

# The study of multimedia forum assisting high-level concept representation

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## 摘要

本研究(多媒體討論區協助高層次概念呈現之研究)提出一個運用在同儕回饋教學活動的線上非同步式多媒體討論區互動系統,利用文字、聲音、圖像及電子黑板等多樣化的媒體工具組合,吸引學習者踴躍參與學習討論、並協助學習者在討論的過程中能充分的表達自己的高層次概念。

此一非同步式多媒體討論區互動系統僅需一般的網路頻寬與多媒體設備即可,使用者可自我控制或重複媒體的播放,來達到學習進度的自我控制。我們實作此一互動系統並進行課程實驗,利用學習活動引導學習者進行深入討論,之後針對課程討論內容做相關性分析,其結果顯示此多媒體的互動系統較純文字系統更能讓學習者充分表達、並呈現較完整的概念。

**關鍵詞:** 多媒體討論區、高層次概念

## Abstract

This research proposes an on-line asynchronous multimedia forum allowing learners to conduct their learning process. The multimedia forum provides multiple media including text, voice, pictures, and electronic blackboard to attract learners to involve discussions and help learners express their high-level concept. The learners can express their opinion by employing multimedia they would like. Also they can self control their learning progress and rehearse discussion content by playing the multimedia.

An experiment was conducted in an attempt to investigate the performance of the forum with the analysis of the content. The results show that the multimedia discussion forum provides a better and more complete way to express opinion than the text-based forum.

**Keywords:** multimedia forum, high-level concept

## 1. Introduction

In the asynchronous learning environment, the discussion forum plays an important role on interaction between classmates and teachers. However, most of the asynchronous forums are text-based and it is not easy for learners to express opinion completely when the topic of high-level concept is discussed (Bloom, 1956). In other words, learners may become frustrated in learning because of the limitation of the expression in the text-based forum. To improve the efficiency of expressing opinion, the multimedia forum is proposed to provide not only text but also versatile media including voice, pictures and electronic blackboard to attract and help learners to involve and share their high-level concept. Figure 1 shows the diagram of comparing the completeness of high-level concept between multimedia and text-based discussion forum. In the left picture, each piece of puzzle represents one kind of medium. Learners can express their opinion completely by combing these media including text, voice, pictures and electronic blackboard...etc. In the right picture, it is a text-based forum, in which it is hard for learners to express their opinion completely.

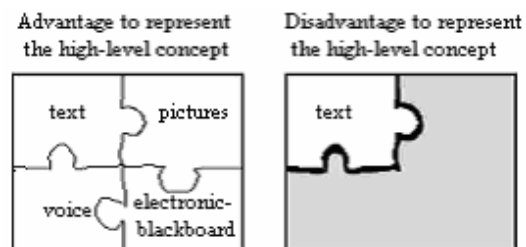


Figure 1 Advantage of using multimedia

In this study, to investigate the relationship between the combination of multimedia and the completeness of expressing concept in the multimedia discussion forum, multimedia discussion forum was built and employed for experiment.

## 2. The relation study of concept similarity

The concept distance measured by concept matrix was employed to investigate concept similarity. Follows are some related literature reviews.

### 2.1 Formulating-Hypotheses item

Electronic Essay Rater (EER) is an automatic essay evaluating system developed by Educational Testing Service (ETS). At the early stage, the major subject of EER classified the content into several classes and built the concept grammar rules (Kaplan, Randy M., Randy E. Bennett., 1994). However, there are several problems in above processes. Firstly, the most concept can not be presented with texts clearly. Secondly, the relevance is not obvious among concepts. Thirdly, analyzing the large database and calculating the weight of each concept may reduce the system performance.

To avoid above problems, EER uses Formulating-Hypotheses item (F-H item) method—a question and answer model (Kaplan and Bennett, 1994). Following is an example of F-H item.

*Sample correct responses to the old curricula item*

1. *Knowledge we got before seems less useful in our daily life.*
2. *Knowledge acquired from school can not completely apply to daily life.*
3. *Knowledge can not follow up the thread*
4. *There is much redundant knowledge in old curricula.*
5. *Knowledge we acquire is non-systematic.*

Then, the answering results of F-H item are classified into several parts; the relevant parts are categorized into the same category. In this way, we can get multiple-category rubrics. The rubric forms the concept grammar by transformation of synonym and grammar

In this study, the researcher considers the data are not large enough to get concept similarity from the general information retrieving method by calculating the keyword weight of sentences. Furthermore, these data embrace text, voice and pictures, and they can not be classified by computerizing. Therefore, the data have to be manually decomposed to several sentences in brief and classified to several items similar to the form of F-H item.

### 2.2 Concept matrix

This study builds the concept matrix to

discuss the concept similarity of content. Here are theories about building a concept matrix as following.

