Educational Technology International
2007, Vol. 8, No. 2, 53-71

Comparing Learning Outcome of e-Learning with Face-to-Face Lecture of a Food Processing Technology Course in Korean Agricultural High School

Sung Youl PARK* Hyeon-ah LEE

Konkuk University

Korea

This study identified the effectiveness of e-learning by comparing learning outcome in conventional face-to-face lecture with the selected e-learning methods. Two e-learning contents (animation based and video based) were developed based on the rapid prototyping model and loaded onto the learning management system (LMS), which is http:// www.enaged.co.kr. Fifty-four Korean agricultural high school students were randomly assigned into three groups (face-to-face lecture, animation based e-learning, and video based e-learning group). The students of the e-learning group logged on the LMS in school computer lab and completed each e-learning. All students were required to take a pretest and posttest before and after learning under the direction of the subject teacher. A one-way analysis of covariance was administered to verify whether there was any difference between face-to-face lecture and e-learning in terms of students' learning outcomes after controlling the covariate variable, pretest score. According to the results, no differences between animation based and video based e-learning as well as between face-to–face learning and e-learning were identified. Findings suggest that the use of well designed e-learning could be worthy even in agricultural education, which stresses hands-on experience and lab activities if e-learning was used appropriately in combination with conventional learning. Further research is also suggested, focusing on a preference of e-learning content type and its relationship with learning outcome.

Keywords : e-learning, educational effects, experimental study, analysis of covariance

* Dept. of Educational Technology, Konkuk University
psyhyl@konkuk.ac.kr

Introduction

New information and communication technology (ICT) is a vital tool to bridge information society to knowledge society and has resulted in quiet revolution of education over the past decades. The use of distance learning is a primary example of ICT in education (UNESCO, 2003). As a communication measure, internet technology has played great role in facilitating between teaching and learning (Roberts & Dyer, 2005). Internet based e-learning has become more and more popular and expanding rapidly both in education and industry (Gunasekaran, McNeil, & Shaul, 2002).

Korea is one of the leaders in the use of e-learning in education. According to Economist Intelligence Unit (2003), its e-learning readiness was ranked 5th in the world. The market size of e-learning in Korea was 1,300 billion won (about $1.37 billion) in 2004, and its entire market is expected to grow 6,800 billion won (about $7.16 billion) by 2010 if the meaning of e-learning is applied to broad senses, including broadcasting education, service, content, technology, and educational hardware industry (Korea Institute for Electronic Commerce, 2005).

The development of e-learning of Korea has been supported by various governmental organizations. The Ministry of Labor (2003) has provided supportive measures of e-learning based training system for industry. The Ministry of Commerce, Industry and Energy (2004) proclaimed the Law of Facilitating Development of e-Learning Industry in 2004. Specifically, the Ministry of Education and Human Resource Development launched an "e-learning implementation strategy" under the banner of "Building a Lifetime e-Learning Nation" in November 2004, which means expanding education from the primary and middle schools to the high schools, and finally, to adult and vocational education (Ministry of Education and Human Resource Development, 2004).

Advantages of e-learning often comprise flexibility, convenience, facilitation of communication between teachers and learners, greater adaptability to a learner's

needs, and more variety in learning experience with the use of multimedia and the non-verbal presentation of teaching material (Wikepedia, 2007). Gammill and Newman (2005) argued that three major reasons, enhancing the quality of learning, maintaining competitive advantage, and improving access to education and training, stand out among many reasons why educational institutions introduce and adopt e-learning. On the contrary, e-learning has several constraints and limitations yet to be solved. A poor or insufficient technology infrastructure may lead to unsavory experiences that can cause more damage than good to teachers or students (Naidu, 2006). The lack of face-to-face interaction is another chief disadvantage of the e-learning (Burbles, 2004). Meanwhile, others state that this disadvantage can be overcome if the teacher is a good facilitator and if appropriate communication tools are employed (Lehman, 2004). However, lower learning achievements of e-learning compared to face-to-face method are found in some special topics, even though many people on the side of e-learning insist there is no difference between them (Park, 2003).

