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The Influences of Quality Team Interaction on the Changes of Entrepreneurial Giftedness Self-Evaluated by Gifted Korean Adolescents Participating in a Project-Based Entrepreneurship Education Program

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< Abstract >

The aim of this study was to examine the influences of facilitative team interaction on the educational outcomes (self-evaluated entrepreneurial giftedness) of a project-based learning (PBL) program designed for entrepreneurial-gifted Korean adolescents. One-hundred thirty-one (131) gifted adolescents participated in the two-day PBL gifted program provided by KAIST. Self-evaluations of entrepreneurial giftedness for the basic and the advance course were collected before and after provision of the program, and the perceived quality of team interaction was also assessed. Using repeated-measures ANOVA, the main effects and interaction effects of time and perceived quality of team interaction on entrepreneurial giftedness were analyzed. The level of entrepreneurial giftedness self-evaluated by the basic class participants before the program started was higher than that in the advanced course, while the post-scores were not significantly different between the basic and advanced course after controlling for the impact of the pre-scoring. The quality of team interaction was shown to have a more positive impact on the changes in entrepreneurial giftedness for the advanced course than for the basic course. The change of entrepreneurial giftedness for the basic course increased significantly in both of the groups with high and low quality of team interaction. In contrast, however, the change in self-evaluated entrepreneurial giftedness increased significantly in the group with high quality of intra-team interaction, although the change was weak in the group with a low quality of interaction. The study results are discussed in light of the social influences interacting with entrepreneurial competence in gifted adolescents and the educational implications of how to facilitate entrepreneurial giftedness.

Keywords: project-based learning, quality of team interaction, entrepreneurial giftedness

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프로젝트 기반 기업가정신 교육 프로그램에 참여한 한국 영재청소년들의 자기평가 기업영재성 변화에 대한 팀 상호작용 질의 영향

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< 요 약 >

본 연구의 목적은 기업영재 청소년들을 대상으로 프로젝트 기반 기업가정신 프로그램의 교육성과(자기평가 기업영재성)의 변화에 대한 촉진적 팀 상호작용의 영향을 탐색하는 것이다. 이를 위하여 한국과학기술대학교에서 이틀간 운영된 PBL 프로그램에 참여한 131명의 영재청소년들을 대상으로 프로그램 실시 전과 후에 각기 자기보고식 검사에 의한 기업영재성 측정치와 지각된 팀 상호작용 질 자료를 수집하였다. 반복측정 ANOVA를 적용하여 기업영재성에 대한 시간 및 팀상호작용의 주효과와 상호작용효과을 영재교육 프로그램 기초반과 심화반에 대하여 각기 분석하였다. 연구결과에 따르면, 프로그램 실시 전에 기초반 학생들의 기업영재성 자기평가 수준은 심화반 학생들보다 높았으나, 초기치의 효과를 통제한 후에는 기초반과 심화반 학생 간 기업영재성 자기평가 수준에는 유의미한 차이가 없었다. 한편, 기초반의 경우 기업영재성 자기평가 수준의 프로그램 전후 변화는 팀상호작용이 높은 집단과 낮은 집단 모두에서 유의미하게 상승하였다. 반면에 심화반의 경우 상호작용의 질이 높은 집단에서는 기업영재성 자기평가 수준의 변화가 유의미하게 크게 상승하지만, 상호작용의 질이 낮은 집단에서는 유의미하게 상승하지 않았다. 본 연구의 결과와 관련하여 청소년 영재 대상 기업영재성 교육 프로그램의 성과에 미치는 사회적 영향과 이들의 기업영재성을 촉진하기 위한 교육적 시사점에 대하여 논의하였다.

주제어: 프로젝트 기반 학습, 팀 상호작용 질, 기업영재성

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I. INTRODUCTION

In the millennium era in which the social and economic system has been transformed into a knowledge-based society and high value-added knowledge rapidly emerges as a core economic resource of the nation, nurturing talented people who can create practical and productive ideas is becoming a core task to prepare future societies (Lee et al., 2010). In order to meet the demands of the era, the Korean Intellectual Property Office and the Korea Invention Promotion Association launched the "Next-Generation Gifted Entrepreneurship Development Project" in 2009, as a part of a policy effort to foster creative people who have the abilities to solve practical and complex problems in the uncertain modern society, beyond the limits of existing academic-oriented gifted education such as for children and adolescents gifted in mathematics and science (Choi & Lee, 2013).

Entrepreneurial gifted adolescents, called next-generation gifted entrepreneurs in Korea, are defined as special students among the invention-gifted with abundant potential to grow into creative entrepreneurs utilizing their intellectual property (Lee et al., 2010). Along with cognitive development, they need social and emotional development for the potential of gifted youths to bear fruit in global entrepreneurship in the future (Choi & Lee, 2013). Specifically, they urgently need a variety of social competencies, including leadership, social cognition, interpersonal and communication skills, etc., to nicely manage staffs and colleagues, to handle crisis and conflicts, and to persuade counterparts and negotiate with partners, and so forth (Lee, Jeong, Kim, & Choi, 2010). Furthermore, these social abilities cannot be obtained through short-term cognitive training but require long-term social and personal maturity starting from childhood and adolescence (Littunen, 2000).

To achieve this specific policy, the Korean Intellectual Property Office, in collaboration with KAIST and POSTECH, two of the top Korean universities renowned in the fields of science and technology, establishing a special educational institution at each university, have educated by 2020 a total of 1,700 youths who have high potential to develop into future entrepreneurs showing promise in high value-added technology-based businesses (Yoo & Baek, 2020). Specifically, the two universities have worked on unique entrepreneurship education programs, designed for smart adolescents to build up their creative problem-solving skills and entrepreneurial spirits. In particular, the Creative Center for

Entrepreneurs (CCE), which is managed by KAIST, focuses on a team project-based learning model to promote not only the development of intellectual competencies but also that of social capabilities such as leadership and interpersonal and communication skills for the gifted youth (Yoo et al., 2016).