#### (1) Sentence similarity

We assume that a specific domain of knowledge includes 7 keywords: “a1”, “a2”, “a3”, “a4”, “a5”, “a6”, “a7”. There is a sentence Q1, including keywords: “a1”, “a5”, “a6”, “a7”, and the Q1 converts to a 7-dimension vector:

$$q1 = [ 0 \ 1 \ 0 \ 1 \ 1 \ 1 \ 1 ]$$

Vector q1 expresses the sentence Q1. If the element in q1 is 1, it indicates that there exists the keyword, and vice versa.

We assume there is another sentence D1, including keywords: “a2”, “a4”, “a5”, “a6”, “a7”, and the D1 converts to a 7-dimension vector:

$$d1 = [ 0 \ 1 \ 0 \ 1 \ 1 \ 1 \ 1 ]$$

There are the other sentences D2 and D3. Their vectors are as following.

$$d2 = [ 1 \ 1 \ 1 \ 0 \ 0 \ 1 \ 1 ]$$

$$d3 = [ 1 \ 0 \ 1 \ 0 \ 1 \ 0 \ 0 ]$$

For finding the sentence which is most similar to Q1, we can calculate the values of  $q \cdot d_i^T$ . The results are 4, 3, 1, therefore, D1 is most similar to Q1.

#### (2) Concept-mapping method

If the learners' questions are not processed and replied in the asynchronous discussion, they would be frustrated and their learning motivation would be reduced. Therefore, to get possible solutions of the dangling questions, concept-mapping method and information retrieving method can be used to find articles, which is mostly similar to the content dangling question, from the database Chang (2002). In this way, the system can automatically find the mostly relevant articles from database and response to the dangling question.

There are some problems by calculating the keyword weight of sentences. The problems are as following:

1. It takes us much time on mathematics calculation and reduces the system performance; especially large loading articles, because the system has to classify articles into several classes, and make similar ones into the same category.
2. The problem of vocabulary-gap. Because information retrieval is a complex process, we have to deal with it by computerizing. However, it's difficult for system to recognize synonyms, metonyms and



The multimedia forum was designed to include three media - text, voice, pictures and the electronic blackboard to satisfy which students would like. Only narrow bandwidth network such as dial-up line and simple multimedia device such as earphone are required in the proposed system. Figure 3 shows the system interface.

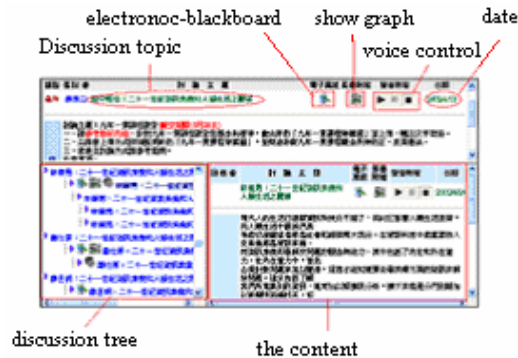


Figure 3 Operation interface

The multimedia forum requires only simple multimedia device such as an earphone, microphone, and modem (56kbps is well). The multimedia interactive programs are executed and the articles of the learner are recorded in the server. Further, the multimedia stream server streams the voice.

### 3.3 Building concept matrix

This section discusses the distance among articles. The concept distance means the reversed of concept similarity. Firstly, we have to find the relevance of articles. Then, we can get a relevance score by using information retrieving method. Because the articles include the potential concept, the relevance among the articles should be built on the concept-mapping method (Chang, 2002).

Secondly, the research limits the discussing topic to the specific domain. It means that we don't need a large intellectual database. Therefore, we don't need professional articles to be the training set. Moreover, it is hard to calculate each keyword weight of sentences with a few samples (Burstein and Kaplan, 1995).

Thus, we refer the concept-mapping method to evaluate the distance among articles. Firstly we have to find a way to build concept structure. Refer to F-H item method, Burstein (1999) pointed out that "F-H item was classified by vocabularies and phrase." Therefore, it is easier if we can build the concept structure of each article.

### (1) Building conceptual categories

During the data collecting stage, collected data are not enough to get concept similarity from the general information retrieving method by calculating the keyword weight of sentences. Furthermore, these data include text, voice and pictures, and are not easy to be classified by computerizing. Therefore, the data have to be manually decomposed to several sentences in brief and classified to several items similar to the form of F-H item.

Besides decomposing the article into several sentences, some sentences with the similar concept are categorized to the same concept. In other words, a concept-category includes several sentences with the similar concept.

### (2) Concept matrix of article

We decompose an article classified to several concept categories and get its concept matrix. Each category includes several concepts. If there are four mainly categories, A, B, C, D; each category contains four concepts; and there is an article containing the concept 1 and 3 in category A, we can describe it with the form, concept A {1, 0, 1, 0}.

