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Version of record first published: 24 May 2011

To cite this article: Jie Chi Yang & Sherry Y. Chen (2012): Investigation of learners' perceptions for video summarization and recommendation, Interactive Learning Environments, 20:4, 369-385

To link to this article: http://dx.doi.org/10.1080/10494820.2010.486888

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Investigation of learners’ perceptions for video summarization and recommendation

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(Received 9 October 2009; final version received 7 April 2010)

Recently, multimedia-based learning is widespread in educational settings. A number of studies investigate how to develop effective techniques to manage a huge volume of video sources, such as summarization and recommendation. However, few studies examine how these techniques affect learners’ perceptions in multimedia learning systems. This article aims to examine learners’ perceptions for summarization and recommendation, with an emphasis on the perspective of prior experience. In this study, we developed a multimedia content summarization and recommendation system, which can automatically extract summaries from raw video sources and recommend suitable video content to learners through emails. The results demonstrate that learners’ prior experience and preferences for the presentation of document types affect their perceptions, including the enhancement of interests, the ease of information acquisition and the intention for the further use of the system. Finally, the findings are applied to develop a framework that can support for the design of multimedia learning systems.

Keywords: multimedia; prior experience; recommendation; summarization; video

1. Introduction

Multimedia applications are rapidly increasing with the widespread use of digital video technology. Various studies have demonstrated that video is a suitable tool for context-based learning (Choi & Johnson, 2005; South, Gabbitas, & Merrill, 2008). However, video content is usually displayed linearly so it takes much more time to see videos. To address this issue, there is a need to have mechanisms to help learners choose video content that is suitable for specific learning activities. Thus, we propose a mechanism that combines two techniques: summarization and recommendation. The former focuses on how to extract semantic information from original videos while the latter emphasizes on how to recommend suitable video content to learners from a huge database (Yang, Huang, Tsai, Chung, & Wu, 2009). The purpose of video summarization is to preserve the most informative parts of the original videos. Therefore, video summarization is essential for enabling the learners to skim through video contents (Hidaka & Nakajima, 2007; Money & Agius, 2008; Truong & Venkatesh, 2007). On the other hand, recommendation is a technique which can help
learners reduce their information overload and provide advice to find suitable content (Itmazi & Megias, 2008; Lee & Kwon, 2008). It seems that these two techniques serve different purposes, however, the combination of summarization and recommendation can be a useful mechanism to enhance student learning.

Due to the usefulness of these two techniques, a number of studies also attempt to develop video summarization techniques (Gao, Wang, & Yong, 2008; Hidaka & Nakajima, 2007; Wu & Yang, 2008), as well as video recommendation techniques (Lekakos & Giaglis, 2006) to manage a huge volume of video sources in the past ten years. These techniques are useful but it is still unclear how these techniques affect learners’ perceptions in multimedia learning systems. In this vein, this study not only develops a mechanism that combines these two types of techniques, but also investigates how learners perceive these two types of techniques.

Investigating learners’ perceptions needs to consider human factors, which play an important role in multimedia learning (Chen, Ghinea, & Macredie, 2006). In particular, prior experience is a critical factor (Chen, Fan, & Macredie, 2006) because it can influence how learners select information to place in memory and link new information to that already stored in memory (Spyridakis & Isakson, 1991). Several studies have found that learners with different levels of prior experience benefit differently in multimedia learning systems (Beier & Ackerman, 2005; Falk & Adelman, 2003). Learners with a high level of prior experience and those with a low level of prior experience show different preferences in the use of multimedia learning systems (e.g. Calisir & Gurel, 2003). However, current research lacks a sufficient understanding of how these are related to summarization and recommendation used in multimedia learning systems. Therefore, this study examines learners’ perceptions from a perspective of prior experience. It is hoped that by assessing learners’ perceptions a greater understanding of the role of prior experience in multimedia learning can be reached.

In summary, the contributions of this study are two-fold: (a) to develop summarization and recommendation techniques to support multimedia learning systems and (b) to examine learners’ perceptions for these two types of techniques. This article is structured as follows. Section 2 describes related works on video summarization and recommendation techniques, as well as the effects of human factors on multimedia learning. Section 3 describes an empirical study, which examines learners’ perceptions of summarization and recommendation used in a multimedia learning system. Results and discussions of the empirical study are then presented in Section 4. The article subsequently moves on to Section 5, which develops a framework based on the findings of this study. Finally, conclusions are drawn in Section 6.

2. Related work

2.1. Video summarization and recommendation

Several studies indicate that multimedia is often more useful for learning and teaching than traditional text-based presentation (Lalley, 1998; Mackey & Ho, 2008; Mayer & Moreno, 2002). Therefore, multimedia learning systems, which have recently emerged as major tools for learning in educational settings, could greatly improve learners’ attitudes and motivation. Among various multimedia elements, video presentation is particularly useful. As suggested by Shea (2000), a well-designed video application can motivate, save time, and help learners overcome their
difficulties. In addition, Choi and Johnson (2007) found that video applications can enhance learners’ motivation and satisfaction and keep their attention. Thus, the popularity of videos is increased, which, in turn, also raises the demands for videos.

A consequence of the growing demands is that sophisticated technologies are needed for representing, modeling, indexing, and retrieving videos (Sebe, Lew, & Smeulders, 2003). Video summarization is one of the technologies that helps users to meet these needs by developing a condensed version of a full length video stream through the identification of the most important and pertinent content within the stream (Fonseca & Pereira, 2004). Along with this direction, many studies attempt to enhance the functionalities of videos with summarization, which is a mechanism for generating a short summary of a video (Hidaka & Nakajima, 2007; Truong & Venkatesh, 2007). Basak, Luthra, and Chaudhury (2008) present a video summarization technique based on a supervised discovery technique. In their summarization scheme, a user provides the desired summaries for a subset of video data within a class of video datasets of similar nature. The summaries of the rest of the video datasets are generated according to this supervised information. Additionally, Peng et al. (2009) propose a system for automatically summarizing videos based on a user experience model. The user experience model takes account of users’ spontaneous behaviors when viewing videos.

The studies demonstrate that a lot of effort has been put into video summarization. Due to such effort, video summaries can be presented with various formats, for example, sequence of stationary images (key frames) or moving images (video skims) from the source video. Regardless of the formats used to present the summaries, video summarization would be beneficial to learners. This is because several audiovisual cues can be incorporated to present a condensed and succinct representation of the content of a video stream and learners can produce greater incorporation of external information (Money & Agius, 2008).

One of the purposes of using video summarization is to make recommendations. Recommendations, which give advice and suggestions based on a user’s prior experience, have been applied in various applications, including digital libraries (e.g. Bollen, Nelson, Geisler, & Araujo, 2007) and electronic business (Liu & Shih, 2005; Shih & Liu, 2008). For example, Cunningham and Frank (1999) developed a recommendation system based on the transaction records of books borrowed from a university library. They found that the recommendation system is not only useful to guide users to relevant documents, but also to determine a library’s physical layout. Wang, Chuang, Hsu, and Keh (2004) developed a recommendation system for the cosmetic business. They found that the recommendation system could not only help users find the right products, but also to find the right products at the right time. In addition to digital libraries and electronic business, recommendation systems can also be applied to other applications, such as movies (Lekakos & Caravelas, 2008), academic papers (Middleton, Shadbolt, & De Roure, 2004), and TV (Velusamy, Gopal, Bhatnagar, & Varadarajan, 2008). Likewise, we can also use recommendation systems to support learning, where, in turn, learning objects can easily and efficiently be accessed and learners can be guided to interesting or useful learning objects (Burke, 2002). Conversely, the learners would spend more time selecting suitable learning objects and less time involved in the actual learning activities if recommendations were not provided.
2.2. Prior experience

The studies presented in Section 2.1 suggest that summarization and recommendation systems are useful ways for learners to absorb information. However, it is still unclear whether all learners would value these two techniques because previous research found that learners’ characteristics affect their learning preferences (e.g. Minetou, Chen, & Liu, 2008). In particular, some studies have found that learners with different levels of prior experience benefit differently from multimedia learning systems (Calisir & Gurel, 2003; McDonald & Stevenson, 1998; Shin, Schallert, & Savenye, 1994).

