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Influences on the Academic Achievement of General Chemistry Based on the Interest for Chemical Subjects of High School

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Abstract

To find out the effect of interest on chemical content, interest in chemistry, choice of science elective subjects, teaching-learning characteristics that make it difficult to understand contents, academic achievement in general chemistry according to university admission screening, etc. were surveyed on 51 students enrolled in the department of chemistry education at P college of education. As a result of the survey, it was found that the interest in Chemistry I, Chemistry II, and general chemistry increased significantly to 94.6%, 73.7%, and 66.0%, respectively. 39.3% of the students answered that they had a lot of difficulty in understanding general chemistry. The characteristics of learners who make it difficult to understand the content were found to be 'lack of willingness to learn' such as 'lack of understanding chemical concepts' and 'lack of problem solving', due to the lack of 'basic knowledge'. As a way to solve these difficulties, 'expert help' appeared the most. The grades of general chemistry of students who entered the regular admission were relatively higher than those of occasional recruitment.

Keywords: *Elective Subject in Science, Interest in the Content, How to Resolve Difficulties, Academic Achievement, Lack of Willingness to Learn*

1. INTRODUCTION

The current science curriculum has strengthened students' scientific capabilities to adequately respond to rapid social changes. To do this, scientific experiments and experiences for solving natural phenomena and real life problems are first conducted, and then the understanding of the core concepts of science is emphasized [1]. Students are supposed to acquire the knowledge they want and understand the core concepts through student-centered inquiry experiments. In particular, it not only emphasizes a systematic understanding of chemistry, but also focuses on internalizing science education by linking it with real life from a convergent perspective. Therefore, in order to faithfully realize the science curriculum in the school field, a selection-oriented curriculum was introduced in which students select the subjects to be completed in the science subjects [2].

The selection-oriented curriculum can satisfy each student's learning needs and has great advantages in providing opportunities for career exploration in the future. However, as students select and complete only a few subjects in science, learning deficits can occur, and there is a problem that scientific concepts and

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principles cannot be comprehensively understood. In particular, not only was the interest in chemistry low, but also the academic achievement of general chemistry in universities was relatively low [3-5]. Therefore, students can choose their preferred science course according to their interest, curiosity, scientific grades, university majors, etc. Since the options according to these students' interest greatly affect teaching-learning methods, content understanding, academic achievement, etc., research on them is urgently needed.

Since chemistry subjects have a clear hierarchy, step-by-step learning is required [6]. In the chemistry curriculum of high school, the concept of chemistry consists of the structure of matter, the properties of matter, and changes in matter. Since the properties of the matter vary depending on the structure of the matter, the chemistry curriculum is organized to learn the structure first and then the properties of the matter. The organization of Chemistry I only explains the areas of 'structure of matter' and 'chemical change', so the scientific concept is simple and the application is relatively narrow. On the other hand, Chemistry II explains 'the properties of matter' and 'chemical change', so chemical concepts are complex and highly applicable. As such, the composition of Chemistry I and Chemistry II is completely different from each other. Since the content is relatively simple in the 'structure of matter' presented in Chemistry I, students can get a good grade on the test with little effort. Since the section of the 'properties of matter' organized in Chemistry II are diverse and complex, it is not only difficult to understand the contents, but there are many contents to be learned. Therefore, students are choosing more ‘Chemistry I’, which is easy to score on the College Scholastic Ability Test [7].

Currently, the chemistry curriculum gives students the right to choose a subject in ‘completed course in high school’ and ‘college entrance examination’. When deciding on a subject, students choose by considering factors such as 'interest in the subject', 'teaching-learning method', 'school grades', 'major field to enter', and 'benefit or disadvantage in the college entrance exam'. In particular, students were found to choose the most confident subject in the College Scholastic Ability Test [8, 9]. Due to these factors, 'subject selection in high school' and 'subject selection in the exam' may be limited to specific subjects that students prefer [5].

Even if students complete only a specific science subject, science curriculum of high school is organized so that the concept and principles of science subjects can be taught-learned. In other words, the situation is systematically supported by ‘expanded operation of the elective curriculum of high schools', ‘available to open science courses by the university-level program', and ‘operation of key schools by specific subject area'.