Assuming there is an article including concepts A {1, 0, 1, 0}, B {0, 1, 1, 0}, C {1, 1, 0, 0}, D {0, 1, 0, 1}, we get the concept matrix of the article as following.

$$\begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix}$$

### (3) Concept distance

After analyzing all articles, we get a unit-concept containing all concepts of the discussing topic as figure 4. In one article, an expression may directly touch with the discussing topics, area x and z. On the other hand, its response may directly touch with the discussing topics, area x and z. Therefore, the summation of area 'x' and area 'y' is the concept distance between expression and response.

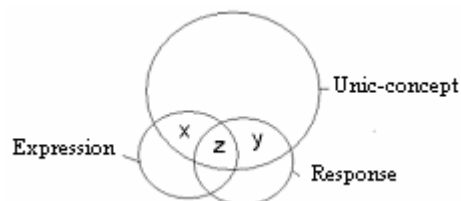


Figure 4 Concept Distance

To calculate the concept-distance between the article and its response, we have to calculate their distances with concept category A as following:

$$\overline{AA'} = \sqrt{(a1 - a1')^2 + (a2 - a2')^2 + (a3 - a3')^2 + (a4 - a4')^2}$$

Therefore, the distance between one article and its response is

$$\overline{AA'} + \overline{BB'} + \overline{CC'} + \overline{DD'}$$

Assuming the concept matrix of one article is

$$\begin{bmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

and the concept matrix of response is

$$\begin{bmatrix} 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \end{bmatrix}$$

therefore,

$$\overline{AA'} = \sqrt{(0-0)^2 + (1-1)^2 + (1-1)^2 + (0-1)^2} = 1$$

$$\overline{BB'} = \sqrt{(1-1)^2 + (0-1)^2 + (0-0)^2 + (1-0)^2} \cong 1.42$$

$$\overline{CC'} = \sqrt{(1-1)^2 + (1-1)^2 + (0-1)^2 + (0-1)^2} \cong 1.42$$

$$\overline{DD'} = \sqrt{(0-1)^2 + (0-0)^2 + (1-1)^2 + (1-1)^2} = 1$$

Finally, we get a distance matrix:

$$\begin{bmatrix} \overline{AA'} \\ \overline{BB'} \\ \overline{CC'} \\ \overline{DD'} \end{bmatrix} = \begin{bmatrix} 1 \\ 1.42 \\ 1.42 \\ 1 \end{bmatrix}$$

Therefore, the distance between expression and response of articles is  $1+1.42+1.42+1=4.84$ .

#### 4. Data analysis and results

There are totally 35 students' discussion portfolios collected in the research. Excluding data which include no response, irrelevant response, and social response, there remain 21 complete students' portfolios. According to portfolios, learners express their opinion by two ways, one is multimedia and another is text-based. Therefore, the researcher divides

these students into two groups, one is multimedia and another is text-based. In multimedia group, there are 11 students using multimedia to express their opinion. In text-based group, there are 10 students using text to express their opinion. Speaking in students' responses, all of them in these two groups respond their comments by text.

#### 4.1 Concept distance between article and unit-concept

We divide all articles into four mainly concept categories, and each category includes several concept classes. We can call the mainly concept categories as a "unit-concept." Therefore, "the distance to unit-concept" is from the concept of each article to unit-concept. The more distance, the more difference - it means the relevance is far between concept of article and unit-concept. In the study, learners who use multimedia to express their opinion can get a shorter distance than the ones who only use text. Regarding the response, the multimedia group also gets a shorter distance than the text-based group does although all responses are text-based.

In other words, using multimedia forum can let learners express their opinion and respond their comments complying with discussion topic. However, during the analyzing process, the researcher finds that even though the distance between each concept of article and unit-concept is longer in text-based group, the distance between concept of expression and response in text-based group is shorter than in multimedia group (0.55). Figure 5 shows the results.

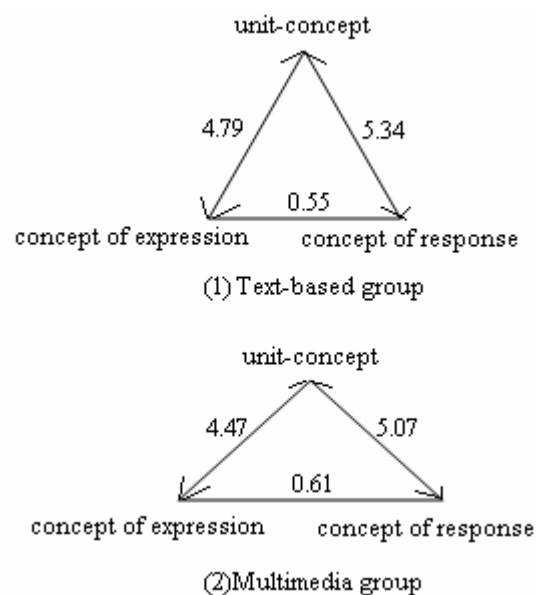


Figure 5 Distance between article and unit-concept

## 4.2 Concept area

Regarding the four mainly concept categories as a 2-dimension abscissa, we can locate learner's concept of article, which are divided into four mainly concept categories, on the abscissa with four points. Linking these four points, we get an area called concept area as following figure 6.

