A Study on Search System for E-learning Products

Gwi-Im Jung [1)], Sang-Sung Park [2)], Young-Geun Shin [3)], Dong-Sik Jang [4)]

Division of Information Management Engineering, Korea University
([1)] lily8424, [2)] hanyul, [3)] toctop, [4)] jang@korea.ac.kr)

Abstract

In this paper, we propose the E-learning product search system (ELSS) which can provides high quality information fitted to the learners' demands. ELSS can also provide the accurate information that doesn't contain unnecessary information in mass e-learning products on the internet. Through multiple agents, this system extracts the optimal output based on input data such as learner's demands and interests. In addition, BP (Back Propagation) algorithm is applied to the multiple agents to obtain optimal results. Input variables are designed by Extended TAM (Technology Acceptance Model) for the high reliability of ELSS. The factors that learners consider when choosing E-learning products are analyzed by extended TAM and the factors are extracted by SEM (Structural Equation Model) analysis.

1. Introduction

After the appearance of the internet, our life style has been remarkably changed. Shopping, financial payment and commercial transaction on the Web are revitalized and the circulation of personal knowledge and creating information has become major flow on the Web. In this new area, the number of people offering or receiving information and knowledge has been increased. Not only simple information but many activities for professional education are developing on the internet. This is called e-learning, learning on the Web. E-learning has been applied to schools and companies. This is becoming popular learning-way in next generation. As the development of e-learning, thousands of commercial e-learning sites emerged and extended into the world market. So, many studies on e-learning are actively performing. In this paper, we propose E-learning product search system (ELSS) to search accurate e-learning products that learners need among the e-learning contents and services. Learners are expected to receive fast and accurate e-learning contents by ELSS.

2. Theoretical Foundations

2.1 E-learning

E-learning is the Web based system combined with education and network technology such as internet or intranet. In other words, this is called online or cyber education. E-learning is more becoming common for the culture which is sensitive to the fast transfer of information. In addition, it can provide the education contents at a reasonable price. Thus, the markets for e-learning are rapidly growing. According to IDC in 2003, the sizeable market for e-learning recorded 91 million dollars in 2003, 130 million dollars in 2004 and 240 million dollars in 2006. It is steadily growing more than 30~40% per year. Many countries including Korea are expanding the e-learning services for the educational reform.

2.2 Extended TAM

Technology Acceptance Model (TAM) was introduced by TAM Davis(1989). TAM is a way for grasping the interrelation behavior intention to use or get a line on influence factors of the technical attitude. TAM is based on the Theory of Reasoned Action (TRA) introduced by Fishbein and Ajzen. TRA regards an attitude as the sum of the conviction, intention and action. In addition, it includes social aspects of the attitude. Actually, this theory predicts not the attitude but the intention of the attitude. So it assumes that the intention and the attitude are nearly same under a proper condition. [1] TAM applied users' technology acceptance process based on the interactions of constructs. Davis explained that the facts to influence on the attitude or the intention of attitude are Perceived Usefulness and Perceived Ease of Use. In other studies, one or more prior variable have been used. But critical researches are presented. They said TAM did not care environmental variables. Venkatesh(2000) showed Extended TAM for making up for this weak point. [2] Extended TAM introduced external facts like

Perceived Usefulness, Perceived Ease of Use, facts to influence on it, personal experience and social phenomenon. Studies to consider the subjective point of view have been going by using Extended TAM.

2.3 Multiple agent system

Multiple agent system consists of single agents. Agent contains auto-software to have intelligence themselves and to act instead of users. Agent can make decision automatically and operate independently. It is a unit for achieving an aim with mutual cooperation. And usually it is originated in AI. Because a single agent can work only based on the installed program, it has difficulty processing complex data. The other side, the multiple agent system can communicate with other agents. Thus, it can have united-processing capacity through the cooperation of each agent which has different functions. Because new agents can be added as needed, extension of system is easy. Single agents of multiple agent system must have some abilities like self-control system, communication ability, cooperation ability, adaptation ability, and confidence. [3]

3. Research Methodology

3.1 Research model and hypotheses

The facts to influence on learner using E-learning can be listed through Extended TAM. The external-variables used in this study are not only perceived usefulness and perceived ease of use which are root-variables but also perceived enjoy, reputation, individual preference, functional service, price, economy of time and marketing. External variables except root-variables, we referred to prior studies or reviewed fit for the purpose of this study. In this study, we designed an assumption based on the interaction among variables; it showed in a diagram such as Fig.1.