However, despite these institutional complementary policies, these policies are not being operated well in reality in the school field. Therefore, it was found that students have difficulty understanding the basic concepts and contents of chemistry due to problem-solving-oriented teaching-learning for college entrance examination [10]. As a result, since a limited curriculum for college entrance exams is operated, not only distorts the science curriculum of high school, but there is a considerable gap from concept-oriented learning for general chemistry [8].

In the College Scholastic Ability Test, students do not choose a science exploration course or only complete ‘science subject I’ to enter the science and engineering department of university. This science selection curriculum leads to learning deficits in science subjects and is changing into a means of entering college [11]. As a result, it is reported that the connection between chemistry and general chemistry is low in high school, intellectual curiosity is lowered, and learning time is wasted [12]. In addition, it is reported that the degree of interest and understanding of general chemistry at university is greatly influenced by whether or not students have completed science elective courses in high school, and that there is a large difference in understanding of chemical content among college students [13]. Therefore, there is an urgent need for research that can increase the degree of understanding of the contents of chemistry according to the students' interest in chemistry. In the results of previous studies, it was reported that as students entered science and engineering colleges after completing only ‘science subject I’, it was relatively more difficult to receive university education due to lack of scientific literacy and scientific competency, and there was a large difference in understanding chemical concepts [5, 14].

According to a study by Schwartz et al. [15], it was reported that completing courses related to one's career or college major in the future had higher academic achievement in college than completing all science courses. On the other hand, completing a science course in high school affects academic achievement in college, but the effect is not significant, and the depth of content is different from that of major subjects except for college liberal arts subjects, so it was found to have little effect [16]. Currently, students are choosing science elective courses in consideration of their aptitude, interest, university career, etc. in high school education, but various results are coming from previous studies. Therefore, more research on the necessity of an elective curriculum in high school is urgently needed, and the next curriculum should be organized based on them.

2. RESEARCH METHODS

2.1 Object of Study

Chemical education students who entered with a dream of becoming chemistry teachers had different curiosity and interest in chemistry than other major students, and these curiosity and interest in chemistry were studied on understanding and academic achievement.

The subjects of the study were 56 students who enrolled in the department of chemical education at the college of education of P in Gyeongnam. A survey was conducted on them, and the research contents were analyzed for 51 people who faithfully responded to the survey. Students' academic achievement was based on ‘Chemistry I’ grades (students admitted through occasional recruitment) of high school, ‘Chemistry I’ grades (students admitted through regular recruitment) of college entrance exams, and ‘average grades’ of general chemistry.

In both high school and college entrance examinations, these grades of ‘Chemistry I’ are 9 grades, and the standard regular distribution is shown in Figure 1. In high school, the grade of 'Chemistry I' was until the first semester of the third grade, and the average value of 'Chemistry I' was used as it was. The average grade of ‘Chemistry I’ in the college entrance screening is 1-5. For the grades of general chemistry, the average of grades in the first and second semesters was used as academic achievement. Based on the interest of chemistry subjects, the research contents were investigated on the characteristics of learners in teaching-learning of chemistry subjects, how to resolve difficulties in chemical content, the academic achievement of general chemistry for each university admission screening.

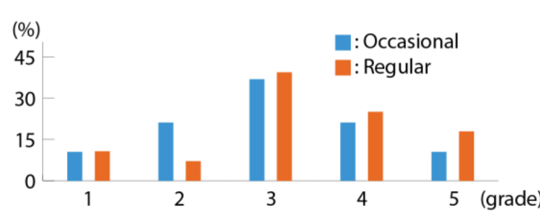

Figure 1. Grade of ‘Chemistry Ⅰ’ in college admissions (occasional, regular)

2.2 Questionnaire Survey

For students enrolled in the Department of Chemical Education, the effect of interest in chemistry on content understanding and academic achievement in high schools and colleges was investigated, respectively. It is to study the purpose of introducing an elective curriculum that allows students to choose their major areas of career and interest and receive appropriate education, and these results can be reflected in the next curriculum.

For this study, the questionnaire used was modified to suit the characteristics of students enrolled in the department of chemistry education using the previous test tool [3, 5, 7], and then the first preliminary survey was conducted on 17 students. Based on the preliminary survey, the questionnaire was finally revised by synthesizing 'the students' understanding of the questionnaire' and 'professor and expert opinions', etc.