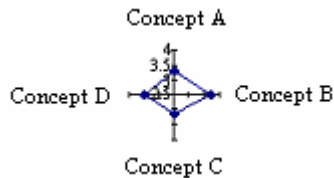


Figure 6 Concept area

In the study, not only expression but also response of concept area in multimedia group is bigger than in text-based group. The rate of concept area between expression and response is 0.169, which is much smaller than the number of multimedia group. This result may be caused by the limitation of text because it's difficult to completely comprehend others' opinion by text only. Therefore, the concept area of response in text-based group is smaller than the area in multimedia group.

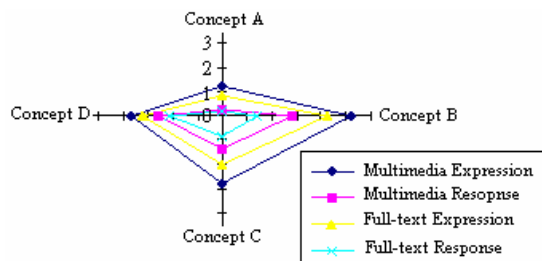


Figure 7 The comparison of expressing and responding concept area between multimedia group and text-based group

## 4.3 Article distance

For clearly describing our statement, we here call the concept distance between expression and response as a "article distance."

The difference of concept area and article distance is the higher rate of conceptual area between expression and response doesn't mean the article distance is lower. The article distance in multimedia group and text-based group is as Figure 8. The article distance in multimedia group is larger than the distance in text-based group. After analyzing articles, we assume the critical factor is "learners' optional response". Most learners toward responding the specific

concept and ignore other parts. Furthermore, a multimedia expression, such as a simple graph, may conclude many potential concepts, which are difficult to describe by text. Therefore, there is a limitation when learners response their comment by text to multimedia expression. In short, the article distance in multimedia group is larger than in text-based group.

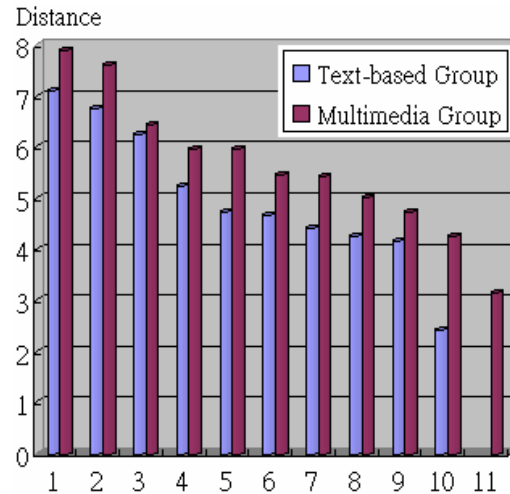


Figure 8 Article distance in multimedia group and text-based group

## 5. Conclusion and Suggestion

The usage of information technology and multimedia has been worth researching in information educational development. Combing applications of information technology and multimedia with remote teaching curricula, we build an interacting multimedia forum to support a good applicative demonstration for the on-line asynchronous learning. Following discoveries are from the analyses of discussing articles.

1. Using multimedia discussion forum to express opinion can let learners get much clearer and more comprehensive about the discussing topic. According to the report, learners can widely and deeply discuss the topic from above mentioned four concept categories. Therefore, the concept area will get broader and broader.
2. Using multimedia forum to express opinion can popularly get learners' responses to many aspects. Although most learners express their opinion by text in multimedia forum, learners' are willing to respond their opinion with wide discussion.
3. The learners can not express their opinion completely by text whether in multimedia

group or text-based group.

Data analyses of this study are based on the relation of articles. Considering the data are not large enough, we classify concepts manually and build concept matrix on each category. This is a necessary process to automatically build concept matrix by information retrieving method.

Adding multimedia to the forum system can stimulate learner's learning motivation, as an assist device let learners express their opinion completely and be willing to reply their responses wildly and deeply. Here are with several teaching suggestions as following.

1. The critical issue of learning is in time scaffolding and guide by the teacher. That may make multimedia forum achieve maxima efficiency.
2. Encouraging learners to use the multimedia discussion system as much as possible in order to be familiar with its function.
3. The more high-level discussion topics are designed, the more efficiency multimedia forum makes.
4. It's not necessary to limit the type usage of media devices. Our suggestion is to let learners freely and completely express their opinion, but don't constraint their optional rights of media types.

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