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A Study on Learners' Perceptions and Learning styles of Task Research (R&E) conducted by Science High School Students

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Abstract

We studied learners' perceptions and learning styles of project research activities in the chemical field conducted by 54 science high school students. In a survey of students' perceptions of task research, positive responses were found in "internal motivation," "cooperation," "task solving," and "tenacity and immersion," and statistically significant differences were found in "self-directedness," "cooperation," and "tenacity and immersion" by year. The 'lower' group responded most positively in the 'cooperation' category, and the 'higher' group responded most positively in the 'task solving' category. As a result of investigating the learning styles of the students who conducted the task research, it was found in the order of assimilator, converger, accommodator, and diverger. The assimilators showed the characteristic of systematically and scientifically approaching the problem. Convergers were found to have excellent problem-solving and decision-making ability, are practical, and have experimental-based thinking characteristics. In this study, the characteristics of science high school students showed well in the results of the learning style performed.

Keywords: *Science high school, project research, learner's perception, learning style*

1. INTRODUCTION

In the era of the 4th industrial revolution, an educational environment of self-directed problem-solving methods in which learners ask and answer their own questions is required to foster creative talents in the field of science and technology. In this environment, education in which learners solve problems through creative thinking and cooperation can be effective. In this context, learning activities in the form of task research that enable self-directed learning are more important than task research (R&E) in which existing experts participate.

From 1982 to the present, 20 science high schools and 8 gifted schools have been established and operated to foster scientific talent. Early science high schools' curriculum was centered on specialized subjects in mathematics and science, and in particular, project-based activities such as 'task research' to develop scientific inquiry and problem-solving skills were operated as the school's own curriculum. In order to develop scientific inquiry and creative problem-solving skills, existing educational methods alone have limitations, so task research (R&E) was proposed as a new science education program, and it was applied to the Korean Science Gifted School for the first time since 2003 [1].

Students go through a self-directed problem-solving process through R&E research activities, and in this

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process, they can experience scientific research methods and develop problem-solving skills [2]. The findings that the results of task research in gifted schools are very effective in science gifted education have had a great impact on the spread of this project not only to science high schools but also to science-focused schools, which are general high schools.

There are two types of task research (R&E) operation: participation in scientific research through actual research experience and student-led project-type research [3]. In the field, it is operated under the names of 'task research' and 'autonomous research' as student-led project-type research [4-8].

As a result of analyzing a questionnaire on the effectiveness of task research for students who experienced the task research program, positive results were reported in the order of cooperation with colleagues, acquisition of scientific knowledge, and attitude of scientists [9]. In the perception of R&E programs run by science high schools and science gifted schools, students' perception of the merits of R&E programs was similar to the purpose of R&E [10]. In addition, as a result of grasping the experience and meaning of R&E for college students with experience in R&E, they recognized that it helped a lot in actual scientific research [11]. There have been a number of prior studies related to R&E programs, such as research on the operation of R&E programs [12-13], research on chemical exploration R&E programs [14], etc., but most have been studies on R&E in the form of private studies, and research on student-led task research is almost insignificant.

In student-led task research, there are studies that report the main flow of research and the subjectivity of students' cognitive behavior at each stage of inquiry. However, it is difficult to find a study related to the learning style of the student-led task research program [15].

2. RESEARCH METHODS

2.1. Object of study

For three years (2011, 2013, 2019), we investigated learners' perceptions of science high school students' chemistry task research (R&E). The subjects of this study were 54 students who conducted chemistry task research (R&E) at G Science High School in Gyeongnam.

G Science High School operated a student-centered self-directed task research program within the regular curriculum as a subject of 'task research (or convergence science exploration)' for a year from the first grade gifted class activity and the second semester of the first year [4-6]. The task research team consists of three students in one group, and students will have experience in inquiry learning through self-directed selection of topics, experimental design, experiment performance, analysis of results and conclusions, writing reports and posters, and presentation of outputs.

The survey of students' perceptions of task research was conducted through surveys and in-depth interviews after completing task research activities in the relevant year. Prior to the survey, the subjects were informed that the results of the task research perception survey and individual difference survey would be used only for research so that personal information was not revealed, and only the data of students who agreed were used for the study.

