

# Design of Intelligent Tutoring Engine for U-Learning Service

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**Abstract**—As distance learning services are becoming increasingly popular and necessary services for effective learning methods, various well-formatted multimedia contents can be integrated into various learning contents. And a large number of learners log in e-learning system at the same time and need various learning guidance. Thus e-learning service needs automated and intelligent Tutoring Engine that can infer needs of each learner and deliver personalized appropriate learning contents with learning characteristics and personal learning devices environment. In this paper, we design u-learning service with automated Tutoring Engine. Proposed u-learning system has automated tutoring engine that could lighten the burden of teachers and instructors and deliver appropriate personal learning contents. Automated tutoring engine can analyse learner's learning information and extract demands and needs of learners. From the learning demands and needs, personalized learning contents can be modified from source of learning contents. Personalized learning contents can stimulate learning motivation.

**Index Terms**—u-learning, automated Tutoring Engine, personalization of learning contents, adaptation of learning contents, educational devices.

## I. INTRODUCTION

Rapid development of communication technologies and internet based service widely affect various industries services fields. Especially e-learning and distance learning were newly emerged and many investments and researches have been made for e-learning and distance learning. And e-learning market rapidly expanded, and many countries have recognized importance of e-learning and have considered e-learning as people's welfare. For e-learning, cyber universities, learning contents development companies and e-learning platform companies have been making profits. With well-formed IT infrastructures and well-made e-learning contents, e-learning can decrease personal educational expenses and improve efficiency of national education system. And personalized education can be delivered to learners and massive education can be possible with e-learning. Especially for life-long education and digital division, e-learning is the best way to offer learning contents to learners of all ages and wide variety of people. And at the same time, number of learner can access to various learning

contents and e-learning service. Nowadays mobile devices and mobile communication networks are able to deliver learning contents to learner regardless of learners' location and time. As developments of mobile technologies, e-learning and m-learning can provide more learners with flexible learning contents. But, as the more learners access to m-learning service, the more academic affair lecturers and teachers should do for learners. As the more learner access to m-learning service, specially learning interactions can be a big burden to lecturers and teachers so that many researches and funds have been focused on automated Tutoring Engine. Automated Tutoring Engine is computer programs that are designed to incorporate techniques from the AI community in order to provide tutors which know what they teach, who they teach and how to teach it[Intelligent Tutoring Engines: an overview]. Automated Tutoring Engine can reduce a burden of lecturer's tutoring and instruction for number of learner. For automated Tutoring Engine, contents adaptation engine play an important role. We propose contents adaptation engine tracks and analyses learner's property(e-portfolio, preference, learning ability), learner's environment(learning environment, learning device), learner's activity(learning activity, learning interaction), and decides and deliveries appropriate learning contents for each learner.

The remainder of paper is organized as follows. In chapter 2, we review previous automated Tutoring Engine research. The proposed automated Tutoring Engine is described in chapter 3. We introduce the architecture and function modules of automated Tutoring Engine. And tutoring decision factors are defined and described. Finally, we conclude in chapter 4.

## II. RELATED WORKS

Roll, Aleven, McLaren and Koedinger [1] presents immediate metacognitive feedback on students' help-seeking errors with intelligent Tutoring Engine and intelligent system help-seeking skills of learners. To give metacognitive feedback, the Tutoring Engine detects metacognitive errors. The Tutoring Engine uses only metacognitive errors and provides only level for hints for help seeking skill. In the Tutoring Engine, there are limited tutoring for help seeking, and the learning sequence and learning contents are not dealt with. And mobile devices for e-learning and educational devices capacity are not considered. [2] hypothesizes that positive feedback works

by reducing student uncertainty about tentative and presents constraint-based Tutoring Engine(SQL-Tutor). The constraint-based Tutoring Engine helps students learn from their errors.

