A Personalized Video Learning System by Artificial Bee Colony Algorithm on Social Network Site

Hsin-Chin Chen*, Chia-Cheng Hsu, Ying-Hong Pu, Kuo-Kuang Huang, Yueh-Min Huang
Department of Engineering Science, National Cheng Kung University
Tainan, Taiwan
luckyqq50@gmail.com

ABSTRACT

With the rapid development of the Internet technology, social network sites have been popular e-learning platforms, and Facebook is one of famous social network sites in the world, which facilitates information sharing and interpersonal relationships. Recently, Facebook has been regarded as a knowledge sharing and collaborative learning platform in a variety of fields for education, and it has been applied as a sharing video materials platform for learning English. However, those shared video materials may not conform to an individual’s learning abilities and needs. In order to enable learners to learn the most suitable and useful video materials for learning English, this study proposes a personalized video learning system on Facebook based an artificial bee colony algorithm to provide the suitable video materials according to difficulty level of video materials, learner’s behavior, and degree of association related to specific course topics to accommodate individual preferences. The experimental results indicate that the proposed system not only provides learners the suitable video materials for learning English, but also promotes their learning satisfaction and interest.

Keywords: Facebook, Video, Artificial bee colony algorithm, English

I. INTRODUCTION

Social networking sites (SNSs) have become more and more popular in recent years, and its services are to facilitate relationships between users and provide a sharing platform for users to share their events, photos, ideas, activities, and interests with their friends [1]. Users can create individual profiles to present and update their backgrounds and interests and allow friends to browse their profiles. There are many social network sites such as Facebook, MySpace, Google+, and Twitter, which has been the necessary communication tool in our daily life. Social network sites have been used on a variety of education fields, which provides a virtual interactive learning platform to communicate with each other for learners [2].

Recently, Facebook becomes the most popular social networking site in the world, and it can help users create personal file to introduce personal basic information and the system informs the status of their friends automatically. User can also create an activity or group on Facebook, and the system will invite their friends to join this specific group. In addition, Facebook is a multimedia sharing platform, which allows users to upload music, photos, and videos to share with their friends in the personal wall [3].

Several studies have started to investigate the benefits of Facebook for learning English, and it could provide an online cooperative platform for learners [4]. Facebook could have positive impact on the attitude towards English learning, which improved the students’ language skills and learning confidence and motivation. Building an environment for learning foreign language on Facebook, and learners, teachers, and foreign students were conducting group discussion [5]. The results indicated Facebook promoted the chances of speech interaction among learners and enhanced their communication ability. It was convenient to establish communities in Facebook, where learners could share their thinking in the communities, and participate in cooperation and discussion to improve their teaching and learning [6]. Hence, Facebook can enhance the effect of cooperative learning, and can let learners learn English together more effectively.

A personal wall of Facebook could be provided to share multimedia materials for learners. Instructors and students could share all types of learning materials on their personal walls, such as articles, figures, and videos. Moreover, digital videos have been a popular foreign language learning media for learners, which could provide a learning environment to preview and review the learning content without instructors’ teaching [7]. Several studies indicated digital video could promote learner’s motivation, interests, concentration, and comprehension for learning foreign language effectively [8] [9]. For this reason, students can use Facebook to receive a lot of video learning materials for learning English from their friends on their personal walls.

However, the shared video materials may not meet the needs of learners since there is no consideration about learners’ interests and English ability, which affects their learning motivation and outcome. Therefore, an effective video learning material recommendation approach needs to consider the interesting topic of the course, learner’s interests, and the difficulty of the learning materials to meet individual needs and further improve their learning outcome and achieve better personalized learning.

This study proposes a personalized video learning system (PVLS) on Facebook that recommends the most suitable video learning materials based on the interesting topic of the course, and the difficulty of the learning materials. The proposed system traces learners’ favorite topics of video materials automatically according to learner’s behavior on Facebook. An artificial bee colony (ABC) algorithm is utilized to search the most suitable video learning materials via the individual learning needs. Meanwhile, an experiment was conducted with
The ABC algorithm was proposed by Karaboga [10], which employs swarm intelligence to find near-optimal solutions, which was applied on the various research areas [11][12]. The procedure of the ABC algorithm is shown as Figure 1.