Educators have noticed lately a proliferation of e-learning contents and have adopted them into their instruction. However, there still exists the need to examine its effectiveness on learning (Khalifa and Lam, 2004). The current research into the effectiveness of e-learning lags far behind compared to the e-learning development in practice (Dunstan, & Dick, 2004). The evaluation and systematic assessment of e-learning achievement could be the base for whether educators should continue to adopt or to modify its application (Bae, 2004).

The use and application of e-learning in vocational education is low when it is compared with that of general education in Korea (Park, Lee, Yu, Seo, & Lee, 2005). There is also a lack of student centered instructional materials in vocational high schools and a need for the development of e-learning contents. Further, little research has been conducted to verify e-learning's effect on learning outcomes in agricultural high schools in Korea (Park et al., 2006). In addition, there is very little data which identifies if various types of e-learning content produce a different

learning achievement in agricultural education in Korea.

This study examined the result of e-learning effects on learning outcome compared with a lecture format after two types of e-learning contents were developed in a food processing course of an agricultural high school in Korea. It focused mainly on the following research questions:

1. Was there any significant difference between the e-learning outcome and lecture outcome?

2. Was there any significant difference between the e-learning outcomes according to its delivery content types?

E-learning contents and website

Contents

E-learning contents are resources covering a specified area of knowledge, prepared to be delivered in electronic form through mainly internet. Content is also a term often understood in the discussion of instructional design and development. There are four different views on understanding content: information-based, objectives-based, media-based, and experience-based. An information-based content means all the information and knowledge is to be learned. An objectives-based content is a collection of learning objectives specifying behavioral outcomes. Media-based content is all the text, graphics, videos and other multimedia components of an instructional application. Experience-based content is the sum of all instructional components in learning applications (Allen, 2003). The content in this article mostly uses a media-based definition, because the information and knowledge to be learned were exactly the same for the experiment.

"Food Processing Technology II" is a major course and is compulsory for students majoring in food processing technology at an agricultural high school in Korea. One lesson, "How to Make an Apple Jam" was selected as an experimental

topic from the course. Two types of e-learning content, animation based (Figure 1) and video based (Figure 2), were developed according to rapid prototyping model. Rapid prototyping model is a modified ADDIE model (analysis, design, development, implementation, and evaluation). The rapid prototyping model introduces feedback from potential learners and reflects them onto making a prototype. Once a final prototype is completed and agreed among the content's developing members, additional development works such as programming can proceed (Kruse, 2007).

The researchers worked as instructional and web designers. An agricultural high school teacher in charge of teaching the course joined and co worked as subject specialist with the researcher for the development of e-learning. Three students participated in developing a prototype for feedback. They were excluded later as experimental subjects. Right after the final prototypes for both contents were made, the researcher created every story boards needed for actual content pages.

