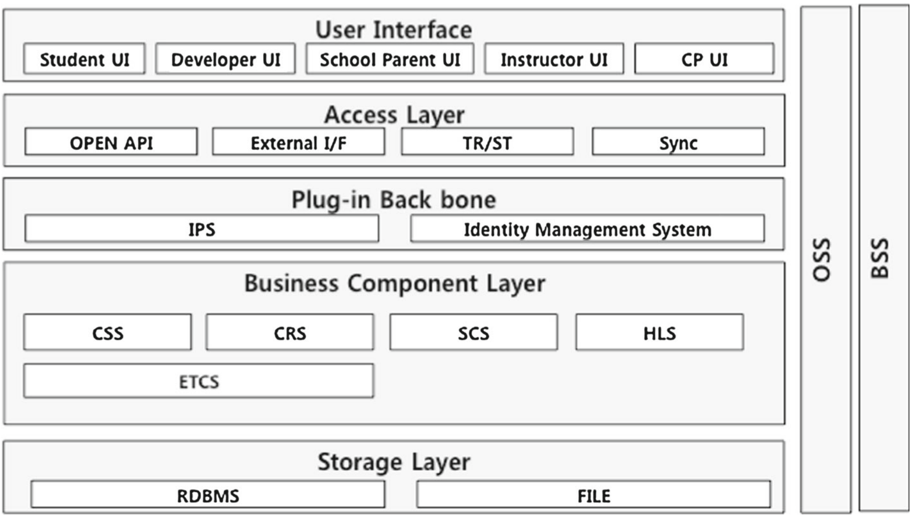

Fig. 3 Components level of structured plug-in ITLA system

where independent plug-ins are available. Such an environment prefers an open type system rather than closed one for further expansion, and has been designed and developed for the organic plug-in of the system. The plug-in type can provide the system according to the requirements of the user, combining the needed system modules into a unit according to the country, company, demands, and requirements of the school for 'Smart Education'.

The structured plug-in ITLA system is an integrated educational content service for learning content management, preparation, and teaching/learning, according to international standards. The established system can help the management and preparation of content based on the curriculum of the Korean education system. Further, it supports the automatic transferring and transmission of content formats, which are in accordance with the characteristics of devices for various smart device services. Further, the learner provides a strong connection to learning by integrating home and school into an environment for learning through the ITS and EPS.

Figure 3 shows the component level of the system. The component consists of User Interface, Access Layer, Plug-in Back Bone, Business Component Layer, Storage Layer, OSS, and BSS.

Abbreviations for each systems are as follows: Content Producer (CP), User Interface (UI), Interface (I/F), Transcoding and Streaming (TR/ST), Integrated Plug-in System (IPS), Contents Service System (CSS), Contents Repository System (CRS), Smart Class System (SCS), Home Learning System (HLS), Etcetera Support System (ETCS), Resource Database Management System (RDBMS).

The user interface provides services to the CP, student, developer, school parent, and instructor through web and mobile devices. CP UI provides functions including the registration of content for education content developers. Student UI provides services for educational content for students. Developer UI provides developer portal functions for using Open API. The school parent UI provides learning result monitoring functions for parents. Instructor UI is for educational content preparation and provides a lecture interface function for teachers.

The Access Layer consists of Open API, External Interface, and TR/ST (Transcoding and Streaming) to provide education platform functionality to the outside. Open API provides education component functions to the outside in the form of Open API. The External interface is for interlocking with an external system. TR/ST provides encoding, format transferring, and streaming functions for video content.

The Plug-in Back Bone constitutes the basis for an education platform that provides integrated functions including accreditation and login functions to add business logic into the plug-in through Integrated Plug-in System (IPS) and Identity Management System (IMS). IPS is a backbone, to which the education component can be plugged in. It manages module combination function (Mash-UP) and Open API while IMS manages revisions and authority of the user.

The business component consists of Contents Service System (CSS), Contents Repository System (CRS), Smart Class System (SCS), Home Learning System (HLS) and ETCS. CRS authorizes storing and manages content through an automatic content transferring and transmission system supporting inter-screen, smart education material preparation system, and international standard and non-standard content management systems. SCS provides assistance methods for improving learning results, learner profile management, real-time learning evaluation, real-time learning status monitoring, intelligent tutoring, and screen education for learning based on smart classes. HLS supports the parent-support system and customized learning (e-Portfolio) for home schooling. ETCS supports multi-language.

The storage layer consists of files, which store file-based education content (video, e-book, PPT, digital textbook), and RDBMS, which stores user profiles and messages. OSS provides monitoring of the entire system, with statistics that support business and reporting functions.

The structured plug-in ITLA system has been designed in the form of a platform based, Open API system. The concept of open API platform architecture is indicated in Fig. 4.

