

An Instructional Design for the Converged English-Science Teaching Method using PBL Model in Elementary School

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PBL 모형을 적용한 초등학교 영어·과학 융합 수업 모델 설계

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Abstract In order to cultivate talented people with national economic influence in the rapidly changing 21st-century modern society, STEM(Science Technology Engineering Mathematics) education has been emphasized in advanced countries such as America and England. In South Korea, STEAM(Science Technology Engineering Arts Mathematics) education is emphasized by adding Arts. The objective of STEAM education is to strengthen the interest and motivation of learners, to focus on experience, exploration, experimentation, to solve convergent thinking and real-life problems, rather than cramming method of teaching and memorization. This study identifies an instructional design for converged English, the world's official language, and science which is found in nearly all disciplines. With the development of the 4th industrial revolution based on the PBL model, learners participate in their lessons voluntarily for problem-solving skills. The instructional design based on the ADDIE model consists of 5 procedures: Analysis, Design, Development, Implementation, and Evaluation. The goal of fostering talented people with national economic influence is also important, and the teacher in education must recognize the importance of STEAM education and an appropriate instructional design should be studied constantly.

요약 급격히 변화하고 있는 21세기 현대 사회에서 국가 경제력을 갖춘 인재 양성을 위해 최근 미국, 영국 등 선진국을 중심으로 STEM(Science Technology Engineering Mathematics) 교육이 점차 강조되고 있으며 우리나라에서는 Arts(예술)를 추가하여 STEAM(Science Technology Engineering Arts Mathematics) 교육이 나타났다. 융합(STEAM) 교육 목표는 기존의 주입식 및 암기식 교육이 아닌 학습자들의 흥미도와 학습에 대한 동기 부여를 강화하여 체험, 탐구, 실험이 중심이 되어 융합적 사고와 생활화 문제를 해결할 수 있는 능력을 갖추어 국가 경제력을 강화하는 것이다. 본 연구가 이루어진 Y 초등학교에서는 세계 공용어로 자리매김한 영어와 4차 산업 혁명으로 인한 발전으로 거의 모든 분야에서 찾아볼 수 있는 과학을 융합하여 학습자들이 주도적으로 수업에 참여하여 문제해결능력을 향상할 수 있는 PBL 모형과 ADDIE 모형이 기반이 된 수업 모형을 설계하였다. 이 모형은 크게 5가지 절차로 분석(Analysis), 설계(Design), 개발(Development), 실행(Implementation), 평가(Evaluation)로 구성된다. 국가 경제력을 갖춘 인재 양성이라는 목표도 중요하지만, 교육 현장에 있는 교사들이 융합(STEAM)교육의 중요성을 인지하고 이에 알맞은 수업 설계에 관한 연구가 지속하며 강화되어야 한다.

Keywords : Analysis, Design, Development, Evaluation, Implementation, PBL Model, STEAM(Science Technology Engineering Arts Math)

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1. Introduction

There are two types of talented people in 21st modern society. First, the ability to quickly learn new knowledge. Second, problem-solving skills, communication skills, teamwork, and the ability to use technology. To keep up with the fast pace of the world, recently developing countries such as America and England have gradually emphasized on STEM education, and STEAM education has been implemented by adding Arts in Korea. Arts can be extended to a wider area, including arts as well as liberal arts education.

STEAM education aims to strengthen the interests and motivation of learners, rather than traditional infusion and teacher-centered education, to focus on experience, exploration, and experimentation[1-2]. STEAM education is a policy within the framework of the national curriculum related to Science, Technology, Engineering, Arts and Mathematics. Traditional education focuses on knowledge, concepts, and theories by each subject but the goal of STEAM education is to strengthen learners' interest and motivation.

Likewise, society wants to cultivate talented people with convergence capabilities, but STEAM education has not been generalized in the school field or it provides a one-time level of convergence lessons focused on specific subjects[3].

In this study, an instructional model is designed by PBL(Problem-Based Learning) method which is based on constructivism that learners acquired knowledge by peers and interaction, and they participate in the lesson voluntarily for problem-solving skills[3]. And English subject which is the world's official language and Science subject which is found in almost all the fields with the development of the 4th industrial revolution are combined for convergence education in this study. According to S. D. Schoettler(2015), the combination of

teaching foreign language and STEM education can meet the needs and interest of diverse learners and further influence the future career choices of learners[4]. And English textbooks recognize the importance of convergence education, but the research on it is practically inadequate[5], so this study conducted English convergence education.