H_1: The perceived usefulness has a positive and significant effect on the behavioral intention to use.
H_2: The perceived ease of use has a positive and significant effect on the behavioral intention to use.
H_3: The perceived enjoy has a positive and significant effect on the behavioral intention to use.
H_4: The reputation has a positive and significant effect on the behavioral intention to use.
H_5: The individual preference has a positive and significant effect on the behavioral intention to use.
H_6: The functional service has a positive and significant effect on the behavioral intention to use.
H_7: The price has a positive and significant effect on the behavioral intention to use.
H_8: The economy of time has a positive and significant effect on the behavioral intention to use.
H_9: The marketing has a positive and significant effect on the behavioral intention to use.
H_{10}: The behavioral intention to use has a positive and significant effect on the real behavior to use.

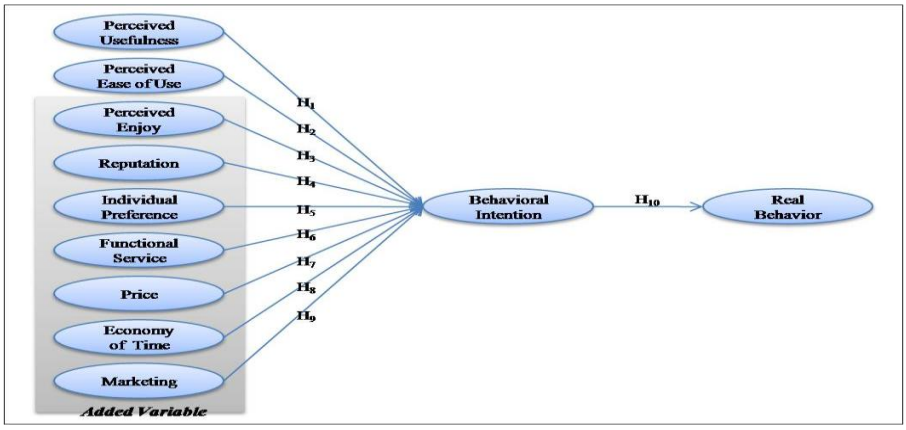

Fig. 1 Relationship structure model

3.2 Measurement Variables

Questions consist of the selected-variables. The selected questions based on the established studies because of its content validity and significance. [4][5] Concluded facts in this study are used in ELSS as input variables. Also, we added output variable needed for capacity-test-experiment of BP algorithm. Used measurement variables are as follows.

Table 1 Summary of measurement variables

Measurement variables	Definition	Scale
Perceived usefulness	The degree of intention to adopt e-learning will be	The rating of input variables was based on a scale of 1-7, 7 being best and 1 worst
Perceived ease of use	The convenience of e-learning contents and service	
Perceived enjoy	The extent to which the activity of using the e-learning is perceived to be enjoyable	
Reputation	Opinion or view one about e-learning	
Individual preference	Contents visual impressions, recommend lecturer	
Functional service	Service and contents speed, service efficiency	
Price	The package price/rate	
Economy of time	Free from time, economy of moving time	
Marketing	Discounts, events, and marketing	
Behavioral intention	The behavior intention toward e-learning	
Real Behavior	A learner's real behavior on e-learning	
Choose a e-learning product	The existent e-learning product (Output data of BP)	Multiple-Choice

3.3 Data collection

We surveyed people who can easily access the internet and have experience in using E-learning service. 200 questionnaires were distributed and 176 questionnaires were analyzed except 24 questionnaires which were incomplete and un-filled.

3.4 Reliability and Factor analysis

Before studying SEM, we carried reliability and factor analysis out for internal consistency and validation. SPSS 12.0 software was used on the experiment. Cronbach' *a* was evaluated by the standard of reliability more than 0.7. [6] In factor analysis, we used a principal component method and varimax rotation method for abstracting factors. The standard of factor loading was more than 0.4. The results are presented in Table 2. PE4 and IP2 are eliminated because they weren't fitted to the standard. Except the eliminated things (PE4 and IP2), all samplings are acceptable more than 0.5 and all Cronbach' *a* coefficients also presented more than 0.7.

