

Improvement of Diagnosis-Supplement System for Basic Academic Skill based on Affordance Theory in the Context of HCI

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Abstract—The purpose of this study is to apprehend a problem of user affordance and to suggest an improvement plan to make the better usability of Diagnosis-Supplement System for basic academic skill. Starting in 2013, from 5 cities and provinces, this system was developed, and in 2015, it was completed construction in all (17) provinces. Now, this system serves diagnosis test and supplement study materials for underachievement students from 3rd grade to 8th grade. As of 2015, the role of this system is gradually increased that 16 million students, about 4% of pupils throughout the country are now using it. In turn, this study tries to analyze various ranging requirements of teachers and experts by doing focus group interview in terms of user affordance and try to suggest the way to improve this system for the sustainable use. Henceforth the results of this study, which includes specific problems of physical, cognitive, sensual affordance and a design prototype to improve these problems, can be an important base material for the process of improving Diagnosis Supplement System for Basic Academic Skill with effective and intuitive system.

Keywords—basic academic skill; web-based test; diagnosis-supplement system

I. INTRODUCTION

Researches on web-based evaluation or learning system have been continuously studied in the area of computer, education, and e-learning [1][2][3].

Most studies, however, focus on learning and evaluation environments for students with general academic levels [4][5]. In other words, there is lack of researches about the systematic supporting system for students who lack basic academic skills.

In the case of Korea, an instruction of students who are lack of basic academic skills is left to each teacher's own discretion. This situation causes growing need for continuous customized learning and evaluation support policy to improve basic academic skills. Lack of basic academy skills can not only cause emotional problems such as test anxiety, learning interest degeneracy, negative self-concept but also cause school maladjustment problems [6]. As such, lack of basic academy skills impedes stable personal growth and national development. Korean Government hereby provides 'Diagnosis-Supplement System for Basic Academic Skill' to support continuous and customized learning for students who have a weak academic skills [7].

However, as the number of users of this system is getting increased, a variety of usability provisions are brought up [8].

Starting in 2013, from 5 cities and provinces, this system is now used in all provinces since 2015.

Therefore, this is a suitable time for analyzing recommend improvement. In turn, this study tries to analyze user affordance and try to suggest the way to improve this system's User Interface for the sustainable use.

II. MATERIAL AND METHOD

A. Basic Academic Skill Related Studies

The United States announced 'The National Education Technology Plan 2010' in 2010 to build a technology-based and efficient education system to improve students' college and graduation rates and reduce the gap in academic achievement. In particular, we are making efforts to establish an evaluation system that uses student learning data by establishing Assessment as one of the five major tasks. The US evaluation system was designed to measure and manage the status and performance of learning activities by students based on technology and developed a standard evaluation system and evaluation process to support students' continuous academic growth by collecting and analyzing real-time learning data [11].

The French 'diagnostic assessment' has been conducted in the native language (French) and mathematics subjects for elementary school juniors and junior high school students since 1989 with national level academic achievement

evaluation. In recent years, Kindergarten is the language for the yearly scholastic improvement, and French and Mathematics is the elementary school. The purpose of the evaluation is to find a more efficient teaching method and use it in teaching and learning guidance of students [12].

The UK emphasizes the development of key skills needed in a knowledge-based society. In particular, elementary schools emphasize basic literacy and numeracy. The UK has a National Curriculum Assessment (NCA) for all schools and all students. This NCA assessment is of interest to many schools because the academic achievement rate is open to the public and has provided relative improvements since 2002. This improvement score is provided to parents to evaluate the quality of education objectively [12].

In this way, Korea and other advanced countries are also carrying out the national basic competency evaluation in order to enhance national competitiveness. This suggests that various efforts are being made at the national level to evaluate the quality of education and to improve the efficiency of education.

Researches related to web-based evaluations are as follows. Jung Han Ho (2009) analyzed an effective web-based evaluation system through qualitative research on computer-based evaluation in the education field. With this research, he suggested that some functions such as taking an evaluation at the desired time, checking various opportunities for the exam and confirming the results immediately can make learners satisfied with evaluation system [13].