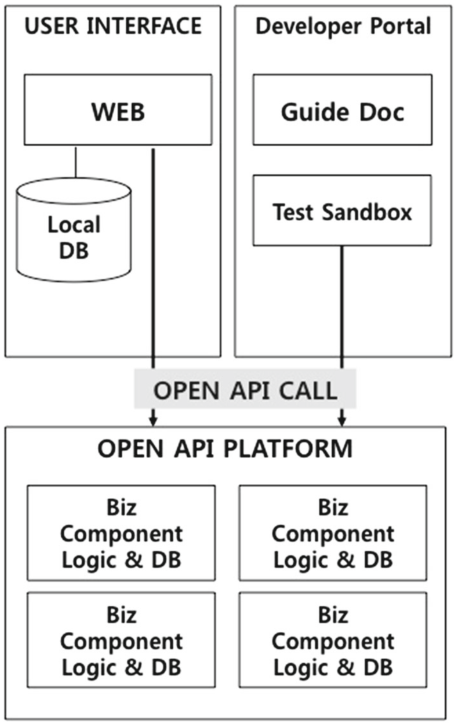

Fig. 4 Open API platform of structured plug-in ITLA system

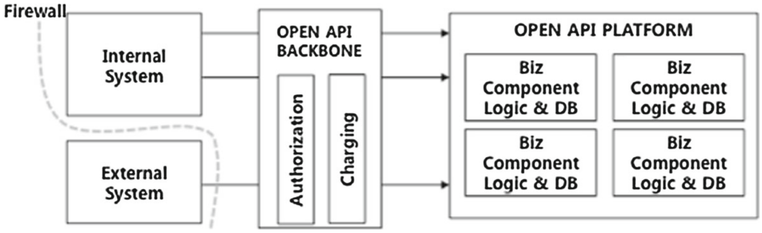

Fig. 5 Open API access of structured plug-in ITLA system

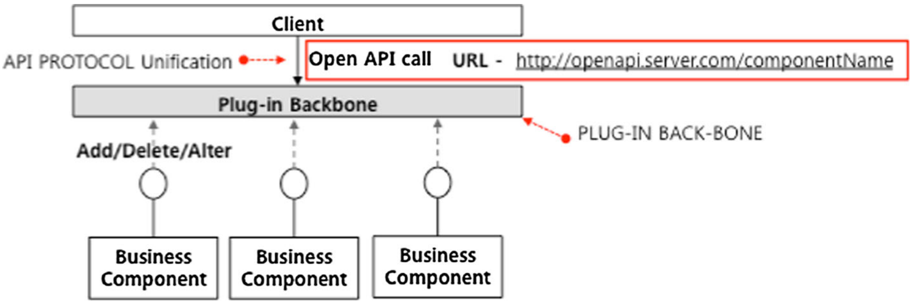

Fig. 6 Plug-in type of structured plug-in ITLA system

Open API does not support the full scenario for User UI or a certain user, but provides a function specialized in business logic and constitutes the user scenario by combining this API in the UI layer. Major business logic is realized in the form of a component of the Open API platform, and retains data for professing business logic. The UI layer does not store business logic or data, and uses a component inside the user platform. Further, it implements UI data and a user interface. The Open API platform exposes Open API to enable the user (developer) to develop a relevant application. The developer portal provides an explanation on Open API and sample documents via the website to support the user (developer). Further, Sandbox provides a separate environment in which the developer can test Open API.

For Open API (which is exposed to the developer), there are two factors that account for API usage and authority for the developer to use API. The structure for sorting out these two problems is indicated in Fig. 5.

The clients that use Open API can be classified into internal and external systems. The internal system can be called through Open APIs without separate accounting or verification while the external one requires accounting, verification, and has a firewall for security. The verification/authorization and accounting needs to be applied for the component, which has the same business logic, according to the type of client. Therefore, the component processes pure business logic and locates the backbone in front of the component to apply verification/authorization and accounting according to the type of request. The structured plug-in ITLA system provides integrated education services by exposing functions based on Open API, and has been designed in the form of a plug-in for further expansion. Client uses one URL in order to call Open API. However, the component for processing business logic is dispersed and can be added, deleted, or exchanged, if required.

Figure 6 shows the structure in which client code is minimized to reflect such characteristics of the plug-in architecture; the business component can be expanded by plugging the business component into the platform easily. To do so, the backbone to which the business component can be plugged in is required; further, the same API protocol should always be used, as various business components are serviced. It is also single Open API platform for the client, although many products are used.

4 Experimental Method and Result

4.1 Experimental Method

Elementary schools in Gyeonggi-do, in South Korea participated in a test on the effects of the structured plug-in ITLA system. To apply the structured plug-in ITLA system to schools, one electric board, one electric lecture desk, three wireless routers, and 20 smart pads were installed in each school as seen in Fig. 7. 219 fourth-year students from six classes participated in the 'Society' course, and all instructors were educated regarding how to use the system prior to the test.

