A Case Study on Project-Based Learning for the Gifted: Development of Educational Software Using Multimedia Data

HOSSOOK KIM¹ and HYOUNGSEOK KIM²
¹Dept. of Mathematics & Computer Science, Korea Science Academy of KAIST
105-47 Baekyangfwamnun-ro Busanjin-gu Busan, 614-100, Republic of KOREA
khosook@kaist.ac.kr
and
²Dept. of Multimedia Engineering, Dongeui University
176 Eomgwang-ro Busanjin-gu Busan, 614-100, Republic of KOREA
hskim@deu.ac.kr

Abstract: We performed a project-based learning for mathematical and scientific gifted students, which develop educational software programs using multimedia data, in order to enhance their information scientific creativity, problem-solving ability, and teamwork. Through the project progressing we propose a new procedure of project-based learning which is suitable for information science, and introduce project topic selection methods, evaluation methods, and practical considerations in aid of their strong motivation. We introduce our project results in detail and hope that it can give actual help to other teachers who will phase in the team project-based learning of information science for the gifted high school students.

Key-Words: Project-based learning, Multimedia data processing, Gifted and talented education, Information science

1 Introduction

What is the gifted and why do we consider the curriculum of computer science for gifted students? Gifted and talented children are those identified as outstanding abilities by professionally qualified persons, are capable of high performance. The children require different educational programs and/or services beyond those normally provided by the regular school program in order to realize their contribution to self and society [1]. To achieve these objectives KSA (Korea Science Academy) of KAIST was established in 2003. KSA is the first educational institution of Korea for scientifically gifted students of the national level, and aims to nurture creative global leaders who can contribute to human society [2].

In general, there are three educational objectives of informatics for gifted children. One is an academic information education as a field of science. The other is one needed in the use of computer technology as a scientific research tool. The third is to enhance the creative problem solving ability that is the most important objective. The ability is to logically understand the given problem, to be capable of designing a creative solution, and to cooperate with each other in order to efficiently solve the problem. Specially, it has been needed the creative problem solving ability in the recent situation where all sciences rely heavily on the use of computer. To achieve these objectives KSA has been providing a variety of educational programs in the department of information science. However, the lecture-based learning is capable of achieving the goal of understanding all of subject contents, whereas there is a limit to achievement of the goal of enhancing the creative problem solving abilities.

In this paper, we propose a project-based learning to achieve the learning objectives of information science through which the gifted students may logically understand a variety of real world problems, develop the algorithms to creatively resolve the problems by using computer, and efficiently organize the solutions in cooperation with team members.

2 Related Work

A variety of studies have proven that when implemented well project-based learning can enhance students' passion for learning. Moreover, project-based learning has several good advantages. Through the process that students participate in solving the problems related with real life, they may...
take a variety of interest that cannot be provided by the teaching-learning method that emphasizes on only acquisition of knowledge and technique. The project-based learning method enables them to enhance self-motivation and responsibility, to develop cooperative spirit through team work, and to apply the knowledge learned in class to the real life problems [3]. Moreover, the students may demonstrate better teamwork and communication skills. They have a better understanding of the complexities of other issues involved in professional practice [4].

The project-based learning proposed in this paper is based on the enrichment model of Renzulli [4] which is mainly used in the field of gifted and talented education. The enrichment triad model makes students find out their research topic, do research for themselves, and produce inventive outcome. It is evaluated as one of the learning methods that are mostly suitable to draw out and train students’ capacities. The model consists of three learning stages: exploration, acquisition, and investigation. In the third stage of the enrichment learning, students actively perform all learning activities such as problem finding, the design of research methods, and the prediction of final outcomes, and teachers play the role of a coach who make students rightly perform these activities.

3 Research Method and Procedure

3.1 Research Object and Environment

This study was conducted in two classes of 22 students at Korea Science Academy of KAIST that is a gifted science high school in Korea. The classes consist of 4 girls and 18 boys, and the subject is “data structure and algorithm I” which is an elective course of information science. The course is for students who completed course “JAVA programming” which is a basic liberal arts educational course of KSA.