Kang Eun Ju et al. (2005) proposed a method to achieve effectiveness for web-based evaluation or learning system in education field by suggesting a way to improve teaching-learning materials of EDUNET contents. The study noted that it is necessary to provide materials meets the curriculum, level specific materials for students' characteristics and educational activity materials for schools for effective teaching and learning support [7]. To activate Diagnosis supplements system use, the Jeon Su Jin and Kim Han Sung (2016) analyzed present status of its usage and opinion of experts. With this, it suggests implications for activation of a system for teachers and students [14]. And *Imane Kamsa, Rachid Elouahbi, Fatima El Khoukhi*(2017) also said that interaction is an important key to online learning. And that this could be done through cooperative learning and learning agents. In other words, for successful e-learning, it is necessary not only to provide learning contents but also to interact with teachers and students or students and students online [15].

Next, Iowa Assessment, Khan Academy, and Knowre are regarded as a typical service which is similar to the web-based diagnosis-supplement system. In the case of Iowa Assessments [16], it measures achievement and growth of students from kindergarten to high school seniors. Iowa Assessments provide evaluation materials. The evaluation materials are very easy to access so teachers and parents of the students can judge college acceptance and job acceptance. Furthermore, Iowa Assessments developed strict learning standards for the measurements of the students. It enables lower level students to have much more time to solve evaluation problems compare to the high-level students who have to solve the problem by the time appointed. Khan

Academy provides individual learning dashboard [17], which allows students to solve exercises, watch video lecture and so on based on their own learning pace. It covers a various subject such as mathematics, sciences, computer programming, history, arts, economics and so on. In particular, in the case of mathematics programs, it utilizes the latest technology in many parts from kindergarten curriculum to differential and integral calculus in order to lead students well. Lastly, Knowre[18], a mathematical education portal, provides digital contents so that it enables personalized, customized learning experiences for students. It figures out learning gap between each student, provides complementary support to the students based on curriculum and provides comprehensive data and learning environment in which student can participate. These services, however, mainly focus on delivering learning contents, so the process of diagnosing the level of the students plays a small roll in each service, which is different from the diagnosis supplement system for basic academic skills.

Diagnosis Supplement System for Basic Academic Skill, treated in this study, can be characterized by accurately diagnosing the level of the basic education level of learners and providing customized supplementary learning materials based on the results. However, research on the usability of this national level service which is the only service provided in Korea has never been conducted yet.

Therefore, this study is meant to propose a design prototype to diagnose the problems of the usability of the diagnosis supplement system for basic academic skills based on the affordance theory from the viewpoint of HCI and to improve it.

B. Diagnosis-Supplement System for Basic Academic Skill

Ministry of Education in Korea has been carrying forward an 'academic ability improvement policy' from 2011. With this policy, elementary and middle schools have used this system since 2013. It provides a standardized teaching-learning model for students who are lack of basic academic skills [9][10].

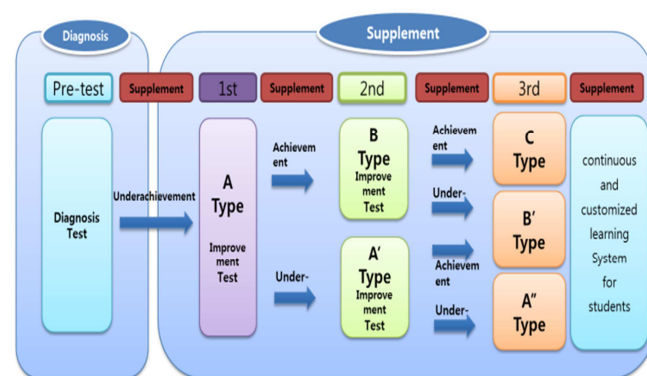


Fig. 1 Process of Diagnosis and Supplement

The process of this system, 'how it works' can be explained with Fig. 1 below. Firstly, by using a diagnostic tool, it can distinguish underachievement student from the others. After this, enroll an underachievement student on the system, students can take three step tests to check their improvement. By taking this test, students can check the wrong answer again because this system provides