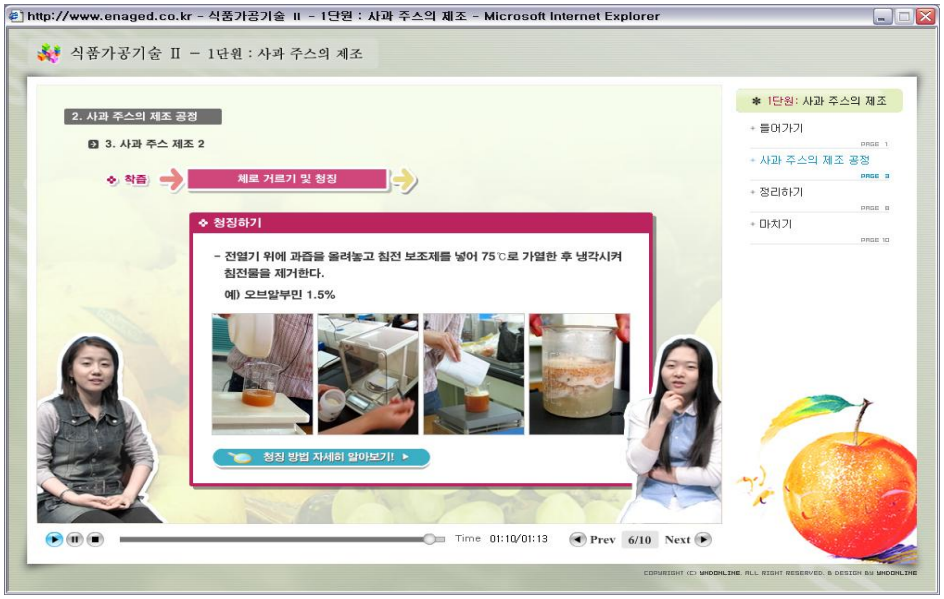


Figure 1. Example screen capture of animation based content

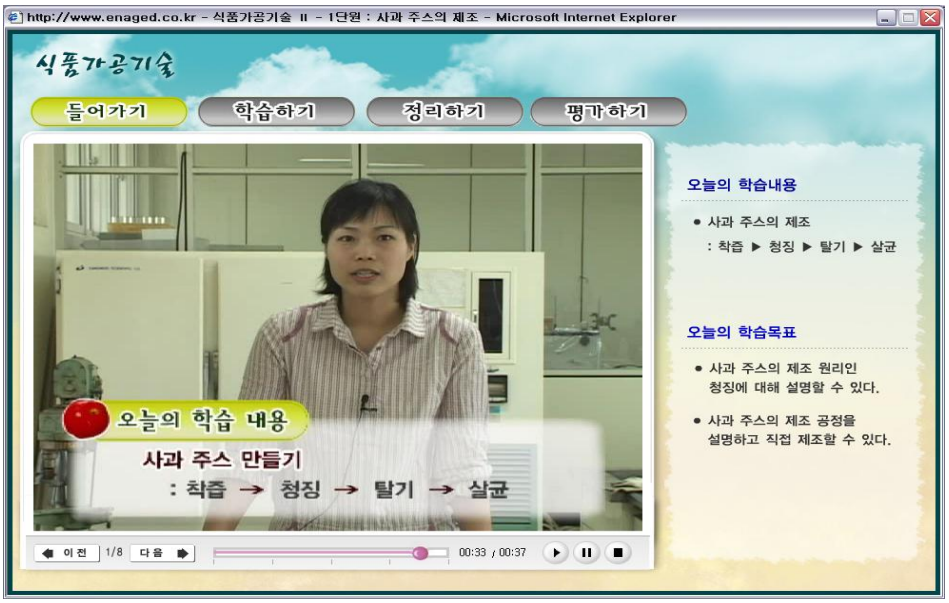


Figure 2. Example screen capture of video based content

Finally, the animation based e-learning content was made by flash animation programming introducing a storytelling technique. The storytelling technique is often used motivate the students to engage in learning (Huffaker, & Calvert, 2003). Like other storytelling technique contents, this content contains animation, illustration, simulation, demonstration, and narration (Browaeys, & Wahyudi, 2006).

On the other hand, the video based content included the real teacher' instruction video and the information to be learned at the same time. The information to be learned in both animation and video based contents were identical, but in a different format. Both contents were about 25 minutes long.

Website

After developing the contents, they were loaded onto the website (http:// www.enaged.co.kr), which has a simple learning management system (LMS) function as well. Figure 3 shows the front web page of the system.

