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A Study on the Development of Teacher Training Programme for Maker Education

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Abstract

Maker education, a new project-based education trend, is becoming important for developing students' creativity, confidence and interest in science and technologies. It can create opportunities for young students to turn their ideas into reality and is consistent with the goals of the Free Semester Program in Korea. This study developed and applied a project-based training programme for 72 teachers to change perceptions on the necessity and possibility of maker education. After training, there were statistically significant differences in teachers' perceptions on the necessity of providing maker education when the project group utilised ICT (e.g. 3D printers and Arduino). In addition, through an open-ended survey, necessary things for implementing maker education in each school were discussed.

Keywords: Maker education, Teacher training program.

1. Introduction

Educating creative people based on new ideas and challenges has to be regarded as the goal of education in the 21st century. As part of an effort to develop students' creative talent and convergent thinking, the Korean Ministry of Education introduced the Free Semester Program to middle school students in May 2013; for one semester of their three years at middle school, students can engage in a variety of activities for focusing on boosting creativity and career planning without the burden of exams. During the free semester, students study normally in the morning, but in the afternoon they can take part in various curriculums, including arts, sports activities, science experiments or work-based

training courses offered by their school.

However despite good intentions, according to an analytical study on the Free Semester Program, there have been some problems, including a lack of experience programmes for students and teachers training programmes, as well as poor external lecturers. Due to the lack of time and expertise, teachers have not been able to develop and operate various programmes due to the conditions and characteristics of each school (Shin et al., 2015; Heo, 2015).

This study recommends 'maker education' because it is consistent with the goals of the Free Semester Program. Both aim to cultivate students' creativity, innovation and entrepreneurship. Maker education is a new project-based education trend, not a specific teaching method, for motivating students to make what they want to. In this process, students learn entrepreneurship and design-based thinking and sometimes utilise technologies such as Arduino and 3D printers. This can create opportunities for young students to turn their ideas into reality, and they can develop confidence, creativity and an interest in science, technology, engineering, math, art and learning as a whole through making. The final purpose of maker education is to cultivate more innovative individuals (Yang & Li, 2015; Jordan & Lande, 2016; Zhou, 2016).

This study developed a maker education teacher training programme to provide teachers with sufficient information and teach them how to deal with technologies, as well as give them the opportunity to experience maker activities that create something they wanted. In-service training and education are necessary to teachers as an ongoing process that allows them to familiarise themselves with new education trends (Moini, 2008).

The purpose of this study is to make teachers recognise that implementing maker education is necessary and possible through this teacher training programme. By comparing teachers' pre- and post-training perceptions about the necessity and possibility of providing maker education, this study verified the effectiveness of the training programme.

2. Method

2.1. Participants

The total number of teachers who took part in the survey was 72 (11 male, 61 female). The teachers who volunteered to participate in the study came from 42 different middle schools in Daejeon and Sejong. They all had previous professional experience as teachers, ranging from 3 to 30 years, and were responsible for planning free semester curriculums.

From the pre-questionnaire, it was found that only one teacher (1.4 %) had teaching experience in maker education, whereas seven teachers (9.7 %) had only heard of maker education. Most teachers (64 teachers, 88.9 %) did not know what maker education was.

2.2. Development of teacher training programme

The teacher training programme for maker education (three days) was designed with the help of education specialists and maker instructors. The first-day curriculum focuses on an introduction to the

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concept of maker education, including utilising various technologies (Table 1). The second and third days focus on project-based training (Table 2). The teachers took the first-day classes together, but on the second to third days, they were separated into five project groups.