2.2. Survey of students' perceptions of task research (R&E)

The classification framework for the perception survey on the process of conducting task research was revised and supplemented after review by one science education expert and two doctoral students in science education. A questionnaire was developed according to the stage of the inquiry activity, and after the first preliminary interview with one student was conducted to confirm that the answer was consistent with the development intention, it was revised and supplemented after review by science education experts. After that, the second preliminary interview was conducted with two students, and the final revision and supplementation were made.

The questionnaire items were classified into areas such as problem recognition (topic selection) process, problem-solving process, research effect, etc. according to the process of conducting task research. The problem recognition process consisted of four questions corresponding to motivation and topic selection methods, and the problem-solving process consisted of seven questions corresponding to each team's role, task research process, and difficulties in the process. Finally, the task research effect part consisted of two questions corresponding to satisfaction.

In order to quantify students' perception of task research, scoring criteria for descriptive responses were prepared. Each of the six detailed items was set from a minimum of 1 point to a maximum of 5 points, and students' responses by question were quantified based on the scoring criteria. In order to secure reliability in the quantification process of students' descriptive free responses, one professor of chemistry education, two doctoral programs, and two chemistry teachers evaluated all 54 students. Items with a difference of more than 1 point between evaluators in the scoring process were finally scored through discussion with one science education expert. In order to compensate for the reliability problem caused by students' self-report responses, three chemistry teachers at G Science High School, including researchers, reviewed individual students' quantified scoring results one by one, and went through the process of correcting students' scores with significant differences from actual observations.

2.3. Evaluation of research task

The tasks studied by students for 6 months were evaluated based on the difficulty of the problem-solving method. Each of the difficulty items of the problem-solving method was divided into 1 to 3 points. The evaluation framework was revised and supplemented after review by one professor of chemistry education and two doctoral courses in science education. The evaluation was decided through consultation if there was a difference in scores after individual evaluation by the three chemistry teachers who taught the task research in the year.

2.4. Learning style test

Kolb, who insisted on the empiricist learning model, expressed learning in four processes: reflective observation, active experiment, concrete experience, and abstract conceptualization. The learner goes through all four learning stages, and among them, there is an area that the learner prefers, and learning takes place best in that area. Therefore, Kolb referred to the area preferred by learners as the learning style, and classified it into diverger, assimilator, converger, and accommodator [16].

The learning style test paper was used by adapting Kolb's 'Learning Style Inventory' into Korean and consists of a total of 12 questions [17]. Students participating in the survey were encouraged to read the questions and set the highest priority and the lowest as 4, and then choose the second and third positions. The Cronbach α value for each item of the test item was 0.6 or more (0.631~0.859). For the classification of learning styles, the results of previous studies on general high school students were used as criteria for the classification of learning styles [18].

2.5. Statistical processing method

The IBM SPSS Statistics 28 program was used for statistical processing. Through cross-analysis, the correlation between the characteristics of the research task and the questions recognizing the task research and the learning style and the questions recognizing the task research was investigated. Descriptive statistics and cross-analysis were used to confirm the distribution according to individual differences, and differences in task research perception between groups divided into research task characteristics and learning style characteristics were confirmed by performing one-way ANOVA.

2.6. Research questions

This study attempted to investigate students' perceptions of research tasks, project research stages, and effects conducted in science high schools, and to analyze differences in perceptions according to learning styles. In order to achieve the research objectives, the following specific research questions were set up.

First, how do science high school students perceive self-directed task research (R&E)?

Second, how do the characteristics of research task correlate with task research perception?

Third, how does the learner's learning style affect the perception of task research?

3. RESEARCH RESULTS

3.1. Perception of task research activities

In the task research (R&E), students' perceptions of the problem-solving process and activities were investigated and analyzed. Figure 1 shows the ratio scores (1 to 5 points) for each item in the perception survey of the task research.

Science high school students were 44.4% (5, 4 points) who positively recognized the necessity and purpose of task research in the category of 'internal motivation.' In the 'self-directedness' item, 33.3% (5, 4 points) of the students who actively proposed their ideas in the subject selection process were found to participate. In the 'cooperation' category, 52.8% (5, 4 points) of students responded that the cooperation was generally well done. As for the 'task solving' item, 44.5% (5, 4 points) of students who completed the task by scientific method were found. In the 'tenacity and immersion' category, 68.5% (5, 4 points) of the students who self-directed and persevered were found. As for the 'satisfaction' item, 74.1% (5, 4 points) of the students answered that the task research activity was meaningful regardless of the results. That was similar to the results of previous studies [19].

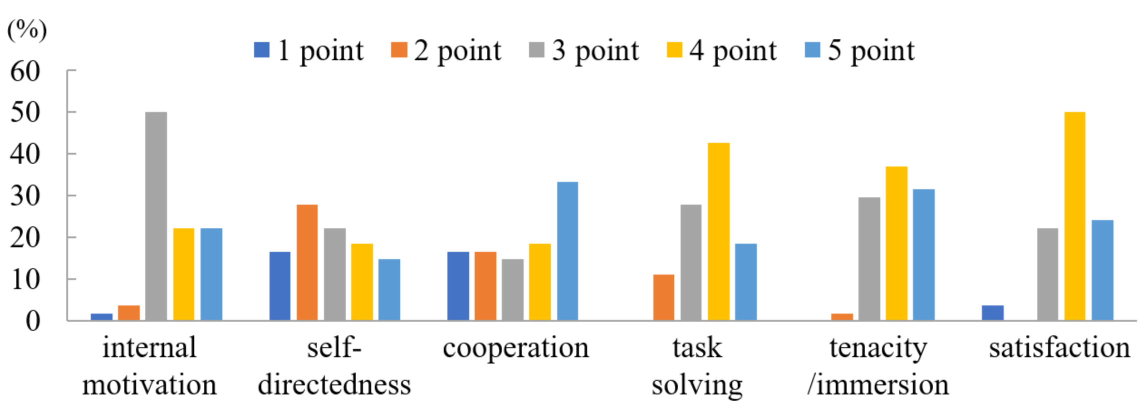

Figure 1. Percentage of scores for each individual question in the perception survey of the task research

In order to confirm the difference in students' perceptions of task research by year, ANOVA was performed on the perception survey questions of task research by year, and post-verification was performed. The results are shown in Figure 2.

There was no significant difference in the student's task research perception survey by year in terms of internal motivation, task solving, and satisfaction questions. However, it was confirmed that there were statistically significant differences in the questions of self-directedness (F:7.601, p:.001), cooperation (4.623, .014), and tenacity and immersion (3.919, .026). In particular, students in 2013 showed a lower average in self-directedness than students in other years, but showed a higher average in internal motivation and cooperation questions. This is similar to previous research results [20]. In the case of persistence, immersion, and satisfaction questions, the average was low in recent results.

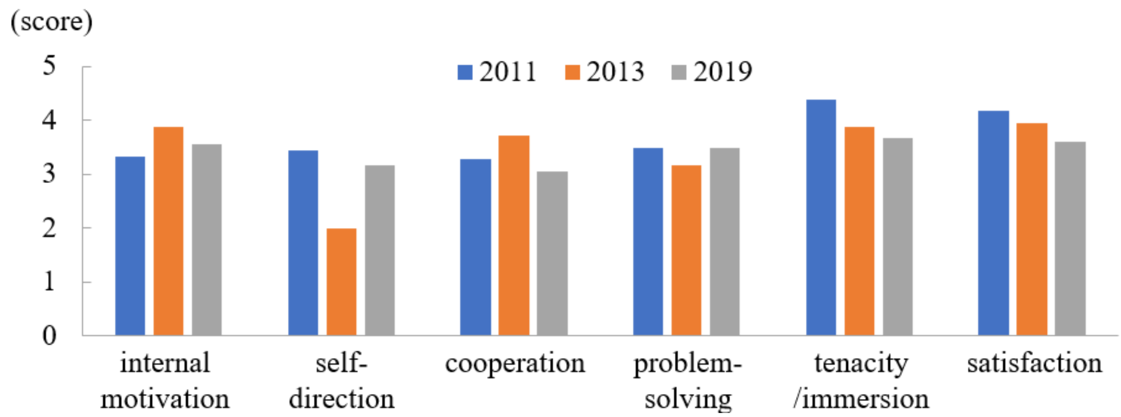

Figure 2. Average score for each question in the perception survey of task research by year

The students' responses to the descriptive question, "What do you think is the reason why students do task research activities in science high schools?" about the necessity and purpose of task research are as follows.

> *"Korean students do not have the opportunity to experiment, and most of them try to become scientists, but they need more understanding of scientists. I think task research is to provide students with a small but 'scientist' opportunity." "Students in science high schools fall into research jobs a lot in the future, so gaining experience in advance for that time is meaningful. It will help a lot if you learn how to collaborate with your team members and think together in advance."*

According to the students' responses, most of them recognize that scientific research methods will be beneficial in experiencing scientific research methods, solving problems through cooperation and communication, and cultivating scientists' attitudes. That is similar to previous studies [9-10, 21].

3.2. The degree of level of task research conducted according to research task activities

Depending on the learner's experience and the level of the research task, the way to understand the task and solve the problem scientifically can vary [22]. In order to judge the degree of performance of students' task research, research tasks for each team were evaluated. According to the evaluation results, the research task level was divided into 'higher,' 'middle,' and 'lower' groups, and the higher level was 4 teams, the middle level was 8 teams, and the lower level was 6 teams.

ANOVA was performed on the task research recognition survey questions according to the characteristics of the research task to confirm the effect of the level of the research task on the perception of the task research. The results are shown in Figure 3. As a result, there were statistically significant differences in the questions of 'cooperation' and 'task solving' depending on the characteristics of the research task. The cooperative question had the highest average (3.72) at the 'lower' level, and the 'higher' level had the highest average (4.00) for the task solving question.

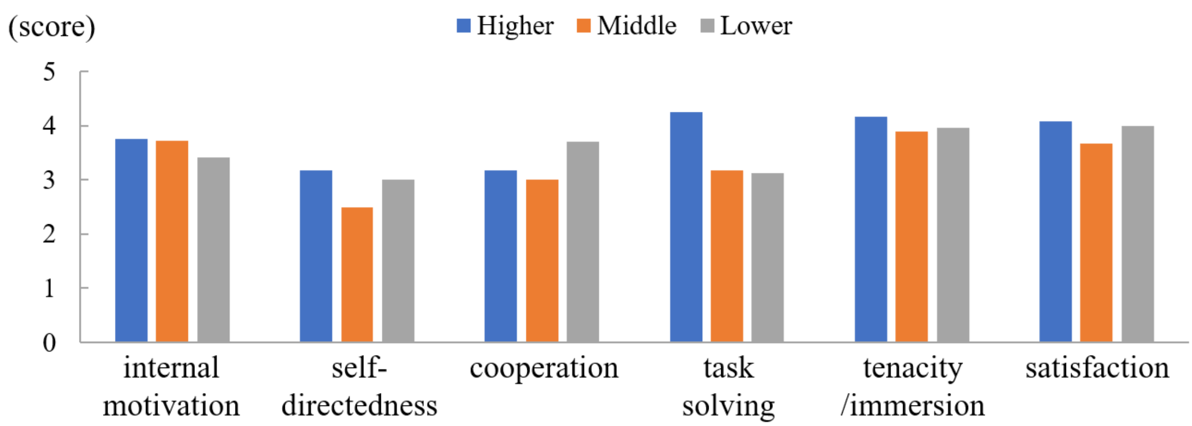

Figure 3. Average score of the perception survey on task research according to research task level

"Is there enough role-sharing and cooperation among the team members? If not, what do you think is the biggest reason?" Regarding the descriptive question about cooperation, the team's responses with the research task level of "higher" and the team students with "lower" are as follows.

> *'higher' level: "No. Our team has generally not worked well together because OO led most of the research and most of the paper and it only did what OO told us to do." 'lower' level: "My group believes that the division of roles and cooperation have been moderately well done. I think each member had good advantages, such as making reports or charts well or presenting well."*

To the descriptive question, "What was the most difficult thing while conducting task research activities and why?" which is a question about task solving, the responses of the team students with the research task level of "higher" and "lower" are as follows.

