the experimental group, but the significance level of each factor in the two groups was higher than .05, indicating no significant difference between the groups. Therefore, it was confirmed that the control group and the experimental group were homogeneous groups for learning motivation.

B. Results of Post-test

1) Comparison of Post-test Results Between Groups: After the experiment, a post-test was performed to confirm the study results and whether there were any significant differences between the control and experimental groups. Moreover, Table 9 shows the post-test results of creative problem-solving skills compared to the t-test.

TABLE IX
RESULTS OF POST-TEST FOR CREATIVE PROBLEM-SOLVING ABILITY

Sub-Factor	Group	M	SD	T	P
Knowledge in a specific area, function of thinking, skill and mastery	Control group	3.30	.636	-.563	.578
	Experimental group	3.45	.798		
Divergent thinking	Control group	3.37	.756	-.927	.362
	Experimental group	3.64	.807		
Critical and logical thinking	Control group	4.00	.748	-.600	.554
	Experimental group	4.15	.622		
Motivational elements	Control group	3.54	.861	-2.216	.035*
	Experimental group	4.14	.601		

(*p < .05)

As a result of the post-test on creative problem-solving ability, the average value of the experimental group was overall higher than that of the control group. As a sub-factor, the p-value of the ‘Motivational elements’ area was .035, which was below the significance level of .05, indicating a statistically significant difference. Therefore, it was confirmed that the creative problem-solving ability of students who took the CT-CPS model-based software class had a significant effect in the ‘Motivational elements’ area among the sub-factors of creative problem-solving ability compared to the students who took the problem-based learning type software class.

Table 10 shows the results of the comparison between groups of the learning motivation post-test.

TABLE X
RESULTS OF POST-TEST FOR LEARNING MOTIVATION

Sub-Factor	Group	M	SD	T	P
Internal goals	Control group	3.75	0.826	-.897	.378
	Experimental group	4.00	0.701		
External goals	Control group	3.73	0.811	-.007	.994
	Experimental group	3.73	0.883		
Control of learning beliefs	Control group	4.02	0.584	-.871	.391
	Experimental group	4.20	0.579		
Self-efficacy	Control group	3.30	0.827	-2.113	.044*
	Experimental group	3.89	0.695		

(*p < .05)

The average value of the experimental group was overall higher than that of the control group, and as a sub-factor, the p-value of the ‘Self-efficacy’ area was .044, which was below the significance level of .05, indicating a statistically significant difference. Therefore, we could not reject the second research hypothesis as a whole, but it was confirmed that the learning motivation of the students who took the CT-CPS model-based software class had a significant effect in the ‘Self-efficacy’ area among the learning motivation sub-factors compared to the students who took the problem-based learning type, software class.

2) Comparison of Pre- and Post-test Results Within the Groups: In order to examine the changes in creative problem-solving ability and learning motivation within each experimental group, the pre-and post-scores were compared, and Table 11 shows the results of the control group's paired sample t-test.

TABLE XI
COMPARISON OF PRE- AND POST-TEST RESULTS OF THE CONTROL GROUP

	Sub-Factor	Paired	M	SD	T	P
Creative Problem-Solving Ability	Knowledge in a specific area, the function of thinking, skill, and mastery	pre	2.81	.523	-2.192	.047*
		post	3.30	.636		
	Divergent thinking	pre	2.76	.662	-2.381	.033*
		post	3.37	.756		
	Critical and logical thinking	pre	3.74	.346	-1.142	.274
		post	4.00	.748		
	Motivational elements	pre	3.26	.454	-1.192	.255
		post	3.54	.861		
Learning Motivation	Internal goals	pre	3.48	.567	-1.005	.333
		post	3.75	.826		
	External goals	pre	3.70	.502	-.155	.879
		post	3.73	.811		
	Control of learning beliefs	pre	3.71	.448	-1.588	.136
		post	4.02	.584		
	Self-efficacy	pre	3.23	.373	-.300	.769
		post	3.30	.827		

(* : p< .05)

As a result of comparing the pre-test and post-test for each test in the control group, among the sub-factors of the creative problem-solving ability test, p-values were .047 and .0332 in the ‘Knowledge in a specific area, Function of thinking, Skill and mastery’ area, and the ‘Divergent thinking’ area, respectively, therefore, the significance level was less than .05, and a statistically significant change was observed, and there was no statistically significant difference in the sub-domain of the learning motivation test, but an increase in the mean value was observed in all areas. Table 12 shows the results of the paired sample t-test of the experimental group.