3.2 Organized Project Performance Process

In general, information science projects through programming are accomplished by the three processes: preparation, progress, and presentation and evaluation. In project preparation process, teachers suggest information on project procedure, schedule, and valuation criteria. Students organize teams by themselves and write their project proposals. The proposed proposals are presented in class and the project scope may be rearranged through deep discussion with all students and the teacher. Moreover, our model adapted a co-advisor system so that students can be advised by the experts in the field of the proposed project. For example, if the topic of a team is about physics, the team should have a physics teacher as its co-advisor. The co-advisor has to evaluate whether the topic is meaningful from a physical point of view, whether the result of the project can reach the goal, and whether the students may assiduously participate in the project. The basic project processes such that analysis, design, implementation, and unit test are performed by students themselves after school. In an interim announcement, the direction of project progressing and project matters can be discussed with other teams and advisors. When project is finished, the students make a poster with Power Point and then present the final result of the project with software testing. In the final presentation the assessment of the advisors and the mutual evaluation of students are accomplished as the final process.

3.3 Considerations in Topic Selection

Multimedia is a new type of media which provides the public with both information and pleasure by using information contents and process such as text, audio, video, animation, and interaction. Computer of the early days deals with only text, whereas that of nowadays is able to process a variety of media compounded from audio and video due to the progress of input and output technologies. So multimedia becomes a useful tool to present freewheeling solutions of practical life problems which are resolved by our gifted students. The use of multimedia is a requirement of our project-based learning.

There are several considerations in topic selection. The topic should be selected in real life problems. The solutions of the problems must be educational software programs which deal with multimedia data and enables students to confirm the educational effect of information science. The main idea of the solution should be induced by examining the problem from various angles. Moreover, each of team members must be enabled to play their own role for themselves.

3.4 Considerations in Evaluation

The objectivity and fairness of evaluation are fundamental factors for successful project accomplishment. So in our project-based learning model, the project rubrics were provided in all
evaluation process and the excessive competition was prevented by adopting absolute evaluation. The agents of evaluation consist of the following three groups: individual students who carry out the project, the primary advisor who is the teacher of the class, and the co-advisors who give academic assistance to project teams. So each team was able to get dimensional feedback from the agents through multi-phasic evaluation such as individual evaluation, peer evaluation between project team members, mutual evaluation of teams, and expert evaluation.

4 Project-Based Learning Outcomes
In this section, we introduce some educational software programs of the fields such as music, history, and chemistry, which are outcomes of our project-based learning. And we review our final presentation conference in order to improve on our learning model.

4.1 Music: Chord Generator
This software generates suitable chords for given melody lines. In general music consists of melody and chord. It is intimately related with music transcription to look for the suitable chords for the melody. Music transcription is hard for beginners because it needs a lot of knowledge of harmonics. In this project, students resolved the problems by using a genetic algorithm. This software enables you to automatically generate stable chords for a given melody so that it helps novice musicians to easily compose and arrange music. The software has several functions: musical note input, tone selection, chord output, chord modification, and chord saving as shown in Fig. 1.

Fig. 1: Music : Chord generator program

Fig. 2: History : Chronological territory change program
4.2 History: Chronological Territory Change Program
This software enables students who are studying history to see at a glance the changes of chronological territory and to effectively study history by relating the change with the characters of chronology. If students change the year by using a scroll bar, then the program dynamically shows the change of territory and the important characters of the time on a computer screen. So this program enables them to interestingly study history as shown in Fig. 2.

4.3 Chemistry: Chemical Nomenclature Learning Program
It is fundamental to know the exact name of chemical compounds when students study chemistry. This software was made to help students study chemical nomenclature. The menu of the program is so organized that students can practice the study of chemical nomenclature over and over again by quiz per category for chemical compounds such as inorganic compound, organic compound, and complex compound as shown in Fig. 3. If they need some help when it comes to solving quiz, the software enables them to learn the related contents by pressing a hint button.

4.4 Final Presentation Conference
We held the final presentation conference in the last class of the semester. All of students of the two classes attended the conference and other students out of the class as well as co-advisors are invited. Students made and displayed posters which explain the results of project. Moreover, all of software programs developed in class are also exhibited so that everyone may execute them. This conference was a good chance for students to understand the importance of user-centered project design and feel a great sense of accomplishment in their team.
project. Fig. 4 shows the scenes of our final presentation conference.

5 Conclusion
In this paper, we introduced a project-based learning process of information science for the gifted students of mathematics and science. We gave students the right to freely choose the topic of their team project, and they have to develop educational software programs by using multimedia related with various real life problems. We performed co-advisor system, multidimensional evaluation and final presentation conference for increasing students’ participation and the completeness of projects. In order to show the superiority of our model we introduced three project outcomes which have been processed under our project procedure. This case study may be useful as reference material when teachers progress information science classes in order to increase the creative problem solving ability and teamwork of students.

References: