Linking Classroom Studies with Dynamic Environment.

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***Abstract*—Technology is touching every aspect of our lives and learning is not an exception. Mobile technologies and e-learning can be used to eliminate the boundaries of classroom. To circumvent the boundaries imposed by classroom and incorporate real-world elements as a part of the learning process, there is a need to establish a connection between class and the dynamic environment. In an attempt to take studies outside the classroom boundaries and use the real-world as a component in learning, we propose a system with an aim to improve learning outcomes by linking classroom studies with the outside world. Taking classroom studies as the basis, the system explores World Wide Web to find its applications in augmenting the teaching-learning process. These probable applications are recommended to the students. We conducted a survey and collected responses from 69 students enrolled in the second and third years of the undergraduate program in computer engineering in our university. An analysis of the responses obtained shows that the students find the information recommended relevant to their observations as well as interesting. This indicates that the inclusion of dynamic environment in the process of learning in a personalized manner can lead to better learning outcomes.**

Keywords—E-learning, Dynamic Environment, Image Based Search

I. INTRODUCTION

The use of interactive technology and collaborative tools improves the quality of learning in the class, which is one of the goals of e-learning [1, 2]. However, learning cannot be limited to classroom or a boundary. It is a widely accepted fact that learning is not an event but a process that progresses continuously [3]. This indicates that the process of learning continues even when the student is outside the classroom in the real-world dynamic environment. Hence, environment becomes an integral aspect of learning.

Although environment plays a significant role in the process of learning, the classroom leaning is still limited to several real and virtual boundaries. If we can establish a relation between what is taught in the classroom and what students observe outside the classroom in the dynamic environment, the quality of learning as well as learning outcomes can be improved significantly [4, 5, 6]. Hence, we propose a system that makes use of environment in enhancing the learning outcomes. The aim is to help students establish a connection between what they learn in the classroom and what they observe when they leave the classroom. There will be random things in the dynamically changing environment that the students observe. However, many of these observations might contain a practical application of what students learn in the classroom. If students can be made aware of these practical applications, then their interest towards studies can be influenced. Motivation and interest are the two factors that affect the quality of learning, and it is because of these two factors, we have different learning outcomes in the same class, taught by the same teacher using the same techniques and following the same textbooks.

Apart from interest, intrinsic motivation is another factor that leads to improved learning outcomes. When a student is able to establish a link between classroom studies and the outside world, intrinsic motivation also tends to increase. All these factors contribute towards improvement in learning outcomes. Hence, such a system can be of use in developing thinkers rather than to promote rote learning. The notes taken by a student during lectures may be considered as a source of information about the learning that took place in the classroom and the observations made outside the classroom may be captured as pictures.

Taking notes during lectures is an integral component of formal classroom learning [7] and academic literacy. Almost every student writes some notes while the teacher is lecturing. However, a combination of variables leads to a variety of note-taking strategies that the students develop over the period of learning [8]. Differences in these strategies make notes a unique source of information about learning that took place in the classroom. We have developed a system that utilizes the potential of notes by relating them to the real world observations. By analyzing the notes of each student, our system can get a huge amount of relevant information on what the students have learnt so far and would probably be interested in. The second input to the system is images. To relate this information with objects present in the real world and to find applications of concepts assimilated in the dynamically changing environment, our system requires student to capture some of their observations as images. As mobile devices with camera are now easily accessible, it is not difficult to click a picture of what students find interesting or useful. Using the picture clicked and the notes students prepared in classroom, our system can provide students useful information from the World Wide Web.

The remaining paper is structured as follows. Section 2 explores the use of images and class notes as learning aids. Section 3 explains the working of our system. Section 4 presents the results and analysis of our survey outcomes. Section 5 concludes the paper.

II. Prior Work

Both images and the Web help students in the process of learning. With exponential enhancements in both hardware and software technologies, large collections of images have been made available on the Web [9]. Query based image content systems are also in use for quite some time now [10, 11]. However, more or less, all sort of multimedia searching research revolves around the retrieval of images from the search engine database using similarity metrics [12, 13, 14]. Venkata and Yadav [15] try to give image based search new directions by searching the Web with content retrieved from image input as query. It is a simple search based on similarity and a list of similar images is returned as results. However, the concepts of segmentation and context are not taken into account.