The survey consisted of 34 questions, including interest in chemical subjects of high school, learners' teaching-learning characteristics in chemical subjects, and academic achievement in general chemistry by admission type. The questions about interest in chemistry of high school and general chemistry, the level difference between these two chemical contents, etc., consisted of a 5-point Likert scale, and allowed them to select terms that correspond to their thoughts. Also, the reason was written down. The remaining questions were in the form of asking students' perceptions, and answers were repeatedly selected. The reason was made to describe. The survey took 50 minutes. The survey was conducted at the end of December 2021.

2.3 Research Questions

After completing chemistry under the current science curriculum, 51 students investigated the effects of confidence and interest in chemistry, learners' learning characteristics, academic achievement, etc. Based on this, the research questions were set as follows.

First, what is the interest in chemistry of high school and general chemistry?

Second, what about the characteristics of learners who find chemical content difficult and how to solve the difficulties?

Third, what is the content understanding and academic achievement of general chemistry according to the university admission types?

3. RESEARCH RESULTS

The rate of completion of science elective courses was investigated, and the results are shown in Figure 2. Chemistry I was 63.5%, Earth Science I was 17.3%, and so on. The reasons for choosing Chemistry I were interesting (50.0%), easy or good grades (25.0%), easy problem-solving (11.1%), etc. It is judged that the students completed Chemistry I to enter the department of chemical education after determining the chemical major they were interested in. In previous studies [8], it was found that the decision of science elective subjects took into account interest in major subjects, basic subjects in major fields, grades in exams, etc. Therefore, the science curriculum is being reflected to some extent in the school field.

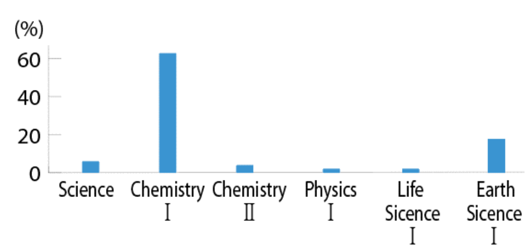

Figure 2. Degree of completion of science elective courses by students enrolled in the Department of Chemical Education

Interesting units were investigated in the chemistry textbook, and the results are shown in Figure 3. The 'chemical reaction', 'chemical bonding', and 'constituting particles of matter' in Chemistry I were found to be interesting units. The reasons for selecting the ‘Chemical Reaction’ were ‘because the chemical reaction equation and quantitative relationship are fun’ and ‘because the content is simple'. The reason for choosing ‘chemical bonds’ is that chemical bonds due to overlapping orbitals have increased interest, the reason for choosing ‘material composition particles’ is that they were interested in understanding the micro-world. On the other hand, it was described because the interest of the unit presented in Chemistry II was very low and the content was difficult to understand. As such, students had a high preference for the unit according to their level of interest.

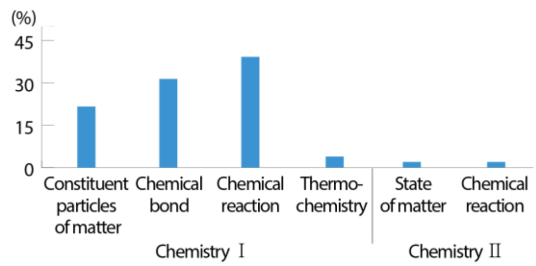

Figure 3. Units interested in chemistry textbooks of high school

As shown in Figure 4, after completing the chemistry course, most students showed increased interest in chemistry. Interest in Chemistry I and Chemistry II increased to 94.6% and 73.7%, respectively. After completing Chemistry I, the positive reasons for interest were ‘it is fun about the contents of Chemstry I’, ‘good grades’, ‘connection with majors and careers’, while negative reasons were ‘because classes focused on problem solving’ and ‘low grades’.

The positive reasons for chemistry II were ‘connectivity with daily life’ and ‘it is fun about the contents of Chemstry II’, while the negative reasons were ‘high difficulty in problem solving’ and ‘because I teach-learn mainly by memorization to prepare for college entrance exams’. Therefore, it is judged that students chose Chemistry I a lot based on their interest in chemistry.