First, the ABC algorithm chooses employed bees, and then each bee randomly finds a food source in the solution space. The amount of nectar for each chosen food source is represented by the calculated fitness value. Second, the employed bees find new food sources near the original food sources in their memory, and share the information about their food sources with onlooker bees. Third, an onlooker bee is employed bees find new food sources. Then, the onlooker bees find new food sources near the selected food source by following Eq. (2) and compute the nectar amount.

\[ x_{ig}(t+1) = \theta_i(t) + \phi(\theta_i(t) - \bar{\theta}_g(t)) \]  

where \( g \) is the dimension of the position; \( k \) is the randomly chosen employed bee; \( t \) is the number of iterations; \( \phi() \) is a random value in the range \([-1, 1]\); \( \theta_i \) is the position of dimension \( g \) of the \( i^{th} \) employed bee; \( \bar{\theta}_g \) is the position of dimension \( g \) of the randomly chosen employed bee; \( 1 \leq i \leq E \); \( 1 \leq k \leq E \); and \( 1 \leq g \leq G \). Fourth, if the fitness value of a solution is related to a specific food source in a continuous predetermined number of iterations, the source is abandoned by the employed bee. The predetermined number of iterations is called \( \text{limit} \) for abandonment. The employed bee becomes a scout bee after abandoning the food source. The scout bee discovers a new food source by following Eq. (3), and then is transformed into an employed bee.

\[ \theta_i = \theta_{\text{ran}} + \delta \times (\theta_{\text{ran}} - \theta_{\text{nec}}) \]  

where \( \delta \) is a random value in the range \([0, 1]\). Finally, the new fitness values and positions of food sources are produced. The new fitness values are compared with the old one to find the best fitness value. The procedure is repeated from the second step until a termination condition is satisfied.

B. Video Learning Material Recommendation System

The video learning material recommendation system used a heuristic algorithm that is called artificial bee colony (ABC) algorithm to search suitable video materials and recommend them to learners. In this study, we consider four variables as the criteria factors to achieve the personalized recommendation. The three variables are as follows: (1) the interested topic of a learner, (2) the difficulty of video material, and (3) the number of “likes” of a video material. Before the recommendation system is discussed, some important variables are listed in Table 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Meaning and explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( s_i )</td>
<td>The selected video material ( i ), ( 1 \leq i \leq M ).</td>
</tr>
<tr>
<td>( t_{ij} )</td>
<td>The relationship between the interested topic ( j ) of a learner and the video material ( i ), ( 1 \leq j \leq P ).</td>
</tr>
<tr>
<td>( w_i )</td>
<td>The corresponding weight of the interested topic ( j ) for a learner, ( 1 \leq j \leq P ).</td>
</tr>
<tr>
<td>( d_i )</td>
<td>The difficulty of the video material ( i ), ( 1 \leq i \leq M ).</td>
</tr>
<tr>
<td>( l_i )</td>
<td>The number of “likes” of the video material ( i ), ( 1 \leq i \leq M ).</td>
</tr>
<tr>
<td>( F(x) )</td>
<td>A fitness function of recommendation mechanism for the video learning system.</td>
</tr>
</tbody>
</table>

\[ F(x) = \sum_{i=1}^{M} w_i s_i t_{ij} \]  

where \( w_i \) is the weight of the interested topic \( j \) for a learner, \( 1 \leq j \leq P \).
In order to search for suitable video material by using the ABC algorithm, a fitness function needs to be defined. Assume that a system includes a video material database that has $M$ video materials, $N_1, N_2, N_3, \ldots, N_M$, and $I$ video materials are selected from the video material database of the learning system. The selected video material $s_i$ is used for recommendation according to the needs and setting of learners on the video learning system. First, when a learner is interested in $T$ topics of the video materials in the video learning system, the video learning record his or her topics of interest according to the profiles and browsing history. Each video $i$, $i \in I$, is selected to correspond with one or more relations. The corresponding relevance, $l_{ij}$, $1 \leq i \leq M \cdot 1 \leq j \leq P$, between the video material $i$ and topic $j$ is set to 1 if the interested topic $j$ of the learner is the same to the topic of the video material $i$. A learner has different weight $w_i$ on the interested topics. For instance, the learner is interested in travel, business, and shop, with the corresponding weight $w_1=0.5$, $w_2=0.2$, and $w_3=0.3$, respectively. In order to obtain the strength of the relevance $\alpha$ between the interested topics of a learner and the video materials, the relevance is formed in (4).