supplement-studying studying materials based on their answer. 3The three-step test consists of A, B, C type of test. The primary improvement test consists of the A type test. The A type test is composed of questions based on the previous year 's curriculum and consists of three homogeneous test forms. If it is judged that the basic education level has been reached in the primary test, the B type test sheet can be carried out in the secondary test. Type B consists of the second semester of the previous year and the first semester of the current semester. Like Type A, it consists of three homogeneous test papers. Otherwise, if it is judged that the basic education level is not reached in the primary test, the secondary test can be used to diagnose basic education ability once more by using the type A homology test paper. In the third examination, the C type test can be conducted. Type C is made up of the curriculum of this year and consists of three homogeneous test sites. If the secondary test reaches the basic level of education, type C can be performed. Otherwise, type A or type B homozygote for each learner level is automatically distributed.

With this, not only students can do their extra study, but also teachers can give follow-up training to their students. Students can use this online program by themselves or an off-line test by taking an exam paper from their teacher. In the case of off-line test, the teacher should put the answer of students on the system then the system automatically presents the result of the calculation.

As of December 2016, approximately 170 thousand students enrolled in this system, which is about 4% of elementary and secondary school students in Korea.

C. Affordance Theory in Context of HCI

In this study, it is important to check what kind of problems are existing in this system in terms of user affordance to make this system better to use for students and teachers.

Affordance is about the interaction between object and subject, so it means the possibility of an action on an object or environment. This term is also used in cognitive psychology, industrial design, and artificial intelligence learning area, meaning 'linking different concepts'. To explain lucidly, when people see the ball, they try to grasp it or throw it and in the case of a button, people push it. Like this, information that object provides make people use this object easily. This kind of affordance researches has been intensively studied mainly by Gibson, Norman, Gaver and so on [19]. Hartson suggests a detailed and systematic affordance model for a variety of systems for applying HCI design like Table 1. Below [20].

This study tries to examine the problems of Diagnosis-Supplement System for basic academic skill by type. In order to do this, this study uses the viewpoint of HCI and the type classification which is proposed by Hartson (2003) to investigate problems [20].

D. Methods

By using FGI (focus group interview) method, this study tries to analyze affordance requirements. The member of groups are divided into two, the first group includes 25 school teachers who are running this diagnosis system, and

the other group members are 17 school inspectors and commissioners from 17 metropolitan and provincial offices of Education.

Drawing affordance requirements in terms of the menu structure, UI/UX, the process of learning material distribution from FGI and Classifying these requirements based on three types of the category, physical, cognitive, sensory affordance to suggest a way to improve this affordance problem.

For this analysis, all the discussions done between focus groups are recorded. These records are divided into three types in terms of affordance theory. After that, some prototypes are proposed to solve the problem of each type.

TABLE I
DETAIL TYPES OF AFFORDANCE

Type of Category	Concept
Physical Affordance	The Design properties that help users perform physical actions with interface
Cognitive Affordance	The Design properties that help users recognition what will happen next
Sensory Affordance	The Design properties that help users understand what it means to be aware of

III. RESULT AND DISCUSSION

The research of this study suggests the affordance problem of Diagnosis Supplement System for basic skills based on FGI. After that, discussions are made on ways to solve each problem and propose a design prototype based on this proposed.

A. Problems of Affordance

1) Physical Affordance Problems

Firstly, one is an ambiguity about menu placement. This is a representative example of the physical affordance problem. It needs to be reconstructed with the coherent location of the object and similar functions so that it can be easily configured. In particular, the differences between the top menu, exposed on the first page and the menu exposed on the top can make user confusing because of the different functions.

Secondly, one is the difficulty of the student registration and management process. In order to minimize fatigue and tension in manipulating objects, it should be easy to operate. In this system, however, users have to register each student, select on/off-line test type and then distribute each test paper by themselves. This is too complicated, so it should be improved in an easy way.

