A Study of DLA(Dynamic Level Adjustment) for e-Learning 2.0

YANGWON LIM, HANKYU LIM
Department of Multimedia Engineering
Andong National University
SongChunDong 333, Andong City, KyungBuk
The Republic of Korea
ywon.lim@gmail.com, hklim@andong.ac.kr http://multl.andong.ac.kr

Abstract: - As Web technology and functions have recently changed to a user-focused paradigm, new studies are being conducted to construct dynamic learning content that enables the learner’s participation and continuous learning in the field of e-learning research and design. This thesis covers a study on the degree of difficulty in learner-focused dynamic learning contents to provide efficient learning environments for its adaptation to e-learning 2.0. This study suggests DLA (Dynamic Level Adjustment) to provide learner-focused contents. The suggested system will be a guideline to control and adopt learning content that can be easily applied to the environmental change, and more in-depth future research can be performed by using the system. A dynamic learning content model was made to recognize various learning patterns of learners as a result of the performance evaluation.

Key-Words: - e-Learning, e-Learning2.0, Level Adjustment, Content Reorganization

1 Introduction
Studies on e-learning systems have been performed in two fields – academic and engineering designs in learning. This study focuses on engineering design of e-learning system, and covers the reconstruction and control of the degree of difficulty in dynamic learning content.

Changes become necessary for e-learning in response to various changes in the Web, and flexibilities in time, space, contents, and structure must be provided for the learners on the Web. Studies have been conducted that enable self-controlled and self-driven learning by providing the maximum freedom in selecting the contents, paths, and speed of learning [1].

Recently, studies have begun designing Learning Management System (LMS) and Learning Content Management System (LCMS) by applying Web 2.0 to e-learning systems, or adaptively providing individualized learning environments by analyzing the behaviour information of learners in real-time [2,3]. However, learning content have the downside of inflexibility to changes, and it is very difficult for other learners who use the same content to provide diverse information on learning even though controlling customized learning for each learner is possible.

Studies have been done on the re-adjustment of giving questions by applying a degree of difficulty which corresponds to the learner’s level [4, 5,6, 7], and studies have also been done on the re-adjustment of individualized learning content and on the intellectual learning content system [8, 9, 10]. However, such studies can’t re-adjust to others’ learning by reconstructing ready-made learning content, or can only control the degree of difficulty within the range of giving questions. They are also unable to focus learning methods on each learner despite using the feedback process to reconstruct the learning content.

E-learning content should actively cope with the diversity of learning content and changes in learners, and learning content must be provided in forms suitable for learning by reconstructing or readjusting. To construct organic content, problems in engineering design must be solved by the standardized technical method while the previous learning method has to be kept from the learners’ point of view.

In this study of the reconstruction of learning content and the control of the degree of difficulty, a DLA (Dynamic Level Adjustment) system with strong adaptability to changes of learning information which can be controlled to actively offer learning content is suggested.

The structure of this study is as follows. In Chapter 2, after covering related studies on e-learning 2.0, Web 2.0, and the content reconstruction are covered, the kinds of changes that may arise in combination with e-learning are examined. Chapter 3 explains the research and design of the system for the reconstruction of dynamic learning content and the control of the degree of difficulty. Chapter 4 provides the experiment on the suggested system and its results. Finally, Chapter 5 provides the conclusion to this study.

2. Related Research
2.1. e-learning 2.0
Due to the development of the Internet, a Web-based education system to enable education and learning through the Web has freed lecturers and learners from the restrictions of time and space, progressively transforming lecturer-focused education into learner-focused education [11]. The development of the Web has made it possible to consider the learner’s individual characteristics through effective mutual interaction between learners and content, to foster active motivation in learners [12], and to offer environments for learners to conduct self-directed study [1].

Most of the education engineering studies on Web-based education methods tend to focus on interaction between learners and lecturers – human to human rather than learner to content. But a learning process can not be successfully implemented until interaction between learner and content is effectively achieved, because the interaction between human beings is built on the premise of interaction between learner and content [13]. Thus, this study of e-learning 2.0 will be done in the short run along with the existing education system, and the learners will create their own content.

2.2. Web 2.0
Tim O’Reilly, CEO of IT publishing company O’Reilly Media, described Web changes and trends over the last few years as the second generation of the Web, or ‘Web 2.0.’ Web 2.0 doesn’t indicate a specific technique or service, but denotes major changes in the internet environment which have evolved over the last several years, as well as future trends [14]. This study will cover collective intelligence and Wiki, among the Web 2.0 techniques which are necessary for the construction of the dynamic e-learning system which this study suggests.