$$\alpha = \frac{\sum_{i=1}^{M} s_i \times \left(1 - \sum_{j=1}^{P} (l_{ij} \times w_j)\right)}{\max \left(\sum_{i=1}^{M} s_i \cdot \eta\right)}$$  \hspace{1cm} (4)$$

Second, a difficulty $d_i$ of a video material is considered to as an evaluation factor for learners. The difficulty of a video material should correspond to the ability of a learner. In order to provide suitable video materials to learners, the system uses two variables that are a current level of difficulty $d_{current}$ and a target level of difficulty $d_{target}$. The difficulty of providing video materials between $d_{current}$ and $d_{target}$ is that the video materials can meet learners’ ability and promote their potential performance. When the difficult $d_i$ is between $d_{current}$ and $d_{target}$, a transform function of difficulty $T(d_i)$ is set to 0. To determine the suitable video materials corresponding with a learner, the difficulty of the selected video material is between $d_{current}$ and $d_{target}$ from (5) that is the strength of relevance $\beta$ of the difficult should be close to zero so that the selected video materials meet the needs of the learner.

$$\beta = \frac{\sum_{i=1}^{M} s_i \times T(d_i)}{\max \left(\sum_{i=1}^{M} s_i \cdot \lambda\right)}$$  \hspace{1cm} (5)$$

Third, the system considers the attention and popularity of video materials, namely the number of “likes” of a video material. In order to the degree of popularity in a reasonable range, the number $l_i$ of “likes” of a video material is transformed into a proportional level by using a sigmoidal membership function $L(l_i)$, show in (6).

$$L(l_i) = \frac{1}{1 + e^{-a \delta(l_i - 5)}}$$  \hspace{1cm} (6)$$

The relevance $\delta$ of the selected video materials with attention and popularity is formulated in (7).

$$\delta = \frac{\mu \sum_{i=1}^{M} s_i \times \left(1 - \frac{1}{1 + e^{-a \delta(l_i - 5)}}\right)}{\max \left(\sum_{i=1}^{M} s_i \cdot \mu\right)}$$  \hspace{1cm} (7)$$

Finally, the formula $F(s)$ is the fitness function of the recommendation mechanism consisting of three constraints that are $\alpha, \beta$, and $\delta$, shown in (8), where $s$ is all the selected video material for the fitness function.

$$F(s) = \frac{\sum_{i=1}^{M} s_i \times \left(1 - \sum_{j=1}^{P} (l_{ij} \times w_j)\right)}{\max \left(\sum_{i=1}^{M} s_i \cdot \eta\right)} + \frac{\sum_{i=1}^{M} s_i \times T(d_i)}{\max \left(\sum_{i=1}^{M} s_i \cdot \lambda\right)} + \frac{\mu \sum_{i=1}^{M} s_i \times (1 - L(l_i))}{\max \left(\sum_{i=1}^{M} s_i \cdot \mu\right)}$$  \hspace{1cm} (8)$$

III. SYSTEM ARCHITECTURE

This proposed video learning material recommendation system on Facebook is developed to facilitate learning English based on learner’s interests, the difficulty of video materials, the number of “likes” of a video, and the relevance to specific course topics, as shown in Figure 2. The video learning system contains four main models which include a video material management model, a data collection model, and an ABC algorithm model. The video management model is responsible for the management of accounts, for the assignment of video resources, and for providing video materials for learners. The data collection model gathers video materials from friends and assesses the learning activities of individual learners. The proposed system includes a video material database that has 120 video materials, and two instructors are invited to evaluate the difficulty of video materials. In addition, the ABC algorithm model finds suitable video materials for learners to assist learners to learn video materials.