The questionnaire for analyzing the results were developed, referring to advanced studies. Further, professionals tested the validity of items in the questionnaire through CVR test (contents validity ratio). The equation for CVR calculation formula is Eq. (1) [20].

$$ContentValidityRatio(CVR) = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \tag{1}$$

n_e: the number of respondents who checked 'important' or 'very important'
N: the number of entire respondents

Table 1 shows calculated value.

To test the validity of the questionnaire developed for this research, 10 professional testers participated in the verification. The professional testers that participated in this test qualify as those who satisfy the following criteria:

1. Have more than 5 years career experience
2. Have a doctorate degree or are an authorized instructor
3. Have a minimum 3 years of career experience in computer-related lecture
4. Have experience in carrying out research on smart education

The average, minimum, and maximum CVR test results were 0.75, 0.2, and 1, respectively. Accordingly, the item of which CVR is <0.62 has been modified or deleted according

Fig. 7 Classroom at elementary model school

Table 1 Minimum CVR value based on total number of respondents

No. of professionals	Minimum CVR value
5	0.99
6	0.99
7	0.99
8	0.78
9	0.75
10	0.62
11	0.59

to feedback from professionals and teachers. In order for the questionnaire to analyze the efficiency of the structured plug-in ITLA system, 33 items consisting of five categories and a 5-point Likert scale was developed as well.

4.2 Results

The questionnaire developed for analyzing the effects of the structured plug-in ITLA system was carried out on 219 fourth-year students from six classes after the 4-week model school project. Satisfaction levels of students (apart from nine individuals whose answers were not validated) were analyzed using the information of the respondents, as shown in Table 2.

Satisfaction level is one of the indexes to examine the effects of education; many studies have proven that a higher level of satisfaction results in better learning [21]. Accordingly, we could determine the effects of the system by analyzing satisfaction levels of learners through application of the structured plug-in ITLA System, which has been designed and developed through this research, to model elementary schools. Further, we could modify and improve the system according to opinions and results from the instructors and learners. Table 3 indicates questionnaire items, with average and standard deviation.

The major contents of the questionnaire includes proficiency with digital devices, overall attitude towards the lecture, attitude towards smart devices, and the interaction (content quality) and satisfaction level. The overall level of satisfaction for lectures, to which the structured plug-in ITLA system has been applied, was 4.271, which is between ‘satisfied’ and ‘very satisfied’. Further, the figure for ‘I would like to use the ITLA System for other subjects’ was 4.271, which is relatively high. In contrast, the figure for ‘ITLA helps my studying’ and ‘Lecture through ITLA system is an appropriate way for me to study’ was around 3.8, which equates to ‘satisfied’. The smart education environment or system may help the learner’s studying, but in an indirect way rather than a direct one. The overall satisfaction level was 4.067 on average, which means ‘satisfied’.

Table 2 Student information

Class	1	2	3	4	5	6	Total
Student	35	34	36	35	34	36	210
Gender	Boys			Girls			Total
Students	117			73			210

Table 3 Questionnaires

Category	Question	Mean	SD
Proficiency in digital devices	I get an urge to buy a new smart device if I see it	3.710	1.31840
	I would like to use smart devices even though they belong to others	2.962	1.31915
	I can use a new smart device without learning how to use it	3.724	1.19805
	I like new smart devices	3.710	1.17649
	I can use smart devices well on my own	3.957	1.02741
	I like new devices like computers and smartphones	3.743	1.11988
	Smart devices help my studying	3.810	1.01750
	Smart devices are more appropriate for games than studying	2.995	1.20802
Overall attitude towards lecture	I am always interested in what I learned in class	3.700	0.94363
	I concentrate on the lecture	3.676	0.90712
	I try to find new solutions to questions from the lecture	3.586	1.06478
Attitude towards smart devices	I enjoyed the lecture via smart device	4.343	0.98630
	Lecture via smart device has improved my studies.	3.767	1.11443
	The smart device helped me to concentrate on the lecture	3.876	1.09976
	I did not feel uncomfortable taking a lecture using a smart device	4.129	1.09266
	I was not afraid of taking the lecture by using a new smart device	4.219	1.02113
	The pictures, videos, and drawings presented through the smart device helped me to understand the lecture	4.110	1.04557
	I prefer a lecture using smart devices over other types of lectures	3.848	1.20431
	I studied harder thanks to the smart device	3.786	1.03378
	I asked the teacher more questions thanks to the smart device	2.876	1.06887
Interaction (contents quality)	It was convenient to use the learning menu from the ITLA learning system	4.067	0.97595
	It was easy to figure out the process of lecture through the ITLA learning system	4.000	1.01189
	It was easy to use the ITLA learning system	4.262	0.92957
	I could find information easily from the ITLA learning system	3.948	1.06359
	The ITLA learning system presented various videos, pictures, and drawings for lecture	4.205	0.88094
	I was able to ask how to use and about problems of the ITLA learning system	3.910	1.06999
	I could study in cooperation with my colleagues through the ITLA learning system	3.976	1.13425
	The ITLA learning system helped me to concentrate more on my textbook	3.567	1.11871
Satisfaction	I am satisfied overall with the lectures through the ITLA system	4.271	1.06157
	I would like to recommend the lecture through ITLA System to my colleagues	4.057	1.07897
	The ITLA System helps my studying	3.886	1.11805
	Lecture through the ITLA system is an appropriate way for me to study	3.848	1.19633
	I would like to use the ITLA system for other subjects as well	4.271	1.12290