Although some work has been done on the use of images in learning in the last decade, this still remains an active area for research. Much of the research in this field is based on rather simple use of images as query to search engine. However, our system takes the conventional image search to another level by merging what students learn in the classroom and images they take outside the classroom. For this, the base of learning is derived out of class notes.

Notes appropriately depict the topic according to the perception and understanding of the student. Automated tools to capture classroom experience and software that assist students in note taking are quite common. StuPad [16], NoteTaker [17], SideNote [18], Livenotes [19], Slides2wiki [20] and NiCEBook [21] are some tools that assist students in making notes. However, the idea of utilizing notes and the information they contain to improve learning has not yet been worked upon. Our system tries to relate notes taken by students in the classroom to the real world.

III. Linking Class Notes to the Outside World

Our system recommends students relevant information and web pages based on the notes they have written during lectures and some observations they have captured in the form of images. The ability of students to connect the classroom lessons with its applications in the outside world improves their motivation and interest. Keeping this in mind, the system takes the class notes of a topic as input. In the first step, the student uploads the notes of a particular subject in pdf format. The working of our system can be summarized by the following steps.

Step 1: The system extracts text strings after converting the notes user uploads into an image using an optical character recognition system.

Step 2: Because we are dealing with handwritten notes, the strings thus generated might have spelling mistakes, which are corrected before proceeding further.

Step 3: The system then selects nouns as the informative words from the set of text strings.

Step 4: The nouns obtained in Step 3 may have been used in a variety of senses. Hence they are converted into technical terms using an e-book the students are has chosen for a particular subject. While uploading the notes, students are asked to provide the name of that book. The index of the book is then used to give the search a direction.

Step 5: A simple search is carried out to pick up index phrases that contain the exact keyword at some place. Now, we move on with a set of technical words that represent the summary of learning that took place in the classroom.

After referring to the textbook of the course and the index, we get index phrases that are technical and more appropriately depict the terms used with relevance to that course. Similar reference is made for each noun and a set of index terms ***I*** is obtained. This helps in narrowing down the search and we can expect relevant results. For example, after getting the concept words from notes, we have three separate words “process”, “control” and “block”. If we search the Web using any one of the words as a separate search query, the results are likely to be unsatisfactory. This is because each of these words can be used in a variety of contexts and the results would be vague as the search query would lack the sense in which the word is used. However, after referring the index of the book, we get a keyword – “process control block”. This represents the exact term in which the user is probably interested. All such index phrases containing the concept words in some form will be taken as keywords.

After the system gets the relevant information from the notes, it is time to see what observation comes from the dynamic environment. While moving, suppose a student finds an object that she/he would like to know more about. She/he can just submit the picture to any search engine. This will give general search results with web pages containing all sort of information. However, relating this observation to classroom study is the aim of our system. For this, meaningful information needs to be extracted from the image as well. Following steps are involved in processing images.

Step 6: A student uploads an image of the observation she/he wants to pick from the environment. The system identifies important distinguishable objects from the image. An image may contain just one object, or have an entire scene containing several objects.

Step 7: Store the objects that are identified from image in $\boldsymbol{T}$. Let $\boldsymbol{T}$ be the set of objects present in the image.

Now, the system has information derived from two completely different sources. The next step is to utilize this information and formulate a relevant search query. After performing an exhaustive search with all the available tags and technical terms, the search results we get need to be scrutinized. The entire process of filtering is as follows.

Step 8: Using a cross product of all the objects detected, $\boldsymbol{T}$, and the index phrases extracted, $\boldsymbol{I}$, the system generates appropriate search queries.