The proposed system monitors the learning activities of students in order to obtain their interests. Keywords are applied to search the interest of students on specific topics. When a learner is interested in a specific topic and the number of browser hits on related videos goes up, the interest increases. With regard to related specific course topics, the number of “likes” and the number of comments on a video material are recorded automatically. The system provides a user-friendly interface for learners, as shown in Figure 3. The learner can set
the system parameters and modify the weight of the course topic and the difficulty, which depends on the assigned learning subject. After the settings are set, the system shows the suitable video materials automatically.

Figure 2. The system architecture of the personalized video learning system.

IV. EXPERIMENT DESIGN

A. Experimental Procedure

A total of 58 college students volunteered to participate in this experiment at Department of engineering science, National Cheng Kung University. In order to confirm the English ability of students, they needed to conduct a pre-test which included reading comprehension and listening comprehension. They used the proposed personalized video learning system to learn video materials by using a computer, and they could learn the most suitable video learning materials based on their preferences. In addition, the total experimental time was approximately one week. At the end of the experiment, a questionnaire survey was given to the students to evaluate their learning satisfaction of the learning activity, and the results indicate an average rating of 3.91 and a standard deviation of 0.83. Students have the high degree of learning satisfaction for this PVLS, and they consider that the PVLS could help them to understand English video material (mean = 4.06 and SD = 0.79). In addition, most students stated that they think the PVLS can enhance the impression of English video materials (mean = 3.81 and SD = 0.92), and they recommend this PVLS for other courses (mean = 4.10 and SD = 0.78). For this reason, we conclude that the PVLS can effectively promote the students’ learning satisfaction in the activity.

B. Measuring Tools

The questionnaire was examined by domain experts, who approved its validity. The reliability of this questionnaire was analyzed through utilizing the SPSS software. Cronbach’s α is a measure of internal consistency for each dimension of the questionnaire [13]. Roberts and Wortzel [14] indicated that a Cronbach’s α value higher than 0.7 indicates a highly reliability. The results show that the Cronbach’s α values of the questionnaire (α =0.79) is higher than 0.70.

The developed questionnaire was verified by conducting factor and reliability analysis. This questionnaire identified the three factors as follows: (1) learner’s learning satisfaction; (2) learner’s learning interest; (3) learner’s technology acceptance. In the first factor of this questionnaire, the goal was to collect information about the students’ learning satisfaction for the PVLS. The second factor was to explore the students’ learning interest for the PVLS. The third factor was to explore the students’ technology acceptance for the PVLS. Each question was rated on a five-point Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree).

V. RESULTS OF THE EXPERIMENT

A. Learning Satisfaction

Table 2 shows the mean and standard deviation for the learning satisfaction of the learning activity, and the results indicate an average rating of 3.91 and a standard deviation of 0.83. Students have the high degree of learning satisfaction for this PVLS, and they consider that the PVLS could help them to understand English video material (mean = 4.06 and SD = 0.79). In addition, most students stated that they think the PVLS can enhance the impression of English video materials (mean = 3.81 and SD = 0.92), and they recommend this PVLS can be used in other courses (mean = 4.10 and SD = 0.78). For this reason, we conclude that the PVLS can effectively promote the students’ learning satisfaction in the activity.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I consider that the proposed PVLS could help me understand English video materials.</td>
<td>4.06</td>
<td>0.79</td>
</tr>
<tr>
<td>2. I consider that the proposed PVLS could provide me the suitable video materials.</td>
<td>3.75</td>
<td>0.88</td>
</tr>
<tr>
<td>3. Are you satisfied for the proposed PVLS in the English course?</td>
<td>3.94</td>
<td>0.82</td>
</tr>
<tr>
<td>4. I believe the proposed PVLS can help me promote my English ability.</td>
<td>3.81</td>
<td>0.84</td>
</tr>
<tr>
<td>5. I believe the proposed PVLS can enhance the impression of English video materials.</td>
<td>3.81</td>
<td>0.92</td>
</tr>
<tr>
<td>6. I recommend this proposed PVLS can be used in other courses.</td>
<td>4.10</td>
<td>0.78</td>
</tr>
</tbody>
</table>