An earlier study by Mitchell, Chen, and Macredie (2005) examined how prior experience influences students’ learning performance in, and perceptions of, a multimedia system. The results indicate that the participants with lower prior experience show a greater improvement in their learning performance than those with higher prior experience. More specifically, the multimedia system can help the former build a solid grounding by recalling what they have already learnt from the lecture. Conversely, the latter get fewer benefits from the multimedia system. Another study by Grimley (2007) explored whether the principles of cognitive load and multimedia theory are mediated by cognitive style, gender, and prior experience. Among these three factors, prior experience affected learning performance. Learners with a higher prior experience answered more questions correctly than those with a lower experience.

The other study by Moos and Azevedo (2008) examined the relationship between prior experience and self-regulated learning within a multimedia learning task on the conceptual understanding of the circulatory system. The results suggest that prior experience is significantly related to the participants’ self-regulated learning within multimedia systems. It also demonstrates that prior experience is positively related to the participants’ planning and monitoring, and negatively related to their use of strategies when regulating their learning with a multimedia learning task. Additionally, Smits, Boon, Sluijsmans, and van Gog (2008) examined the effectiveness of different levels of prior experience with different types of feedback content and timing. The results indicated that all learners spent more time on reading feedback than those in the conditions of delayed elaborate feedback and delayed global feedback. However, they also found that the global feedback was more effective than elaborate feedback for learners with a higher level of prior experience but those with a lower level of prior experience did not show such a difference.

A more recent study by Chrysostomou, Chen, and Liu (2009) investigated learners’ preferences in using multimedia learning systems. Prior experience, especially computer experience, is a key human factor that influences learners’ preferences. The higher prior experience learners prefer dynamic buttons and multimedia windows and like to use dropdown menus, while the lower prior experience learners favor static buttons and a single window and dislike drop-down menus. The studies mentioned above suggest that learners with different levels of prior experience showed different perceptions in multimedia learning. Understanding learners’ prior experience can influence the system success directly and indirectly (Torkzadeh & Lee, 2003). Thus, these human factors may also have potential to affect learners’ perceptions for video summarization and recommendation and the acceptability of multimedia learning systems. To this end, how prior experience affects learners’ perceptions for summarization and recommendation in a multimedia learning system is addressed in this study.
3. Method design

3.1. Participants
A total of 31 students, which included 20 males and 11 females, participated in this study. The sample size was in line with previous studies in learning technology, e.g. Chu, Hwang, Tsai, and Chen (2009) and Rafi and Samsudin (2009). The participants were students in a university who volunteered to take part in the study. All participants came from different colleges of the university, but most of them had the basic computing and Internet skills necessary to operate a multimedia learning system.

3.2. Instruments

3.2.1. Multimedia summarization and recommendation system
This study adopted a multimedia content summarization and recommendation system (Yang et al., 2009), which can receive the raw video data as input and extract caption words from the raw video. It is worth mentioning that any kinds of video can be used as video sources for the system. However, we selected 181 Discovery videos as the video sources because of the popularity of these videos. The system includes the following elements:

- Video Cover: The cover image of the video.
- Video Description: Brief descriptions of the content of the video.
- Video Summary: Consists of summarized video captions and key video clips corresponding to these captions.
- Hyperlinks: Links for accessing the top five ranked video summaries.

The system can automatically extract summaries from raw videos and recommend relevant content to learners by multimedia-based emails. In other words, the two core functionalities of the system are summarization and recommendation, which are illustrated in Figure 1. Summarization is handled by the mechanism of question and answering (Q/A based approach). More specifically, learners can submit their questions and then the system will find appropriate answers.

![Figure 1. The process of the system.](image-url)
for the questions by extracting passage-level answers from different segments of video captions (Lee, Wu, & Yang, 2009). These extracted answers are used to generate video summaries by using a ranking algorithm (Wu, Yang, & Lee, 2008). Once this summarization process is completed, the ranked video summaries are stored in the video summary database for further use.

On the other hand, recommendations are undertaken by comparing the relevance between generated summaries of video clips with learners’ profiles which include information about their interests, major subjects, favorite movies, and their personal data. The data in learners’ profiles, which are stored in an XML-based format, are used to match with generated video summaries. A relevant score with regard to a video summary is calculated based on a similarity measurement with cosine value (Baeza-Yates & Ribeiro-Neto, 1999). The higher relevant score, the more likely this video will be of interest to the learner. If the score exceeds a threshold, an auto-generated multimedia-based email will be sent to the learner. More specifically, if a video summary and a learner profile share some similarities, the system extracts the email address from the learner profile and sends a multimedia-based recommendation email automatically. The multimedia-based email includes the video cover image, brief descriptions, extracted video summaries (roughly < 25 sentences) which contain summarized video captions and key video clips corresponding to these video captions. With such an approach, the system can extract video summaries rapidly from a large database of videos, saving time for learners. In other words, the system can recommend relevant video clips to learners based on their needs. Thus, learners can immediately use the new video to acquire information, instead of spending a lot of time scanning irrelevant videos.

3.2.2. Questionnaire
A paper-based questionnaire was used to examine students’ perceptions to video summarization and recommendation. More specifically, the perceptions identified in this article are mainly concerned with the perceptions of system usage effort, which are important variables in information system attitudes (Davis, 1989). Such perceptions include five main parts in the questionnaire: (P1) recommendation, (P2) summarization, (P3) enhancement of interests, (P4) ease of information acquisition, and (P5) intention for the further use of the system. Table 1 presents the explanation of these five parts. All questions in every part use a five-point Likert scale consisting of the response options: strongly agree, agree, neutral, disagree, and strongly disagree.

3.2.3. Personal information sheet
The personal information sheet contains five items which are listed in Table 2. The first three items are used to understand the participants’ personal background and their prior experience and preferences on accessing videos. The last two items are used to identify learners’ interest topics and their favorite movies, which will be used to build their profiles for dealing with video recommendations.

3.3. Procedure
The procedure of this study consists of three steps, which are illustrated in Figure 2. At the beginning, each participant was asked to fill out a personal information sheet.
In the next step, all of the participants were required to interact with the multimedia learning system. They would receive a video summary with video clips from multimedia-based recommended emails. The duration of this process took approximately 40 min. Upon the completion of the aforementioned steps, each participant was asked to fill out the questionnaire to express their perceptions of the recommendation and summarization.

### 3.4. Data analyses

The data collected from the questionnaire were coded for quantitative analyses. The participants’ responses given on the Likert scale were coded as follows: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. The Pearson Correlation (two-tailed) was applied to analyze the participants’ responses to the
items of the questionnaire. In addition, descriptive statistics for the questionnaire is also analyzed in terms of mean and standard deviation. In addition to descriptive statistics analysis, an independent samples t-test, which is suitable for identifying significant differences of two independent groups (Stephen & Hornby, 1997), was applied to conduct data analyses.

4. Results and discussions

4.1. Overall perceptions

After analyzing the students’ responses to the questionnaire, we found that they gave high scores for most of the items. Table 3 presents the results of the mean score and standard deviation of each part of the questionnaire. As show in this Table, part 1, P1: recommendation, received the highest score and part 5, P5: intention for the further use of the system, obtained the second highest score. These results suggest that the participants appreciated the recommendation and summarization on video content provided by the system as well as they considered that the combination of recommendation and summarization enhanced their interests, allowing them to acquire information more easily, and increased their intentions for the further use of the system.