Step 9: A lot of results are produced, but we are particularly interested in web pages where any $\boldsymbol{T_i}$ and $\boldsymbol{I_i}$ co-occur frequently. For filtering, the system uses Mutual Influence Factor (MIF) to represent a count of positional relationship of tags and index phrases in a particular web page.

$$M.I.F. = 1 - \frac{1}{1 + e^{-(\alpha \cdot X + \beta)}} \qquad \ldots (1)$$

where $\boldsymbol{X} = |\boldsymbol{P}[\boldsymbol{I_i}]-\boldsymbol{P}[\boldsymbol{T_i}]|$ with $\boldsymbol{P}$ being a keyword-position map that maps a keyword to its position in the document, α is slope factor and β is bias factor [22].

A high MIF score represents a low distance between the index phrase and the tag word. For example, the system used 336 index words from the notes of students attending a course on operating systems and crossed them with 11 tags picked from an image of a sea shore. The initial search results obtained were 15878 web pages and were based only on keyword matching. On applying the MIF score filter, the system can narrow it down to 25 results. For the above results, $\alpha = 0.01$ and $\beta = 0$ were used. A higher value of α would eventually lead to a lower value of MIF. Thus, α is inversely proportional to the number of filtered results. Similarly, a positive β value leads to a lesser number of results and to increase the search results we can set the value of β to a negative number.

Step 10: Web pages with high mutual influence score were found to be more relevant and hence the topmost was recommended as information to the students.

IV. Experimental Results

To assess the relevancy of the results, notes of students studying a course on operating systems were taken. Class notes along a random images clicked (for example, Fig. 1 and Fig. 2) were given as input to the system. The images, notes and recommendations were circulated among the students who have studied the courses on operating systems and high performance computing. Some questions were asked to check whether the students found any connection between the notes uploaded, the image taken and the information generated by the system. The results are depicted in Figs. 3-6 where the graphs show the responses gathered. The students were asked to rate the relevance of the results on a scale of 1 to 5, where 1 means the results were not much related to the image uploaded and the notes and 5 represents a high relevance. A total of 69 students responded to the survey and the results indicate that linking classroom studies to dynamic environment is indeed beneficial for students learning.

Fig. 1: First image clicked by student

Fig. 2. Second image clicked by a student.

For Fig. 1 and notes of operating system, the students uploaded, the system found a connecting link in 'Leaky-bucket thread scheduler in a multithreading microprocessor'. Since one can see a major portion of the image is covered with water. Leaky-bucket scheduling algorithm is definitely an element of surprise and of course relevant. However, it is the users who can decide whether the information is useful for them or not.

After analyzing the notes, detecting objects from the image and making use of the procedure discussed above, the following recommendations were produced for two images and notes of operating systems and high performance computing courses.

R1: For Image 1 and notes on operating systems information about "Adaptive job scheduling using neural network priority functions" was given as recommendation to the user.

R2: For Image 2 and the same notes, the system found a connecting link in “Leaky-bucket thread scheduler in a multithreading microprocessor”

R3: In an attempt to find the relation between Image 1 and the notes on high performance computing, “Personal rapid transit system having linear induction motor installed on bottom of vehicle” was found most suitable.

R4: “Exploration method and system for detection of hydrocarbons from the water column” was the title of the article that suited best for Image 2 in context of high performance computing.

