

A Study on the Change in Science Grades and the Influence of Science Grades by Level according to Non-face-to-face and Face-to-face Teaching-Learning

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Abstract

We compared and analyzed the changes in students' science grades and their effects on science grades by level (upper, middle, and lower) according to non-face-to-face and face-to-face teaching-learning. 66 students from A Middle School in Gyeongsangnam-do were selected for the study. As a result of analyzing the change in science grades according to the teaching-learning type, the average score of science grades by non-face-to-face teaching-learning was lower than the corresponding score of science grades of face-to-face teaching-learning. As a result of comparing the level of understanding of learning content according to the evaluation type (paper-written, study-paper) in non-face-to-face and face-to-face teaching-learning, the average scores of science grades by paper-written and study-paper evaluations in non-face-to-face teaching-learning were significantly low. In addition, as a result of comparing the effect on science grades by level according to the teaching-learning type, the average score of science grades of lower-ranked students in non-face-to-face teaching-learning was relatively low.

Keywords: Non-face-to-face Teaching-learning, Science Grades by Level, Paper-written Evaluation, Study-paper Evaluation, Upper- and Lower-ranked Students

1. INTRODUCTION

In order to prevent the spread of COVID-19, 'social distancing' was implemented at the national level. In accordance with this national emergency situation, the Ministry of Education converted school education into non-face-to-face teaching-learning [1]. As school education was suddenly changed to a non-face-to-face teaching-learning environment, many problems with non-face-to-face teaching-learning were exposed. In other words, non-face-to-face teaching-learning caused various problems such as difficulty in understanding content, communication difficulties such as question-answer and feedback, poor quality and level of online lectures due to lack of online teaching-learning content, etc [2-5]. It was found that these problems of non-face-to-face teaching-learning could be overcome by learners' active self-directed teaching-learning [6-10]. Factors such as instructor-learner interaction such as seeking help and feedback to increase learning satisfaction, behavioral control that is not shaken by the surrounding environment, etc. were found to have an effect on self-directed teaching-learning. When applying these factors effectively, it was found that it could

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bring good results in teaching-learning [11, 12]. In particular, in non-face-to-face teaching-learning, these variables were found to have a great influence on self-directed teaching-learning will.

As a result of research on the effect between self-directed teaching-learning will and academic achievement [13, 14], academic achievement was different according to self-directed teaching-learning will [15]. Students with high self-directed learning ability have higher academic performance than students with low academic performance [16, 17], and it was found that they could effectively control the entire teaching-learning process as well as make continuous efforts to understand knowledge and information in the teaching-learning process.

On the other hand, learners with low self-directed willingness to teach-learn were found to have low academic achievement because not only social skills but also effective interaction did not appear [8]. In addition, it was found that students with low self-directed willingness to learn (active motivation) had low academic achievement, resulting in various problems (difficulty in college adaptation, psychological problems) [18].

Therefore, since the level of students' academic achievement differs according to their self-directed teaching-learning will, it is urgent to study the relationship between self-directed teaching-learning will and academic achievement by level in non-face-to-face teaching-learning.

Since the will to self-directed teaching-learning in the 2015 revised science curriculum can affect academic achievement, self-directed teaching-learning is emphasized through student participation-oriented classes, group-oriented inquiry classes, etc [19]. This curriculum emphasizes scientific core competencies (communication skills, problem solving skills, etc.) so that students can comprehensively understand the basic concepts of science through inquiry experience [20]. In particular, it was found that communication (interaction) such as seeking help, feedback, etc. between instructors and learners greatly contributed to the academic achievement of non-face-to-face teaching-learning [21-25].

Students with high academic achievement can understand the learning content relatively well and grasp the teaching-learning process even if there is no instructor-learner interaction. On the other hand, it was found that students with low academic achievement were difficult to understand the learning content in instructor-centered classes, and even if they did not understand, it was difficult to actively ask and answer questions (through manual learning activities) [3, 21]. Therefore, it was found that the higher the instructor-learner interaction, the higher the class satisfaction, while the lower the interaction, the lower the class satisfaction [22].