2.2.1. Collective Intelligence
As the number of internet users rapidly increases, users themselves generate data on the Web. Collective intelligence is a user-focused concept that it makes possible to provide service and satisfy the various needs and desires of users in the changing environment of the Web. Decentralization, network effect, and collectivization by individual contributions are the important factors in Web 2.0, and create a good environment for building collective intelligence. A collective body can make better decisions and solve more difficult problems than several individuals with professional knowledge [15]. Web 2.0 motivates and uses collective intelligence [16]. In e-learning, while collective intelligence is shown when the correct answers to problems or questions are discovered, it is difficult to use this collective intelligence for problems requiring skillful techniques. This thesis suggests a design to solve those problems through collective intelligence.

2.2.2. Wiki
The origin of Wiki is the Hawaiian ‘Wiki Wiki, which means ‘be fast,’ ‘hurry,’ and ‘not bound in formalities.’ Wiki in this context refers to a CMS (Content Management System). One of its characteristics is that many people can add, edit, and manage the content together. Not only does it allow content users to correct existing content or add new content, but editors can easily approach and produce content including hyperlinks without any knowledge of markup languages such as XHTML [14, 17, 18]. Using Wiki characteristics in e-learning allows a learner to construct a set of learning content from which other learners can reproduce new learning content. This thesis suggests a reconstruction system of content by learners called LCC (Learner Created Content) through using Wiki.

2.3. Bayes’ Theorem
Bayes’ Theorem (or Bayes’ Law) is a method of calculating the probabilities of two random events, represented as P(A|B). Assuming that one event certainly happens among n mutually exclusive events (A1, A2,....An), B represents the conditional probability of another event. P(B), the probability that B happens before obtaining new information, is called prior probability. P(A|B), the probability that A happens after the information, is called posterior probability.

\[
P(A|B) = \frac{P(A_{1}) P(B|A_{1})}{\sum_{k=1}^{n} P(A_{k}) P(B|A_{k})} \quad (1)
\]

In this thesis, Bayes’ Theorem is used to automatically construct learning content in an e-learning system for the reconstruction of dynamic content and to control the degree of difficulty.

3. Reconstruction and Control of Difficulty for Learning Content
The studies of the reconstruction of dynamic content and the control of the degree of difficulty suggested in this thesis allow learners to reconstruct the subjects (content or courseware) that they want to learn in diverse ways. Learners can use dynamic learning content, both from lecturers and from the collective intelligence of other learners, self-adjusted to their individual levels and their
interest. The structure of the e-learning system designed in this thesis is as follows Fig.1.

![Fig.1. Diagram for Dynamic e-learning System](image)

- Interested Courseware Management System
  This is a controlling system of the content that learners with access to e-learning system want to study.
- LCC (Learner Created Content)
  This is a controlling system of the learning content reconstructed and reproduced by learners. The content can be corrected and supplemented as needed.
- Learning Wiki System
  This is a learning control system using collective intelligence for many learners to construct one or more sets new learning content.
- Feedback System
  This is a learning content reconstruction system which collects information from many learners and calculates statistics for the collected information.

3.1. Learning Content by Participation of Learners
Learners can study information generated from other learners’ experiences and knowledge by using collective intelligence in this dynamic e-learning system. LCC (Learner Created Content) consists of information from other learners’ about related studies, learning methods, and the solutions to problems. Learners will be able to learn about related fields of knowledge in addition to the ones they have studied. The learner-involved system using collective intelligence will be a reliable model that can actively cope with various and newly generated information.

E-learning content can be corrected and by learners, and the Wiki system will save the new content, solutions, and methods which are constructed by the lecturers. The content becomes more diverse as the learners’ group expands, and the degree of difficulty can be dynamically determined by each learner’s classification. Learners can also suggest the learning methods or the answers to questions about the content, and the information not only helps other learners to learn easily and quickly, but also fosters the construction of content by learners as well as by lecturers because new learning content can be produced by questioning the content.

3.2. Extraction of Learners’ Behavior Information
Learner behavior generates feedback with which to reconstruct learning content. This happens automatically based on interactions between the learner and the content systems during learning, and is saved and constructed by the following events.

