Exploring the Emerging Technologies on Senior High School Curriculum

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Abstract:

In this study, the investigators employ emerging technological innovations to develop the mathematical teaching modules in project-based courses. The final result was presented in the students' academic performance of the end of semester. And the high school students' inquiry learning spirits are elevated, too. Moreover, the investigators make students understand the essence of mathematics and science through teaching innovative curricula and also make them learn more about the scientific method.

Keywords: Smart handheld devices, Emerging technologies, Mathematical modeling

1. Introduction

In Taiwan, mathematics curricula have been revised for many times. However, the framework of the main courses just slightly modified a little [1]. Up to now, there is only computational mechanics, mathematical tools and geometric drawing which are added in the mathematical instruction, but emerging technological courses almost got no mention in senior high school [2]. Also, because tests have a powerful "backwash" effect, this makes students just learn how to manage the skill in tests with teachers [3].

Our study adopts the National Experimental High School at Central Taiwan Science Park as the target school for the study. Our study aims at developing and exploring the curriculum design of smart handheld devices in senior high school, and a teaching evaluation will be carried out in the end. The content of the research is as follows: (1) development of project-based courses in problem-solving; (2) curriculum integration. The incorporation of emerging technology into the curriculum of senior high school will be accomplished within three years through the project-based courses in phases. Finally, a curriculum evaluation will be adopted to assess the outcome of the instruction by the Center of Teacher Education at National Chung Hsing University.

Specifically, the overall objectives for this integrated program are:

(A) developing innovative courses on green energy and handheld devices.

(B) studying the effect of project-making on the teachers and students.

(C) proposing criteria suitable for the evaluation of project-based learning to assess the outcome of this project.

(D) exploring the effect of the courses mentioned above on the teachers and students through the evaluation and action study.

This curriculum development study implements the High Scope program through practical courses developed using special topics to establish an approach for improving the effectiveness of student skill or ability acquisition. For example, their curiosity toward new knowledge, independent thinking, problem solving, descriptive skills, social life adaptability, group co-operation, memorization, creativity, execution, as well as gaining practical knowledge and learning techniques, good living habits, and effective operating models. Furthermore, the project's objective is to encourage enthusiasm toward learning about emerging technologies within the National Experimental High School At Central Taiwan Science Park, as well as promote further student, parent, and teacher understanding of inquiry- and integration-based educational concepts and methodologies. It is anticipated that the characteristics of a school-based curriculum can be gradually developed and established to become a foundation for improving the contents of other courses in the future.

2. Materials and Methods

The study aims to incorporate emerging technology into high school mathematics. The most powerful way to sustain in global competition is to develop emerging technological innovations. Therefore, many of the developed countries try to strengthen advanced technological development capabilities to grow national economy [5]. Furthermore, the "high scope program" is implemented in over 40 countries and elaborated many times, and also constructs the systematic methodology, including the scenario analysis and so on [6].

The instruction with information technology integrated is not just teaching "information class" but using information technology to reach the instructional objectives and nurturing students the interests and passion for learning as well as promoting student learning achievement. In addition, teachers have to enrich themselves' background knowledge in order to apply and plan instructional strategies in courses [7].

In addition, there are a lot of hillside disasters which are caused by extremely climate change and illegal land usage in Taiwan in recent years [11]. Therefore, in order to allow students to learn more about protecting national forest lands and to strengthen students the ability of analyzing the mathematical data efficiently, constructing the basic mathematical models, as well as promoting reasoning skills in mathematics instruction, the investigators develop the teaching materials which include bias function applied in emerging technological innovations for hillsides conservation. [8-10]

To increase high school students' interest in learning about new scientific knowledge and the effectiveness of their skill or ability acquisition, our study employs technological fields such as smart handheld devices, and incorporates them into high school earth sciences, mathematics, information technology, and other academic subject knowledge. These are then applied in the inquiry-based learning of environmental sciences. This is done to achieve the expected outcomes of the project for this year, which include the following :

(1) Developing new course prototypes on emerging technological innovations such as: "GIS and GPS Smart Handheld Device Applications," "Integrated Development of Smart Handheld Devices and Computational Mathematics."

(2) Strengthen high school teachers' spirit of inquiry-based teaching and professional knowledge of emerging technology.

(3) Increase high school students' interest in learning abstract mathematical and scientific subjects.