[3] develops an intelligent Tutoring Engine (ITS) that tries to promote engagement and learning with dynamically detecting and responding to learners' boredom and disengagement. ITS uses a commercial eye tracker and then attempts to reengage the learner with dialog For the Tutoring Engine, eye tracking information is only learners' learning information and there is no consideration for modification of learning contents and educational devices capacities. [4] proposes Why2-Atlas that analyses learners' explanations of physics and highlights misconceptions and incomplete explanations of learners. Why2-Atlas presents these issues by a dialogue with the learners and asks the learners to correct their essay. In [5], REALP is designed to help learners read and comprehend textbooks, provides personalized lexical practices materials that are collected on the web. REALP intelligently constructs learning contents according to learner's capacity and ability. [6] eTeacher is an intelligent agent that personalizes e-learning activity guidance. eTeacher constructs learner's learning history through tracking learning activity and performing of learners. And eTeacher extracts learning information from learner's learning profile and provides personalized contents with learners and manages learning sequence. [7] The Cognitive Tutor Authoring Tools (CTAT) is example-tracing Tutoring Engine. CTAT traces learners' learning activity and compare it with models of problem solving. And CTAT provides learning guidance on problem solving activity. In CTAT, instructors create a tutor interface by themselves and demonstrate the problem-solving activity.

Previous research works mainly focused on learners' psychology and learning activity. But nowadays learning environments are affected by educational devices, especially educational devices' capacities and interface. We consider learning environments that are constructed by educational device.

### III. PROPOSED AUTOMATED TUTORING ENGINE

Proposed automated Tutoring Engine tracks and analyzes learner's property, learner's environment, learner's activity, and decides learner's learning state so that appropriate learning contents for a learner can be selected, modified and delivered to the learners and optimized and personalize learning environment can be established. We propose u-learning environment that can be provided by automated Tutoring Engine. Proposed automated Tutoring Engine considers learner's personal learning environment and learner's educational devices environment. Learner's personal learning environment is personal learning preferences that decide structure and sequence of learning contents. Learner's educational devices environment is computational resources of educational devices that is needed to play and support learning contents and learning activities on desktop computer, PDA, and smartphone. Computational

resources of educational devices have various kinds and types of IT hardware and software.

Proposed automated Tutoring Engine collects and analyzes learning environment information(learner's property, learner's environment, learner's activity) from learner's e-portfolio and learner's educational devices. Learner's e-portfolio is not easily changed. It takes a time for learner's e-portfolio to be changed. But learning environment information from learner's educational devices is changeable according to educational devices of learner, since a learner can change his/her educational devices while e-learning service. Proposed automated Tutoring Engine decides appropriate learning environment according to learning environment information.

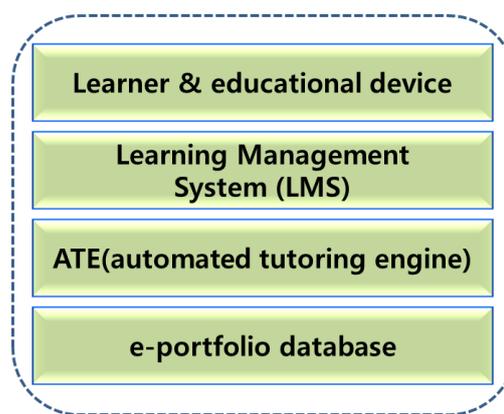


Figure 1. Architecture of proposed automated tutoring engine

Proposed automated Tutoring Engine consists of learners and educational devices, LMS(Learning Management System), ATE(automated tutoring engine) and e-portfolio database.

- Learner and educational devices : source of learning activities and educational device resource information and learning agents
- LMS : management, assessment and adaptation of learners and learning contents
- ATE : collection and analysis of learning environment information
- e-portfolio database : learners' learning history and competence

#### A. Definition of Learning Environment Information

ATE needs various learner's learning information that can be classified into three groups. Three groups are learner's property(e-portfolio, preference, learning ability), learner's environment(learning environment, learning device), learner's activity(learning activity, learning interaction). Learner's property is slowly changed and managed by learner's e-portfolio DB. And learner's activity and learner's environment are not stored in learners e-portfolio DB and easily changeable.