TABLE XII
COMPARISON OF PRE- AND POST-TEST RESULTS OF THE CONTROL GROUP

	Sub-Factor	Paired	M	SD	T	P
creative problem-solving ability	Knowledge in a specific area, function of thinking, skill, and mastery	pre	2.81	.558	-2.272	.038*
		post	3.45	.798		
	Divergent thinking	pre	2.96	.543	-2.387	.031*
		post	3.64	.807		
	Critical and logical thinking	pre	3.53	.349	-3.552	.003**
		post	4.15	.622		
	Motivational elements	Pre	3.40	.566	-5.021	.000**
		post	4.14	.601		
learning motivation	Internal goals	pre	3.44	.602	-2.563	.022*
		post	4.00	.701		
	External goals	pre	3.56	.574	-.729	.477
		post	3.73	.883		
	Control of learning beliefs	pre	3.77	.566	-2.671	.017*
		post	4.20	.579		
	Self-efficacy	pre	3.23	.504	-3.416	.004**
		post	3.89	.695		

(* : p< .05, ** : p< .01)

As a result of comparing the pre-and post-tests for each test in the experimental group, in all the creative problem-solving ability test sub-factors, p-values were .038, .031, .003, and .000, respectively, so the significance level was less than .05, indicating a statistically significant change. Moreover, among the sub-factors of the learning motivation test, ‘Internal goal’, ‘Control of learning beliefs’, and ‘Self-efficacy’ excluding ‘External goal’ had p-values of .022, .017, and .004, respectively, so the significance level was less than .05, and a statistically significant change was observed. In addition, the mean value was observed in the entire area of the experimental group.

The factors of each test are the comparison results between groups of the post-test and the comparison results of the pre-post tests of the experimental group. Table 13 shows the factors that showed statistically significant improvement. As a result of comparing the tests between groups, it can be seen that the CT-CPS model-based software course had a positive effect on the improvement of the ‘Motivation factor’ area of the creative problem-solving ability test and the ‘Self-efficacy’ area of the learning motivation test compared to the problem-based learning model software course.

C. Interpretation of Quantitative Analysis Results

TABLE XIII
COMPREHENSIVE TEST RESULTS FOR EACH TEST FACTOR

Test	Sub-Factor	Statistical Improvement of Comparison Results Between Post-Test Group	Statistical Improvement of Pre and Post Comparison Results of the Experimental Group
Creative Problem-Solving Ability	Knowledge in a specific area, function of thinking, skill, and mastery		○
	Divergent thinking		○
	Critical and logical thinking		○**
	Motivational elements	○	○**
Learning motivation	Internal goals		○
	External goals		
	control of learning beliefs		○
	self-efficacy	○	○**

(**: p< .01)

In addition to pre and post-test comparison results within the group, the CT-CPS model-based software course, through the process of finding and solving problems independently, showed improvement in all areas except for ‘External goal’. In particular, it can be said that the areas of ‘Critical and logical thinking’, ‘Motivational elements’, and ‘Self-efficacy’ showed very big improvement

D. Results of Qualitative Analysis

In this study, subjective responses to project reports were analyzed for qualitative analysis of the effects of CT-CPS model-based software classes on creative problem-solving ability and learning motivation of non-major students. In addition, meaningful answers were further analyzed in the suggestion area of class evaluation and the subjective feedback area of the evaluation stage. Fig. 1 shows the visualization using keywords for easy recognition [47].

Fig. 1 Visualization of KeyWords

As a result of analyzing the qualitative responses of students who took software classes applying the CT-CPS model. However, it was difficult to set and implement topics to be solved in real life. The majority of opinions were that it was good to feel a sense of accomplishment by using the learned functions to solve problems individually and by successfully implementing the app. The following are student responses related to creative problem-solving ability.