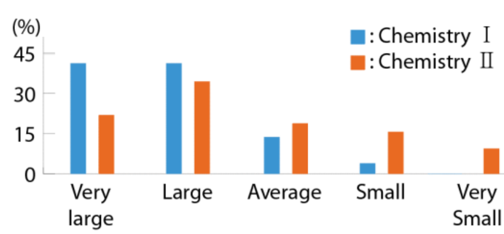

Figure 4. Interest in chemistry subjects (Chemistry Ⅰ, Chemistry Ⅱ) of high school

Figure 5 shows the results of investigating the change in interest in general chemistry. 66.0% of students showed an increase in interest, while 30.2% of students answered that interest decreased. While teaching-learning of chemistry subjects in high school focuses on college entrance exams, interest in general chemistry has increased due to ‘expanding applicability’, ‘explaining concepts’, and ‘illustrations in real life’. On the other hand, the reason for the decrease in interest was that the contents of general chemistry were difficult to understand. Therefore, it was found that not only the interest in chemical content but also the composition and organization of textbooks are very important to understand the contents of textbooks well. As a result of previous research [17], it was emphasized that interest is closely related to the contents and composition of the textbook.

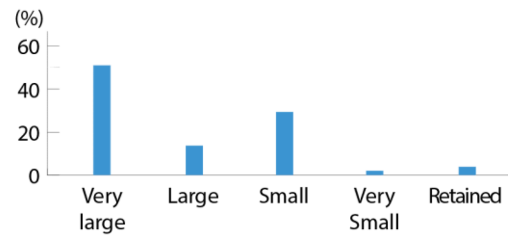

Figure 5. Changes in interest after completing general chemistry

The results of a survey on units that are difficult to understand in chemistry subjects of high school were presented in Figure 6, and the 'oxidation/reduction' and 'acid/base' units were recognized as the most difficult units. These units have a lot of content to learn and are concepts with depth. The definition of oxidation-reduction is learned step by step, such as 'movement of oxygen' in middle school, 'movement of electrons' in high school, and 'change of oxidation number' in ChemistryI. Students perceived the concept of deepening oxidation-reduction as difficult content.

Since the acid-base unit was also described in depth-expansion according to grade (definition of Arrhenius, definition of Bronsted-Lowry), these contents were difficult to recognize. It was difficult to recognize that the concept expanded from ‘definition of a substance providing H+ and OH- ions’ to ‘definition of proton (H+) migration in one reaction’. In particular, students responded that since these two units have expanded concepts defined step by step according to grade, it becomes difficult to define the next step without understanding the definition of each step.

The concept of 'spontaneity of response' was recognized as difficult because it was necessary to judge reversible or irreversible after considering three variables (enthalpy, entropy, temperature) at the same time. Therefore, it is judged that it should be reflected in the next science curriculum in consideration of the degree of students' perception of these contents.

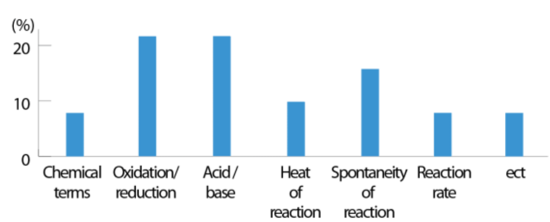

Figure 6. Units that are difficult to understand in chemistry textbooks of high school

Among the units of general chemistry, the units that students find difficult were investigated, and the results are shown in Figure 7. Difficulties were recognized in the order of 'electrochemistry', 'thermochemistry', 'complex ion equilibrium', etc. The content of electrochemistry (cell, charge flow, etc.) is the basic concept of oxidation-reduction, and the content of 'thermochemistry' is the basic concept of enthalpy, the concept of the state of matter, etc. The 'complex ion equilibrium' was first introduced in general chemistry, and it was difficult to recognize unfamiliar concepts (ligand, transition metal, etc.). Therefore, if students do not understand these concepts well in high school, the contents of these units are inevitably difficult.

On the other hand, the unit that learned in-depth in high school, especially the unit that frequently appears on the CSAT, understands the concept well through problem-solving-oriented learning, so the degree of difficulty was relatively low. Therefore, since there is a great link between chemistry of high school and general chemistry of college, it is proved that the content of general chemistry is difficult without understanding the chemistry content of high school [3-5, 8].