During the process of project-based group learning, learners will not only increase their level of knowledge through the group tasks while discussing their ideas and experiences with other members of the group at hand, but they can also help each other and encourage their own efforts in the group, sometimes arguing and resolving conflict as well (Kang, Yoon, Lim, & Yoo, 2012). In this sense of socially and emotionally facilitative interactions, the project-based learning model can be an excellent educational model for gifted youths to effectively promote entrepreneurial giftedness for the next generation of gifted entrepreneurs who need to develop both intellectual capacities and social and emotional competencies as well, required for practical creativity in the future.

According to the existing literature, learners can carry out the problem-solving process and finally produce creative results by facilitating interactions with group members (Lee, 2015; Lee, 2018). The manifestation of giftedness through these synergies of collaboration can be further promoted through constructive conflicts among group members (Van den Bosche et al., 2011). In other words, the facilitative team interaction increases the depth and breadth of the understandings of both the team members and group task as well, thus creating a new agenda in the process of exchanging ideas with group members with different opinions. Thus, the synergy of collaboration through facilitative interaction can be a pivotal foundation for generating new ideas in the collective learning process. Furthermore, the influence of facilitative interaction can be more powerful in business organizations (Lee, 2018), where individuals are typically in charge of occupational segments but incessantly connect and collaborate with other individuals and divisions in partnership. Thus, collaboration competencies with others are required to solve new problems in competitive business fields in modern corporate organizations. Specifically, searching for help that informs the group that they need new ideas or knowledge, providing ideas and knowledge which are requested by other team members, and the supportive atmosphere within a team are all known to have positive impacts on team performance (Lee, 2018). As such, the quality of team interaction within a group is supposed to enhance the development of an individual's abilities as well as that of the group. However, even though there have been numerous team project learning activities for gifted children at diverse educational sites to

date, little research has been conducted to identify the influences of facilitative team interactions on the changes in entrepreneurial giftedness. Team project group activities can also promote sociality and problem-solving at the same time (Van den Bosche et al., 2011), but it has not been identified whether the effects of team interactions experienced through these group work have the same impact between levels of entrepreneurial educationa programs. Therefore, more in-depth exploration is understand the impact of team interactions on changes in entrepreneurial giftedness depending on the characteristics of gifted children.

The aim of this study was to examine how project-based group learning affects the development of entrepreneurship in gifted youth. Specifically, this study focused on the influences of facilitative group interactions on the educational outcomes of the entrepreneurship and intellectual property education program designed for gifted adolescents. We hypothesized that the quality of the team interaction will have a significant impact on the development of the entrepreneurial talents of smart adolescents. This study thus attempted to identify the influences of facilitative interactions on the program outcomes of entrepreneurial gifted youth participating in project-based entrepreneurship education programs. Thus, we proposed the following research questions: First, are there differences in self-evaluated scores of entrepreneurial giftedness between program levels? Second, did the gifted youth who participated in the project-based entrepreneurship education program make significant changes in entrepreneurial giftedness before and after the program? Second, are there differences in the changes in entrepreneurial giftedness depending on the level of program and the level of team interaction quality among the gifted youth who participated in the project-based learning program?

Ⅱ. THEORETICAL BACKGROUND

1. Entrepreneurial giftedness

Entrepreneurial giftedness refers to talented individuals who have succeeded in business by creating new ventures (fulfilled entrepreneurial giftedness) with at least a minimal financial reward or who demonstrated exceptional potential ability to succeed (prospective

entrepreneurial giftedness) (Shavinina, 2009, p.793). Scholars assert that entrepreneurial giftedness is yet an unexplored topic, and research on this issue is still in its initial stage in the field of gifted education (Shavinian, 2009).

In Korea, entrepreneurial gifted youths are referred to as "next-generation gifted entrepreneurs." The specific definition focuses on intellectual property and students who have the potential to grow into creative entrepreneurs and who are expected to produce highly valuable intellectual property (Lee et al., 2010). They are expected to have the potential to develop valuable business items based on high-level intellectual property by utilizing creative ideas, commercializing the items and successfully operating them in business fields. The definition also refers to those with convergent talents who generate creative with significant social values and initiate innovations (Choi & Lee, 2013).

According to entrepreneurship research, risk-taking tendency, tenacity, curiosity, or leadership, generally known as the characteristics of successful entrepreneurs, are more like a kind of personality trait that would not be achieved in a short period of time (Littunen, 2000). However, there are plenty of studies on the personality traits of entrepreneurs who have already succeeded in entrepreneurship, but little is known about how entrepreneurship develops from childhood to adulthood. In this sense, exploring the developmental characteristics of teenagers who show the potentials of entrepreneurial giftedness is important in that it can provide a key clue to fostering entrepreneurial giftedness. In this regard, researchers assume that students showing potential in entrepreneurial giftedness have somewhat different characteristics from those students showing their intellectual ability based on academic subjects such as math and science. Specifically, Yoon and Choi (2013) found that entrepreneurial gifted individuals have extravert and persuasive personality characteristics, compared to other gifted groups. Regarding the concept of entrepreneurial giftedness, Lee and his colleagues (2009) attempted to draw up the concept of next-generation gifted entrepreneurs by reviewing the existing research on competence theory, important event techniques, behavioral interviews, and expert interviews, and derived a total of eight competency factors, including creative problem solving, leadership, communication skills, challenge spirit, entrepreneurial ethics, self-directed learning ability, math and scientific achievement, and intellectual property expertise, as the core competencies of next-generation gifted entrepreneurs. In addition, Lee, Jeong, Kim and Choi (2010) theoretically reviewed the validity of the concept model of core competency of next-generation gifted entrepreneurs, derived by Lee et al. (2009) in the previous year, and

developed self-assessment tools for the core competencies, observation tools for external behaviors, and interview tools for past behaviors related to the core competencies.