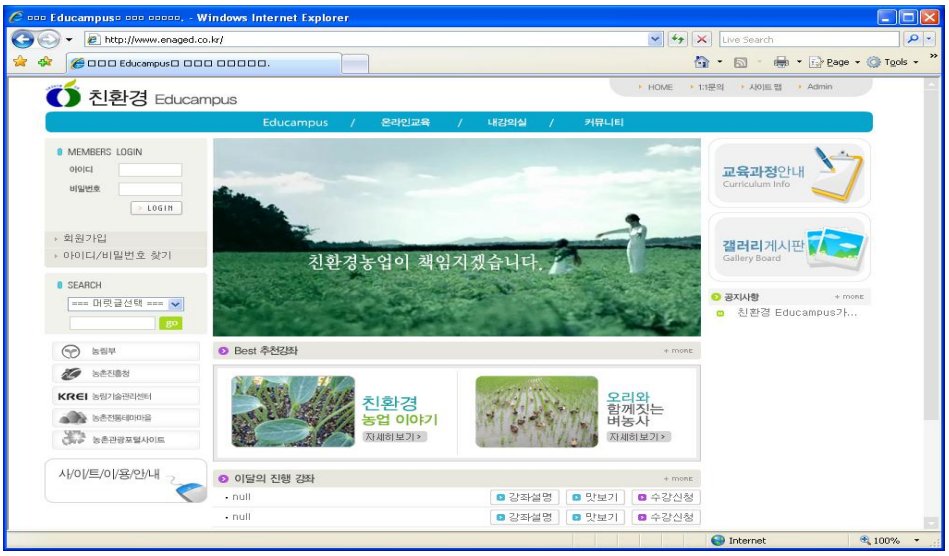


Figure 3. Website of study

Method

Research design

A pretest-posttest comparison group design was adopted for the study. The control group consisted of the students who received face-to-face lecture. Meanwhile, the experimental group was divided into two sub groups which were animation and video content groups. A one-way of analysis of covariance was introduced to test hypotheses. The pretest score was set as a covariate. The structural model for the study was $y_{ij}= \mu+\alpha_j+\beta_1(x_{ij} - \mu_x)+e_{ij}$,where $y_{ij}= i^{th}$ group and j^{th} student learning achievement posttest score, μ=grand mean, α_j =i group effect, β_1= covariate regression coefficient, μ_x= pretest mean score , $x_{ij}= j^{th}$ observation on the covariate (pretest score) in the i^{th}group, e_{ij}=individual error. Based on the design and the model, the following hypotheses were set. Hypotheses 1 and 2 are related to the research question 1 and hypotheses 3 are related to the research question 2 in the introduction part.

H_1: There is no significant difference in student posttest scores among the groups when their pretest scores as covariate were controlled.

H_2: There is no significant difference in student posttest scores between face-to-face lecture group and e-learning group (animation + video) after controlling pretest scores.

H_3: There is no significant difference in student posttest scores between animation and video based e-learning group.

Experimental subjects and process

Sixty third-grade agricultural high school students from two classes whose major is food processing technology participated in the experiment. The school is located in Kwangwon Province in Korea. Each class had 30 students, but only 54 students who attended both the pre and posttest were included in the experiment for the analyses. Male students were 21 (38.89%) and female students were 33 (61.11%). This ratio was ideal because a class of food processing technology in agricultural high school in Korea on average has normally more female students than male students. A completely randomized design (CRD) was introduced for the experiment. The students were assigned into each group according to their random numbers generated by the "RANUNI" command of statistical analysis system

Table 1. The number of students in each experiment groups

Method	*Face-to-face* (%)	*Animation based* (%)	*Video based* (%)	*Total* (%)
Male students	10 (62.50)	7 (35.00)	4 (22.22)	21 (38.89)
Female students	6 (37.50)	13 (65.00)	14 (77.78)	33 (61.11)
Total	16 (100)	20 (100)	18 (100)	54 (100)

(SAS) software package (SAS Inc, 1999).