> *'higher' level: "I think the argue with the task research team was the hardest. Since it's the first time we've studied so closely with the three of us, we have different thoughts, and since we're young students, there was a debate about small things." 'lower' level: I think it was the hardest when I lost interest. Even if the results don't come out if it's fun, the task research time was good, but if I lose interest, I don't want to do it, so the atmosphere was not good.*

In the research task, it was found that when the difficulty of the task solving method is low, it shows weakness in creative task solving ability due to low sense of achievement in task-solving. On the contrary, in the case of research tasks that require high difficulty, even if there is difficulty in accessing the task, it was found to be a positive response to task solving with a high sense of accomplishment due to problem-solving. These results were similar to previous studies [22].

3.3. Correlation between learning style and perception of task research

The learning styles of students who conducted chemical task research according to the Kolb learning style were investigated, and the results are shown in Figure 4. As for the distribution of learning styles of all students, assimilators (42.6%) showed the highest distribution, followed by convergers (31.5%), accommodators, and divergers. Assimilators are capable of logical and inductive reasoning and are good at observing the properties of nature or things. In addition, convergers were found to be practical, experimental-based, and have excellent problem-solving and decision-making skills. These findings are characteristic of the learning styles of science-gifted students. That is similar to previous studies [23].

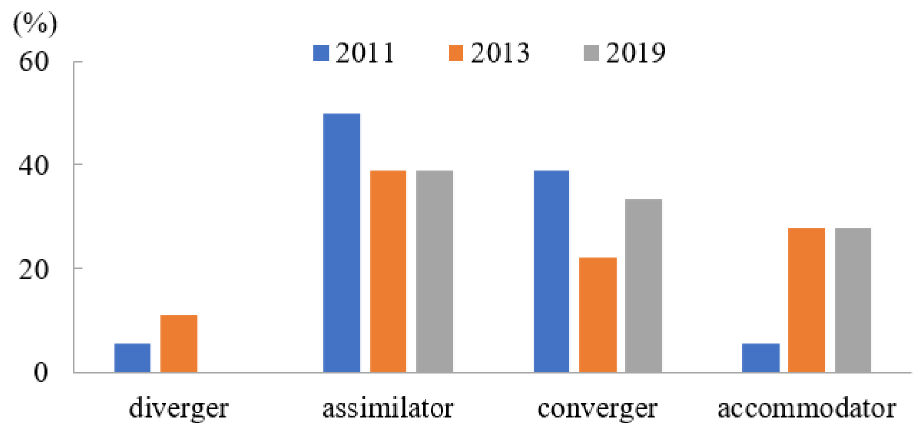

Figure 4. Distribution ratio of learning styles of science high school students by year

ANOVA was performed to confirm the correlation between science high school students' perception of task research and learning style. The results are shown in Figure 5. The group (balancer) with different learning styles showed relatively high average values in 'internal motivation,' 'cooperation,' 'task solving,' and 'satisfaction.' The team with two or more convergers showed the highest average of 'self-directedness,' and the team with two or more assimilators showed the highest average of 'tenacity and immersion.' There was no statistically significant difference in all questions.

