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Analysis of the Sociality and Democratic-Citizenship Changes from the Application of the Scratch Remix Function in Cooperative Learning

Oh-Han Kang*

Abstract

This study analyzed changes in sociality and democratic-citizenship among elementary school students in the information class and the science class at the Science Education Institute for the Gifted, who were divided into an experimental group and a control group. The experimental group engaged in the Learning Together (LT) cooperative form of learning for which the remix function of Scratch, an educational programming language, was applied, while the control group was given general instructor-led lessons. Members in the experimental group were able to modify processes during projects through the usage of the remix function, thereby actively participating in the projects and eventually generating team-based results. The post-class t-tests showed a greater degree of improvements in sociality and democratic citizenship for the experimental group that was offered the remix-function-based cooperative learning than the control group. Statistically significant differences were present between two groups particularly in "cooperative spirit" sub-domain of sociality and the "community" and "responsibility" sub-domains of democratic citizenship.

Keywords

Cooperative Learning, Democratic Citizenship, Remix, Scientifically Gifted Elementary Student, Scratch, Sociality

1. Introduction

Sociality is the degree to which individuals tend to associate with one another in social groups and form cooperative societies. People with a high degree of sociality tend to enjoy group activities, behave well in cooperative environment, engage with numerous acquaintances, and cause little conflict in social environment. The degree of an individual's sociality considerably depends on the individual's childhood experiences, and may have lifelong impact on the individuals' morality. Societal activities during childhood provide youths with opportunities to interact with different types of people and an interaction with diverse people is likely to develop students' sociality [1]. Sociality refers to maintaining individuals' positive social interaction, being accepted by others, and being adequately adapted to important social environments including school [2].

Democratic citizenship is a democratic and autonomous tendency, whereby an individual tries to grasp life situations objectively, and whereby the individual thinks and acts with a community spirit, a

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Corresponding Author: Oh-Han Kang (ohkang@anu.ac.kr)
* Dept. of Computer Education, Andong National University, Andong, Korea (ohkang@anu.ac.kr)

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participatory awareness, and a sense of responsibility. Furthermore, citizens with the democratic-citizenship tendency possess the core elements of a sense of human dignity and basic order, an understanding of the procedures for a liberal society, and a rational decision-making ability. The fundamental functions, which a democratic citizen should be equipped with, include a problem-assessment ability, a critical-thinking ability, a problem-solving ability, an understanding capability regarding those with different interests, an ability to make the most-appropriate choice and a rational judgment, and an ability to exercise political influence [3].

Cooperative learning can be achieved more effectively through a non-competitive cooperation process compared to the predominant processes of competitive learning or independent individualized learning. The cooperative learning utilizes the interactive process of the cooperation among learners as the core element of the learning process and avoid the one-sided nature of communication in instructor-led competitive classes. Cooperative learning is a learning method wherein students perform the same tasks and encourage each other in the mutually shared process, and involves the provision of mutual help, encouragement among students, the collaborative solving of tasks, and ultimately goal achievement for students.

Among the cooperative-learning models is the Learning Together (LT) model that was developed by Johnson and Johnson [4]. Cooperative learning means that the students study together in small groups to maximize each other's benefits by aligning their interests. The features of the LT model include positive interdependence among classmates, the allocation of the learning materials to the students themselves, inter-classmate assistance, and face-to-face interaction.

The cooperative-learning models that have been introduced so far share the collaborative characteristics, whereby the interaction among the small-group members enables the learning-group members to work diligently and to help each other in achieving common learning objectives.

On the web-based Scratch platform, it is possible to share saved projects, and the shared projects can be modified and edited by others through the use of the remix function [5,6]. The learners modify and complement each other's projects by using the remix function, and cooperative learning becomes possible among the learners as they try to reach their goals.

In this study, the experimental group and the control group are composed of 36 elementary students from the information class and 30 elementary students from the science class of the Science Education Institute for the Gifted. The classes of the experimental group involved the application of the Scratch remix function, and the control group proceeded with general lecture classes in science and math. A post-class analysis was performed to identify any significant differences in the sociality and the democratic citizenship between two groups.

2. Related Research

At the commencement of this study, a variety of research studies had been conducted on sociality and democratic citizenship through cooperative learning with Scratch. Kim and Im [7] showed that smartphone addiction has a statistically significant negative influence on sociality development in high graders of elementary school. Lerner and Mikami [8] carried out a sociodramatic affective-relational intervention through the use of drama activities for students with disabilities to teach the purposive behavior of social skills; as a result, the interactions among the classmates increased, and the social skills

of the student participants improved. Newmann [9] suggested that the functions of a democratic citizen should be a conversational ability, a data-processing ability, the ability to describe decision-making processes, the ability to justify an individual's opinion regarding controversial public issues, the ability of applying principles of justice, and a cooperative ability.