Table 1. First-day curriculum: Introduction to the concept of maker education

Time	Topics
09:20–09:30	Orientation: Maker movements and 4th Industrial Revolution
10:30–11:20	Future changes due to 3D printing and modelling
11:30–12:20	How to teach entrepreneurship to students
12:20–13:30	Lunch and tour of Maker space
13:30–14:20	Various works utilising Arduino
14:30–15:20	Easy creation with Scratch X
15:30–16:20	Thinking creatively with design-based thinking

Table 2. 2nd–3rd-day curriculum: Project-based training

Project group	3D Printing	Arduino	Scratch X	Entrepreneurship	Design-based thinking
N=participants	N=32	N=17	N=6	N=7	N=10
Subject	Creating a personalised keychain and light with a 3D printer	Creating an RC car with Arduino and Bluetooth	Creating a fun game using Scratch X	Establishing a business plan to attract investment	Designing and making a water bottle to improve the drinking experience through innovation

This programme also provides teachers with a maker education syllabus for the Free Semester Program, an external lecturer pool and maker spaces to solve the free semester problems highlighted in previous studies.

2.3. Data collection

Ex-ante and ex-post surveys were carried out for all participants. The ex-ante survey was given to teachers at the beginning of the first day, and the ex-post survey was implemented at the end of the training.

To determine the change in teachers' perceptions between before and after the training, the same questions on the necessity of providing maker education and the possibility of implementing maker education in each school were included in both surveys. The teachers used a five-point Likert scale to respond to the same questions (Table 3).

The purpose of the other ex-ante questions was to determine the background of the participants (Table 4), and that of the ex-post questions was to investigate their opinions about the training programme (Table 5).

Table 3. The same questions included in the ex-ante and ex-post surveys

1. The necessity of teaching maker education (Likert scale)
2. The possibility of implementing maker education (Likert scale)
3. Reasons why it is impossible to implement maker education (multiple-choice question)

Table 4. Ex-ante questionnaire

1. Gender (multiple-choice question)
2. Teaching career (multiple-choice question)
3. Majors (multiple-choice question)
4. Understanding level of maker education (multiple-choice question)
5. The motivation for participating in training (multiple-choice question)

Table 5. Ex-post questionnaire

1. Evaluation of whole training programme (Likert scale) – interest, difficulty, adequacy of time
2. Interesting points and reasons (open-ended question)
3. Difficult points and reasons (open-ended question)

2.4. Analyses

To investigate whether statistically significant differences existed between the ex-ante and ex-post surveys, analysis was performed using R software version 3.2.0 (R Foundation for Statistical Computing, accessible at www.r-project.org). The continuous variables were analysed for normal distribution with the Shapiro–Wilk test, and continuous variables following a normal distribution were compared using the Student's t-test. Variables not following a normal distribution were compared with the Wilcox test. $P < 0.05$ was regarded as statistically significant.

3. Results

3.1. The analysis of the change of teachers' perceptions

Teachers' perceptions on the 'necessity of providing maker education' differed depending on the project group (Table 6). There were statistically significant differences between the ex-ante and ex-post surveys in the project groups using 3D printing and modelling (Wilcox test, $p = 0.0018$), Arduino (Wilcox test, $p = 0.0047$) and Scratch X (Wilcox test, $p = 0.0368$).

The results of the project groups with entrepreneurship (Paired T test, $p = 0.6036$) and design-based thinking (Wilcox test, $p = 0.233$) were not statistically different. This indicated that it was more effective for teachers to make a prototype utilizing ICT, such as 3D printers, Arduino and Scratch X, than just using paper.

Table 6. Teachers' perceptions on the 'necessity of providing maker education'

Project group	n	Average (5-point Likert scale)		P-value
		Before	After	
3D Printing & modelling	32	4.2815	4.6875	Wilcox test, p=0.0018
Arduino	17	4.2352	4.8235	Wilcox test, p=0.0047
Scratch X	6	4	4.8333	Wilcox test, p=0.0368
Entrepreneurship	7	4.7142	4.5714	Paired T test, p=0.6036
Design-based thinking	10	4.5	4.8	Wilcox test, p=0.233

On the other hand, although all the average scores of each project group increased, the scores for the 'possibility of implementing maker education' did not change significantly after the training

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programme (Table 7).