As in the above descriptions, the concept of entrepreneurial giftedness is closely related with social and practical values. For example, creative problem-solving skill involves practical competencies, usually required when carrying out a real project with practical and creative thinking ability. Similarly, leadership, communication ability, challenge spirit, and entrepreneurial ethics, which were derived from the leadership competence model of Qinn (1996), all consist of critical factors that are needed in business leaders who are generally in charge of the risk management of people, works, and changes (Lee et al., 2010). Thus, the concept of entrepreneurial giftedness, unlike other areas of giftedness that focus on academic achievement, such as science and mathematical giftedness, is more likely to encompass socio-economic values rather than a relatively neutral one (Yoo, 2013). For a relatively adjacent group to gifted entrepreneurs, gifted inventors have similar psychological and intellectual characteristics with gifted entrepreneurs, for example, creative problem-solving skills, powerful drive, initiative and passion (Choi & Jhun., 2010). However, the concept of entrepreneurial giftedness adds social abilities to the characteristics of the inventive gifted, especially needed for organizing manpower and generating socio-economic values. The gifted entrepreneurs need to work with other smart people for innovative socio-economic changes. The abilities to help effectively collaborate with others, such as interpersonal and communication skills, are essential for them to conduct innovative projects and to manage business organizations.

2. Project-based learning and facilitation interaction

Collaborative learning, especially team project-based learning, has been proposed as an effective education model for facilitating the intellectual and social growth of next-generation gifted entrepreneurs (KAIST Center for Creative Entrepreneurs, 2020). In team project-based learning, interactions between members of the team are fundamental elements of the team process, and positive and effective interactions among learners are key factors for achieving successful learning outcomes (Kim & Kang, 2016). However, the amount of team interaction itself does not necessarily account for the learning outcomes. Scholars believe that the quality of the member interactions is more important than the amount of the member

interactions and that the interaction quality has a positive effect on learning outcomes (Johnson, Johnson & Roseth, 2010). In this regard, Johnson (2010) proposed the concept of facilitative interaction in relation to the quality of the interaction. Facilitative interaction refers to mutual states in which team members encourage each other's efforts in a group and promote group processes to achieve common goals (Wen, 1998). Being in a facilitative interaction means that cognitive and social processes occur simultaneously, in which the learners in the team connect their experiences and knowledge to the collective task at hand, sharing their problem-solving skills with other group members, voicing and arguing opinions with each other, and encouraging each other's efforts. Besides, the facilitated interactions that occur in the context of team-based learning are known to lead to more positive learning outcomes (Kang, Yoon, Lim, & Yoo, 2012).

3. Relationships between entrepreneurial giftedness, project-based learning, and facilitative interaciotion

So far, studies on entrepreneurial giftedness, project-based learning and facilitative interaction have been rare. Recently, related research has been attempted by some scholars who study entrepreneurial giftedness. Regarding the unique learning experience for next-generation gifted students, Yoo et al. (2016) observed 26 students participating in an educational program designed for the next-generation gifted entrepreneurs, and revealed that the innovative educational experiences were central phenomena that promoted their entrepreneurial giftedness in adolescence. In regard to the innovative educational experiences, four key factors were found: cooperation, creativity, practicality, and identity. These findings mean that team project-based learning for the next-generation gifted can be an effective education model for promoting their entrepreneurial giftedness. In addition, Yoo and Baek (2020) applied the concept of shared mental model to identify how the facilitative interactions between team members affect their entrepreneurial giftedness and creative efficacy in team project-based learning situations. They work found that member-related shared mental models were fully mediated in both team interaction and entrepreneurial giftedness, and team interaction and creative efficacy, but the mediated effects of task-related shared mental models werenot significant. Their findings suggest that social and emotional capabilities that utilize team members' resources are key factors to enhance

the entrepreneurial giftedness and creative efficacy of gifted teenagers.

Ⅲ. RESEARCH METHODOLOGY

1. Project-Based Entrepreneurial Gifted Education Program

This study utilized the entrepreneurship gifted education program of KAIST CCE to explore the effects of facilitative interactions on the entrepreneurial giftedness of students in the process of project-based learning activities. KAIST CCE selects eighty middle-school students every year and operates a two-year online and offline course for gifted education to enhance entrepreneurship, future insight, intellectual property expertise, etc. CCE operates online gifted educational programs on entrepreneurship, intellectual property rights, future technology trends, future society, humanity studies and technology start-up trends, and the offline programs focus on a team project-based entrepreneurship education program to apply the intellectual capacities enhanced by the online programs to creating ideas and problem-solving in real technology fields. The adolescents who participated in this study were all students who participated in the entrepreneurial gifted program based on intellectual property at KAIST CCE. The offline camp event of the KATST CCE is held four to five times a year, including a selection camp. The offline camp invites experts to provide participating students with the latest up-to-date knowledge and issues in society, including the latest future technology (information technology, biological technology, nano technology, environment technology, space technology, and culture technology), called the 6Ts, and carries out project-based learning activities to draw creative ideas through group work. Afterwards, patent writing and application activities follow with expert mentoring provided. Specifically, those gifted education programs are run based on team project-based learning, and the main goal of the education program is the ability to find and solve real-world problems, especially to look at rapidly changing social problems and practice finding problems that have great social influence. Participants then address the problem in a complex way through a thinking process that sets up and reviews various hypotheses. Collective discussion has a very important role in this process. The main theme of the team project, conducted in January 2020, was artificial intelligence. The teams consist of groups

of four to six. The composition of the team project-based learning activities is shown in <Table 1> below.

<Table 1> Activity contents of the team project

Stage	Activity	Contents	Hour
1	Lecture (topic introduction)	Artificial intelligence and business application	1h
2	Lecture (topic introduction)	Artificial intelligence and startup	1h
3	Team activity	Designing ideas, surveying existing technology and current service provisions, establishing problems, generating ideas, etc.	4h
4	Interim consulting and team activity	Interim consulting by expert panels (5-minute presentation and 5-minute feedback) and on-going team activity	3h
5	Team activity	Improving and revising ideas	3h
6	Team activity	Preparing for final presentation and submitting manuscripts	2h
7	Final presentation	Expert panel evaluation and peer evaluation (7-minute presentation and 3-minute Q&A)	3h

The team project began with two lectures which two experts introduced from contrasting perspectives on the main topic. One expert was an industrial engineering professor who taught artificial intelligence at KAIST, and the other one was a business expert who had started a venture company related with artificial intelligence. The students participated in both lectures and the team discussion to solve the tasks given in advance. The tasks presented were as follows: “to come up with ideas for a feasible algorithm of artificial intelligence” and “to apply artificial intelligence algorithms and come up with ideas for a practical applicable collaborative robot (a robot that can work with human workers).” Without problem definitions or specific answers in advance, the students were only presented with the big issue of artificial intelligence, and each team was expected to define the problems and to search for solutions using its own initiative. Along with the tasks, students were also provided with a problem-solving process based on problem-based learning. While solving the team tasks, each team was guided to discuss the key points of the problem-solving process and to include the key points in the team presentation materials.

The team project-based learning activities were implemented following a series of problem-solving processes shown in <Table 2>. The procedures of the project were carried out step by step, repeated, or mixed. For example, students could go back to the second

step to re-examine the current status of related technology development while identifying problems at the third step or set a goal for the first step and identifying problems for the third step together. As such, students were expected to conduct activities autonomously according to the procedures of the project. In particular at the second stage, students searched the archives of existing intellectual property including related patents, to investigate the existing state of technology development and service situation. All the participants had previously been trained in patent applications, so they were able to investigate intellectual property rights such as patents. As a next step, team activities for problem-solving ideation were conducted for four hours after expert lectures, and a mid-term inspection was conducted for three hours by one expert in charge of the lecture. Before the mid-term inspection, most of the students went through a rough process of coming up with ideas, investigating the current state of existing technology and service, and creating ideas. Most teams developed several problem-solving ideas which were often checked during the mid-term inspection, but experts also gave each team appropriate feedbacks according to the progress levels and orders. After the mid-term inspection, students revised their ideas, and some teams reorganized their main topic. In other words, some of the problem-solving processes went back to the first stage and re-started again, and some of the ideas were expanded by specifying further each stage. The students then drew up specific solutions to the problem and prepared presentation materials in the form of a PowerPoint presentation.

<Table 2> Project-based problem-solving process of the KAIST program

Stage	Topic	Questions
1	Setting goals	What is your goal? What improvement is needed regarding artificial intelligence? What kind of problems or inconveniences are there now? What will be different from now in 10 to 15 years?
2	Checking facts	(Surveying existing technology and service status) With regard to your goals, what is the current state of technology development and what are some similar services?
3	Identifying problems	(Detailing problems) What problems do you need to solve specifically to achieve your goals?
4	Generating ideas	(Problem-solving ideas) What are the product/service ideas for achieving goals or problem resolution?
5	Finding solutions	(Choosing the best solution) Which of the many ideas is the solution for our team?
6	Workaround Details	(Concrete content) Use the discussion content from Steps 1 to 5 to summarize the specifics of the team solution.

2. Participants

131 middle and high school students participated in this study, who were attending the basic and advanced program of KAIST CCE in January 2020. All students participating in the program were selected through KAIST CCE's giftedness identification system for recruiting next-generation gifted entrepreneurs. These students were evaluated as having high potential as entrepreneurial giftedness through a series of systematic evaluation of gifted students such as document screening and expert interviews. Data collection was conducted for the students in the form of a questionnaire. The entire training schedule was open for five days from January 7 to January 11, 2020, and the team project activities examined in this study were conducted for two days from January 7 to January 8. The survey was conducted twice, on January 7th, the starting date of the corresponding entrepreneurship education program, and on January 11th, when the program ended. The age range of the participants was from a minimum of 13 to a maximum of 18 years of age. The demographic data are presented in <Table 3>.

<Table 3> Demographic information of participants

Category	Sub-category	Number	Percent
Program level	Basic	69	52.7
	Advanced	62	47.3
Gender	Male	92	70.2
	Female	39	29.8
Grade	Middle school 2nd	46	35.1
	Middle school 3rd	36	27.5
	High school 1st	34	26.0
	High school 2nd	15	11.5
School type	General middle school	72	55.0
	General high school	34	26.0
	Self-regulation high school	12	9.2
	International middle school	7	5.3
	Special-purpose high school	3	2.3
	No answer	3	2.3

3. Measurement

가. Quality of team interaction

Twenty 'Cognitive Interaction' questions, based on the questions introduced in the "Group process survey" developed by Wen (1998) and translated by Kim and Kang (2015), were used to measure the quality of the team interaction. Item examples include 'our team respected each other's opinions and thoughts,' 'our team shared work fairly' and 'our team shared the necessary data and information.' The questions were measured on a Likert five-point scale, and high scores indicated the learner perceives high levels of encouragement and facilitation of each other's effort among team members. The current study had an alpha efficient of .98. for the quality of the team interaction scale.