Numerous research papers studied the influence of education on the adolescents' sociality and democratic citizenship. These studies analyzed how learners' conscious level changed by administering follow-up questionnaire surveys after learners finished a curriculum or completed learning activities. This paper followed a similar approach through conducting a questionnaire to explore how cooperative learning with programming language can reinforce sociality and democratic citizenship.

As is previously mentioned, Johnson and Johnson [4] developed the LT model, a cooperative-learning model with a group-compensation structure for individual achievements and cooperative acts. The LT model is a type of the common-task structure in which the interaction among the team members is stressed, and experimental research was conducted on elementary students for all of the typical curriculum subjects.

Slavin [10] defined cooperative learning as a way of learning whereby students study common tasks and encourage each other. Moreover, she added that it is a learning strategy for students with a diversity of attributes, such as those regarding ability, gender, or socio-economic status, whereby they can form learning groups, help and encourage one another, solve learning tasks, and reach their goals. Nattiv [11] stated that cooperative learning increases a positive sense of self-conception, self-esteem, and positive feelings for both the classmates and the school. Besides, positive effects on the achievements in the affective domains, such as the interpersonal relationships, attitudes and values, and self-esteem, were observed.

When the user is logging into the Scratch homepage, it is possible to automatically save projects during the working process, and if projects are shared on the Scratch website, anyone can modify and edit the shared projects using the remix function.

Hill et al. [12] carried out relative research in the environment of the web-based Scratch program. He analyzed the participants' perception of the remix function, and he statistically analyzed the results by applying the five models for which the participants' gender, age, and remix conditions are applied. In addition, he analyzed the plagiarism-related content by centering on the similarity between the remix projects and the original projects. Hill and Monroy-Hernandez [13] then compared the quality of the results of the individual work and that of the results of the common work on Scratch, and he also studied whether the common work exerts any effect on the quality improvement of the results in terms of the coding and design work. This study showed that the coding work is effective when it is done as common work.

3. Research Contents

3.1 Learning Design

Subjects in this research were elementary students of the Science Education Institute for the Gifted at Andong National University, and the experimental group and the control group were assigned 36 students and 30 students respectively. The information course for the elementary students of the Science Education Institute for the Gifted is composed of two classes, and each course is a semester long covering

information subject. Each class consists of 12 students, and the detailed composition of each group is shown in Table 1.

Table 1. Composition of the research-subject students

	Class	Number of Students	Grade	Lesson	
				Semester	Contents
Experimental group	Information	12	6th	Spring, 2014	Table 2
	Information	12	6th	Fall, 2014	Table 2
	Information	12	6th	Spring, 2015	Table 2
Control group	Science	18	6th	Spring, 2016	Science
	Math	12	6th	Spring, 2016	Math

Currently the following learning methods are used in classes: competitive learning for which learners compete as individuals or in teams, individual learning with no competition, and cooperative learning with group compensation and cooperation for the reaching of the goals. According to the research findings, cooperative learning is far more effective in terms of achieving learning objectives and value formation compared to competitive learning or individual learning.

In this paper, to facilitate cooperative learning, small groups of two to four students were organized, and the LT model was used to evaluate teams and compensate for their cooperation. Since the LT model is comprehensive and general, it facilitates the cooperation among team members and competition among the teams. Moreover, because teachers have flexibility in the degree to which they apply the model to reflect their educational philosophy or learners' characteristics, the cooperative-learning function can be dramatically improved.

For this research, the main learning tool was Scratch, a computer-programming language that is a basic component of information science. Scratch provides the remix function that allows anyone to modify and edit shared projects on the Web. Once an environment for the sharing of individually produced projects is set up on the Scratch website, anyone can make a new version by modifying the existing project.

The topics for the Scratch lessons are shown in Table 2. Since the curriculum was designed in the framework of cooperative learning, students were allowed to modify the projects after the completion of the individual projects. Similarly, in the process of the modifying and complementing the projects, students learned to help each other and to achieve common learning goals.

Table 2. The Scratch-lesson curriculum

No.	Topics for lessons	Number of times
1	Animation realized through Scratch	3
2	Multimedia realized through Scratch	3
3	The encounter of math and computer - 1	3
4	The encounter of math and computer - 2	3
5	Alignment algorithm realized through Scratch	3
6	Search algorithm realized through Scratch	3
7	Using the various sensor functions through Picoboard	3
8	Producing a game program using Picoboard	3
9	Producing a game program by applying the mathematic algorithm	3
10	Producing a game program by applying the information-science algorithm	3
11	Problem-solving based on logical thinking	3
12	Problem-solving based on creative thinking	3

During the Scratch lessons, the experimental group performed cooperative learning in the form of LT model shown in Fig. 1. The developed LT model consists of lesson information step, LT cooperative learning step, and assessment step. In the lesson information step, a teacher introduces new materials to ignite learning motivation and presents learning objectives with direct instruction. In the LT cooperative learning step, a teacher assigns students to groups, arranges a classroom, provides appropriate materials, and explains the task and cooperative goal structure to the students. As part of the learning activity, the students produce individual projects to solve tasks, produce a remix project for task solving, and present team projects. The teacher needs to carefully monitor how well the groups are functioning. The assessment step consists of team evaluation based on Scratch project and team report.

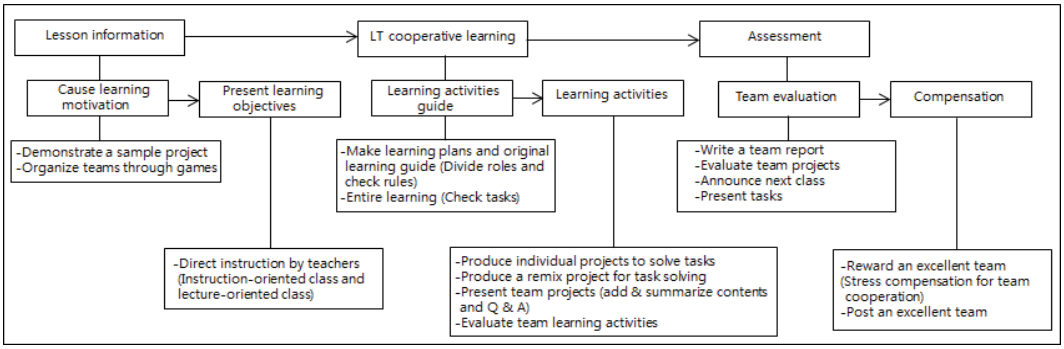


Fig. 1. Flowchart of the LT-model-applied cooperative learning.

3.2 Research Design

Table 3 summarizes the experimental design for the analysis of the effect of cooperative learning on the students' sociality and democratic citizenship after they used Scratch remix function; accordingly, *t*-tests were carried out on the independent samples. The pre-test questionnaires were undertaken by the students at the start of curriculum, and the shared homogeneous nature of the experimental group and the control group was confirmed. After the classes, post-tests were conducted, and based on the changes in the sociality and the democratic citizenship, an analysis was performed to determine whether a significant difference is present between the experimental and control groups.

Table 3. Experimental design

	Test1	Class	Test2
Experimental group	O_1	X_1	O_2
Control group	O_1	X_2	O_2

O_1 = pre-test (sociality and democratic citizenship), O_2 = post-test (sociality and democratic citizenship), X_1 = Scratch cooperative learning using the remix function, X_2 = general lecture class related to science/math.

This study modified a questionnaire verified as a sociality-assessment tool [14] to fit contexts in Scratch. For this research, sociability, independence, law-abiding spirit, and cooperative spirit were adopted as the variables of sociality, and the survey consists of a total of 28 questions with seven questions per variable. The sound reliability coefficient of the 28-question sociality test is a Cronbach $\alpha = 0.904$ (>0.6).

The promotion of democratic citizenship is only possible when learners participate in a variety of group

activities, respect each other's opinions, and become responsible for the common goals, not just their own goals, through education. In this respect, cooperative learning is a more effective and proper learning structure to foster democratic citizenship, compared with competitive learning or individual learning.

For this research, a survey that was used for the evaluation of democratic-citizenship in the previous studies [15] was referred to, and it was modified in the context of Scratch-remix lessons. Democratic citizenship comprises 10 virtue items including respect of human rights, autonomy, responsibility, cooperation, justice, law-abidingness, sense of community, consumer ethics, public interests, and agreement. The instrument for the evaluation of democratic citizenship consists of 20 questions, with two questions per virtue item. The reliability coefficient of the democratic-citizenship test is a Cronbach α = 0.909 (>0.6), which is sound.

The data according to the survey results were analyzed using the SPSS version 23 program. After the provision of the education, the *t*-tests of the independent samples were conducted to compare the changes in the sociality and the democratic citizenship of the two groups.

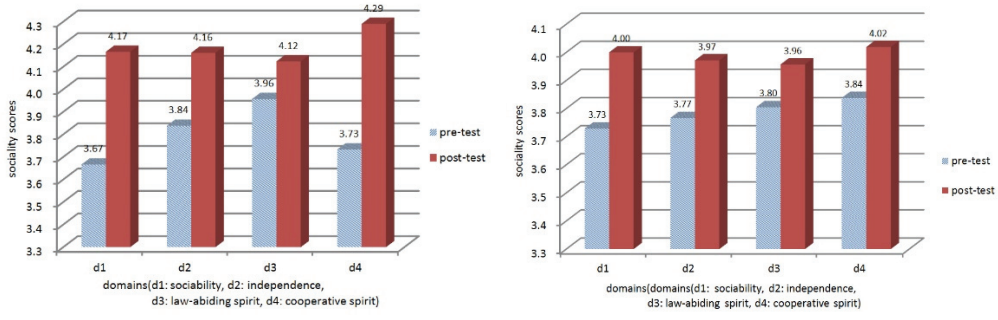
4. Research Results

In this study, before the beginning of the semester, sociality and democratic-citizenship pre-tests were conducted, and at the end of semester, after the classes were held during the semester, post-tests were carried out. With the exception of six students whose survey answers are not significantly meaningful, the survey results of 30 of the students from the total of 36 experimental-group students were selected as the subjects of the analysis.

Questionnaires were used for the pre-tests and the post-tests. The questionnaires consist of a 5-point Likert-type scale, and by giving high points to the positive aspects and low points to the negative aspects, the results were analyzed according to the averages of the points.

4.1 Sociality Analysis

To identify the effects on the four sociality domains, sociability, independence, law-abiding spirit, and cooperative spirit, another questionnaire was used. The questionnaire includes 28 questions, with seven questions per domain and the allocation of a 5-point scale to each question. Fig. 2 shows changes in sociality of the experimental group and the control group.



(a) (b)

Fig. 2. Changes in sociality of the two groups: (a) experimental group and (b) control group.

Based on the average standard points of the four domains, the SPSS program was used to conduct the *t*-tests of the independent samples with a level of significance of $p = 0.05$. To determine whether a significant difference was present between the experimental and control groups, a post-test was performed after the classes on sociality change were given. Moreover, the sociality and its sub-domains were analyzed to determine whether there was a significant difference between the two groups.

Through the pre-test, the homogeneity between the experimental group and the control group was verified, and, as shown as in Table 4, it was confirmed that the two groups were homogeneous ($p > 0.05$, $t < \pm 1.96$).

Table 4 displays the results from the sociality post-test that confirm the presence of a significant difference between the experimental group and the control group ($p < 0.05$, $t > \pm 1.96$). The results showed that the average point of the experimental group was 4.19 points while that of the control group was 3.99 points; the experimental group scored 0.2 points higher on average than the control group.

Table 4. Sociality pre- and post-test results

	Group	Number of students	Average	SD	*t*	df	*p*
Pre-test	Experimental	30	3.80	0.36	0.144	58	0.886
	Control	30	3.78	0.41			
Post-test	Experimental	30	4.19	0.38	2.222	58	0.030
	Control	30	3.99	0.32			

Table 5 compares the post-test results of the experimental group and the control group by sub-domains of sociality.

Table 5. Sociality post-test results by domain

	Group	Number of students	Average	SD	*t*	df	*p*
Sociability	Experimental	30	4.17	0.43	1.561	58	0.124
	Control	30	4.00	0.40			
Independence	Experimental	30	4.16	0.53	1.611	58	0.113
	Control	30	3.97	0.37			
Law-abiding spirit	Experimental	30	4.12	0.51	1.419	58	0.161
	Control	30	3.96	0.40			
Cooperative spirit	Experimental	30	4.29	0.42	2.646	59	0.010
	Control	30	4.02	0.38			

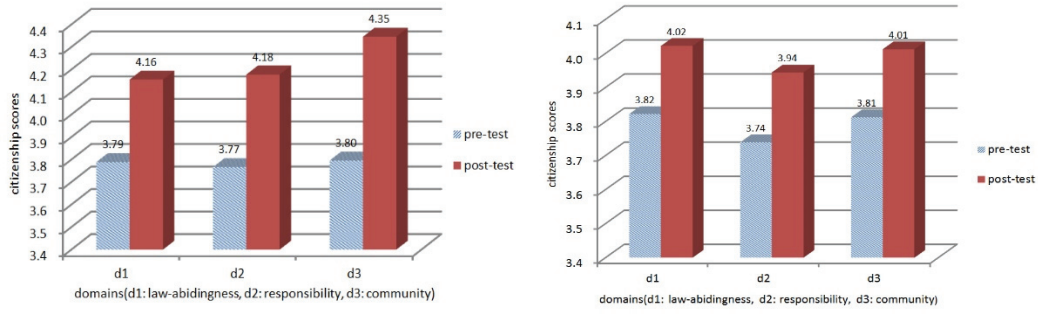
Post-test results by domain showed that, the differences between the experimental group and the control group were 0.17 points, 0.19 points, 0.16 points, and 0.27 points for sociality domains, sociability, independence, law-abiding spirit, and cooperative spirit respectively. Among these, a statistically significant difference, with a significance probability of $p = 0.010$ ($p < 0.05$), was evident in the cooperative spirit of two groups; however, statistically significant differences were not evident between two groups in terms of sociability, independence, and law-abiding spirit, as the significance probabilities were $p = 0.124$, $p = 0.113$, and $p = 0.161$, respectively ($p > 0.05$).

These results showed that the use of the Scratch remix function facilitated the cooperative learning process through the production of team projects, whereby the sociality of the learners was improved. While the difference in cooperative spirit between two groups can be attributed to a greater degree of improvement in the experimental group, it was widened by diminished cooperative spirit of the control group from limited opportunity to participate in the learning experience by learners in unilateral direction of instructor-led learning methods.

4.2 Analysis of the Democratic Citizenship

Regarding the instrument for the democratic-citizenship evaluation, the survey consists of a total of 20 questions, with two questions per virtue item of democratic citizenship. For the comparison, a calculation of the total points, which range from one to five points per question, was performed.

The 10 virtue items were classified into three sub-domains of law-abidingness, responsibility, and community. Law-abidingness includes the virtue items of respect of human rights, justice, and law-abidingness; responsibility includes the virtue items of autonomy, responsibility, and vocational ethics; and community includes the virtue items of cooperation, sense of community, public interests, and agreement. Fig. 3 shows the changes in democratic citizenship of the experimental group and the control group.



(a) (b)

Fig. 3. Changes in democratic-citizenship of the two groups: (a) experimental group and (b) control group.

Table 6. Democratic-citizenship pre- and post-test results

	Group	Number of students	Average	SD	*t*	df	*p*
Pre-test	Experimental	30	3.80	0.44	-0.203	58	0.840
	Control	30	3.82	0.39			
Post-test	Experimental	30	4.24	0.39	2.660	59	0.010
	Control	30	3.97	0.38			

Based on the average standard points of the three sub-domains, *t*-tests of the independent samples were performed with a level of significance of $p = 0.05$. Table 6 shows the results from the democratic-citizenship pre-test for the experimental group and the control group. The pre-test of the homogeneity between the experimental group and the control group, as shown in Table 6, confirmed that that the two

groups were homogeneous groups ($p > 0.05$, $t < \pm 1.96$).

The post-test results are presented in Table 6, and the presence of a statistically significant difference between the experimental group and the control group was confirmed ($p < 0.05$, $t > \pm 1.96$).

Table 7 demonstrates the post-test results of the three sub-domains of democratic citizenship for the experimental group and the control group.

Table 7. Democratic-citizenship post-test results by sub-domain

	Group	Number of students	Average	SD	*t*	df	*p*
Law-abidingness	Experimental	30	4.16	0.48	1.094	58	0.279
	Control	30	4.02	0.46			
Responsibility	Experimental	30	4.18	0.45	2.139	58	0.037
	Control	30	3.94	0.39			
Community	Experimental	30	4.35	0.40	3.016	58	0.004
	Control	30	4.01	0.46			

The results showed that the average differences between the experimental group and the control group in three sub-domains of democratic citizenship—law-abidingness, responsibility, and community—to be 0.14 points, 0.24 points, and 0.34 points respectively. Among these, the significance probabilities of responsibility and community are $p = 0.037$ and $p = 0.004$, respectively, and this confirms the presence of a statistically significant difference between the two groups ($p < 0.05$). Nonetheless, in terms of law-abidingness, with a significance probability of $p = 0.279$ ($p > 0.05$), the presence of a statistically significant difference between the two groups cannot be confirmed.