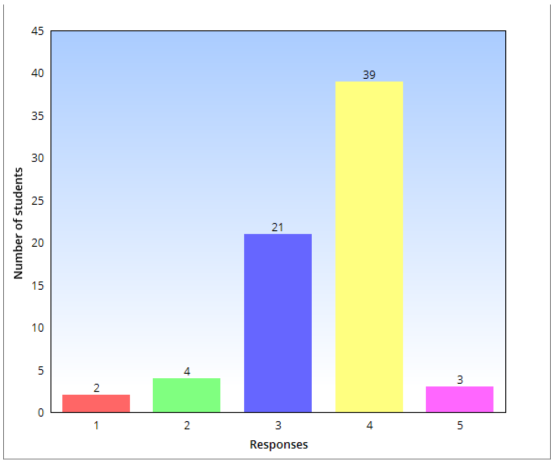

Fig. 3: Responses for R1

As seen in Fig. 3, a total of 39 (56.5%) of the students found R1 considerably relevant as they have given it a high rating of 4. Although some respondents have not found the result useful, majority has given a rating above average and this indicates that the results were quite relevant. From the analysis of the survey results, it can be concluded that the students found R2 even more relatable as 29 (42.0% of the total students) gave R2 a ranking of 4 and a quite high percentage of students found it relevant enough to be given a score of 3 (Fig. 4). R3 also received the scores of 3 and 4 from a total of 48 students (36.2% and 33.3% responding with ranking 3 and 4 respectively) as seen in Fig. 5. Students also found R4 quite relevant as the responses most students gave range from 3 to 5 (Fig. 6).

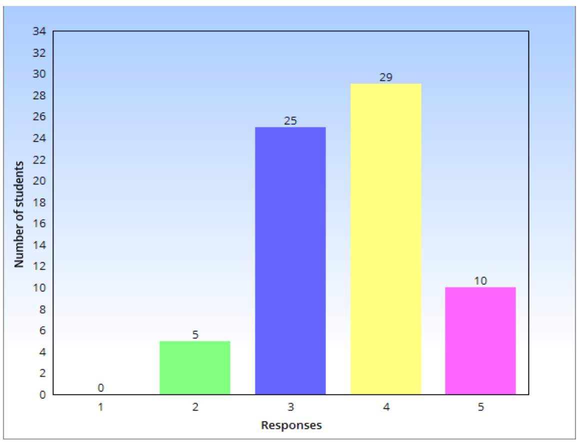

Fig. 4: Responses for R2

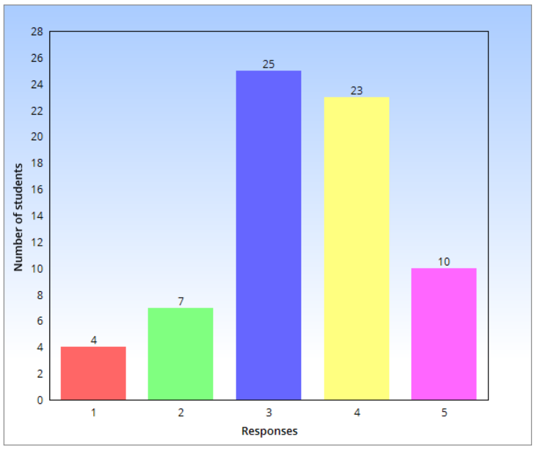

Fig. 5: Responses for R3

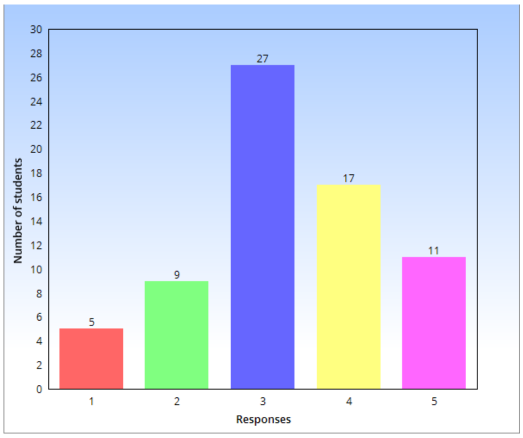

Fig. 6: Responses for R4

V. Conclusion

The system to link class notes to environment can also be viewed as a way to find out applications of classroom studies in the any object the student observes outside the classroom, and that too in a personalized manner. It utilized class notes for the betterment of the learning process with the help of mobile technology. It can be seen that environment is an inseparable component of learning and its connectivity with classroom learning can open the doors for improved learning outcomes. The results of the survey indicate that the information generated by the system was quite relevant, but a few improvements can improve the results and hence the learning outcomes as well.

Although this is just an attempt to make learning ubiquitous by eliminating the boundaries of classroom, the results are encouraging enough to work towards the concept of learning on the fly. Learning on the fly or learning in the dynamically changing environment can definitely produce intellectuals with strong base and professionals with capabilities of reasoning rather than just promoting rote learning. Hence, the advancements in technologies can be used in the direction of making learning ubiquitous.

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