나. Entrepreneurial giftedness

The Next-Generation Gifted Entrepreneurship Competency Inventory (Lee et al., 2010) was used to measure the entrepreneurial giftedness of the study participants. The inventory is a self-evaluating questionnaire consisting of eight sub-factors and 173 items, including 47 items for creative problem solving, 16 items for challenge spirit, 17 items for self-directed learning, 13 items for math and science skills, 10 items for intellectual property expertise, 32 items for leadership skills, 24 items for communication skills, and 14 items for business ethics. Item examples include "I try to deliberately change the perspective of an object," "I analyze in accuracy and detail the ripple effects on oneself and organization," "I listen to and consider the intentions, backgrounds of the speaker's intentions and understand requirements," and "I pay attention to issues related to corporate social responsibility." The self-evaluated total scores of the inventory has a very high internal consistency (Cronbach's α = .99 for pre-scores and .989 for post-scores). Cronbach's α for the internal consistency of self-directed learning ability is .923 (pre) and .940 (post), for mathematics and science skills .933 (pre) and .957 (post), for intellectual property expertise .894 (pre) and .922 (post), for leadership ability .936 (pre) and .944 (post), for communication skills .948 (pre) and .950 (post), and for business ethics .925 (pre) and .938 (post), respectively.

4. Data Analysis

Prior to conducting statistical test of research data based on research problems, an independent t-test was conducted to test homogeneity between the two groups of program levels of entrepreneurial gifted program before the program started. On the basis of research problems, the data analysis method was applied as follows: First, ANCOVA with controlling pre-scores was conducted to test whether there were differences in the self-evaluation scores of post-scores of entrepreneurial giftedness between the basic and advanced courses. After controlling the effects of the pre-scores, pre-scores were set as covariates to verify whether there were significant differences in the post-scores of entrepreneurial giftedness between the two groups. For ANCOVA, we first verify the homogeneity of regression lines between program levels to verify that there is no interaction effect between program levels and post-scores. In addition, Levene's test was conducted to verify the homogeneity assumption of the entrepreneurial giftedness post-score error variance between program levels prior to the application of covariates, and prior scores were set to covariates and ANCOVA was performed. Second, a two-way RM ANOVA was conducted to verify whether changes in entrepreneurial giftedness self-assessment with program level and the quality of team interaction were statistically significant. To conduct RM ANOVA, the sphericality assumption must be satisfied. Spherical assumption refers to the equality of variance over time differences in repeated data. Typically, iterative measurement ANOVA performs a sphericality test of Machly, which yields the results of the analysis only when the measurement point is more than three times. However, sphericality verification was not required in this work because it was measured only twice before and after.

Ⅳ. RESULTS

1. Differences in self-evaluated entrepreneurial giftedness between program levels

We used independent group t-test method to verify whether there was significant difference in the total pre-score of entrepreneurial giftedness between the basic and advanced level classes. Levene's test met the assumption of equal variances between the two groups (F=.0561, n.s.). The difference in the total pre-score of the self-evaluated entrepreneurial giftedness between the two groups was statistically significant (t = 0.547, $p<.05$). Then, we conducted ANCOVA that set the pre-score of entrepreneurial giftedness as covariates to verify whether there was a significant difference in the total post-score between the basic-level classes and the advanced-level classes. First, to ensure that there was no interaction effect between the program level and the pre-score of the entrepreneurial giftedness, we attempted to verify the equality of regression lines between program levels. As a result of performing the statistical analyses, the p value of the interaction effect between the program level and the pre-score of entrepreneurial giftedness was not significant (F = 2.048, n.s.); thus, the equality assumption for the regression line slope was met. Before applying the covariates, we verified the assumption of the equal variance of the post-scores of entrepreneurial giftedness between the program levels, and the assumption of equal variance was met (F = 3.681, n.s). Therefore, we set the pre-scoring as covariates and performed ANCOVA procedures. As a result of controlling for the effect of the pre-scores, the main effect of the program level on the total post-score of perceived entrepreneurial giftedness was not statistically significant (F= 1.546, n.s.). Although the pre-test scores of the entrepreneurial giftedness measured by the self-evaluated questionnaire prior to the implementation of the program were statistically significantly higher for the basic-level class than for the advanced-level class, there was no statistically significant difference between the two levels after controlling for the confounding effects of the pre-test scores.

<Table 4> Means and standard deviations of research variables

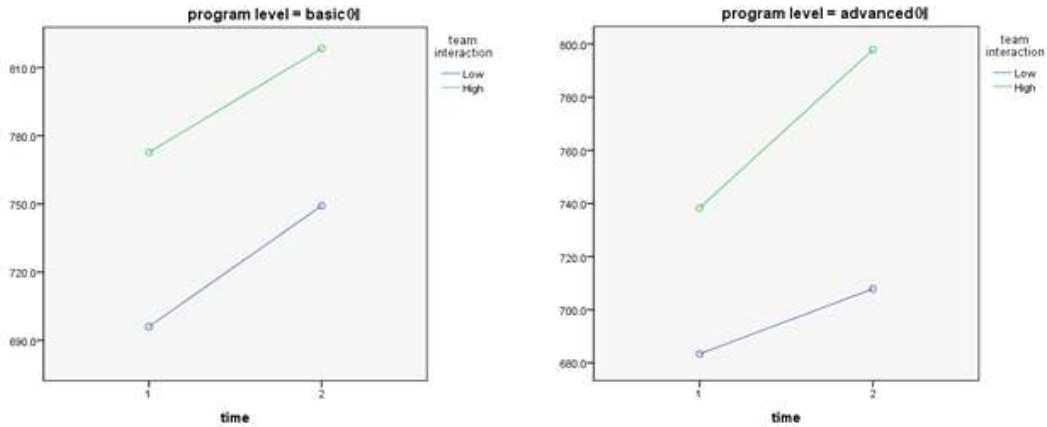
Variables	number of items	Basic Level				Advanced Level				independent t-test		F (ANCOVA results of post-score)
		Pre (n=69)		Post (n=47)		Pre (n=62)		Post (n=52)		Pre	Post	
		M	SD	M	SD	M	SD	M	SD			
total entrepreneurial giftedness	173	784.52	76.11	790.43	65.90	746.79	94.93	758.08	84.62	2.52*	2.11	1.62
creative problem solving	47	195.25	20.19	214.21	16.75	187.19	27.57	207.35	24.93	1.92	1.62***	0.97
initiative	16	69.46	7.31	73.57	6.74	66.60	8.67	72.02	8.20	2.05*	1.03*	0.14
self-directed learning	17	71.59	9.30	78.60	7.09	68.34	11.74	71.96	12.81	1.77	3.23**	9.91**
math & science ability	13	57.29	7.81	59.66	5.36	52.06	11.14	54.33	12.45	3.08**	2.81***	0.42
intellectual property	10	44.14	4.54	45.96	4.80	41.34	7.42	43.52	6.42	2.58**	2.15***	0.84
leadership	32	178.93	21.54	144.47	13.51	170.97	22.59	138.69	17.92	2.06	1.82*	1.95
communication	24	106.10	11.93	109.94	15.81	103.34	12.43	108.69	11.59	1.30	0.44	0.03
business ethics	14	61.75	7.12	65.41	5.48	56.95	9.51	61.52	9.10	3.29	2.60**	1.69