Positive effect of the cooperative learning with the Scratch remix function is confirmed as evidenced by the three sub-domains of the democratic-citizenship analysis, and this is particularly the case for the responsibility and community sub-domains. These results can be used to interpret that the use of the remix function of Scratch, whereby cooperative learning was experienced through the production of team projects, resulted in the improvement of the democratic citizenship of the learners; in particular, the responsibility and the community of the experimental group experienced positive effect. Meanwhile, the absence of a significant difference in law-abidingness between two groups can be attributed to the fierce competition that was present among the teams within the experimental group due to the expectation for compensation.

Among the three sub-domains of democratic citizenship, responsibility and community show a significant difference between the two groups; from these, an analysis of the changes of the virtue items of the community sub-domain, cooperation, sense of community, public interests, and agreement, which show the biggest difference in terms of the average values, was performed. Table 8 displays the *t*-test results of the independent samples of the four virtue items.

It was confirmed that, in terms of the four virtue items of the community sub-domain, cooperation, sense of community, public interests, and agreement, the average differences between the experimental group and the control group were 0.44 points, 0.28 points, 0.2 points, and 0.12 points, respectively. Among these, the significance probabilities of cooperation and agreement were $p = 0.010$ and $p = 0.003$, respectively, and a statistically significant difference was present between two groups ($p < 0.05$); however, in terms of community, public interests, and agreement, statistically significant differences were not present between two groups.

Table 8. Post-test results of the community sub-domain by virtue item

	Group	Number of students	Average	SD	*t*	df	*p*
Cooperation	Experimental	30	4.42	0.59	2.678	58	0.010
	Control	30	3.98	0.69			
Sense of community	Experimental	30	4.38	0.55	1.890	58	0.064
	Control	30	4.10	0.61			
Public interests	Experimental	30	4.17	0.56	1.446	58	0.153
	Control	30	3.97	0.51			
Agreement	Experimental	30	412	0.42	3.068	59	0.003
	Control	30	4.00	0.62			

5. Conclusion and Discussion

In this paper, the changes in the sociality and the democratic citizenship of elementary-school students from the Science Education Institute for the Gifted were analyzed after they were divided into general instructor-led classes and cooperative-learning lessons for which the Scratch remix function was used.

The Scratch remix function enables learners to improve their sociality and democratic citizenship, as it encourages them to respect each other's opinions and fulfill their responsibilities during the class. Through an analysis of the effectiveness of the cooperative-learning-based Scratch lessons, it was possible to verify whether the improvements of the sociality and the democratic citizenship show significant differences; two groups showed statistically significant differences in terms of the sociality and the democratic citizenship.

There were sociability, independence, law-abidingness, and cooperative spirit in the sub-domains of sociality. The difference in cooperative-spirit domain between two groups was statistically significant, while no statistically significant difference was found in sociability, independence, and law-abidingness.

There were law-abidingness, responsibility, and community in the sub-domains of democratic-citizenship. Two groups show a statistically significant difference for responsibility and community, but a statistically significant difference was not found for law-abidingness.

Among the three sub-domains of democratic-citizenship, community showed the biggest difference on the average. Hence, an analysis was made on the changes of the four sub-virtue items in the community domain. According to the results, two groups also represented a statistically significant difference in terms of cooperation and agreement, which are two of the four virtue items in the community sub-domain.

According to the above statistical analysis, the cooperative learning for which the Scratch remix function is used can improve both the sociality and the democratic citizenship of elementary students.

However, there are some limitations to generalize findings from this research given the projects' duration, the sample characteristics, and the sample size. Each curriculum is a semester-long during which learners' sociality and democratic citizenship are subject to changes from other exogenous factors. With respect to sample characteristics, research subjects were constrained to students from the Science Education Institute for the Gifted, so it may be difficult to apply findings to all other students. In terms of sample size, the number of students in the experimental group and the control group sample was limited consisting of 30 respectively.

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Oh-Han Kang https://orcid.org/0000-0001-6654-0104

He received B.S. degree in Electronic Engineering from Kyungpook National University. He received M.S. and Ph.D. degrees in Computer Science from Korea Advanced Institute of Science and Technology (KAIST) in 1984 and 1992, respectively. He had worked for the Applied Systems Research Center, Qnix Computer Co. Ltd., as a senior researcher from 1984 to 1994. Since March 1994, he has been working as a professor at the College of Education in Andong National University. His research interest includes grid computing, scheduling algorithm, and computer education.