- Student 1: I felt that the ability to think is the most important because the app is completed through the process of constantly thinking about and executing the blocks to create this function.
- Student 2: When I first encountered the subject, I felt a sense of pressure, but the fact that I was able to create an app myself through lectures and practice was surprising, and it was interesting to see how it works as I envisioned and built it. While doing the project, I realized that even a simple function had to go through more processes than I thought, and I could feel the computer accept and execute only commands.

In addition, they expressed their efforts and will to succeed in areas that could not be solved even after the project, and they wanted to develop more advanced major-related or major-related apps. And after that, it was confirmed that there was a motivation to learn the advanced software course. The following are responses related to learning motivation.

- Student 3: It was new to use only the apps that had already been made, and it was difficult to make the process by dividing roles with each other, but it was fun. It was a project that made me want to develop a better app by further developing it along with the major I will learn in the future.
- Student 4: I felt accomplished and proud when the project was gradually completed in the direction we wanted.

In another opinion, app inventor programming is suitable for improving the basic understanding of coding, and the project class allowed team members to share various ideas and foster a sense of collaboration. Moreover, it was found that other teams' planning intentions and creative ideas were impressive. Therefore, the software class based on the CT-CPS model had a positive effect on cultivating creative problem-solving ability and learning motivation, and it was analyzed that it was a beneficial class for non-major college students to feel the importance of the 4th industry.

IV. Conclusion

In this study, a CT-CPS model-based software liberal arts course was designed and applied to non-majors, and the effectiveness of creative problem-solving ability and learning motivation was verified. An independent sample t-test, paired sample t-test, and qualitative response analysis were performed for the analysis. The CT-CPS model-based software class had a positive effect on improving the creative problem-solving skills of non-majors. In particular, the experimental group showed a significant change in the 'Motivational elements' area among the sub-factors of the creative problem-solving ability test compared to the control group. In addition, as a result of comparing the pre-test and post-test for each test in the experimental group, there were statistically significant changes in all areas of 'Knowledge in a specific area, the function of thinking, skill, and mastery', 'Diffused thinking', 'Critical and logical thinking' and 'Motivational elements' of the creative problem-solving ability test.

The CT-CPS model-based software class had a positive effect on improving the learning motivation of non-majors. In particular, the experimental group showed a significant change in the 'Self-efficacy' area among the sub-factors of the learning motivation test compared to the control group. In addition, as a result of comparing the pre-post tests of the experimental group, among the sub-factors of the learning motivation test, there were significant changes in 'Internal goals', 'Control of learning beliefs', and 'Self-efficacy' excluding 'External goals'. Through qualitative analysis, it was confirmed that the software class to which the CT-CPS model was applied affected the cultivation of creative problem-solving ability and learning motivation through discovering and solving problems on their own in real life.

In summary, the CT-CPS model-based software class finds and recognizes problems to be solved in daily life or major, and it could be judged that it effectively improved learners' creative problem-solving ability and learning motivation in the process of imagining and solving ideas. It must be applied to various programming languages in the software class based on the CT-CPS model for non-majors. In this study, the app inventor programming language, which allows non-major college students to create android apps without professional programming knowledge easily, was used in the class. This study analyzed the CT-based app inventor class as a programming language suitable for non-majors to improve their basic understanding of coding. If the effectiveness of programming classes through other software can be verified, it will be a more reliable software class model.

Extracurricular activities for students who have taken software liberal arts classes for non-majors or activities linked to follow-up class programs should be prepared. It will be possible to further inspire learning motivation and a sense of achievement through software exhibitions, creative idea contests, and software experience activities, where the output of the class can be practically used.

There is a need to develop a learning model for cultivating the creative convergence capability of non-majors. The effectiveness of the CT-CPS model has already been confirmed in studies for cultivating computational thinking and creative problem-solving skills for elementary, middle, and high school students. However, it is time for systematic software education in connection with the university curriculums. Therefore, if the CT-CPS model is continuously modified and supplemented according to the software competency required by the times and a teaching and learning method is developed, software education can be made more effective.

Through this study, we hope it will be used as a basic background for university software liberal arts education, where the demand for software education is gradually increasing. In addition, we expect that various follow-up studies that suggest effective directions and approaches of software education for non-majors will be conducted.

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