Table 2 Factor analysis results

Measurement variables	Constructs	Factor loading	Cronbach' *a*
Perceived usefulness	PU1	0.846	0.862
	PU2	0.513	
	PU3	0.983	
	PU4	0.604	
Perceived ease of use	PEU1	0.980	0.955
	PEU2	0.842	
	PEU3	0.941	
	PEU4	0.694	
Perceived enjoy	PE1	0.709	0.881
	PE2	0.709	
	PE3	0.576	
	PE4	0.386	
	PE5	0.885	
Reputation	REP1	0.908	0.875
	REP2	0.570	
	REP3	0.581	
	REP4	0.501	
Individual preference	IP1	0.935	0.956
	IP2	0.347	
	IP3	0.823	
	IP4	0.823	

Functional service	FS1	0.913	0.878
	FS2	0.899	
	FS3	0.753	
Price	PRI1	0.921	0.727
	PRI2	0.570	
	PRI3	0.802	
Economy of time	EOT1	0.815	0.861
	EOT2	0.728	
	EOT3	0.625	
Marketing	MAR1	0.598	0.736
	MAR2	0.778	
Behavioral intention	BI1	0.545	0.894
	BI2	0.854	

3.5 Structural equation results

SEM analysis used AMOS software. AMOS has an advantage; it can analyze easily when demanding complex analysis more than regression. In the experiment, we abstracted the interaction among variables using AMOS and studied SEM. To verify the goodness of fit for the model, we used NFI, GFI, AGFI, CFI, RMSR, RMSEA and x^2 / degrees of freedom. [7][8] The goodness of fit for the relationship structure model presented in Table 3. As a result, all the things met the standard and proved that it is a proper model for SEM. The facts, except perceived enjoy, has a direct influence on behavior intention of E-learning (H_1, H_2, H_4, H_5, H_6, H_7, H_8, H_9 and H_{10} are supported). While perceived enjoy doesn't (H_3 is not supported). The construction that Behavioral intention has influence on Real behavior of E-learning was selected and it proved that the construction of external-variable is important. Accepted factors are used as input variables of ELSS. The result of SEM analysis presented in Table 4.

Table 3 Model fit indices

Fit index	Recommended value	Observed value
x^2 / degrees of freedom	≤ 3.00	2.010
GFI	≥ 0.90	0.908
AGFI	≥ 0.80	0.858
NFI	≥ 0.90	0.921
CFI	≥ 0.90	0.983
RMSR	≤ 0.10	0.070
RMSEA	≤ 0.08	0.008

GFI = goodness of fit index, AGFI = adjusted goodness of fit index, NFI = normal fit index
CFI = comparative fit index, RMSR = root mean square residual, RMSEA = root mean square error of approximation

Table 4 SEM analysis

Hypothesis	Path Relationship	Path coefficients	Results
H_1	Perceived usefulness → Behavioral intention	0.23	Accept
H_2	Perceived ease of use → Behavioral intention	0.37	Accept
H_3	Perceived enjoy → Behavioral intention	0.07	Reject
H_4	Reputation → Behavioral intention	0.55	Accept
H_5	Individual preference → Behavioral intention	0.18	Accept
H_6	Functional service → Behavioral intention	0.23	Accept
H_7	Price → Behavioral intention	0.24	Accept
H_8	Economy of time → Behavioral intention	0.19	Accept
H_9	Marketing → Behavioral intention	0.33	Accept
H_{10}	Behavioral intention → Real behavior	0.65	Accept

4. E-learning product search system (ELSS)

ELSS is a system which analyzes demands from learners and recommend proper E-learning product. ELSS is designed for the multiple agent which consists of 6 agents. ELSS has a same construction with Fig 2.

4.1 Personal Agent

A personal agent conveys data received from learners to the integrated data store agent. UI consists of facts from SEM analysis using Extended TAM. For receiving learner's exact tastes and demands, this agent designs UI of categories of E-learning and a question form. If a learner inputs basic fact, ELSS rearranges the data and conveys it to the integrated data store agent.

4.2 Data conversion Agent

A data conversion agent digitizes saved data in the integrated data store agent. After using the E-learning, the evaluations of users and the data which are not digitized are stored by numerical transform. Finally, the transformed data are conveyed into the integrated data store agent.