*p< .05, *p<.01, **p<.001

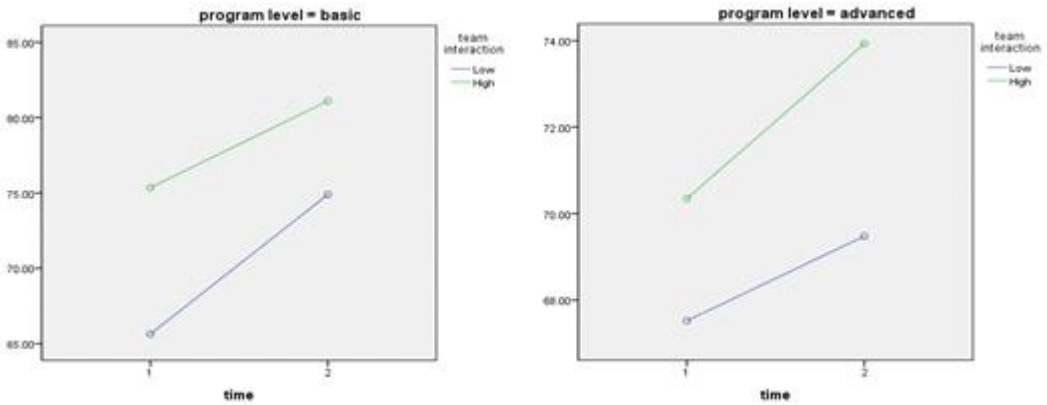
2. Differences in self-evaluated entrepreneurial giftedness by program levels and team interaction quality

Based on the median of the perceived team interaction quality, we divided participants into groups of the top 50% or more and those of the bottom 50% or less according to the level of interaction quality among program participants to verify the difference in entrepreneurial giftedness. In addition, the two-way Repeated Measures (RM) ANOVA method was conducted to verify the differences in the pre-scores and post-scores of entrepreneurial giftedness according to the interaction effects between the program levels and the perceived quality of team interaction. To implement RM ANOVA, the sphericality assumption must be met. Assumption of sphericality means the equality of variances with the time difference of the data being measured repeatedly. Typically, a RM ANOVA is performed with Mauchly's sphericality test, which yields analysis results only when there are three or more measurement times. However, in this study, the sphericality verification was not necessary because only two pre- and post- measurements were taken. As a result of checking the assumption of equal variances of the post-score of the total entrepreneurial giftedness, the assumption of equal variances of Levene's test between the two groups was satisfied ($F=.002$, n.s.). First, the main effect of the time change on the total self-evaluated entrepreneurial giftedness was statistically significant ($F = 78.746$, $p<.001$). However, the change in the scores of entrepreneurial giftedness over time was not significant between the program levels and the quality of the team interaction. On the other hand, we verified whether the effect of each research variable would be significant in the sub-variables of entrepreneurial giftedness. In the eight sub-variables that constitute entrepreneurial giftedness, the effect over time was significant for all sub-variables. However, the changes in self-evaluated entrepreneurial giftedness with the program levels and team interaction quality were different depending on the sub-variables of entrepreneurial giftedness, specifically depending on the basic and advanced classes. In the advanced class, the more facilitative the quality of interaction within the team was, the more evident the changes were in self-directed learning skills ($F=7.928$, $p<.01$), math and science skills ($F=5.104$, $p<.05$), intellectual property expertise ($F=4.580$, $p<.05$), leadership ($F=4.403$, $p<.05$) and

business ethics (F=4.371, p< .05). These results show that when facilitative interaction within the team was active during the performance of the team project, the advanced class students perceived themselves to have increased their entrepreneurial giftedness more after the program was completed than that of the basic class.