This paper contains Introduction in Chapter 1, PBL(Problem-Based Learning) Concept, STEAM(Science Technology Engineering Arts Mathematics) Concept in Chapter 2, STEAM Design Model, Analysis, Design, Development, Implementation, Evaluation in Chapter 3, and Conclusion in Chapter 4.

2. Theoretical Background

2.1 PBL(Problem-Based Learning) Concept

PBL model is not a teacher-centered method but it is based on constructivism that students take part in the class voluntarily with responsibility. In PBL model, ill-structured problems are key-concepts that students try to solve them with their group mates, so they are able to achieve the goal without a teacher's assistance[6-7].

2.2 STEAM(Science Technology Engineering Arts Mathematics) Concept

If we look at the meaning of "fusion" and "convergence" according to the standard Korean dictionary, different kinds of things are melted and merged together or made indistinguishable from each other[5]. Likewise, convergence education in the education field can be regarded as education that converges knowledge or skills of various fields in order to cultivate an integrated, creative and thinking talent. The reason why the U.S. implemented the convergence education is learners' performances

in Science and Math were very declining, and they were not interested in engineering and technology. The U.K., Finland, Israel carried out it as well. In America, President Barack Obama ignited a movement to teach students 21st-century skills to become more competitive with other countries in the fields of STEM. It resulted in millions in funding were invested in many schools to promote STEM study[8-9].

Like the above, convergence education has become important in the educational flow around the world. In 2011, the Korean government created a new education policy by adding Arts to STEM (Science Technology Engineering Mathematics) which was emphasized in America[8-9].

Instead of fragmentary knowledge, diversified knowledge should be applied to real life to solve the problems through convergence education[10].

3. Body

3.1 STEAM Design Model

This study's STEAM design model is based on ADDIE model which is consisted of Analysis, Design, Development, Implementation, Evaluation[11].

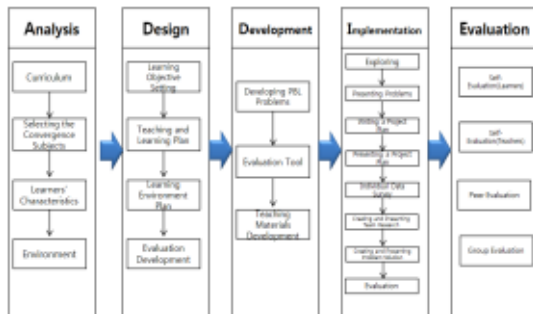


Fig 1. STEAM Design Model based on ADDIE model

3.2 Analysis

3.2.1 Curriculum

What teachers have to do for the effective

learning design at first is exploring the key learning objective and contents, and analyzing the curriculum for the first semester. Pearson Longman Cornerstone 4B is the English textbook used for English specialization at Y elementary school. Unit 4 Problem Solvers aims to learn about current problems, and identify problems and solutions. In Unit 5 Where We Live, the goal is to learn about the environment in which we live, to understand literary works related to tourist attractions and the environment, and to complete an organizational chart. In Unit 6 Links to Our Past, the goal of the lesson is to identify the importance of history, understand the literary works and enumerate stories in order.

3.2.2 Selecting the Convergence Subjects

After reviewing the English textbook curriculum, selecting the units which are capable of linkage and convergence learning is conducted.

This is a table for the comparison between topics from the English textbook and Science textbook.

Table 1. Textbook of English and Science

Subject: English	
Textbook	Pearson Longman Cornerstone 4B
Unit	Unit 4 Problem-Solvers
	Build Unit Vocabulary
	What do you know about problem solvers?
Subject: Science	
Textbook	Science A Closer Look 3B
Unit	Ecosystems
	Living Things in Ecosystems
	Living Things Change Their Environments

3.2.3 Learners' Characteristics

Learners' characteristics and interest were investigated through survey and teachers' observation to motivate learners and to give a sense of challenge. Learners since 1st grade participate in the English class 5 days a week due to specialized English education. The classes are

divided by individual English level. Learners who are in the upper class studied at an English kindergarten or attended overseas training before entering school. The majority of learners regard English as difficult and they are burdened with learning Science in English.

3.2.4 Environment

The objective of English education in the school where this study was done is learner-centered education considering individual differences and abilities. Learners are able to acquire English by communicating freely and learn other subjects in English through the English Immersion Program.

3.3 Design

3.3.1 Learning Objective Setting

The learning goals of the English and Science subjects were set as follows.