In the case of non-face-to-face teaching-learning, if there is no interaction between instructors and learners, such as question-and-answer questions from learners, the instructor judges that the students understood the class content and the class continues [4]. In other words, it is difficult for instructors to grasp in real time whether learners understand the learning content. Therefore, in non-face-to-face teaching-learning, the role of instructor (checking whether or not to participate in learning activities) was found to be a very important factor in determining the learning effect [4, 21, 25]. Meanwhile, as a result of some studies [26, 27], it was found that instructor-learner interaction did not affect academic achievement and class satisfaction in non-face-to-face online teaching-learning.

In this way, according to the situation of teaching-learning, learners' results on academic achievement and learning satisfaction in non-face-to-face teaching-learning appear differently. Therefore, in non-face-to-face and face-to-face teaching-learning that relies on self-directed teaching-learning, it is important to study the changes in students' science grades and the effects of science grades by level (upper, middle, and lower).

2. RESEARCH METHODS

2.1 Object of Study

With social distancing caused by COVID-19, school education was converted to non-face-to-face online teaching-learning. According to these changes, changes in science grades due to non-face-to-face and face-to-face teaching-learning and the degree to which non-face-to-face teaching-learning affects science grades by level (upper, middle, and lower) were studied.

Selected middle school 2nd graders conducted non-face-to-face teaching-learning using science textbooks for the 2nd grade of middle school during the 1st and 2nd semesters of 2020. Face-to-face teaching-learning was conducted using science textbooks for the third grade of middle school during the first and second semesters of 2021, when the same students became the third grade.

The same science teacher conducted non-face-to-face classes in 2020 and face-to-face classes in 2021. As the second graders became the third graders, the composition of all students was the same. Both second and third graders were divided into three classes, and the number of students in each class was the same. For these 2nd and 3rd graders, the effects of science grades according to non-face-to-face and face-to-face teaching-learning are compared and analyzed.

Science grades according to non-face-to-face and face-to-face teaching-learning were compared as the average value of science grades in the first and second semesters of all students. The upper, middle, and lower grades of science grades were divided into 1/3 students (22 students each) from 1st to 66th, according to the order of grades. After adding up the science scores of 22 people at each level, the average score was used.

2.2 Class contents and evaluation contents

Science classes were conducted for 17 weeks on a semester-by-semester basis (68 hours/semester). Students in the 2nd grade of middle school conducted classes according to the contents of the 2nd grade science textbook. Units 1-5 of science textbooks were taught for the first semester, and Units 6-9 of science textbooks for the second semester. For non-face-to-face teaching-learning, online real-time teaching-learning was conducted, and the number of hours was the same as face-to-face teaching-learning.

Science classes were conducted four hours a week, and non-face-to-face teaching-learning was conducted for the first and second semesters of 2020. The paper-written evaluation was conducted by dividing the midterm and final exams per semester. The paper-written evaluation (deepened content evaluation) focused on measuring scientific thinking and problem-solving ability by understanding scientific concepts, application to real life, etc. As for the evaluation questions, 15 questions were presented in narrative form (70%) and short answer form (30%), and the achievement of the paper-written evaluation was evaluated with a perfect score of 100. The test questions were presented by the science teacher.

The evaluation of the study-paper (basic content) was conducted after learning each subunit of the science textbook. 25 questions were presented for each subunit content, and it was an entry-type question. After having students solve the problem, the teacher evaluated the content. Each subunit of the science textbook is organized to teach-learn for 3-4 sessions (a week).

2.3 Research questions

Since non-face-to-face teaching-learning is an instructor-centered class in which instructors unilaterally give lectures, learners with high academic achievement can follow the learning content relatively well, but students with low academic achievement cannot achieve their learning goals. Learners may show high academic achievement when reinforcing a high level of effort and attention concentration in their teaching-learning. Therefore, the will to self-directed teaching-learning can greatly affect academic achievement.

This study studied the degree of change in students' science grades according to non-face-to-face and face-

to-face teaching-learning, and also studied the effect of non-face-to-face teaching-learning on science grades by level. Accordingly, the research problems of this study are as follows.

1. What is the change in students' science grades according to non-face-to-face and face-to-face teaching-learning?
2. What is the effect of non-face-to-face teaching-learning on science grades by level (upper, middle, and lower)?
3. What is the effect of non-face-to-face teaching-learning on the level of understanding of learning content (deepened content, basic content)?

3. RESEARCH RESULTS

3.1 Analysis of science grades according to teaching-learning Types (non-face-to-face, face-to-face)

For 2nd and 3rd graders, the science grades of 1 year through non-face-to-face and face-to-face teaching-learning were analyzed, and the average scores of science grades of 2nd and 3rd graders are shown in Figures 1(a) and 1(b), respectively. When comparing the average scores of 2nd and 3rd graders according to the teaching-learning type, the average scores by non-face-to-face teaching-learning were lower than those by face-to-face teaching-learning, respectively. In addition, for the same students, the average score by non-face-to-face teaching-learning (2nd grader) was also lower than that by face-to-face teaching-learning (3rd grader).

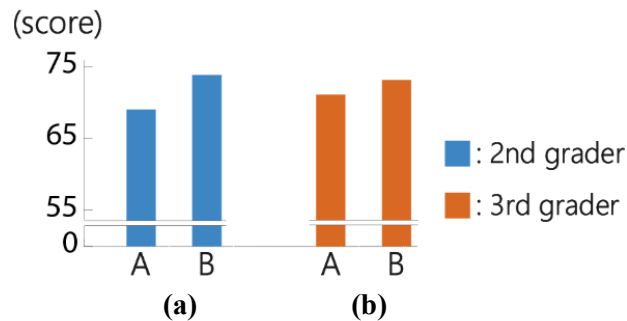


Figure 1. Comparison of average scores in science grades in 2nd (a) and 3rd graders (b) according to teaching-learning types (non-face-to-face, face-to-face). Non-face-to-face class and face-to-face class are denoted as A and B, respectively.

These results showed that the will of self-directed teaching-learning in non-face-to-face teaching-learning was relatively lower than that in face-to-face teaching-learning, so the average score of science grades in non-face-to-face teaching-learning was lower. In particular, in non-face-to-face teaching-learning activities, it was found that the immersion of teaching-learning through personal behavior control, instructor-learner interaction, etc. had a great influence on science grades.

As a result of previous studies [11, 13, 14], it was found that the higher the intensity of learning immersion according to behavior control in non-face-to-face teaching-learning activities, the higher the student's academic achievement. In addition, it was found that the more active the interaction between instructors and learners in non-face-to-face teaching-learning, the higher the student's academic achievement [4, 12, 19].

Therefore, these results suggest that students' science grades are influenced by teaching-learning types. In other words, it was found that science grades in non-face-to-face teaching-learning depend on the degree to which they actually participated in science classes (self-directed teaching-learning will).

The lowest and highest scores of science grades according to teaching-learning types (non-face-to-face, face-to-face) were compared, and are shown in Figures 2(a) and 2(b), respectively. As a result of comparing the lowest scores, the lowest score by non-face-to-face teaching-learning was significantly lower than the corresponding score by face-to-face teaching-learning. On the other hand, in the comparison of the highest scores, the highest score by non-face-to-face teaching-learning was slightly lower than that of face-to-face teaching-learning. According to the teaching-learning type, the lowest score in science grades changed considerably, but the highest score was almost the same.

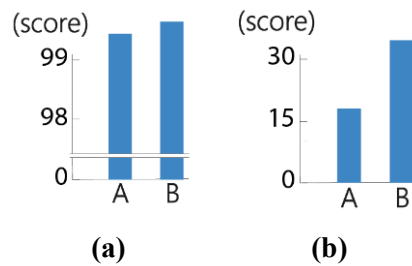


Figure 2. Comparison of the lowest score (a) and highest score (b) of science grades of 2nd graders in non-face-to-face classes and face-to-face classes. Non-face-to-face class and face-to-face class are denoted as A and B, respectively.

As a result of previous studies [8, 11, 14], it was found that lower-ranked students with low academic achievement do not understand the learning content well, especially in non-face-to-face teaching-learning, because it is difficult to immerse themselves in learning by behavior control in teaching-learning activities [3, 21, 22]. As a result, it was found that the level of instructor-learner interaction such as active question and answer of learners was low. On the other hand, it was found that the upper-ranked students with high academic achievement level put a lot of effort into understanding knowledge and information, and effectively managed and controlled the teaching-learning process [16, 17].

Therefore, since students with low grades have lower lowest scores in non-face-to-face teaching-learning, it is important for lower-ranked learners to actively participate in teaching-learning activities and increase their willingness to self-directed teaching-learning to understand the contents and concepts well.

3.2 Comparison of grades in science subjects according to evaluation types (assessment form) in non-face-to-face classes and face-to-face classes

In non-face-to-face and face-to-face teaching-learning, the average score of science grades according to the evaluation type (paper-written evaluation: deepened content, study-paper evaluation: basic content) was compared and shown in Figure 3. In non-face-to-face teaching-learning, the average scores by paper-written evaluation and study-paper evaluation were lower than the average scores in face-to-face teaching-learning, respectively. In addition, in the comparison of non-face-to-face and face-to-face teaching-learning, the difference in average scores between paper-written evaluations was relatively larger than that between study-paper evaluations.

The paper-written evaluation (deepened content) consisting of 70% of narrative questions focused on measuring scientific thinking and problem-solving ability. In order to solve descriptive problems, not only understanding of scientific concepts, but also a wide range of scientific knowledge such as application to real life, application of scientific phenomena, etc. is required. The relatively low score of paper-written evaluation in non-face-to-face teaching-learning is due to the results of learners' low understanding of scientific concepts

and principles as well as their low problem-solving ability to apply them. On the other hand, the evaluation of the study-paper (basic content) was to solve basic problems centered on scientific concepts and principles presented in the sub-units of the science textbook.

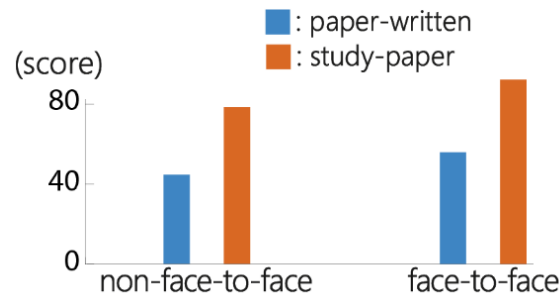


Figure 3. Comparison of average grades in science subjects according to the type of evaluation (paper-written evaluation: deepened content, study-paper evaluation: basic content) in non-face-to-face and face-to-face teaching-learning

Therefore, in order to increase scientific thinking and problem-solving ability in the non-face-to-face teaching-learning process, learners should increase the level of learning immersion through attention concentration and behavior control. In addition, instructors should improve the quality of teaching-learning so that learners can understand the learning content well. In particular, it is more and more necessary to 'focus on teaching-learning by strengthening the will in self-directed teaching-learning' of lower-ranked students.

This reinforcement of will in self-directed teaching-learning is consistent with the results of previous studies that it has a great influence on academic achievement because it increases the understanding of learning content and problem-solving ability [21, 22].

3.3 Comparison of upper, middle, and lower science grades by non-face-to-face and face-to-face teaching-learning

In non-face-to-face and face-to-face teaching-learning, after dividing all students' science grades into upper, middle, and lower levels, the average scores of each level are shown in Figure 4. In the comparison of non-face-to-face and face-to-face teaching-learning, the difference in average scores of lower-ranked students was relatively large, while the difference in average scores of upper-ranked students was almost similar. In addition, differences in average scores of students between upper- and middle-level and middle- and lower-level in non-face-to-face teaching-learning were larger than the relative differences between them in face-to-face teaching-learning, respectively.

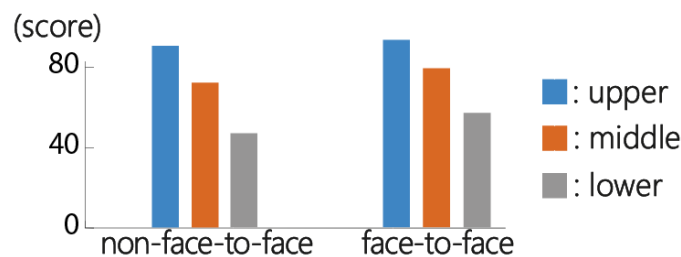


Figure 4. Comparison of average scores between levels of upper, middle and lower science grades according to non-face-to-face and face-to-face teaching-learning

As a result of previous studies [13, 18], in non-face-to-face teaching-learning, when learners pay a high level of attention, academic achievement was high, whereas when learners lack behavioral control and attention, academic achievement was low. In addition, it is known that students with a low level of self-regulated learning will not only have low instructor-learner interaction, but also have low academic achievement due to passive teaching-learning activities [8, 22]. In particular, when the learning content is incomprehensible and difficult, the instructor-learner interaction is low, so academic achievement is low [26, 27].

Therefore, it was found that the lower-ranked students who had difficulty understanding the learning content not only had low self-directed learning willingness to solve the learning task (passive teaching-learning), but also had low confidence in their learning (active learning motivation). As a result, it is judged that the average score of lower-ranked students are lower in non-face-to-face teaching-learning.

In non-face-to-face and face-to-face teaching-learning, the average scores of the upper, middle, and lower paper-written evaluations (deepened content) are compared and shown in Figure 5. In the comparison of non-face-to-face and face-to-face teaching-learning, differences in average scores of middle- and lower-ranked students were relatively large, respectively, while difference in average score of upper-ranked students was almost similar. In addition, in non-face-to-face teaching-learning, the differences in average scores of students between upper and middle, and middle and lower were relatively larger than those in face-to-face teaching-learning, respectively.

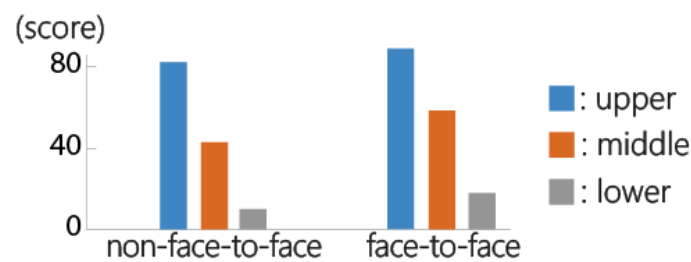


Figure 5. Comparison the average scores of the upper, middle, and lower paper-written evaluations in non-face-to-face and face-to-face classes

In order to measure scientific thinking ability and problem-solving ability, paper-written evaluation was conducted with various problems applying scientific concepts and principles. In order to increase scientific thinking and problem-solving ability in real life, learners should strengthen their learning immersion and improve their understanding of learning content through behavioral control. At the same time, the instructor needs to adjust the speed of teaching-learning after grasping whether learners understand the learning content. In particular, it is more important for lower-ranked students to 'understand the learning content according to learning immersion'.

These results are similar to the results of previous studies that students with a high level of self-directed teaching-learning have higher academic performance than students with a low level of self-directed teaching-learning [16, 17].

In non-face-to-face and face-to-face teaching-learning, the average scores of the upper, middle, and lower study-paper evaluation (basic content) are compared and shown in Figure 6. In non-face-to-face teaching-learning, the average score of lower-ranked student was very lower than that of them in face-to-face teaching-learning, while the average scores of upper- and middle-ranked students according to the teaching-learning type were similar. In addition, in non-face-to-face teaching-learning, the difference in average scores between the middle and lower grades was relatively larger than the difference in upper and middle average scores.

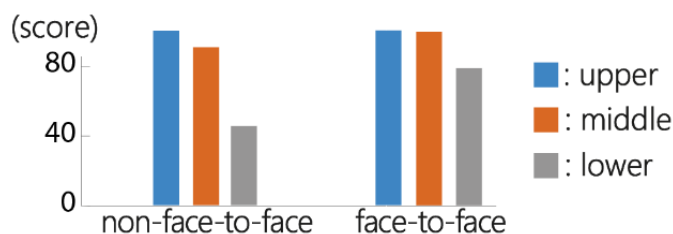


Figure 6. Comparison of the average scores of the upper, middle, and lower study-paper evaluation in non-face-to-face and face-to-face teaching-learning

In the evaluation of the study-paper (basic content), after teaching and learning the contents of each subunit of the science textbook, students' understanding of the content was evaluated as various problems centered on scientific concepts and principles. In particular, in the non-face-to-face teaching-learning process, learners with low achievement levels had low understanding of the learning content due to passive teaching-learning, and there were few questions for understanding the content. In addition, the willingness to focus on learning such as behavior control, learning immersion, etc. was low. As a result, it was found that the teaching-learning will was low in the non-face-to-face teaching-learning process, and the score was low in the evaluation of the study-paper.

Students with such low science scores have a low level of self-directed teaching-learning, so they have a low understanding of knowledge and information in the teaching-learning process and a low active motivation for teaching-learning [8].

4. CONCLUSIONS

As shown in Figures 1(a) and 1(b), the average scores of second and third graders in non-face-to-face teaching-learning were significantly lower than those in face-to-face teaching-learning, respectively. In addition, the average score by non-face-to-face teaching-learning in the second grader was also lower than the average score of face-to-face teaching-learning in the third grader. In this way, according to the teaching-learning type, the average score of students was different.

In particular, in non-face-to-face teaching-learning, the level of willingness to teach-learn such as learning immersion by behavioral control, instructor-learner interaction, etc. was found to be low. As a result, it is judged that the grades of science subjects depend on the will of self-directed teaching-learning in which they participate in teaching-learning.

As represented in Figures 2(a) and 2(b), the lowest score of science grades by non-face-to-face teaching-learning was significantly lower than that of face-to-face teaching-learning. On the other hand, the highest score by non-face-to-face teaching-learning was slightly lower than that of face-to-face teaching-learning. According to the teaching-learning type, the lowest score was quite low, but the highest score was almost the same.

Therefore, since the lowest score of science grades of lower-ranked students in non-face-to-face teaching-learning is lower, it is necessary to actively participate in the process and activities of teaching-learning through attention and behavioral control. It is important to increase the level of self-directed teaching-learning will to understand the contents and concepts of learning well.

As presented in Figure 3, in non-face-to-face teaching-learning, the average scores by paper-written evaluation and study-paper evaluation were lower than those by these evaluations in face-to-face teaching-learning, respectively. In addition, in the comparison between non-face-to-face and face-to-face teaching-learning, the difference in average scores between paper-written evaluations was relatively larger than that

between study-paper evaluations. The score of the paper-written evaluation focused on measuring problem-solving ability was relatively lower in non-face-to-face teaching-learning.

This is judged to be because learners not only have a low understanding of the learning content, but also have a low application to scientific phenomena. Therefore, learners need to increase the level of self-directed teaching-learning will such as attention concentration and behavior control in the non-face-to-face teaching-learning process, and instructors need to increase the quality of teaching-learning to suit the level of learners.

As shown in Figure 4, in the comparison of non-face-to-face and face-to-face teaching-learning, the difference in average scores of lower-ranked students was the largest. In addition, differences in average scores of students between upper- and middle-ranked, and middle- and lower-ranked in non-face-to-face teaching-learning were larger than those between them in face-to-face teaching-learning, respectively. Due to the low level of attention concentration in the teaching-learning process and passive teaching-learning activities, the average score of the lower-ranked students was lower.

Therefore, lower-ranked students with low self-directed learning will have a low level of understanding of learning content, so they have low learning will and confidence to solve learning tasks. As a result, it is judged that the average score of lower-ranked students is lower, especially in non-face-to-face teaching-learning.

As represented in Figure 5, in the comparison of non-face-to-face and face-to-face teaching-learning, the difference in average scores of middle- and lower-ranked students was large, and the change in average scores of upper-ranked students was similar. In non-face-to-face teaching-learning, the average score of the paper-written evaluation of lower-ranked students was relatively lower than that of them in face-to-face teaching-learning. Descriptive problem solving to measure problem-solving ability is judged to be more difficult for lower-ranked students with a low level of understanding of learning content.

As presented in Figure 6, in non-face-to-face teaching-learning, the average score of lower-ranked students was lower than that of them in face-to-face teaching-learning. In particular, the average score of the study-paper evaluation of lower-ranked students was relatively lower.

As a result, since lower-ranked learners have a low level of understanding of learning content, not only the level of understanding of scientific concepts and principles is low, but also the ability to apply natural phenomena is low. This low level of understanding of learning content is not only because the level of learning immersion to teaching-learning is low, but also because effective instructor-learner interaction does not appear.

Therefore, in non-face-to-face teaching-learning, it is important for learners to not only actively participate in learning, but also to identify, check, and control learning tasks or activity status on their own. At the same time, instructors are required to adjust the speed of teaching-learning according to whether learners understand the learning content.

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