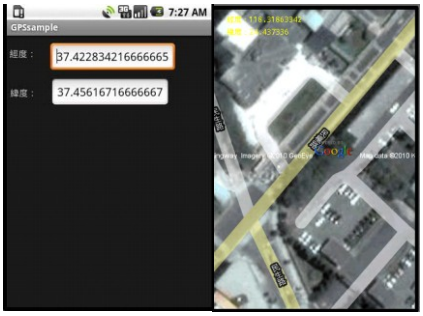
(4) Develop students' scientific inquiry learning abilities and skills.

(5) Develop documentation for educational evaluation of courses characterized by project-based learning.

The development and research of these courses are divided into four phases:

(1) Information gathering and expert/scholar consultation: For information gathering regarding the development of innovative courses for this project, the focus was placed on reference materials regarding smart handheld device technology applications, cooperative learning theory, action research methods, and the research and promotion of the first-phase High Scope program curriculum as the foundational background knowledge for research methodology and curriculum development. For expert/scholar consultation, the green energy and smart handheld device application innovative courses organized a series of High Scope educators' professional development lectures. Furthermore, the project maintained close contact with experts and scholars to enhance professional guidance for curriculum development instructors.

(2) Innovative curriculum development and design: This project's innovative curriculum design focuses on integrating topics, including "technological development of smart handheld devices," "GPS," "GIS," with mathematics, earth sciences, and other foundational high school science courses for curriculum study, thereby making scientific inquiry-learning interdisciplinary and relevant to current environmental concerns. Regarding the educational goals of various innovative curriculum contents, for cognition, students gain an understanding of global climate change and modern technological developments through environmental protection, natural environment, daily life, and other scientific topics. For affective portions of course-learning, the curriculum developed students' scientific inquiry capabilities, such as the ability to observe, gather information, think, discover, cooperate and engage in co-operative learning, and articulate and present. For course learning skills regarding smart handheld devices, through the daily application of GIS and GPS in smart handheld devices, students were taught the essence and content of integrating coordinate transformation from high school mathematics and IT science, thereby experiencing the application of information science in various fields of GPS and GIS(as shown in Pic. 1).



Pic. 1: Smart handheld device in the GPS program design and students use GOOGLE MAP to obtain Satellite picture.

(3) Project-based curriculum implementation: The subject of this project's innovative curriculum research included 89 first-year high school students at the National Experimental High School At Central Taiwan Science Park who enrolled in optional project-based courses for mathematics and the sciences, as well as instructors involved in curriculum design. The curriculum implementation of special topic courses on smart handheld device application were divided into two phases. In the first phase, a series of lectures on new smart handheld device technology were conducted for students and

instructors participating in the project. Through classroom observation records and course-learning forms, curriculum design and development instructors gained an understanding of students' learning situations relating to lecture topics, as well as their attitude toward learning and their feedback. After the lectures, experts and scholars were interviewed, and the contents of the consultation were documented. In the second phase, educational activities were conducted according to the contents of the curriculum design. Course experimental equipment were purchased, and computer classrooms were set up. Through National Chung Hsing University's Educational Laboratory, participating students experienced "GIS and GPS Smart Handheld Device Applications" and other experiential courses for emerging technologies. Information and records obtained in the process of implementing various project-based courses were internally checked, analyzed, and discussed, as well as evaluated and analyzed by outside experts, and used to adjust the contents of the curriculum design.

(4) Examining and investigating the efficacy and results of the curriculum implementation: Results of the various curriculum developments in our study were analyzed using action research and course evaluation. This provided curriculum development instructors with an opportunity to examine, reflect on, provide feedback, and correct the curriculum design content, and strengthen students' scientific inquiry learning spirit and interest in emerging technologies, thereby improving the educational results and efficacy of the course development and implementation. Analysis of the results of curriculum development and the efficacy of implementation will form the basis for the revision of curriculum content for the second year of this project. These analyses will also be available for curriculum instruction resources sharing, and be used for the development of related technology extension courses and other promotion and study on innovative curriculums.

3. Discussion

For the university team of our study, observation and analysis of curriculum teaching or instruction efficacy and student ability performance were conducted using Kirkpatrick's four-level evaluation model for assessment. According to the research structure and the objectives of the research as a whole, the National Experimental High School At Central Taiwan Science Park was assisted in using the PDCA cycle in the "development of innovative high school curriculum integrating smart handheld devices. " Through participatory evaluation, organizational learning was encouraged, and the National Experimental High School received assistance in completing the first year's curriculum development. Evaluative tools, including questionnaires, interviews, classroom observation, and the Delphi technique course evaluation were employed. Furthermore, instructional evaluation results for teachers were facilitated through professional development activities for instructors, development of an information sharing platform, and similar means. Thus, a curriculum evaluation system was gradually established.