In the control group, face-to-face lecture group, students received in traditional lecture, question and answer, and real demonstration. In the experimental group, students studied by themselves through e-learning in school computer labs in which they accessed to the website. In order to avoid the Hawthorne effect (McKnight, Dillon, & Richardson, 1996), those students received instruction at the same time at the same day. The teacher of the course taught the control group of students, and the researchers directed the experimental group students into the each computer lab and guided them into e-learning respectively. As soon as they finished their learning, they took the posttest. The students took the pretests four days before they received their learning.

Instrument and statistical analysis

Two versions of test items, pre and posttest, were developed to assess students' outcome of the course knowledge base. The questions of pretest were identically same as posttest questions, but different orders and sentences were used. Both were a four option multiple choice exam. Each test consisted of 10 questions which dealt with process and procedure of making apple jam. If one had all correct answers, then he or she got 10 points. The scores ranged between 0 to 10. The questions were developed by the teacher in charge of the course who taught in both the face-to-face lecture group and video based e-learning group.

After administering the tests, data were coded into the SAS, and about 10% data were randomly checked for coding error. An analysis of covariance (ANCOVA) technique and two preplanned group comparison techniques with "contrast" options in SAS were carried out to test the hypotheses.

Results

Difference between pretest and posttest scores

Before testing the hypotheses, three t-tests were implemented to see if a learning outcome took place in each group. Without the learning outcome, no significant mean differences between pre and posttest scores, it would not be worthy of testing hypotheses. A summary of t-test results is given in Table 2. The face-to-face group had the lowest pretest score, and the video based e-learning group had the highest pretest score. In accordance with pretest scores, video based e-learning group showed the highest posttest score and was followed by animation based e-learning group and face-to-face group. All pretest scores were bellow five which was the middle score of a possible maximum score of 10. However, all posttest scores were 7 or more, if a principle of round-up was used. This showed that remarkable changes took place in terms of students' knowledge from all kinds of learning methods. The video based e-learning group had the largest difference between pretest score and posttest score. On the other hand, the animation based e-learning group showed the small difference between the scores. According to the t statistics

Table 2. T statistic results of pretest and posttest scores

Group	*Mean of pretest score (SD)*	*Mean of posttest score (SD)*	*Mean difference*	*t-value*	*df*	*p-value*
Face-to-face	3.56 (1.26)	6.5 (1.31)	2.9	-6.44	30	<.0001***
Animation based e-learning	4.05 (2.01)	6.75 (1.59)	2.7	-4.71	38	<.0001***
Video based e-learning	4.17 (1.20)	7.22 (1.06)	3.1	-8.09	34	<.0001***

*Note: Score range 0-10; ***p<.001 level (two-tailed), df=2(n)-2 since new difference score was calculated. according to within subjects design*

and p-values, every group had significant mean differences. Therefore, learning achievements occurred regardless of the group due to learning process, and the researchers could move ahead to test hypotheses. If there was no difference between pretest scores and posttest scores, then it may be useless to test group difference of posttest scores according to learning methods.

Hypothesis 1

Hypothesis 1 "There is no significant difference in student posttest scores among the groups when their pretest scores as covariate were controlled" was set to see if group mean differences exist after removing previous knowledge effect. According to the statistics in upper Table 2, posttest score of face-to-face group (mean=6.5) was lower than both the animation based e-learning group (mean=6.75) and the video based e-learning group (mean=7.22). The video based e-learning group has the highest posttest score. However, the result of ANCOVA showed no difference among the groups. A summary of ANCOVA statistics is included in Table 3. Based on the results (F=1.02, p-value=.6799), the hypothesis was not rejected and should be adopted. In other words, there was no overall effect of learning method on learning outcome after controlling previous knowledge. In addition, it was further identified that the pretest score as covariate was not linearly related to their posttest score. This is interesting result because it is generally known that students' previous knowledge is related to their future knowledge. This may be because all pretest scores had almost the same centering on 4, which could not

Table 3. Statistics of ANCOVA

Source of variation	*df*	*Type III SS*	*MS*	*F*	*p-value*
Group (treatment)	2	4.64	1.82	1.02	.6799
Pretest score (regression)	1	3.38	3.38	1.89	.1752
Residual (error)	50	89.48	1.79		
Total	53	97.50			

differentiate each group. Another possible reason may be the lack of the number of experimental subjects since this study included only 54 students.