Learner's learning information is formatted and transferred in format of XLM, and collected by XMLE. Lastly learner's learning information is stored in learner's e-portfolio DB or ATE. According to learner's learning information, ATE decides and requests appropriate and personalized learning contents. Learner's information is like as bellows;

- Learner's property
  - e-portfolio : name, identification, birth date, The highest level of education, job, learning disability and learning difficulty, previous subject grades
  - preference : preferred learning type(text, video, audio, pictures, animation, etc.)
  - learning ability : numerical value of subjects learning abilities
- Learner's environment
  - learning environment : desktop computer, PDA, smartphone, pad computer, audio support, video support, keyboard type, network speed, etc.
  - learning device : CPU speed, main memory card volume size, display size, hard disk volume size, etc.
- Learner's activity
  - learning activity : activity level of learning time
  - learning interaction : initiative level of interaction with learning contents

**B. Automated Tutoring Engine**

On ATS(Automated Tutoring Engine), learners can use various types of learning devices(desk-top computer, lap-top computer, smart phones, tablet computers, etc. with internet facility) and various operating systems(Windows by Microsoft, Android platform by Google and OHA, IOS by Apple, etc.).

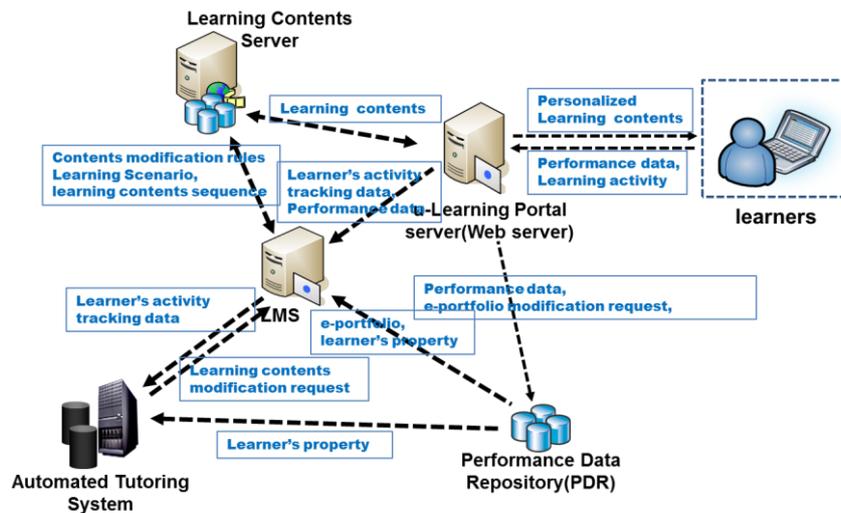


Figure 2. U-Learning management system with automated tutoring engine

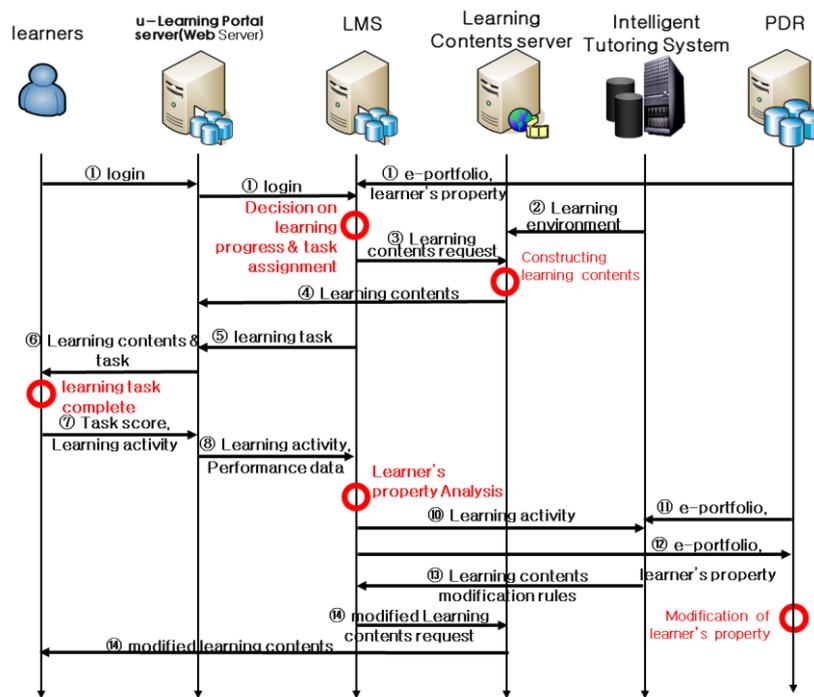


Figure 3. Message flow for u-Learning with automated tutoring engine

When a learner logs on u-Learning portal server(web server) with desk-top computer, a learner is provided standard learning contents from LMS through u-Learning portal server(web server). And he/she completes his/her learning tasks. During the learning task completion, the learner automatically sends learning performance data and learning environment and learner's activities to LMS. u-learning portal server is the bridge role in ATS. u-learning portal server collects learners' performance data and learning activity. u-learning portal server delivers learning performance data and learning environment and learner's activities to LMS, and communicates with learning agent on learner's educational devices and tracks learner's learning activity. Sometimes a u-learning portal server plays a role as a mobile web server according to learner's educational device types. Lastly a u-learning portal server relays adapted learning contents to learners from a LMS.

LMS receives learner's activities and learner's environment from educational agents of educational devices LMS also receives intrinsic motivation and extrinsic motivation data from ATS that analyzes learner's property and learner's performance and extracts intrinsic motivation and extrinsic motivation data. After that, LMS decides workload and contents type for the learner based on analyzed information of ATS. LMS sends learning contents to u-Learning portal server that delivers the learning contents to the learner.

ATS receives learner performance, learner's property and learner's activity from LMS and infers and extracts cognitive load, intrinsic motivation and extrinsic motivation of a learner. After that, ATS combine learner's environment with cognitive load, intrinsic motivation and extrinsic motivation of a learner, and can decide appropriate learning contents type for the learner. And ATS may change the learner's property (e-portfolio, preference, learning ability).