Table 4 shows that P1 and P2 are significantly correlated to P3 ($p < 0.01$) and P5 ($p < 0.05$). More specifically, there are positive relationships between learners’ appreciation of the recommendation and summarization techniques and their perceptions of the enhancement of their interests and between their appreciations of these techniques and their intentions for the further use of the system. The Table also indicates that P2 is significantly correlated to P4 ($p < 0.05$). In other words, the

<table>
<thead>
<tr>
<th>Parts</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1: Recommendation</td>
<td>4.32</td>
<td>0.653</td>
</tr>
<tr>
<td>P2: Summarization</td>
<td>4.00</td>
<td>0.856</td>
</tr>
<tr>
<td>P3: Enhancement of interests</td>
<td>4.13</td>
<td>0.670</td>
</tr>
<tr>
<td>P4: Ease of information acquisition</td>
<td>4.16</td>
<td>0.523</td>
</tr>
<tr>
<td>P5: Intention for the further use of the system</td>
<td>4.26</td>
<td>0.575</td>
</tr>
</tbody>
</table>

Table 4. Correlation between each part ($N = 31$).

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Pearson correlation</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td>Pearson correlation</td>
<td>0.358*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.048</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td>Pearson correlation</td>
<td>0.485**</td>
<td>0.696**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.006</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P4</td>
<td>Pearson correlation</td>
<td>0.297</td>
<td>0.446*</td>
<td>0.720**</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.105</td>
<td>0.012</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>P5</td>
<td>Pearson correlation</td>
<td>0.392*</td>
<td>0.406*</td>
<td>0.573**</td>
<td>0.485**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.029</td>
<td>0.024</td>
<td>0.001</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01.
appreciation of the summarization technique is positively related to the perceptions for the acquisition of information. The Table also shows that there are positive relationships between P1 and P2 ($p < 0.05$). The appreciation of the recommendation technique is significantly correlated to the appreciation of the summarization technique. These results suggest that the appreciation of the design of a system can improve learners’ perceptions so it is necessary to design a system from a user’s point of view. Furthermore, P3 (enhancement of interests), P4 (ease of information acquisition) and P5 (intention for the further use of the system) are significantly correlated to each other ($p < 0.01$). Thus, learners’ perceptions of a particular item are likely to be related to the other item. In other words, increasing learners’ positive perceptions needs to take into account multiple items, instead of focusing on a single item.

4.2. Prior experience

This section presents the relationships between learners’ prior experience and their perceptions. The participants’ prior experience was measured based on the number of movies seen per week and the time length of movies seen per day, details of which are presented in Figures 3 and 4.

The independent samples $t$-test was performed to examine the relationships between the participants’ levels of prior experience on seeing movies and their perceptions for the enhancement of interests, the ease of information acquisition, and the intention for the further use of the system (Table 5). Regarding the enhancement of interests, the result showed that there was a significant difference ($p < 0.05$) between the participants who saw few movies and those who saw many movies in a week. The former gave higher scores than the latter. Regarding the ease of information acquisition, the result of the $t$-test showed that there was a significant difference.

![Figure 3. Numbers of movies seen in a week.](image)

![Figure 4. Hours of movies seen in a day.](image)
difference ($p < 0.05$) between the participants who saw few movies and those who saw many movies per week. A similar result occurred in the analysis for another item, of which the $t$-test result showed that there was a significant difference ($p < 0.01$) between the participants who saw few movies and those who saw many movies per day (Table 6). Again, these results showed that the former rated higher scores than the latter.

Regarding the intention for the further use of the system, there was, however, no significant difference between the participants who saw few and those who saw many movies, regardless how many numbers of movies were seen per week or how much time they spent seeing movies per day. The above findings indicate a notable phenomenon that there was a negative relationship between the levels of learners’ prior experience and their perceptions. Those who had a lower level of prior experience had more positive perceptions of the enhancement of their interests and the ease of information acquisition. Conversely, those who had a higher level of prior experience had less positive perceptions for the enhancement of their interests and the ease of information acquisition.

### 4.3. Preferred type of material

This section presents the relationships between the preferences for the material types and their perceptions. The preferences for the material types was measured based on whether they preferred text or video, details of which are presented in Figure 5.