Table 4 Average and reliability of question categories

Item	Questions	Mean	Cronbach α
Proficiency with digital devices	8	3.576	0.815
Overall attitude toward lecture	3	3.654	0.785
Attitude toward smart devices	9	3.884	0.905
Interaction (content quality)	8	3.992	0.900
Satisfaction	5	4.067	0.928

Interaction (content quality) is an item for evaluating the effects of the learning system used for the structured plug-in ITLA System. The average score was 3.992, meaning 'satisfied'. The major responses for using the ITLA learning system include 'it was easy to use the ITLA learning system' and 'the ITLA learning system helped me to concentrate more on my textbook', of which scores were 4.262 and 3.567, respectively. The reason could be that the role of the instructor is more important for the learner to concentrate on, rather than a digital textbook or smart class environment. Overall, learners have appeared to be satisfied with how to use the learning system, navigation, rich learning resource, and cooperation support.

The items for proficiency with digital devices, overall attitude towards lecture, and attitude towards smart devices were used for figuring out proficiency with digital devices and overall attitude towards the lecture for students of the model school for this research. The satisfaction levels of students with smart devices and lectures through smart device were 3.576 and 3.884, respectively, which means they are satisfied with the lecture in general. The score for overall attitude towards lecture was 3.654, which is between 'normal' and 'yes' for items including 'I am always interested in what I learn from the lecture', 'I concentrate on the lecture' and 'I try to find new solutions to problems', indicating that they are generally affirmative towards the lecture.

Cronbach α was employed to the analysis reliability of each item, as shown in Table 4. All areas were found to show high levels of reliability, with scores between 0.785 and 0.928.

5 Conclusions

Ever since 'smart education' became a world issue, various studies have been carried out at the national level to lead the future of education. There are insufficient systems for such education in Korea, while other nations are well into the development of various systems for 'smart education'. An environment for such education has been established.

This paper proposed an integrated smart education system. The proposed system is designed in the form of a structured plug-in for an integrated and expandable system, and can be customized according to the needs of the government, enterprise, and school. That is to say, such education systems can be applied to the educational environment of other nations as well.

Elementary schools were selected for the application of the structured plug-in ITLA System to analyze the effects throughout the 4-week test. Since learner satisfaction was found to be important for PISA technical report, and such elements were analyzed continuously [21]. Further, various studies have already proved that higher level of learner satisfaction on 'smart education' can result in better results from said education. As it were, we can verify the effect of this system by analyzing the satisfaction level of learners. Accordingly, the questionnaire on satisfaction was developed and its reliability was tested by professionals. The questionnaire consisted of five categories including proficiency with digital devices, overall attitude towards lecture, attitude towards smart devices, interaction (content quality), and satisfaction. The number of questions was 33 in total, and a 5-point Likert scale was employed.

Fourth-year students of 6 classes answered the questions after the 4-week test. 210 responses (apart from 9 individuals that were not validated) were used to compare and analyze the satisfaction of students. The overall satisfaction level was 4.067, which means 'satisfied'. The Table 4 indicates scores for each item.

According to the results from analysis on satisfaction and interaction (content quality), the education achievement level and effects of the structured plug-in ITLA system can be seen as affirmative in general. In addition, we could see the positive attitude of students towards smart devices and lectures via smart devices by analyzing responses to 'proficiency with digital devices' and 'attitude towards smart devices'. Further, responses to 'overall attitude towards lecture' indicated the overall attitude of students towards the lecture.

Also, there has been various feedback on the system for improvement, including 'legibility of fonts of digital material is low', 'authorization request function is required', 'order of entering family name is different for other nations', 'short-cut button is required', 'system typographical error has been found' and 'inconvenience in turning pages of digital material'.

We hope that the system, which has been developed through this research, along with improvements according to results from this research and feedback from model schools, would be applied not only to the Korean educational environment, but also for other nations to analyze the effects of the system for the international educational environment for supporting research on future education.

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