4.3 Integrated data store Agent

An integrated data store agent constructs DB by saving learner's information from a personal agent. Constructed DB is used as an input data of the central processing agent. The integrated data store agent is capable of two-way communication with a data conversion agent and a central processing agent.

4.4 Central Processing Agent

A central Processing agent is the most important part in ELSS. This agent abstracts output to convey to learners. The central processing agent consists of BP algorithm. Between the integrated data store agent and the information filtering agent obtain output through BP algorithm. The obtained output conveys to the communication agent.

4.5 Information Filtering Agent

An information Filtering agent offers output data of the central processing agent through filtering a variety of search engines and E-learning products. Through the search engines, the central processing agent and two-way communication, the data are renewed.

4.6 Communication Agent

A communication agent conveys output from the central processing agent to learner. It conveys data estimated by learner about the outputs of the integrated data store agent. The conveyed data are used as input data of BP.

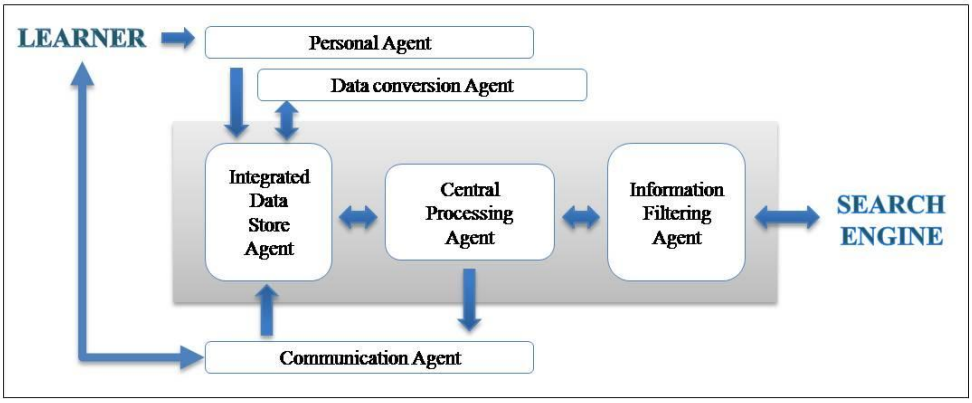

Fig. 2 Structure of ELSS

5. Central Processing Agent using BP

A central processing agent is designed to extract a result value using BP algorithm. The motivation of using BP algorithm is its ability of learning relationships in complex data sets which can't be easily perceived by humans. It has the ability to modify the output according to the changing of user context. It doesn't require whole network rebuild when new context comes. [9]

The input variable of ELSS is SEM analysis results that have perceived usefulness, perceived ease of use,

reputation, individual preference, functional service, price, economy of time and marketing. From learner input data offered based input variable. The following equation depicts an input data:

$$\mu_j = \frac{\sum_{i=1}^{n} x_i}{n} \tag{1}$$

The process of BP algorithm shown in Fig. 3, it consists of five element types: input data, synaptic weights, summing junction, activity function and output. The function of BP neuron is calculated the sum of input and connection strength. And then it is calculated again through activity function. Prior to substituting in activity function, output value of hidden layer is

$$Sum_k = \sum_{j=1}^{n} \mu_j w_{kj} \tag{2}$$

By activity function α calculated value is output value of hidden layer. One such output value of hidden layer is

$$O_k = f(\sum_{j=1}^{n} \mu_j w_{kj}) \tag{3}$$

Activity function use sigmoidal function that has between 0 and 1 by result value of function. One such sigmoidal function is

$$\log sig(\alpha) = \frac{1}{1+\exp(-\alpha)} \tag{4}$$

The output of output layer can calculate same method as the output of hidden layer. One such output value of output layer is

$$y_l = f(\sum_{k=1}^{m} O_k w_{lk}) \tag{5}$$

Consequently, final output of network seems to be next.

$$Y_k = \sum_{k=1}^{m} w_{lk} \log sig(\sum_{j=1}^{n} w_{kj}\mu_j + w_j) \tag{6}$$

Finally, the forward phase where activations are propagated from the input to the output layer and the backward phase where the error between the observed actual and the requested nominal value in the output layer are propagated backwards to modify the weights and bias values.