LMS can adjust learning scenario and learning sequence according to ATS decision or AST request change of assessment difficulty level.

① Learners log on a U-learning portal server(web server) with desk-top computers, smart phones, or tablet computers and, at the same time, log on Learning Management Server(LMS) with single-sign-on protocol. And LMS receives learners' previous performance data and learner's property from e-portfolio DB. LMS sends learner's previous performance data and learner's property to AST.

② AST infers appropriate learner's learning scenario and sends the inference result to LMS. LMS decides learners' workload, learning sequence and task assignment, and constructs learners' learning contents.

③ LMS sends personalized learning contents to educational devices. A learner reads, plays learning contents and interacts with learning contents. Learning agents on his/her educational devices occasionally send learning environment, learning device information, learning activities, and learning interactions to LMS. And LMS receives learning environment and delivers them to ATS.

④ ATS requests modifications of learning contents according to inferred and analyzed learning environment information.

⑤ After learners finish their task, they should take an examination for their task. And examination score is sent to LMS. And LMS delivers learner's examination score to ATS. ATS analyses learner's examination score and changes their e-portfolio. After that, ATS requests that LMS modify learning contents and learning sequence for a learner according to ATS' analysis results.

#### IV. CONCLUSION

We propose u-Learning system that can deliver personalized learning contents with one source of learning contents(standard learning contents). For personalized learning contents, automated Tutoring Engine has to decide learner's demand and needs. For classification of learner's demand and needs, we define information of learner's demand and needs as learner's property, learner's environment and learner's activity. Learner's property is learner's personal learning preference, as like as e-portfolio, preference and learning ability. Learner's environment is learner's personal learning tools and environment state as like as learning environment, learning device. Learner's activity is learner's action in order to learn something as like learning activity and learning interaction with learning contents, peer learners and instructors. Automated Tutoring Engine analyzes learner's property, learner's environment and learner's activity, and infers learner's demand and needs. According automated Tutoring Engine's inference, personalized learning contents can be modified from source of learning contents. We propose u-learning system message flow and service flow with automated Tutoring Engine. Proposed u-learning system can provide efficient learning environment for a learner and learners receive and execute appropriate learning contents with learning instruction information, subject alerts and learning activities feedbacks from automated Tutoring Engine.

We have a plan to design learning contents adaptation engine that can modify and reconstruct source learning contents into personalized learning contents.

#### ACKNOWLEDGMENT

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