[Figure 1] Changes of total entrepreneurial giftedness by program levels and team interaction quality



[Figure 2] Changes of self-directed learning ability by program levels and team interaction quality

<Table 5> F statistics of 2-way Repeated-Measures ANOVA results

Variables	within-effect F statistics				between-effect F statistics		
	time	time*level	time*interaction	time*level*interaction	level	interaction	level*interaction
total entrepreneurial giftedness	78.746***	.773	.292	.207	4.186*	27.045***	.597
creative problem solving	72.203***	.096	1.882	1.941	2.919	28.226***	.371
initiative	45.581***	.003	.898	1.501	1.211	21.657***	.000
self-directed learning	66.069***	4.934*	.155	7.928**	2.965	12.678**	.585
math and science ability	7.885**	.018	.004	5.104*	7.950**	8.036**	2.041
intellectual property	10.770**	.090	6.308*	4.580*	6.479*	18.002***	1.889
leadership	38.658***	1.065	.372	4.403*	2.593	27.400***	.022
communication	24.304***	.581	.008	1.444	1.123	23.546***	.169
business ethics	31.540***	.099	.162	4.371*	8.368**	24.162***	1.694

*p< .05, **p<.01, **p<.001

V. DISCUSSION

This study examined the impact of facilitated interactions among team members in project-based learning activities for gifted students on the changes in their self-evaluated entrepreneurial giftedness. The main results of this study are discussed as follows.

First, the level of giftedness perceived by the gifted students of the basic class before the program started was higher than that of the advanced class. The post-scores were not different between the program levels after controlling for the impact of the pre-scoring. These results show that the gifted students of the basic class excessively appreciated their entrepreneurial giftedness at the time of being selected for the entrepreneurship education program, while the level of competency assessment for themselves became realistically adjusted for those of the advanced class who had completed the one-year project-based entrepreneurship education and entered the higher level. The measurement tool applied to assess entrepreneurial giftedness was a kind of self-report evaluation questionnaire, which assesses a sort of belief and self-evaluation on the competencies rather than an objective measurement of entrepreneurial giftedness. Thus, some considerable self-bias in the questionnaire response can occur depending on how one views one's competence on one's own. This may be related to the impact of ability grouping on self-esteem or self-assessment, which Wong and Watkins (2010) once referred to as a kind of Big Fish Pond effect. This is also in line with Ireson, Hallam, and Plewis (2010)'s findings that, in the case of ability grouping, students with higher levels of academic achievement have a lower self-concept, and students with lower levels of academic achievement have a higher self-concept. In other words, the fact that only one student in a school with ordinary students was selected for a special program, right after being selected as a participant in the entrepreneurship gifted educational program, is likely to enhance the self-evaluation of his or her own entrepreneurial giftedness. In the case of the advanced-class students, they had already completed a year of the project-based entrepreneurship program with their peers who are as capable as they are, and the enhanced self-esteem effect of selection disappears, and a new standard is set for more competent start-ups. On the other hand, after controlling for the effects of the initial values, there was no significant difference between the groups in the degree of pre-post changes. As such, the self-evaluation of

entrepreneurial gifted students in the advanced class is lower than that of the basic classes but the performance of the program itself is no different from that of the basic classes and the advanced class. This result verifies that the program itself has the same level of effectiveness between the basic and the advanced.

Second, the team interaction quality was shown to have a positive impact on the self-evaluation of entrepreneurial giftedness of the advanced class rather than the basic class. In the basic class, self-evaluation of entrepreneurial giftedness increased significantly both in the groups with and without facilitative team interaction. In the advanced class, however, the change in entrepreneurial giftedness increased significantly in the group with a high intra-team interaction quality, although the change was weak in the group with a low interaction quality. These results imply that as the understanding of entrepreneurship and the related capabilities and skills increase, the greater the impact of teamwork and other social interaction effects has on the manifestation of entrepreneurial capabilities. In other words, for gifted students who have completed the basic class and have been promoted to the advanced class, the enhancement of their self-evaluation on entrepreneurial giftedness due to the initial selection effect has disappeared, but if the group dynamics within the team are positive and facilitated, that is, the more they are exposed to each other's supportive and facilitative environment among their peers, the more positive the self-evaluation related to entrepreneurial giftedness changes. Efficient group work in problem-based learning is known to promote the level of engagement and the participation of students (Kokotsaki, Mnezies, & Wiggins, 2016). In other words, the facilitative interaction can be seen as an improvement in self-evaluation of one's ability by mutually promoting participation in the task and capacity building between them. Promoting interaction in peer support, especially in the process of a team project, may have the effect of elevating a positive belief in one's ability. These results suggest that as the understanding of entrepreneurship and businesses and the capabilities and skills involved increase, the greater the impact of social interactions, including teamwork, has on the manifestation of entrepreneurial competencies.

A comprehensive presentation of theoretical and educational implications of this study, combined with the discussion of the above findings, is as follows. First, the study suggests that the manifestation of personal competencies, such as entrepreneurial giftedness, which require a variety of convergence competencies, including practical problem-solving and interpersonal competencies and cognitive capabilities, can be promoted through facilitative team interactions. Second, the result that the performance of facilitative team interactions in

the advanced class is more significant to the change in entrepreneurial giftedness than in the basic class of the program asserts that as the knowledge the gifted students in the program increases, the more significant the interpersonal cooperative communication is to the individual's performance. These results are in line with the fact that improving leadership and interpersonal skills are important factors in entrepreneurship (Vecchio, 2003). These results can be said to be evidence of quantitative research compared to qualitative studies of good conduct (Lee, 2015) in that the facilitative group interaction is not only beneficial to the positive atmosphere or group performance within the group, but also to individual capabilities. These results suggest that the development of social capabilities, such as communication skills and empathy skills, is strongly required to develop the personal and collective capabilities of talented people in modern society, where convergence capabilities are more required.

There are several limitations to this study and further studies need to explore the following additional problems: First, the entrepreneurial giftedness tool used in this research is a self-reporting question that does not measure the objective performance of an individual's giftedness. Therefore, the measure of an individual's entrepreneurial giftedness is not free from the respondent's bias towards social desirability. Subsequent studies need to introduce assessment tools that can measure more objectively performance capabilities as a result of entrepreneurial education programs. Second, although this study was conducted on gifted children who participated in the pre-post-design to verify the effectiveness of the program, random sampling or experiment-control group design was not strictly applied. Therefore, a more rigorous experimental design is needed to control for individual variations and to verify the effect that the quality of the interaction in the team activities has had on entrepreneurial giftedness and creativity as a result of the program.