The evaluation system developed by our study is conducted through five channels or methods:

(1) Assisting to define the curriculum capability index: The capability index for smart handheld devices courses developed by instructors was organized and sent for assessment to a team or panel of Delphi technique experts, including approximately six domestic scholars and experts with specialties related to the discussed courses. The results were provided to instructors as the basis for adjustments

to curriculum development.

(2) Quantitative data analysis: through the administration of a pre-test questionnaire sampling and testing and statistical analysis, students' knowledge on the application of GSP in smart hand-held devices were assessed. These figures were then provided to instructors as reference and advice in developing special-topic practical courses.

(3) Qualitative survey interviews: The university team within the project evaluated the instruction from a theoretical perspective. Through classroom observation(as shown in Pic.2), interviews with the four curriculum development instructors, and interaction and discussion between the evaluation team and instructors, it became apparent that the instructors' professional literacy regarding emerging technology instruction had grown. Furthermore, through semi-structured interviews with students who had participated in the project's special topic courses, the reliability and validity of the quantitative questionnaire were supplemented.

Pic. 2: University evaluation team engages in classroom observation.

(4) Facilitated the organization of professional development special-topic lecture series for instructors and introduction of the first-phase High Scope program's promotional resources: To allow curriculum development instructors to quickly grasp the spirit of inquiry-based teaching, the evaluation team assisted in organizing workshops to advance instructor professional growth. Science education expert gave post-lecture interviews to raise the instructors' professional science education literacy(as shown in Pic. 3).

Pic.3: Science education expert Hsiao-Lin Tuan was invited to lecture on "The Theory and Practice of Inquiry-based Science Education".

Additionally, we also visited the first-phase High Scope project team for National Miao-Li Agricultural and Industrial Vocational High School (MLAIVS) to observe the experimental model and evaluate its results(as shown in Pic. 4), thereby fully gaining promotional results. This was significantly beneficial to the development of the instructors' curriculum and course or curriculum evaluation.

Pic 4: Team instructors visit National Miao-Li Agricultural and Industrial Vocational High School for exchange.

(5) Development of an information Web site sharing platform: Through the

university team's overall project guidance, the evaluation team integrated all evaluative tools, analysis data, and reference materials and used an internal platform to act as the system for the project's curriculum development and evaluation. The platform allows project participating personnel to search for evaluation results with ease as the basis for curriculum improvement feedback.

4. Results

In the exam-oriented education, it is hard for teachers to make students enjoy math and identify for the core values of mathematics. And in the traditional instruction, students tend not to emphasize on understanding the mathematical concepts in the curricula but the mathematical calculations; also, students usually can't acknowledge that mathematics is an integral part of daily life [4].

In view of this, the purpose of this study is to design innovative mathematical curricula which can make students enhance the abilities about the selection, analyses and application of data in real life. In addition, it is also a chance for teachers to rethink both what should be taught and how it should be taught in the development process. And it is also provided for students to conduct investigation of patterns, relationship and problems as a new learning model. In other words, the curricula are not only innovative teaching modules but also new learning modules.

Furthermore, the investigators employ the smart handheld devices, including Tablet PC and 3G smart phone, which can be widely adopted anywhere and allow student for implementing experiment program and having interaction, to develop the high school innovative mathematical curricula which cater for the needs of society.

The investigators evaluate the feasibility of the curricula and explore the effectiveness in this study. All of the above, we expected that the implemented effect cooperate with "the smart handheld devices" of the trend and the development of modern technology in the world. And also the promotion of a conception of mathematical literacy for students is anticipated.

According to Chiou-mei Hung[12] who inferred that "Science instruction not only should emphasize on modeling activity but also need to make students identify the importance of the modeling contents of its knowledge components." To sum up, the study found that based on this experimental instruction, the students have good performance on research papers and competition [13] (as shown in Pic. 5). Please surf the following URL (www.nehs.tc.edu.tw) for further information. In the future, the project achievement will be reported as experience sharing for curriculum development.

Pic. 5: Students win prizes at the Popular Science Mini-Dissertation contest under instruction of teachers.

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