- Reading Count (RdC):
  This saves the number of times the content is read.
- Reading Time (RdT):
  This saves the time in minutes between the learner’s entering the content page and the learner’s exiting that page.
- Scroll Count (SrC):
  This saves the number of times that the user scrolls up and down the page. The initial scroll number for one page’s content is set to 0.
- Print Check & Count (PrC):
  This indicates whether or not the learner uses a printer, and the number of times the learner prints it.
- Save Check & Count (SvC):
  This indicates whether or not the learner saves the content and the number of times the learner saves it.
- Relational Index Count (RiC):
  This saves the number of keywords used in communication pages such as a board or a chat room. The value is 0 when no information is input, or (0~n) when information is input.

3.3. Construction of Dynamic Learning Content
To operate dynamic learning content, interactions between learners and systems are collected in real time. This information is saved to a database which controls the degree of difficulty of the content and its evaluation. Additional information necessary to reconstruct this content, along with learner event information, consists of the following information when the content is produced by lecturers.

- Estimated Course Level (ECL):
  This is the expected level of difficulty of the content initially input, starting with a real number from 1 to 100. Later adjustments to raise this value represent increased difficulty.
- Estimated Learning Time (ELT): (Minutes)
- Learner Participation Count (Lcnt):
This is the number of learners who study the content. Equation (2), (3), (4) below shows the difficulty control equations, adjusted to reconstruct learning content.

\[ P(\text{FH} \text{Io}) = P(Rd \text{C}_x), P(Rd \text{T}_x), P(St \text{C}_x), \]
\[ P(Pr \text{C}_x), P(St \text{C}_x), P(Ri \text{C}_x) \quad (2) \]

Equation (2) turns to be

\[ P(CL_{n(x)}) = P(CL_{n(x)}) | P(\text{FH} \text{Io}) \]

(3)

And CL(Content Level) is

\[ CL = \frac{1}{n} \sum_{i=1}^{n} P(CL_{i}) | P(CL_{n(x)}) \]  

(4)

In equation (2), (3), (4), the variable \( n(x) \) represents a specific learner for one set of learning content, and the variable \( n \) represents the number of learners who studied the learning content.

The learning content with the level adjustment above provides support for building the dynamic structure for a question-making system to evaluate learning. The difficulty in learning becomes higher as the time to solve problems increases, and the average degree of difficulty on the content or the question can be checked after a specific amount of time. Accordingly, it is designed for each learner to subjectively evaluate their relative learning levels when many learners participate.

Fig. 2 shows the structure for constructing new learning content. This is done by using Bayes’ Theorem to evaluate initial feedback extractor information plus new information about learner participation in the context of previous learning.

3.4. Control Model of Dynamic Learning Content

Learners can study information generated from other learners’ experiences and knowledge by using collective intelligence in this dynamic e-learning system.

Learners can correct and supplement the e-learning content. The Wiki system saves new content, solutions, and methods which are constructed by the lecturers. Content grows more diverse information as the learners’ group expands, and the degree of difficulty can be dynamically determined by the learners’ classification. Learners can also suggest learning methods or answers about learning content. This information will not only help other learners who study the same content, but will also encourage the construction of content by both learners and lecturers because this new content can be produced by questioning the existing content.

Fig. 3 shows the learning content control model which reconstructs learning content.

4. Experiment and Inquiry of DLA System

To realize the DLA system environment suggested in this thesis, MS-SQL2000 was used to create a database that can be operated in the Web 2.0 environment, which is necessary for learning content information, learners’ information, learning control, and reconstruction in MS-Windows 2003. The learner interface was created using script languages such as JavaScript, HTML, XML, and ASP.

Although the suggested dynamic learning content system is a tool to measure the learners’ learning level and the degree of difficulty of the learning content, the experiment in this thesis only shows the calculated results according to the difficulty control method for learning content.
The learners studied applied questions of basic grammar in C language. The learners were 40 engineering college students who understood the basic grammar of C language. After they studied the content, they were evaluated by the DLA system.

The degree of difficulty of the applied questions was described as a value from 1.00 to 5.00, and the initial degree of difficulty was set as 3.00.

In the experiment, learners were randomly given 12 questions to solve from the basic input/output statements and control statements of C language.

Table 1. Analysis of Learning Content with Accumulated Degree of Difficulty

<table>
<thead>
<tr>
<th>Learner(s)</th>
<th>1</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>3.00</td>
<td>2.00</td>
<td>2.33</td>
<td>2.56</td>
<td>2.67</td>
<td>2.85</td>
<td>2.96</td>
<td>2.95</td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>3.00</td>
<td>2.00</td>
<td>2.56</td>
<td>2.85</td>
<td>2.95</td>
<td>3.00</td>
<td>3.05</td>
<td>3.05</td>
<td>3.14</td>
</tr>
<tr>
<td>Q3</td>
<td>3.00</td>
<td>2.00</td>
<td>2.85</td>
<td>3.14</td>
<td>3.23</td>
<td>3.38</td>
<td>3.48</td>
<td>3.54</td>
<td>3.54</td>
</tr>
<tr>
<td>Q4</td>
<td>3.00</td>
<td>2.00</td>
<td>2.33</td>
<td>2.56</td>
<td>2.67</td>
<td>2.85</td>
<td>2.96</td>
<td>2.95</td>
<td>3.00</td>
</tr>
<tr>
<td>Q5</td>
<td>3.00</td>
<td>2.00</td>
<td>2.56</td>
<td>2.85</td>
<td>2.95</td>
<td>3.00</td>
<td>3.05</td>
<td>3.05</td>
<td>3.14</td>
</tr>
<tr>
<td>Q6</td>
<td>3.00</td>
<td>2.00</td>
<td>2.85</td>
<td>3.14</td>
<td>3.23</td>
<td>3.38</td>
<td>3.48</td>
<td>3.54</td>
<td>3.54</td>
</tr>
<tr>
<td>Q7</td>
<td>3.00</td>
<td>2.00</td>
<td>2.33</td>
<td>2.56</td>
<td>2.67</td>
<td>2.85</td>
<td>2.96</td>
<td>2.95</td>
<td>3.00</td>
</tr>
<tr>
<td>Q8</td>
<td>3.00</td>
<td>2.00</td>
<td>2.56</td>
<td>2.85</td>
<td>2.95</td>
<td>3.00</td>
<td>3.05</td>
<td>3.05</td>
<td>3.14</td>
</tr>
<tr>
<td>Q9</td>
<td>3.00</td>
<td>2.00</td>
<td>2.85</td>
<td>3.14</td>
<td>3.23</td>
<td>3.38</td>
<td>3.48</td>
<td>3.54</td>
<td>3.54</td>
</tr>
<tr>
<td>Q10</td>
<td>3.00</td>
<td>2.00</td>
<td>2.33</td>
<td>2.56</td>
<td>2.67</td>
<td>2.85</td>
<td>2.96</td>
<td>2.95</td>
<td>3.00</td>
</tr>
<tr>
<td>Q11</td>
<td>3.00</td>
<td>2.00</td>
<td>2.56</td>
<td>2.85</td>
<td>2.95</td>
<td>3.00</td>
<td>3.05</td>
<td>3.05</td>
<td>3.14</td>
</tr>
<tr>
<td>Q12</td>
<td>3.00</td>
<td>2.00</td>
<td>2.85</td>
<td>3.14</td>
<td>3.23</td>
<td>3.38</td>
<td>3.48</td>
<td>3.54</td>
<td>3.54</td>
</tr>
</tbody>
</table>

Table 1 and Fig.4 show the adjustment of the degree of difficulty from the initial degree of difficulty whenever learners solved the questions. The degree of difficulty is adjusted based on the mean value accumulated by 40 learners, which is more accurate than a decision by lecturers. Learning content developed in this manner can be sorted and given to the learners as easy or difficult questions based on their learning levels.

5. Conclusion

In previous e-learning systems, when curricula have changed or social/cultures changes required the reconstruction of content, this had to be done by lecturers. But in the dynamic flexible e-learning system suggested by this thesis, learning content can be reconstructed by learners.

Learners can be offered learning environments that enable them to study with dynamically configured learning content and to be more active in generating their own e-learning content. In other words, the system was
designed for learners to produce content by inviting their participation through collective intelligence and Wiki of Web 2.0, and to be organized as a learned-focused e-learning 2.0 system that is flexible to the various changes in learning environments by extracting the behavior information of learners during the study. The e-learning content system of this thesis allows learners to reconstruct or reproduce their learning content and to study with the same learning effects as previous learning content. The reconstructed/reproduced learning content can offer other learners a direction of study and additional learning content. A larger number of learners will lead to more exact information and easier learning methods. Constructing content through the e-learning 2.0 system with strong collective intelligence is possible, and it is expected to be possible to design and realize a vital, adaptable e-learning system.

References:


[17] www.c2.com/cgi/wiki