References

Choi, M., & Jhun, Y. (2010). Discourse analysis for deriving characteristics of science-gifted elementary students in inquiry activities. *Journal of Gifted and Talented Education, 20*(1), 369-388.

Choi, M., & Lee, H. (2013). Temperament and character of entrepreneurial gifted students. *Journal of Gifted and Talented Education, 23*(1), 89-107.

Ireson, J., Hallam, S., Hack, S., Clark, H., & Plewis, I. (2002). Ability grouping in English secondary schools: Effects on attainment in English, mathematics and science. *Educational Research and Evaluation, 8*(3), 299-318.

Johnson, D. W. (2010) Cooperative Learning in Middle Schools Interrelationship of Relationships and Achievement. *Middle Grades Research Journal, 5*(1), 1-18.

Johnson, D. W., Johnson, R. T. & Roseth, C. (2010). Cooperative learning in middle schools: Interrelationship of relationship and achievement. *Middle Grades Research Journal, 5*(1), 1-18.

KAIST Center for Creative Entrepreneurs (2021, March 1). http://ipceo.kaist.ac.kr

Kang, M., Yoon, S., Lim, H., & Yoo, Y. (2012). Identifying predicting power of metacognition, perceived interaction, presence on learning outcomes in web-based collaborative learning. *Journal of Lifelong Learning Society, 8*(2), 111-130.

Kim, S., Kang, M. (2016). The relationship between self-efficacy for group work, perceived usefulness, flow, perceived interaction, and learning outcomes in team project-based learning with closed-type SNS. *Journal of Education Information and Media, 22*(1), 85-110.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools, 19*(3), 267-277.

Lee, C., Jyung, C., Na, S., Kim, J., Lim, J., & Back, A. (2010). Developing a competency model for Next Generation Gifted Entrepreneurs. *Journal of Agricultural Education and Human Resource Development, 42*(1), 155-176.

Lee, H. (2018). How does individual creativity in an organization emerge? Centered on the role of promotion focus motivation and help seeking and help giving. *Personnel and Organization Research, 26*(3), 89-124.

Lee, J. (2015). Analysis of the refinement of shared mental model in science-gifted students' collaborative problem-solving process. *Journal of the Korean Association for Science Education, 35*(6), 1049-1062.

Lee, J., Jeong, J., Kim, J., Choi, D. (2010). *Development of evaluation tool and manual for core competencies of Next Generation Gifted Entrepreneurs.* Seoul: Korea Invention Promotion Association.

Lim, K., Heo, H., & Kim, Y. (2009). Team leaders' interaction patterns in online team project. *The Journal of Education Information and Media, 15*(4), 295-317.

Littunen, H. (2000). Entrepreneurship and the characteristics of the entrepreneurial personality. *International Journal of Entrepreneurial Behavior & Research, 6*(6), 295-310.

Quinn, R. E., Faerman, S. R., Thompson, M. P. & McGrath, M. (1996). *Becoming a master manager: A competency framework*. New York: John Wiley & Sons Inc.

Shavinina L.V. (2009) On Entrepreneurial Giftedness. In Shavinina, L.V. (ed.), *International Handbook on Giftedness*. Springer, Dordrecht.

Shavinina, L. V. (2006). Micro social factors in the development of entrepreneurial giftedness: the case of Richard Branson. *High Ability Studies, 17*(2), 225-235.

Shavinina, L. V. (2007). *Early development of entrepreneurial giftedness.* Proceedings of Annual conference of Administrative Sciences Association of Canada (pp. 183-186). Ottawa, Ontario.

Shavinina, L. V. (2008). Early signs of entrepreneurial giftedness. *Gifted and Talented International, 23*(1), 9-15.

Simon, H. A. (2002). Achieving excellence in institutions. In Ferrari, M.(ed.), T*he pursuit of excellence through education* (pp. 181 - 194). Mahwah, NJ: Erlbaum.

Van den Bossche, P., Gijselaers, W., Segers, M., Woltjer, G., & Kirschner, P. (2011). Team learning: Building shared mental models. *Instructional Science, 39*(3), 283-301.

Vecchio, R. P. (2003). Entrepreneurship and leadership: Common trends and common threads. *Human Resource Management Review, 13*(2), 303-327.

Wen, H. M. (1998). *The effects of task structure on group process and quality of group product in a cooperative project-based learning environment.* Florida: The Florida State University.

Wong, M., S., Watkins, D. (2001). Self-esteem and ability grouping: a Hong investigation of the Big Fish Little Pond effect. *Educational Psychology, 21*(1), 80-87.

Yoo, H. (2013). *Psychological characteristics and counseling needs of invention-gifted students.* Proceedings of Annual Conference of Creativity and Invention Education.

Yoo, H., & Baek, M. (2020). The influences of team interactions mediated by shared mental models on entrepreneurial giftedness and creative self-efficacy of entrepreneurial gifted students participating in team project-based learning situations. *Journal of Gifted and Talented Education, 30*(3), 249-276.

Yoo, H., Lee, A., Jung, J., & Lee, K. (2016). *Understanding the process of entrepreneurship development of next generation gifted entrepreneurs in their adulthood: focused on learning activities at educational institutions.* Seoul: Korea Invention Promotion Association.

Yoon, S., & Choi, M. (2013). *The effect of temperament and character on entrepreneurial gifted students' vocational interest: Based on Strong Interest Inventory and TCI.* Proceedings of Annual Conference of the Korean Psychological Association.

Yu, C. (2013). The relationship between undergraduate students' creative self-efficacy creative ability and career self-management. *International Journal of Academic Research in Progressive Education and Development, 2*(2), 181-193.

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