Hypothesis 2 and 3

The "contrast" statements in general linear model (GLM) procedure in Statistical Analysis System (SAS) were used for preplanned comparisons, which test hypothesis 2 and 3, respectively. The results of the contrast were shown in Table 4.

Hypothesis 2 "There is no significant difference in student posttest scores between control group and experimental group (animation + video) after controlling pretest scores" failed to reject. Therefore, it could be insisted that there was no significant difference in learning outcome between the face-to-face lecture method and the e-learning method. This is consistent with the result of hypothesis test 1 to some extent.

Hypothesis 3 "There is no significant difference in student posttest scores between animation and video based e-learning group" could not be rejected either. That means there was no difference between e-learning methods in terms of learning outcomes of the students. The mean of animation based e-learning group posttest was 6.75 and the mean of video based e-learning group was 7.22. This produces just about .5 difference in the range between 0-10 scores. This difference was not enough to differentiate one or another in terms of learning outcome.

Table 4. Contrast preplanned comparison results

Source of variation	*df*	*Contrast SS*	*MS*	*F*	*p-value*
Face-to-face vs. e-learning (animation + video)	1	.23	.23	.13	.7194
Animation vs. Video	1	3.33	3.33	1.86	.1787
Error	50	89.48	1.79		

Discussions and conclusions

Both the e-learning group and the face-to-face lecture group increased their knowledge about the selected academic topic from the course. Their posttest scores were significantly higher then pretest scores. After identifying the students' learning, that is to say, changes in terms of knowledge, the researchers tried to determine whether each learning method are different from one another in terms of learning outcome.

Overall, e-learning turned out to be at least as effective as the face-to-face lecture learning. The results of hypotheses tests showed no significant differences not only between the e-learning and face-to-face group, but also between e-learning groups themselves. According to the difference between their pretest and posttest scores, the video group was identified as having biggest difference, but not statistically significant enough.

It is a trend to believe that e-learning is not different from conventional face-to-face lecture regarding student achievement. Some scholar even insists that it has the potential for an improved education through a higher degree of independent learning and increased amounts of available information (Milheim, 2001). Kekkonen-Moneta and Moneta's study (2002) supported this argument. They pointed out that e-learning students outperformed the face-to-face lecture students and that carefully designed effective e-learning modules may foster higher-order learning outcomes. Even though this study proved no difference between the two learning methods, e-learning method was not superior to the face-to-face method as well. One of possible reasons for that is the students took the posttest right after both e-learning methods were implemented. In other words, the students had no chance to review e-learning contents when they need to, and they were forced to study at the computer lab at the same time as when control group student received face-to-face lecture. According to Strother (2002), replication, convenience and self-paced learning are advantages of e-learning as well as economic benefits.

It may be another possible reason that agricultural high school students in Korea are considered to have a low academic ability and low motivation compared to general high school students in urban area. In spite of this fact, it is interesting enough to know e-learning may be an alternative for development of vocational education which stresses real situation since e-learning can bring about the same learning outcome. Especially, a blended learning approach which combines e-learning and face-to-face lecture could be more helpful. Theory-based topics and difficult experiments are covered in e-learning, and real hands on experience and demonstration may be handled in a conventional off line class.