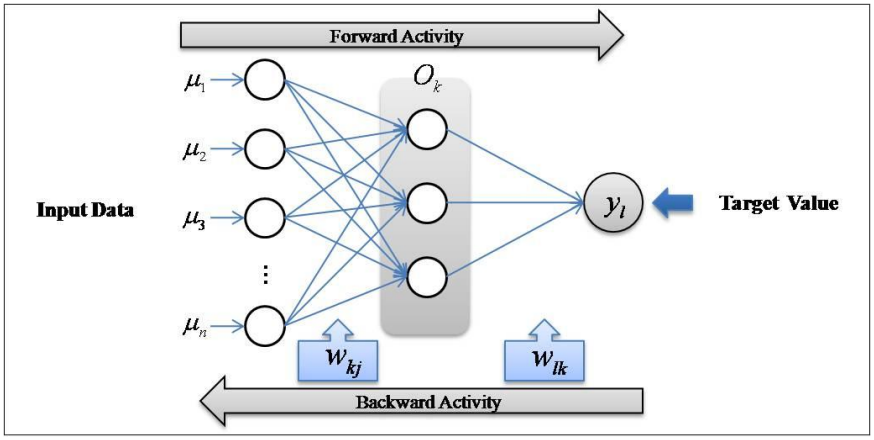

Fig. 3 Structure of BP

6. Conclusion

In this study, we designed ELSS based on multiple agent and BP algorithm is used for enhancing the accuracy of ELSS. Using Matlab software, we tested the performance of BP. In consequence, the accuracy was 92.8% and the learners' demands can explain totally 92.8% satisfied. Elementary or demanded dates of learners are inputted into the ELSS and the results are conveyed to the learners. They can two-way communicate with ELSS and estimate the results. Through this process, they can enhance the satisfaction. In the process, agents are taken charge of each role for rapid and accurate problem-solving abilities. Collecting dates and deriving variables from the learners using this system are also important roles to enhance their satisfaction. This ELSS is expected to be useful contents to the learners. The contributions through this study can be listed as follows. First, while established studies have been devoted to the technique of e-learning contents and standardization in position of an offer, this study tried to make a new access to search e-learning products in position of learners. In this way, we can provide the learners with detail information about e-learning and suited information. Second, we designed ELSS based on multiple agent applied BP algorithm. Therefore, ELSS can perform accurately. Third, input variables are selected by SEM analysis and extended TAM that considers learner's behavior intention for e-learning. The limitation of this study is the lack of information about e-learning search systems. Thus, we could not have enough comparison analysis in this study. This study needs more studies through practical implementation of system in next time.

Acknowledgements: This work is supported by the Brain Korea 21 Project in 2007

References

[1] Fishbein, M. & Ajzen, I.; Belief, attitude, intention, and behavior: an introduction to theory and research, Reading, MA: Addison-Wesley, 1975.

[2] Venkatesh, Viswanath; Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model, Information Systems Research, Vol. 11, No. 4, pp. 342-365, 2000.

[3] T. Bui, J. Lee; An agent-based framework for building decision support systems, Decision Support Systems 25(3), pp. 225-237, 1999.

[4] Hsu, C.L. and Lu, H.P.; Why do People Play On-Line Games? An Extended TAM with Social Influences and Flow Experience, Information & Management, Vol. 41, Issue 7, pp. 853-868, 2004.

[5] Wang, Yi-Shun; Assessment of Learner Satisfaction with Asynchronous Electronic Learning Systems, Information & Management, Vol. 41, No. 1, pp. 75-86, Oct.2003.

[6] J. Nunnally; Psychometric Theory, second ed., McGraw-Hill, New York, 1987.

[7] P. M. Bentler; Comparative Fit Indexes in Structural Models, Psychological Bulletin, Volume 107, Issue 2, pp. 238-246, 1990.

[8] D.Gefen, D.W. Straub, M.C.; Boudreau Structural equation modeling and regression: guidelines for research practice, Communications of the Association for Information System 4(7), pp. 1-70, 2000.

[9] W. Huang and R. Lippmann; Neural net and traditional classifiers, Advances in Neural Information Processing Systems, volume 1, pp. 387-396, 1988.