The independent samples $t$-test was performed in order to examine the relationship between the participants’ preferences for the material types and their perceptions for the enhancement of interests, the ease of information acquisition, and the intention for the further use of the system (Table 7). Regarding the

<table>
<thead>
<tr>
<th>Number of movies seen</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancement of interests</td>
<td>Few</td>
<td>21</td>
<td>4.14</td>
<td>0.727</td>
<td>2.321</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>10</td>
<td>3.50</td>
<td>0.707</td>
<td></td>
</tr>
<tr>
<td>Ease of information acquisition</td>
<td>Few</td>
<td>21</td>
<td>4.48</td>
<td>0.512</td>
<td>2.536</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>10</td>
<td>3.90</td>
<td>0.738</td>
<td></td>
</tr>
<tr>
<td>Intention for the further use of the system</td>
<td>Few</td>
<td>21</td>
<td>4.29</td>
<td>0.561</td>
<td>0.382</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>10</td>
<td>4.20</td>
<td>0.632</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time of movies seen</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancement of interests</td>
<td>Few</td>
<td>27</td>
<td>4.17</td>
<td>0.676</td>
<td>0.946</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>4</td>
<td>3.83</td>
<td>0.636</td>
<td></td>
</tr>
<tr>
<td>Ease of information acquisition</td>
<td>Few</td>
<td>27</td>
<td>4.41</td>
<td>0.572</td>
<td>2.956</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>4</td>
<td>3.50</td>
<td>0.577</td>
<td></td>
</tr>
<tr>
<td>Intention for the further use of the system</td>
<td>Few</td>
<td>27</td>
<td>4.26</td>
<td>0.594</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>Many</td>
<td>4</td>
<td>4.25</td>
<td>0.500</td>
<td></td>
</tr>
</tbody>
</table>
enhancement of interests, the result of the $t$-test showed that there was a significant difference ($p < 0.05$) between the participants who preferred video and those who preferred text. The former gave higher scores than the latter. Regarding the ease of information acquisition, the result of the $t$-test showed that there was a significant difference ($p < 0.05$) between the participants who preferred video and those who preferred text. Again, the participants who preferred video rated higher scores than those who preferred text. Regarding the intention for the further use of the system, the result of the $t$-test shows that there was a significant difference ($p < 0.01$) between the participants’ who preferred video and those who preferred text. The same result was found that the participants who preferred video rated higher scores than those who preferred text. These above findings suggest that the participants’ appreciation of videos can enhance their positive perceptions, including the enhancement of interests, the ease of information acquisition, and the intention for the further use of the system.

### 5. Development of a framework

Based on the results presented in the aforementioned section, Figure 6 presents a framework that illustrates the relationships among the document types (summarization and recommendation), the impacts (enhancement of interests, ease of information acquisition, and the intention for further use of the system), the levels of prior experience and the preferred types of material. This framework can help designers to develop user-centered multimedia learning systems that can provide a proper type of document to learners with a proper level of experience, which, in turn, can produce proper impacts.

- **Document types are interrelated with learners’ perceptions.** The results of the study reveal that the appreciation of recommendation and summarization can increase learners’ positive perceptions. In particular, the appreciation of the recommendation is positively related to the enhancement of learners’ interests and the appreciation of summarization has positive relationships with the ease of information acquisition.
of information acquisition. The reason for the former could be the fact that the recommendation process is mainly undertaken based on learners’ interests (Hsu, 2008; Li, Lu, & Li, 2005; Wei, Moreau, & Jennings, 2005; Yang & Gu, 2006). Therefore, learners thought that their interests were enhanced by the recommendation system. On the other hand, the reason for the latter could be the fact that the summarization process is associated with information extraction, which selects relevant information to facilitate information acquisition and comprehension of the learning content (Kissner, 2006; Lorch, Lorch, Ritchey, McGovern, & Coleman, 2001; Nevid & Lampmann, 2003; Yuan & Sun, 2005).