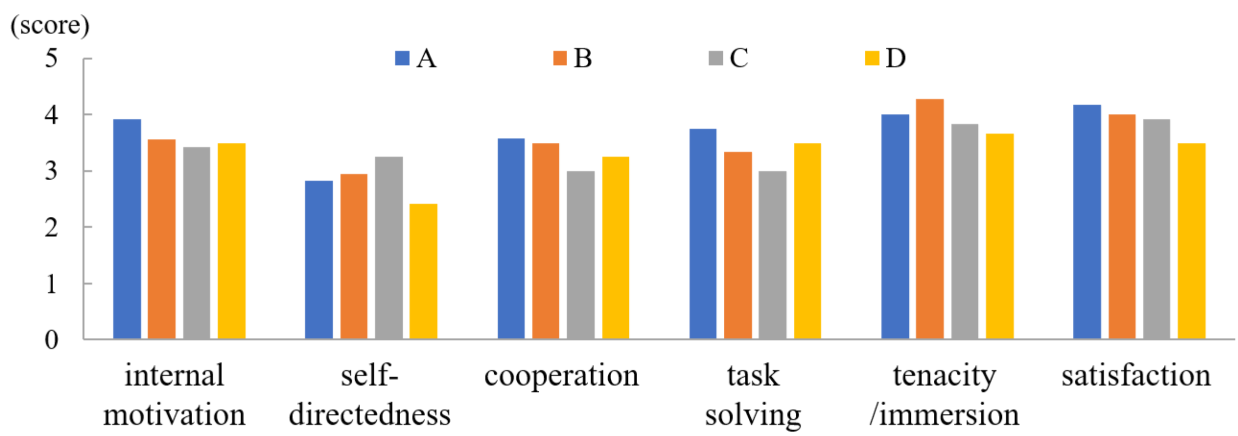

Figure 5. The average score on the perception of task research according to the type of learning style composition of the team. (A: Group with different learning styles (balancer); B: Group with two or more assimilators; C: Group with two or more convergers; D: Group with two or more accommodators)

In order to find out the satisfaction of task research, a descriptive question was asked, "Do you think the task research activity brought meaningful results to you?" Depending on the learner's learning style composition type, we looked at some of the responses from the balancer team (group A) with the highest average score and the group (group C) with two or more convergers with the lowest average score, and the contents are as follows.

group A: "It was significant. This is because I found myself interested in the research field through this task research activity," and "It was perfect. It helped us build a sense of cooperation among our team members and know that this is what research is about." group C: "Yes. I developed a sense of responsibility and learned to be considerate of others." "While conducting the subject research, I learned how to write reports and use experimental equipment, developed some conflict management skills among my team members, and I thought about what to do with future research."

In group A, which includes various learning styles in the students' descriptions, responses related to internal motivations such as scientific research methods, problem-solving skills, and others could be obtained through task research. However, in group C, which included two convergers, the response was somewhat far from the ultimate purpose of the task research. Through this result, the team composition using learning styles seems to positively perceive task research as the learning styles become more diverse.

4. CONCLUSIONS

This study aimed to investigate students' perceptions of 'task research,' an R&E program operated to cultivate creative and convergent talents in science high schools, and to study the effect of students' learning style factors on their perception of task research. After conducting this study, the following conclusions were obtained.

First, science high school students generally showed positive results in "internal motivation" (44.4%), "cooperation" (52.8%), "task solving" (44.5%), and "tenacity and immersion" (68.5%), except for "self-directedness" (33.3%) in the perception factor of task research. In particular, in the 'satisfaction' category, 74.1% were found to be satisfied with the task research. There was no significant difference in 'internal motivation,' 'task solving,' and 'satisfaction' by year. However, significant differences were found in the questions of 'self-directedness,' 'cooperation,' and 'tenacity and immersion.'

Second, research tasks were classified by level according to the difficulty of problem-solving methods for research tasks; the task level was the highest at 'lower' in the 'cooperation' factor, and the task level was the highest at 'higher' in the 'task solving' factor. Third, the assimilator was the highest in the distribution of learning styles, followed by converger, accommodator, and diverger. The task research team (group A), which consists of all different detailed learning styles, showed relatively high average values in terms of 'internal motivation,' 'cooperation,' 'task solving,' 'satisfaction,' and factors. The 'self-directedness' factor showed the highest average in the group (group C) with two or more convergers. The group (group B) with two or more assimilators showed the highest average in 'tenacity and immersion.' However, there was no statistically significant difference in all questions.

Task research is a very effective educational program for science high school students to grow into future scientists. Through student-centered task research, science high school students who are novice researchers experience the process of setting research questions about their interests, planning and conducting experiments, and drawing scientific conclusions through results.

Therefore, the results of this study can be used as a reference to guide students to experience differences in perceptions of chemical phenomena through inquiry activities, as well as form a team based on self-understanding according to learning styles for effective student-led task research.

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