문항반응이론을 이용한 컴포넌트 기반의 U-러닝 시스템

The Component based U-Learning System using Item Response Theory

정 화 영*
HWa-Young Jeong

요 약

u-러닝 환경은 수 없이 많은 단계를 거쳐 발전되어 왔으며, 현재에는 학습자의 학습 결과 분석과 양적인 사용, 질적인 평가 등을 통하여 정립되고 있다. 일반적으로 개선된 학습 효과와 학습자의 학습 결과분석을 위하여 대부분의 학습 시스템이 문항분석방법을 이용되고 있다. 그러나 오늘날 학습 시스템은 문항분석이론 대신에 문항반응이론을 사용하고 있다. 문항분석이론은 시험에 대한 각각의 가능한 응답에 대한 확률을 위해 명확한 모델을 제시한다. 따라서 본 연구에서는 문항반응이론을 이용한 경량 컴포넌트 기반의 u-러닝 시스템을 제시하고자 한다. u-러닝에 적용된 기기는 윈도우 모바일 5.0 환경의 PDA로 하였다.

Abstract

The u-learning environment has been developed through a number of iterations, and has now been formally evaluated, through analysis of student learning results and the use of quantitative and qualitative measures. Generally, for advance learning effect and analysis of student learning results, the most learning system be use to the item analysis method. But, nowadays, it has using the IRT(Item Response Theory) instead of the item analysis method. The IRT adopts explicit models for the probability of each possible response to a test. Therefore, I proposed the lightweight component based u-learning system using the IRT. Applied device of u-learning is PDA which is in Windows mobile 5.0 environments.

☞ keywords: U-러닝 시스템, 문항반응이론, 학습 코스웨어, 소프트웨어 컴포넌트

1. Introduction

Nowadays, a large variety of more and more powerful mobile devices like smartphones, PDA(Personal Digital Assistants), and laptops are available. The increase of computational power and memory space allows the adaptation of applications from different domains into the realm of mobility[1]. Kristóf [2] defines u-learning as learning as it arises in the course of person-to-person mobile communication. Mobile communication is enhanced everyday communication; and just as our everyday conversation is indifferent towards disciplinary boundaries, so, too, is u-learning and m-learning. As mobile connectedness continues to sweep across the landscape, the value of deploying mobile technologies in the service of learning and teaching seems to be both self-evident and unavoidable[3]. Learning system offers many advantages to those seeking to advance their education[6]. An item often appears easy or difficult based on personal judgment, the scientific method of calibration often assigns difficulties higher or lower than one would expect[7]. But, in case of u-learning, individualization learning that presents learning contents and method separately according to learning ability of individuals is deficient. Also, I need to change development method to lightweight component based development in u-learning system.

* 종신회원 : 경희대학교 교양학부 조교수
hyjeong@khu.ac.kr
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In the component based development, based on the idea of distinguishing an object interface and its implementation, a concept of component introduces several interfaces to access a component implementation. Each interface represents a contract between the implementation of the component and the code which uses an interface abstracts provision of a service[8]. So, one of the most important contributions in component models are to separate application programming from deployment. Indeed, deployment descriptors allow component programmers to give information about which services to use.

Thus, my attempt to develop this learning system will be useful in those situations where students are moving on and off campus, but affluent with mobile devices such as PDA. In this paper, I development the lightweight component based u-learning system using item analysis method. For advancing learning result according to student's ability, this system produced the leaning step using item analysis method. I used UML in system design and visual C# of visual studio 2005 in system development. That is, I embodied setting-question parts and the calculation and application parts of the relative correction of item difficulty; they are main business logic, with lightweight component. And then I showed that this system is applicable by assembling and operating the lightweight component which was embodied in u-learning.