B. Learning Interest

With respect to the students’ interest for the PVLS, Table 3 shows that the mean and standard deviation for analysis of students’ interest. The present results indicate an average rating
of 3.92 and a standard deviation of 0.78, and students feel this learning activity is very interesting (mean = 4.17 and SD = 0.79). The result shows that this PVLS could enhance their learning interest and most of students stated that they liked to use PVLS on the video material to learn English. Moreover, most students stated that they think the PVLS is fascinating and amazing (mean = 3.70 and SD = 0.74). Students would like to use this proposed PVLS in the future (Mean = 4.13 and SD = 0.77). It can be seen that the using PVLS can increase the students’ interest for learning English.

TABLE III. ANALYSIS OF THE STUDENTS’ INTEREST ABOUT THE PROPOSED PVLS

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I like to learn English through the proposed PVLS.</td>
<td>3.93</td>
<td>0.76</td>
</tr>
<tr>
<td>2. This proposed PVLS is very interesting for me.</td>
<td>4.17</td>
<td>0.79</td>
</tr>
<tr>
<td>3. The interface of the proposed PVLS is attracting.</td>
<td>3.98</td>
<td>0.84</td>
</tr>
<tr>
<td>4. I would like to recommend this proposed PVLS to my friends.</td>
<td>3.81</td>
<td>0.80</td>
</tr>
<tr>
<td>5. The proposed PVLS is fascinating and amazing.</td>
<td>3.70</td>
<td>0.74</td>
</tr>
<tr>
<td>6. I would like to use this proposed PVLS in the future.</td>
<td>3.94</td>
<td>0.75</td>
</tr>
</tbody>
</table>

C. Technology Acceptance

Table 4 shows the results of technology acceptance questionnaire. In terms of perceived usefulness, the total average value is 4.15. The highest average score is 4.17, with “I think that PVLS for English can elevate my English ability,” and the lowest is 4.13, is “I think that the PVLS for English can elevate learning effects.” Moreover, this result showed that students generally agree with the efficacy of the proposed PVLS for learning English.

Table 5 explains the results of technology acceptance questionnaire for perceived ease of use, and the total average value is 4.07. The highest average score is the item with 4.12. “I think that the interface of PVLS is clear” and “I think that the combination of PVLS for English can make learning activities easier.” The lowest score is 4 “I think that the PVLS is easy to use.” These results showed that students accept the designed interface of the PVLS for learning English.

TABLE IV. ANALYSIS OF THE STUDENTS’ USEFULNESS ABOUT THE PROPOSED PVLS

<table>
<thead>
<tr>
<th>Questions</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I think that the PVLS for English can elevate learning effects.</td>
<td>4.13</td>
<td>0.60</td>
</tr>
<tr>
<td>2. I think that PVLS for English can elevate learning ability.</td>
<td>4.15</td>
<td>0.69</td>
</tr>
<tr>
<td>3. I think that the PVLS for English is useful.</td>
<td>4.15</td>
<td>0.64</td>
</tr>
<tr>
<td>4. I think that the PVLS for English can elevate my English ability.</td>
<td>4.17</td>
<td>0.62</td>
</tr>
</tbody>
</table>

VI. CONCLUSION

This study has used an artificial bee colony (ABC) algorithm to implement a personalized video learning system on Facebook based on the interesting topic of the course, and the difficulty of the learning materials, and individual preferences to generate suitable video learning materials. The ABC algorithm can successively search the suitable learning video materials to meet learners’ needs. In order to investigate the acceptance of the proposed PVLS, this study has developed a questionnaire which includes three factors are learner’s learning satisfaction, learner’s learning interest and technology acceptance. An experiment was conducted to understand students’ learning satisfaction degree of the proposed PVLS. The questionnaire results showed students think a personalized video learning system for learning English is useful and easy to use, and they have a high learning interest. At the same time, students achieve a better learning satisfaction and these results will be as reference for future instructional experimental design. Due to the limitations of this research, the number of students should be investigated to show more objective results. One of future studies may consider factors of learners’ learning styles for the proposed PVLS and improve this ABC algorithm to promote accuracy of the search method.

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