Generally, animation based e-learning contents are considered nice-looking and provide a fancy interface, but expensive cost. Animation based e-learning contents are more preferred and used in web-based training of industry in Korea because of its fancy type of design and flexibility of learning. Dix, Finlay, Abowd, & Beale (2004) identified interface characteristics as a major component of effective man-computer interaction. Meanwhile, this study showed no difference between the selected e-learning methods, animation based contents and video based contents. The result confirms differently Chen's (2005) findings that display interfaces had significant impact on students' elementary knowledge such as facts and concepts regardless of students' levels of prior knowledge.

It is recently often understood that learners want to see their instructors in e-learning mode. Especially, school students tend to like to watch their teachers' instruction in e-learning. Thus, video based e-learning contents for young students are mostly used in both formal and private education in Korea. This is similar to the result of a recent survey done by Brenton Center (2007). It argues that students the mostly prefer course delivery using a combination of web content with video. Further, the researchers identified agricultural high school students as preferring study by e-learning which contains their real teacher after additional interviews with some students.

It may be advisable that a teacher needs to use video based e-learning contents in

an agricultural high school rather than animation based e-learning contents. However, it is hard to insist which type of e-learning contents is better for learning because preference does not always produce better learning achievement. It really depends on students' characteristics and learning environments. Therefore, it is suggested that further research should be carried out which focus on preference of e-learning content type and its relationship with learning outcome.

References

Allen, M. W. (2003). *Michale Allen's guide to e-learning: Building interactive, fun, and effective programs for any company*. Hoboken, NJ: John Wiley & Sons, Inc.

Bae, S. G. (2004 August). EBS's e-learning project for reliving extracurricular lesson. Paper presented at the International Workshop, Asian Development Bank, Manila.

Brenton Centor. (2007, Spring). Distance learning students. *Brenton Center*, *1*(1). Retrieved March 10, 2007, from http://www.ag.iastate.edu/centers/brenton/newsletter/NewsletterS07-1.pdf

Browaeys, M. J., & Wahyudi, S. E. (2006). *Emergent theory and applications in e-learning* (NRG working paper series, January 2006 no. 06-01). Holland: Nyenrode Business Universiteit.

Burbles, N. C. (2004). Navigating the advantages and disadvantages of online pedagogy. In C. Haythornthwaite and M. M. Kazmer (Eds.), *Learning, culture and community in online education: Research and practice* (pp. 1-17). New York: Peter Lang Publishing.

Chen, W. F. (2005). Effect of web-browsing interfaces in web-based instruction: A quantitative study. *IEEE Transaction on Education*, *4*8(4), 652-657.

Dix, A., Finlay, J., Abowd, G. D., & Beale, R. (2004). *Human-Computer Interaction* (3rd ed.). London : Addison-Wesley Pearson Education.

Dunstan, S., & Dick, G. (2004). Developing a framework for evaluating the effectiveness

of e-learning in organizations. *Proceedings of the 2004 International Conference on Informatics Education Research* (pp. 145-153). Washington, DC.

Economist Intelligence Unit (EIU). (2003). *The 2003 e-readiness rankings: A white paper from the economist intelligence unit*. New York, NY: Economist Intelligence Unit.

Gammill, T., & Newman, M. (2005). Factors associated with faculty use of web-based

instruction in higher education. *Journal of Agricultural Education, 46* (4), 60-71.

GunaseKaran, A., McNeil, R. D., & Shaul, D. (2002). E-learning: research and applications. *Industrial and Commercial Training*, *34*(2), 44-53.

Huffaker, D. A., & Calvert, S. (2003). The new science of learning: active learning, metacognition, and transfer of knowledge in e-learning applications. *Journal of Educational Computing Research*, *29*(3), 325-334.

Kekkonen-Moneta, S., & Moneta, G. (2002) E-learning in Hong Kong: Comparing learning outcomes in online multimedia and lecture versions of an introductory computing course. *British journal of Educational Technology*, *33*(4), 423-433

Korea Institute for Electronic Commerce (KIEC). (2005). *The status of e-learning in Korea*. Paper presented at AEN Conference 2005, Tokyo, Japan.