First, Learners are able to define problems and solutions, describe problems and solutions for a variety of situations.

Second, Learners' creativity and cooperation can be improved through problem-solving.

Third, Learners are able to think and learn about environment pollution real life with various perspectives, and learners can be aware of social and scientific problems.

3.3.2 Teaching and Learning Plan

The lesson plan conducted in this study consists of 6 lessons. The subjects and contents of each lesson are as follows.

1st Period (English class)

- Organize ideas by problem and solution.
- Define the problem and solution.
- Choose the problem to write about.
- Think about how you solve the problem.

2nd Period (English class)

- List the information in a problem and

solution chart.

- Present

3rd Period (Science class)

- Watch the video clip of pollution and pictures of the trash can and trash of A school

- Present the PBL problem

- After reading the PBL problem, students share ideas to complete the project plan: ideas, facts, learning issues, action plan.

4th Period (Science class)

- Share the project plan.

- Discuss types of pollution, causes of a big amount of trash, how pollution affects living things, how to protect the environment.

- Talk about the solution.

5th Period (Science class)

- Make the PowerPoint slides to draw up the solution.

- Present by groups.

6th Period (Science class)

- Evaluation Time: journal, self-evaluation, peer-evaluation.

- Survey

- Wrap-up the discussion.

3.3.3 Learning Environment Plan

The shapes of desks are \sqsubset or \sqsupset for cooperation activities, researching, debate and discussion activities. Learners are able to use the computer labs to research.

3.3.4 Evaluation Development

The evaluation methods are group evaluation, team evaluation, and self-evaluation. In self-evaluation, what you learned through learning, the strengths and weaknesses of learning methods, how you feel in class, and how you apply the knowledge you learned in real life. Peer evaluation assesses the performance of peer roles.

3.4 Development

3.4.1 Developing the PBL Problems

The core of PBL learning is the problem. Learners should understand their roles and situations and define the problem. The contents of the problem should be ill-structured and related to real life to make learners solve the problem voluntarily. The way of presenting the problem is verbal description, video clips, handouts, newspapers, and articles. After constructing the problem, it is necessary to examine whether it is appropriate to the level of the learners, that the information is well provided for the inquiry, and that the characteristics of the learners are well-reflected.

Through this procedure, the PBL problems of English and Science convergence class were complete. The goal of Chapter 4 Changes in Ecosystems Lesson 1 Living Things Change Their Environments is to think about environmental pollution and identify the solution. The problem is set as follows.

[Problem]

Good afternoon, we're going to start the Yujung student council meeting now. Have you ever seen a trash can in the classroom and a recycling bin on the ground floor at Yujung School? There is a big amount of trash we can see every day. We've heard about pollution from various mass communication. First, we should make a solution. As a director of the environment, please prepare for those questions until the next student council meeting in Powerpoint for the presentation.

Question #1 What are the different types of pollution?

Question #2 What are the causes of a big amount of trash?

Question #3 How does pollution affect living things (people, animals, plants)?

Question #4 How can people protect the environment?

3.4.2 Evaluation Tool

Evaluation is conducted by group members, peers, and self(learners and teachers). The tools for group evaluation is to assess one's roles and self-evaluation should contain what you learned through learning, the strengths and weaknesses of learning methods, how you felt in class, and how you apply the knowledge you learned in real life. Peer evaluation assesses the performance of peer roles.

3.4.3 Teaching Materials Development

Developing teaching materials are required for the class. Instructional materials for the teachers are teaching-learning plan, problem presentation, video clips, Powerpoint, etc., and preparation of an evaluation sheet for evaluation.

3.5 Implementation

In the PBL implementation phase, the teacher should be a guide and a facilitator to make the exploratory, problem presentation, project plan writing, project planning presentation, individual research, team research report writing, team research report presentation, problem-solving presentation, evaluation.

Project planning writing needs creative thinking and critical thinking while cooperating with peers. In this step, 'What you already know', 'What you want to know', 'What you should know' should be included. After this step, the presentation is required. Revision may occur after the presentation. Individual research and team research are required for problem-solving. This is a process of making solutions based on expertise and information. After creating the report, learners present their works. Through the presentation, learners' confidence can be increased. Based on the train model road of Y. S. Cho(2006) based on the entire problem-based learning model, the execution steps were designed as follows[7].