2. Relate Work

2.1 Lightweight component

The classical designs of component models and architectures either suffer from extensive resource demands(memory, communication bandwidth, CPU) or dependencies on the operating system, protocol, or middleware (e.g. .NET, CORBA ORBs). In addition, any infrastructure must not significantly diminish the ability of applications to address the increasing functionality and complexity demands; otherwise, its adoption would be jeopardized. Hence lightweight component models are needed with containers able to execute on resource-constrained platforms (PDAs) to enable reusability, the dynamic distribution and deployment, location transparency and optimal tailoring of service configurations[15]. It is the main features which are required for embedded systems as Portable, Modular, Simple and Deterministic. In the Simple feature, again in contrast to the well-known component containers such as EJB, CCM or COM+, a container infrastructure for embedded systems must be lightweight, providing a really simple programming model. That is, for extensibility and modularity, the framework should be made of many lightweight components which the user can easily replace or extend[16].

2.2 Ubiquitous learning and Item response theory

Complete independence of both location and time is often emphasized as the main advantage of e-Learning. However, in traditional e-Learning the minimum hardware requirement is still a personal computer(PC), consequently an absolute independence in location is not provided. These independencies are still not fulfilled with the use of a notebook, because a real independency in time and location means learning wherever and whenever a person wants to have access to learning material[5]. Ubiquitous learning(u-Learning) is the next generation of e-Learning and is based on

mobile devices such as PDA. The ubiquitous learning environment is any setting in which students can become totally immersed in the learning process. So, a ubiquitous learning environment(ULE) is a situation or setting of pervasive education (or learning). Education is happening all around the student but the student may not even be conscious of the learning process. Source data is present in the embedded objects and students do not have to do anything in order to learn. Figure 1 shows an example of four students within a ULE in which there are five ubiquitous objects/devices. Each student is part of the many to one relationship within this u-space[4]. Item response theory(IRT) is to test people. Hence, their primary interest is focused on establishing the position of the individual along some latent dimension. The most distinct feature of IRT is that is adopts explicit models for the probability of each possible response to a test[9]. Difficulty level of the questions was verified by presenting the items to content experts and having them rate each item as easy, medium, or difficult. There are different models of item response theory, based on the number of parameters to be estimated for the items. I used a one-parameter model, the Rasch rating scale[10].

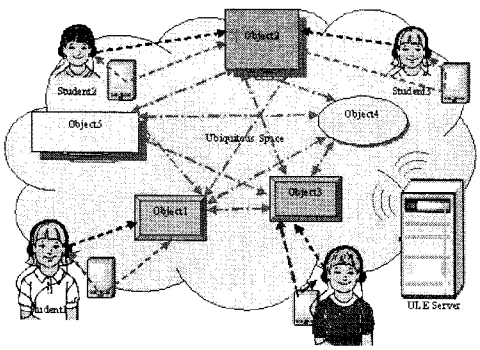

Figure 1. Students within u-space

2.3 Component based learning system

Lightweight component models are needed with containers able to execute on resource-constrained platforms (PDAs) to enable reusability, the dynamic distribution and deployment, location transparency and optimal tailoring of service configurations[11]. It is the main features which are required for embedded systems as Portable, Modular, Simple and Deterministic. In the Simple feature, again in contrast to the well-known component containers such as EJB, CCM or COM+, a container infrastructure for embedded systems must be lightweight, providing a really simple programming model. That is, for extensibility and modularity, the framework should be made of many lightweight components which the user can easily replace or extend[12]. The existing component based learning system is as blow. [13] have implemented web-courseware system by component composition in middleware system and applied component model is EJB. [14] have implemented component based E-learning system which learners are able to select 5 study step by item difficulty. Both of them was deal with only item difficulty of item analysis method. But item difficulty needs to process according to IRT for effective learning analysis and processing. Also, using environment has to be resource-constrained platforms as like PDAs for dynamic usability.

3. Component based u-learning system using item response theory

3.1 Design and development of u-learning system

In the Ubiquitous learning center each student will carry a wireless device (PDA or mobile phone) fitted with headphones. In this research, Figure 2 illustrates the seamless interaction between student and the LMS system and describes the structure of lightweight component within container in PDA. Student is able to use the various contents by PDA.

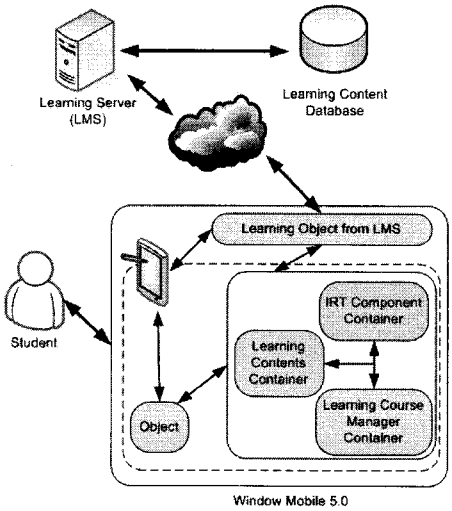

Figure 2. Structure of u-learning system

This can be used to the student in the form of images, text, sound or other format which is contents embedded in the PDA. During the studying learning contents, if the student requires some more additional learning contents, then the student can access the learning server(LMS: Leaning Management System) via the PDA and receive more learning contents from the learning server. Figure 3 shows use-case diagram of this system. Student can select learning course and get the learning object from LMS and learning contents in PDA by learning contents container. After learning process, he can solve the question which is applied before learning effect by IRT component container.

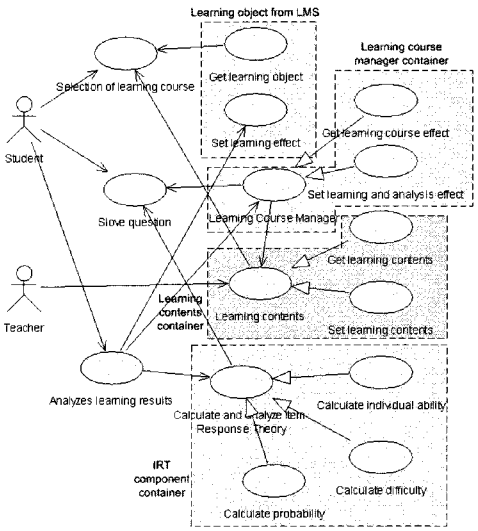

Figure 3. Use-case diagram

After log-in, student sets learning level before entering learning then questions selected by the relative correction of item difficulty corresponding to learning level are extracted randomly in item difficulty of IRT. In case of presenting extracted questions then learning proceeds and learning result by examination paper of student is represented after progression of learning. By learning result, the relative correction of item difficulty, individual ability and probability are calculated. Figure 4 shows sequence diagram of the inner part of lightweight component container for the process learning contents and the relative correction of IRT. The CourseManager deals with the process handling between student and this system. The LMSLearningObject processes to get the learning object from LMS system. The LearningCourseManager maneges the learning course of the student. And the LearningContentsManager operates to search and support the learning contents according to the learning course. Internal methods of component can be called out through

CourseManager. Calculation of the relative correction of item difficulty is requested according to learning result of student. In accordance with the result of the relative correction of item difficulty in IRT, learning level of item is reset by the relative difficulty. When setting-question is requested, items which are selected by student and correspond to learning level are extracted randomly through IRT values and learning analysis data before. Select learning class is provided to student through result which has the analysis data of IRT.