Khalifa, M., and Lam, R. (2002). Web based learning: effects on learning process and outcomes. *IEEE Transactions on Education*, *45*(4), 350-356.

Kruse, K. (n.d.). *Introduction to instructional design and the ADDIE model.* Retrieved January 20, 2007, from http://www.e-learningguru.com/articles/art2_1.htm

Lehmann, K. J. (2004). Successful online communication. In K.J. Lehmann (Ed.), *How to be a great online teacher* (pp. 9-16). USA: Scarecrow Education.

McKnight, C., Dillon, A., and Richardson, J. (1996). User centered design of hypertext and hypermedia for education. In D. Jonassen (Ed.), *Handbook of research on educational communications and technology*. (pp. 622-633). New York: Macmillan.

Milheim, W. (2001). Faculty and administrative strategies for the effective implementation of distance education. *British Journal of Educational Tech*nology, *32*(5), 535-542.

Ministry of Commerce, Industry and Energy. (2004). *A white paper on e-Learning.* Seoul, Korea: MOCIE Ministry of Education and Human Resource Development. (2004). *Adapting education to the information age: A white paper.* Seoul, Korea: Ministry of Education & Human Resources Development/

Korean Education and Research Information Service.

Ministry of Labor. (2003). Corporate *e-learning mid-period plan (2004-2008)*. Seoul: Ministry of Labor.

Naidu, S. (2006). *E-learning: A guide book of principles, procedures, and practices*. New Deli, India: Commonwealth of Educational Media Centre for Asia (CEMCA).

SAS Institute Inc. (1999). *SAS/STAT User's guide, version 8*. Cary, NC: SAS Institute Inc.

Park, S. Y. (2003). *Computer technology and educational technology*. Seoul, Korea: Konkuk University Press.

Park, S. Y., Lee, J. Y., Yu, B. M., Seo, Y. K., & Lee, H. A. (2005). Development of sustainable agricultural web site and contents and evaluation of its educational effects. *Journal of Korea Agricultural Education & Human Resource Development*, *37*(3), 29-46.

Park, S. Y., Kim, S. W., Yu, B. M., Nam, M. W., Kim, H. G., & Lee, H. A. (2006). Development of sustainable agricultural animation e-learning contents and evaluation of its educational effects. *Journal of Korea Agricultural Education & Human Resource Development*, *38*(2), 137-152.

Roberts, T. G., & Dyer, J. E. (2005). The influence of learning styles on students attitudes and achievement when an illustrated web lecture is used in an online learning environment. *Journal of Agricultural Education*, *46*(2), 1-10 .

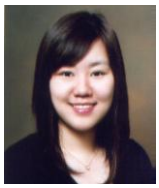
Schoefeld-Tacher, R., McConnell, S. and Graham, M. (2001). Do no harm - A comparison of the effects of on-line vs. traditional delivery media on a science course. *Journal of Science Education and Technology,* 10(3), 257-265.

Strother, J. B. (2002). An assessment of the effectiveness of e-learning in corporate training programs. *The International Review of Research in Open and Distance Learning*, *3*(1), 1-17.

UNESCO. (2003). Communication: from information society and knowledge societies. *The new Courier, 3,* Retrieved January 25, 2007, from http://portal.unesco.org/en/ev.php-URL_ID=14339&URL_DO=DO_TOPIC&URL_SECTION=201.html

Wikipedia. (2007). *E-Learning*. Retrieved January 27, 2007, from http://en.wikipedia.org/wiki/Electronic_learning

Sung Youl PARK
Professor, Dept. of Educational Technology, Konkuk University.
Interests: E-Learning in Vocational Education, Agricultural Information System
E-mail: psyhjyl@konkuk.ac.kr



Hyeon-ah LEE
Researcher, Educational Technology, Konkuk University. Interests: Analyzing Effectiveness of e-Learning
E-mail : floceia@hanmail.net