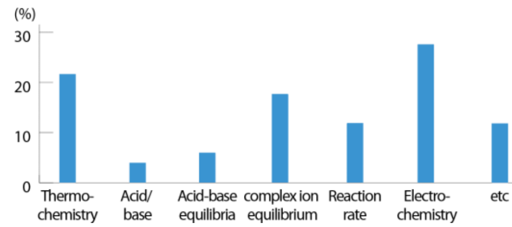

Figure 7. Units that are difficult to understand in general chemistry

The degree of difficulty in general chemistry was investigated, and the results are shown in Figure 8. On a 5-point scale, a nearly normal distribution curve was shown. 39.2% of students answered that the difficulty was 'large', while 23.5% answered 'no'. In the case of students who answered 'large', the reasons for difficulty in understanding the contents of general chemistry were described as 'because it is difficult to understand chemical concepts due to lack of basic knowledge' and 'because the contents of general chemistry have been deepened and expanded'. In the case of students who answered 'none', 'because it is similar to the chemical content of high school' and 'because they took both ChemistryI and ChemistryII', etc. were answered. Since students understood the basic knowledge of chemistry well in high school, it is judged that there is no difficulty in understanding the contents of general chemistry.

In previous studies [7], 47.1% of students who did not complete Chemistry II experienced more difficulty understanding the contents of general chemistry. Therefore, it was found that the degree of difficulty in general chemistry was affected by the completion of chemistry subjects in high school. In particular, as a teaching-learning centered on college entrance exams in the classroom field, the content of Chemistry II appears as a learning defect, and as a result, it is judged that there is a great difficulty in understanding the content of general chemistry.

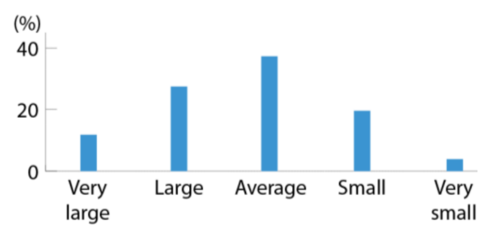

Figure 8. The degree of difficulty in understanding the contents of general chemistry

After examining the characteristics of teaching-learning of learners who find chemistry difficult, the results are presented in Figure 9. The characteristics of learners appeared in the order of 'lack of problem solving', 'lack of basic knowledge', and 'lack of willingness to learn'. The highest number of 'lack of problem solving' was recognized as having difficulties for learners due to factors such as 'applied problem solving' and 'problem solving related to real life'. The 'lack of basic knowledge' responded that the contents of general chemistry were not understood due to 'lack of willingness to learn' and 'lack of interest'.

Therefore, the lack of understanding of the basic concept leads to difficulty in understanding the content, and as a result, it appears as a lack of motivation for teaching-learning, such as a lack of problem solving. In other words, Ausubel's 'psychological significance' stage has not been reached, and students not only do not understand the basic concept of general chemistry well, but also appear as a result of low continuity of learning. When this stage is reached, learners' own learning can continue [18].

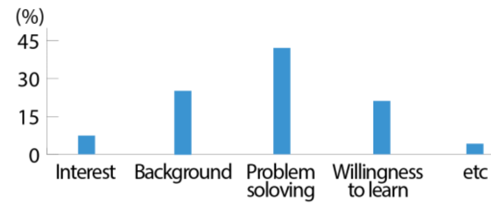

Figure 9. Characteristic factors of learners who find it difficult to understand chemical content (duplicate allowed)

Efforts to solve the difficulty of understanding the contents of chemistry were investigated and shown in Figure 10. As a result, 'expert help' was the highest. In order to understand the chemical content, it was found that it was primarily solved by colleagues and seniors in the group study, and the unresolved part was secondarily solved by 'expert help' such as professors and others. Next, it was found that they solved difficult parts by learning basic concepts (reading textbooks, comparing concepts, solving practice questions, etc.). Therefore, students' efforts to solve the difficulties of chemical content appeared in various ways. More research is needed on this part.