The last one is the difficulty of signing up a membership. In the case of joining the membership, two problems are raised. First, the process of managing consent form from parents whose child is the age of 14 should be improved. The other one is difficulty in registering students with insufficient learning motivation in this system. Therefore, it is necessary to suggest ways to systematically support these problems.

2) Cognitive Affordance Problems

First of all, revising the term ‘basic academic ability evaluation’ is requested. In the case of this system, it is necessary to revise the term ‘evaluation’ into ‘measurement’ from the viewpoint of diagnosing the level of basic education level and providing appropriate supplementary learning data rather than evaluating the learning results of students. Also, the revision of ‘diagnosis prescription learning’ menu is requested. In the case of diagnosis prescription learning, which is presented as a primary menu, can be confusing to users. This is because the term is similar to ‘improvement of diagnostic assessment of basic competency’, which is the main function of this system. Thus, it is necessary to reconfigure the functions actually provided in the menu and modify them into appropriate terms.

The second one is a concise expression of the ‘help’ provided in each menu. Although the system provides a description of the functions for each page, people pointed out that the explanation is too long or complicated to read. Therefore, the description of help should be changed into more concisely.

3) Sensory Affordance Problems

Firstly, there is a need that having unity of button colors for the main functions. Currently, main functions of this system are colored in orange, simultaneously the terms on the page also use orange color, so it makes user hard to distinguish main button and text expressions. Consequently, it is necessary to present appropriate distinction and unity between the functions of the buttons and text expressions of guidance and so on.

Secondly, there is a need that visualizing the test results so that learners can more easily recognize and understand the test results. In other words, there is too much information on the results page based on text form, but this kind of information should be provided in a visualized way.

B. Improvement of UI

1) Physical Affordance Context

In order to improve the functional accessibility of users, we propose a restructured menu with similar function. The result is shown in Fig 2. In the case of the functions currently provided, when there is a user request, the function is temporary added, after the construction in 2013. This causes a low degree of consistency between top menu and sub-menus. Therefore, we classify the top menu with minimum ambiguity; propose sub-menus to each top menu. In particular, restructuring of the menu also included modifications of the menu names from the cognitive affordance view.

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modifications of the menu names from the cognitive affordance view.

In order to improve the student registration system, which is the second problem of physical affordability, this system should not receive as much input as possible other than the information required for the basic education diagnosis evaluation. Accordingly, it should delete date of birth, telephone number, mobile phone number and e-mail address and so on.

The third problem of physical affordability is a difficulty of a membership joining method. In the case of membership joining, especially for students under the age of 14, the consent of their parents is required according to the personal information protection Act, which is regarded as a cumbersome process for both teachers and learners.

In order to solve this problem, it is necessary to collect personal information at the school level or use a mobile phone or SNS authentication, which are widely used recently. In addition, it is worth considering an introduction of O-Auth technology which can be interlocked with other public services.