- **Recommendation is interrelated with summarization.** The results of the study reveal that a significantly positive relationship appeared between recommendation and summarization. It implies that the combination of these two document types may have great effects on the development of multimedia learning systems. This is probably because both of these documents can reduce learners’ information overload. Summarization selects relevant content and condenses it to present a compact form of the original source; therefore, summarization will enable learners to access larger amounts of material with less required reading time (Maybury, 2001). Likewise, recommendation can also reduce learners’ information overload because only relevant documents are recommended to learners. Thus, the combination of these two document types can reduce learners’ information overload, which, in turn, can improve student learning. The designers of multimedia learning systems should carefully consider this issue to integrate these two types of documents effectively and efficiently.

- **Learners with different levels of prior experience have different kinds of perceptions.** The results of the study reveal that learners with different levels of prior experience have different kinds of perceptions, including the enhancement of interests and the ease of information acquisition. Learners who see fewer movies have more positive perceptions. More specifically, they consider that such a system is useful to them to acquire information from the

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**Figure 6. A framework of multimedia learning systems.**

![Image of a framework of multimedia learning systems]

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multimedia learning system and can enhance their interests. In contrast, learners who see more movies have more negative perceptions. They think that such a system is less useful to them to acquire information and their interests are not greatly enhanced. In summary, there are negative relationships between learners’ prior experience and their perceptions. These findings are inconsistent with those of Mitchell, Chen, and Macredie, (2005) who found that there are positive relationships between learners’ prior experience and their perceptions.

- **Learners who prefer different types of material have different kinds of perceptions.** The results of the study also reveal that learners who prefer different types of material perceived differently. Learners who prefer the learning material presented with videos have more positive perceptions for the enhancement of interests, the ease of information acquisition and the intention for the further use of the system than those who prefer the learning material presented with text. These results suggest that the summarization and recommendation are not suitable to all learners and not all learners appreciate the value of videos. Thus, the designers of a learning system should carefully choose a material type based on the preference of each individual learner, instead of implementing videos for all learners.

- **Enhancement of interests, the ease of information acquisition and the intention for the further use of the system are positively interrelated each other.** The results of the study reveal that a significantly positive relationship appeared among the enhancement of interests, the ease of information acquisition, and the intention for the further use of the system. These findings are consistent with those of Alao and Guthrie (1999), which examined relationships among prior experience, interest, learning goals, and conceptual understanding and found that these variables were positively related to each other. This also supports the view of Shen, Chen, and Guan (2007), which indicates individual interests directly contributed to the acquisition of knowledge.

### 6. Conclusions

Summarization and recommendation are useful for student learning in multimedia environments. The contributions of this study lie within two aspects: (a) applications and (b) theories. Regarding the applications, this study developed a multimedia learning system, which used both summarization and recommendation to facilitate video access. We found that such an application had positive effects on student learning, including the enhancement of interests, the ease of information acquisition and the intention for the further use of the system. Regarding the theories, this study examined how learners’ prior experience affected their perceptions in the aforementioned multimedia learning system. We found that prior experience plays an influential role in students’ perceptions for summarization and recommendation. Learners with a lower level of experience show more positive perceptions than those with a higher level of experience.

The aforementioned contributions demonstrate the value of presenting material with summarization and recommendation and the importance of learners’ prior experience in multimedia learning. These contributions can help multimedia designers choose the right material for the right learners at the right stage. However, it was only a small-scale study. Further empirical studies have to be undertaken with
a larger sample to provide additional evidence. The other limitation is that the sample was not very balanced in this study. There were few participants who had a higher level of prior experience (i.e. they saw many movies). This limitation may influence the validity of the results. Therefore, further empirical studies with a more balanced sample are needed to verify the results described in this article. There is also a need to conduct further research to examine how other human factors, such as cognitive styles and gender differences, influence learners’ perception of summarization and recommendation in multimedia learning systems.

Acknowledgments
The authors thank Dr. Yu-Chieh Wu for assisting in the system development and Ms. Yi-Ting Huang for assisting in the experiment. The authors would also like to thank all the subjects who participated in the study. This study was partially supported by grants (NSC 97-2628-S-008-001-MY3, NSC 98-2631-S-008-001) from the National Science Council of Taiwan.

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