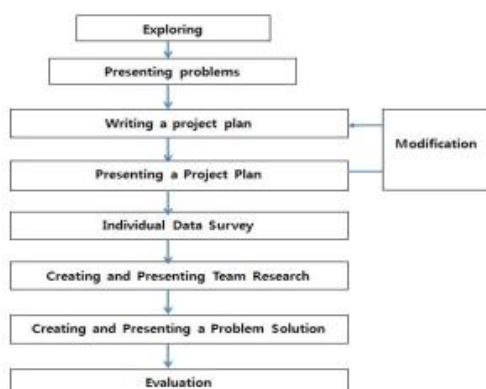


Fig. 2. Implementation

3.6 Evaluation

In the evaluation phase, there is a step of modifying and supplementing a convergence class based on a more effective PBL model based on self-evaluation(learners and teachers), peer evaluation and group evaluation.

4. Conclusion

The ways of traditional education are infusion and teacher-centered focusing on knowledge and theories. But the 4th industrial revolution wants to cultivate talented people who learn and apply knowledge quickly and solve the problems. Advanced countries such as America and England implemented STEM(Science Technology Engineering Mathematics) and a lot of programs regarding STEAM education by adding Arts have been conducted since 2011.

This study is based on instructional design for converged English-Science teaching methods using PBL model and ADDIE model. The effects are as follows.

First, Learners' interest and motivation can be increased through convergence education.

Second, Creativity and converged thinking skill can be cultivated.

Third, The problem-solving skill can be improved through experience and activities

rather than just knowing concepts and theories.

Fourth, Learners can be highly motivated and their confidence and cooperation can be improved.

The importance of convergence education is recognized, but it has not been generalized in the school field. The effectiveness of the combination of teaching foreign language and STEM education is already proved but there is a problem that the actual educational field does not lead to the actual use of English because it emphasizes the content for motivation only.

In the future, a research of the convergence class based on PBL model should be studied constantly to cultivate talented people with national competitiveness.

References

- [1] H. S. Cho, H. Kim, J. Yo. Huh, Understanding of Convergence Talent Education through Field Application Cases, Issue Paper, Korea Foundation for the Advanced of Science & Creativity, Korea Educational Development Institute, pp.1-5.
- [2] J. H. Shim, Y. R. Lee, H. K. Kim, "Understanding STEM, STEAM Education, and Addressing the Issues Facing STEAM in the Korean Context", Vol.35, No.4, pp.709-723, 2015.
DOI: <http://dx.doi.org/10.14697/jkase.2015.35.4.0709>
- [3] C. S. Oh, "Exploring the implementation plan of convergence education at school level in preparation for convergence era", Korean Journal of Educational Research, Vol.57, No.1, pp.331-365, 2019.
- [4] S. D. Schoettler, "STEM education in the foreign language classroom with special attention to the L2 German classroom", Unpublished mater's thesis, Portland State University, Portland, 2015.
DOI: <http://doi.org/10.15760/etd.2310>
- [5] J. H. Sung, "An Analysis of Integrated Education in the 2015 Revised Curriculum and in Middle School English Textbooks", Master's Thesis, The Graduate School of Keimyung University, Daegu, Korea, pp.3, 2019.
- [6] J. Y. Kim, "A Study on the Converged Art-Science Teaching Methods Using PBL Model in Middle School", Master's Thesis, The Graduate School of Education Sookmyung Women's University, Seoul, Korea, pp.5-9, 2018.

- [7] Y. S. Cho, *Theory and Practice of Problem-Based Learning*, Hakjisa, pp. 15-18, 2006.
- [8] S. H. Moon, K. H. Kang, "*Trend of STEAM Education-related Domestic Studies Focusing on Physics-related Studies*", *New Physics: Sae Mulli*, vol. 65, no. 12, pp. 1199-1208, Dec. 2015.
DOI: <http://doi.org/10.3938/NPSM.65.1199>
- [9] J. Gunn. Why the "A" in STEAM Education is Just As Important As Every Other Letter, c2017[cited 2017 November], Available from:
<https://education.cu-portland.edu/blog/leaders-link/importance-of-arts-in-steam-education/>
- [10] J. H. Yoon, "*Analysis of Domestic Research Trends in STEAM-Related Art Education*", Master's Thesis, The Graduate School of Education Soomkmyung Women's University, pp. 15-17, 2015.
- [11] N. Aldoobie, "*ADDIE Model*", *American International Journal of Contemporary Research*, Vol.5, No.6, pp. 68-72, 2015.

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