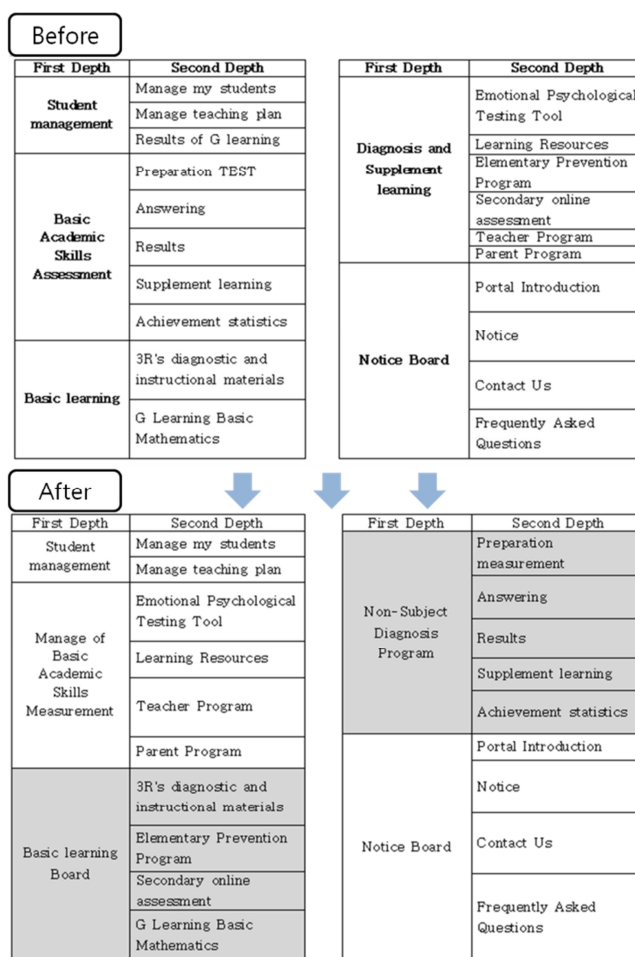


Fig. 2 Restructured Main Menu

2) Cognitive Affordance Context

The first cognitive affordance problem is the difficulty of understanding the terms. Especially various buttons and functions applied in this system need to be improved in the

viewpoint of students. Therefore, the terms for each menu are suggested as follows.

First, change the term evaluation into measurement so that it can reduce the pressure on students. Next, the term history management should be changed into study management so that students can understand the term. Lastly, the term diagnosis supplement learning can be confused with the term of the process of diagnosis supplement, so it should be replaced with Non-Subject Diagnosis program.

The second problem of cognitive affordance is the need of help(instruction). In an attempt to improve help function, we have reviewed all the help on the whole pages and removed redundant and ambiguous expressions and improved the ability to deliver more important messages. The major improvements are shown in Fig 3. In addition, for easier understanding of each function, we proposed a detailed help function that can be seen when the button is clicked.



Fig. 3 Improvement of example for cognitive affordance

3) Sensory Affordance Context

Focused group interviewee demands visualize this system to comprehend a result of learning test easily in terms of sensory affordance problem. Therefore, it is suggested to present the results of three steps of the test at once so that students and teachers can check their own improvements. Furthermore, by using different colors, for example, in the case of reaching learning level, marked it with blue color and marked it orange color when students did not reach learning level. This can make teachers and students check their degree of studying easily. The major improvements are shown in Fig 4.

IV. CONCLUSION

Diagnosis-Supplement System is the only central service that government provides to enhance basic academic skills. This study has a significant meaning by analyzing a wide range of requirement of teachers and experts by doing focus group interview in terms of user affordance and trying to provide a way to improve this system for the better use.

Based on this improvement plan, henceforth, a systematic approach to improving this system should be made through detail design plan. With this, to provide ongoing management for underachievement students in an effective

way and to help teachers who are in charge of this system, this kind of research should be in constant discussion with researchers.

전체 선택	이름/아이디	학년	반	번호	국어	사회/역사	수학	과학	영어	성적표
	강유빈 100117040106	초4	1	6	03/22 제도전	-	-	-	-	내 성적표 보기
	김정 100117041010	초4	10	10	-	03/15 제도전	03/15 제도전	-	-	내 성적표 보기
	I 100117050302	초5	3	2	04/07 제도전	-	-	-	-	내 성적표 보기
	WE 100117050343	초5	3	43	03/15 제도전	03/15 제도전	-	-	-	내 성적표 보기
	ddd 100117050888	초5	8	88	03/22 제도전	03/22 제도전	03/22 제도전	03/22 제도전	03/22 제도전	내 성적표 보기
	임상현 100117061212	초6	12	12	04/18 제도전	04/18 제도전	04/18 제도전	-	-	내 성적표 보기

이름/아이디	학년	반	번호	1차				2차				3차					
				국어	사회/역사	수학	과학	영어	국어	사회/역사	수학	과학	영어	국어	사회/역사	수학	과학
고길동 700216010202	중1	2	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●
고길동 700216010202	중1	2	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●
고길동 700216010202	중1	2	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●
고길동 700216010202	중1	2	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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고길동 700216010202	중1	2	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●
고길동 700216010202	중1	2	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●
고길동 700216010202	중1	2	2	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Fig. 4 Improvement of example for Sensory affordance

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