Figure 10. Efforts to resolve difficulties in understanding the contents of chemical subjects (duplicate allowed)

The distribution of grades of general chemistry according to the grade of 'Chemistry I' of the university admission process (occasional, regular) was investigated, and the results are shown in Figure 11. In the case of students who entered the department of chemistry education through regular recruitment, their grades of general chemistry were relatively higher than those who entered the occasional recruitment. In other words, grades A and B of general chemistry were higher, and grades D did not appear. It means that students are better aware of the contents and concepts of ‘Chemistry I’, and they were confident in getting high grades in the ‘Chemistry I’ subject, so they are believed to have taken the College Scholastic Ability Test.

According to the results of previous studies [7], students who entered through occasional recruitment screening showed relatively high academic achievement in general chemistry. As such, it was found that the grades of general chemistry influenced differently by recruitment screening.

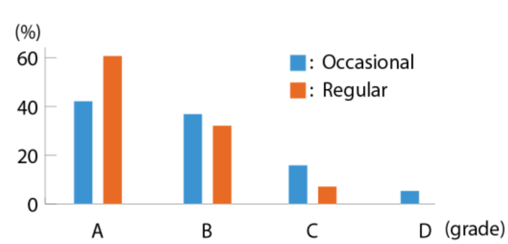

Figure 11. The ratio of the grades of general chemistry according to the grade of ‘Chemistry Ⅰ’ in college admissions (regular and occasional)

4. CONCLUSIONS

For students in the department of chemistry education, the effect of interest in chemical content of high school on factors such as 'whether or not to complete science elective courses', 'the characteristics of learners who make it difficult to understand chemistry', 'how learners solve difficulties on their own', and academic achievement of general chemistry according to college admission screening were studied. As shown in Figure 1, the grade distribution of 51 students in the study was 1 to 5 grades, respectively, for the grade distribution of Chemistry I in high schools and Chemistry I in the College Scholastic Ability Test.

After completing chemistry in high school and general chemistry in college, changes in interest for chemical content were investigated. As a result of the survey, it was found that the interest in Chemistry I and Chemistry II increased significantly to 94.6% and 73.7%, respectively. 63.5% of the students chose Chemistry I, and the reason for the selection was that 50.0% of the students were interested. Since they are interested in chemistry, it was found that they chose Chemistry I to enter the related department of the university after determining the major related to chemistry in advance. In addition, 66.0% of students showed increased interest after completing general chemistry.

The interesting units in the chemistry textbook were 'chemical reaction', 'chemical bonding', etc. in Chemistry I, and the reason for the selection was that they were interesting and easy to understand. The characteristic factors of learners who find it difficult to learn chemical content were investigated in terms of linkage of chemical content. In the chemistry textbook, it was found that the units such as 'oxidation-reduction' and 'acid/base' were difficult. The reason is that these contents are defined step by step according to grade, so the next step cannot be understood without understanding the definition of each step. Therefore, these units, which were deepened and expanded step by step, were recognized as difficult content. In general chemistry, 'electrochemistry' and 'thermochemistry' appeared as difficult units, and these units are similar to the contents of chemistry of high school, so they complained of difficulties in general chemistry.

39.2% of the students answered that they had a lot of difficulty understanding general chemistry, and the reasons were 'because it is difficult to understand chemical concepts due to lack of basic knowledge' and 'because the contents of general chemistry have been deepened and expanded'. On the other hand, 23.2% of the students answered ‘none’, and the reasons were ‘because it was similar to the chemical content of high school', ‘because they took both chemistry I and chemistry II’, etc. The degree of difficulty in general chemistry was different depending on whether or not the chemistry subject was completed in high school.

It was found that it was difficult to understand the chemical content according to the learner's teaching-learning characteristics. The factors were 'lack of problem solving', 'lack of basic knowledge', and 'lack of willingness to learn'. It is judged that students have difficulty in understanding of general chemistry due to a lack of basic knowledge, and that reviews such as ‘problem solving’ have not been made due to a lack of willingness to learn.

As a way to solve the difficulty of understanding the content, it was found that students were receiving the most 'expert help'. In addition, difficult parts are being solved by reading textbooks, comparing concepts, and solving practice problems, and various methods have been found for each individual to solve the difficult parts. The results of this study are expected to contribute greatly not only to the composition and organization of chemistry textbooks, but also to the reorganization of science curriculum and university admission policies in the future.

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