Table 7. Teachers' perceptions on the 'possibility of implementing maker education'

Project group	n	Average (5-point Likert scale)		P-value
		Before	After	
3D Printing & modelling	32	3.75	3.937	Wilcox test, p=0.3034
Arduino	17	3.764	4.294	Wilcox test, p=0.1554
Scratch X	6	3.833	4.166	Wilcox test, p=0.465
Entrepreneurship	7	3.7142	4.285	Paired T test, p=0.2308
Design-based thinking	10	3.8	4.2	Wilcox test, p=0.3613

Before training, the teachers responded to the question on 'Reasons why it is impossible to implement maker education' (Table 8). The most frequent response was 'unsure'. However, after training, 'Insufficiency of school infrastructure' was the most frequent response. This indicated that teachers came to believe that infrastructure is essential for maker education after the training, although a 3-day training programme and more knowledge and information are needed by teachers.

Table 8. Reasons why it is impossible to implement maker education (multiple answers possible)

Possible choices	Before		After	
	n	%	n	%
Lack of knowledge and information	13	15.66	27	30.68
Difficulty understanding content	5	6.02	0	0
Insufficiency of school infrastructure (materials, facilities)	16	19.27	43	48.8
Unsure	49	59.03	18	20.45

3.2. The analysis of the evaluation of the whole training programme

The teachers responded to the questions on the 'Evaluation of the whole training programme' through a five-point Likert scale (Table 9).

Table 9. Comparison of results of 'Evaluation of whole training programme'

Project group	N	Average (5-point Likert scale)		
		Interest	Difficulty	Adequacy of time
3D Printing & modelling	32	4.9375	4.5625	4.3437
Arduino	17	4.9411	4.7058	4.8235
Scratch X	6	4.666	4.666	4.666
Entrepreneurship	7	4.8571	4.7142	4.8571
Design-based thinking	10	4.7	4.5	4.5

In the comparison of the ex-post survey responses to the question on the 'Evaluation of the whole training programme', the average scores of the project groups for 3D printing and Arduino were higher than the others.

The most frequent answer to the question 'What are the interesting points in the training programme?' differed depending on whether the project group utilised ICT. In the project groups for 3D printing, Arduino, and Scratch X, 'Turning ideas into reality with ICT' was the most frequent

answer (40 %) and 'Being able to experience new technologies' was the second most frequent answer (32.7 %).

The teachers of the project group for Entrepreneurship and Design-based thinking selected 'Could be used in school' as the most interesting point (37.5 %), and 'make process was interesting' (32.2 %) as the second most interesting point. On the other hand, the most frequent response to the question 'What is the difficult point in the training programme?' was 'Shortage of time' (41 %). The second most frequent was 'unfamiliar technologies' (32 %). It is suggested that the training period should be longer than three days.

4. Conclusion

The Free Semester Program in Korea is for giving students the opportunity to build their creativity, aptitudes and talents. It requires various experience programmes, and maker education is consistent with the goals of the Free Semester Program. In this study, we developed the project-based teacher training programme for maker education and applied it to 72 teachers to provide them with the opportunity to familiarize themselves with the new education trend and to experience maker activities. To verify the effectiveness of maker education, ex-ante and ex-post surveys were conducted with the teachers, and the following conclusions were drawn.

1) This study led to the recognition that maker education is necessary in a free semester through the project-based teacher training programme. There were statistically significant differences between the ex-ante and ex-post surveys when the teachers utilized ICT (3D printers, Arduino, Scratch X).
2) However, the teachers' perceptions did not show statistically significant differences for the question on the 'possibility of implementing maker education' because of the shortage of school infrastructure. Therefore, prior to implementing maker education, it is necessary to build and expand the infrastructure, as many teachers pointed out.
3) In addition, with regards to the question on interesting and difficult points of maker education, most teachers selected 'Turning ideas into reality with ICT' as an interesting point, but 'Shortage of time' as a difficult point. These results suggest that continuous teacher training utilising ICT is required.
4) Subsequent research to develop improved in-service training reflecting the findings in this study is required.

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