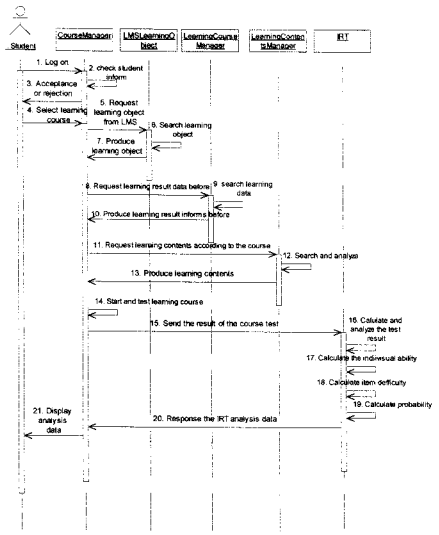

Figure 4. Sequence diagram of lightweight component

4. Application

In this research, I make a simple English learning courseware system using PDA. Student can access learning system through log on. After student log on, he or she can select the relative difficulty which is according to IRT analysis data to study in learning level selecting screen as like High, Normal-High, Normal, Easy-Normal and Easy in Figure 5.

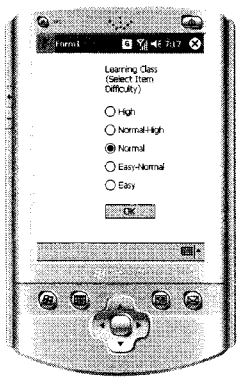

Figure 5. Learning class selecting screen on the Windows mobile 5.0

Figure 6 shows the learning contents and Figure 7 shows the learning result

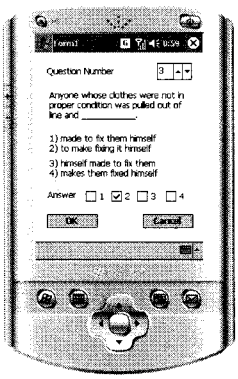

Figure 6. Learning contents

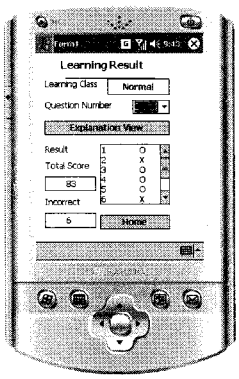

Figure 7. Verification of learning result

5. Conclusion

In this research, I designed and embodied question extracting lightweight component considering the relative correction of item difficulty and applied English question learning system. I let students select the relative difficulty by themselves according to 5 learning levels according to IRT analysis data and can expect more appropriate learning effect. Most of web-based learning system considered only the relative item difficulty in setting-question system but, in this research, I calculated and applied the relative correction of item difficulty according to IRT analysis data and support to use the PDA instrument. Getting out of existing development process in system development, I embodied core business logic as lightweight component which is in container and could increase development efficiency, reusability, maintainability. For these purposes, I used UML in system design. I made modification, maintenance and repair of embodied logic easy by embodying the relative correction of item difficulty in IRT. I made the main business logic as lightweight component using visual C# in window mobile 5.0. Also, in developing learning system similar to this, the relative correction of item difficulty calculating parts can be applied with lightweight component of this research without newly embodying. The concept of ubiquitous computing and u-learning goes beyond portable computers. As new technologies evolve and more pervasive forms of technology emerge, computers will become 'invisible' and will be embedded in all aspects of our life. Ubiquitous technology and u-learning may be the new hope for the future of education.

As a further research subject, it is necessary to prepare the theoretical basis to verify objectivity about the relative difficulty of IRT. Also, with running parallel with detailed classification works such as learning chapter and so forth, student should be able to choose not only learning level but also learning chapter and subjective questions should be applied in company with objective multiple-choice questions followed by 5 options.

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◐ 저 자 소 개 ◑

정 화 영(HWa-Young Jeong)

1991년 목원대학교 수학교육과 졸업(학사)
1994년 경희대학교 전자계산공학과 공학석사
2004년 경희대학교 전자계산공학과 공학박사
2000~2005년 예원예술대학교 게임영상학부/정보경영학부 조교수
2005~현재 경희대학교 교양학부 조교수
관심분야 : 소프트웨어 공학, 컴포넌트 조립/합성, 웹 기반 교육.
E-mail : hyjeong@khu.ac.kr