Analysis of Teachers' Questions in the STEAM Class for Students with Intellectual Disabilities

Park, Yungkeun[1,*]

[1]Department of Elementary Special Education, Joongbu University, South Korea

*Correspondence: Department of Elementary Special Education, Joongbu University, South Korea. Tel: 82-10-6506-5890. E-mail: a5890@joongbu.ac.kr

Abstract

The purpose of this study is to analyze the various characteristics of teacher's question to find out whether teachers who teach STEAM classes are conducting effective classes that can stimulate creativity and improve problem-solving skills. For the purpose of the study, the video recording data of the 8th hour of the STEAM class by two special education teachers and the teaching/learning process plan of the class were collected. Then, researchers and research assistants transcribed all verbal interactions that appeared in class and the researcher read the transcription data line by line and analyzed the type of questions. The results of the study are as follows. First, when examining the questions that appeared in the STEAM class of special school teachers for students with intellectual disabilities by question type, closed questions including cognitive & memorial questions and convergent thinking question were very high, and open-ended questions including divergent thinking questions and evaluative thinking questions were relatively low. Second, the stage of STEAM class was divided into introduction, development, and wrap-up stages, and as a result of analyzing the degree of use of question by special school teacher for students with intellectual disabilities according to each stage, the question was used a lot in the order of development, introduction, and wrap-up stage. By analyzing teachers' question in the operation of STEAM classes, it will be possible to prepare basic data for improving science classes using STEAM education in special schools for students with intellectual disabilities.

Keywords: STEAM education, teacher question, students with intellectual disabilities, science class

1. Introduction

The modern society has entered the era of the 4th industrial revolution, which refers to the AI era, which started with the development of information and communication technology and IT technology (Song et al., 2012). In particular, in the era of the 4th industrial revolution, the issue of how to converge and utilize existing knowledge is important, and nurturing talented people who will lead this era and lead the future is a challenge for all countries around the world. The future-oriented talent that the nation and society currently demand will be a convergence-type talent with communication, cooperation, creativity, and criticism (Song et al., 2021; Kwon & Cha, 2020).

The STEAM, which the Korean government has been promoting since 2011, is not an education that simply conveys knowledge, but an education method that aims to produce new creative products by applying knowledge to real life. In other words, it is an educational method for nurturing talented people with creative personality who can acquire theoretical and conceptual knowledge of science and mathematics, cultivate artistic and emotional abilities, and link and utilize engineering and technology in real life (Kim, 2016).

STEAM education includes the humanities and arts (A) fields considering the humanities literacy and artistic sensibility in science and technology fields such as science (S), technology (T), engineering (E), and mathematics (M). The goal of STEAM education is to increase interest and understanding of science and technology, and to cultivate science and technology-based convergence thinking and real-life problem-solving skills (Park, 2020).

Currently, many countries around the world, including the United States, are recognizing the importance of STEAM

and are making efforts to apply the STEAM to the educational field (Kim, 2016). However, when the needs of STEAM was first raised in developed countries and when it was accepted in Korea, most of the policy establishment and research were conducted for students without disabilities. STEAM research school designation was not made at all for students with disabilities.

In the field of special education in Korea, the process of exploring problems and understanding theories and principles on their own is omitted, and in many cases. In fact, students with disabilities lack the ability to generalize what they learned, and despite the need to provide education that fosters adaptability to real life, adherence to traditional educational methods further deteriorates students' thinking ability, problem-solving ability, and interest in subjects.

STEAM does not use a simple indoctrination method, so it can induce students' interest, and through this, students can cultivate problem-solving ability and creativity through class. It is expected that it will be able to help them have the ability to apply their knowledge to their life. In addition, students with intellectual disabilities naturally interact with other students in the class through STEAM-applied classes, and through this interaction, it is expected that there will be a collective meaning formation process, and this collective meaning formation process can lead the individual meaning formation process

However, in order to guarantee the effect of STEAM, it is necessary to examine whether the teachers who are operating the class are providing student-led classes and classes that foster creativity according to the purpose of the actual STEAM class. In this way, one of the strategies discussed as the professionalism of teachers who conduct STEAM classes is teacher questioning. It is mentioned as important to foster student-led creativity, problem-solving ability and ability to apply knowledge. In general, in a good class, learners actively participate in active verbal interaction between learners and teachers (Kim, 2015; Hong, 2017). It can be said that the teacher's questions are very important to enhance the effectiveness of STEAM classes (Im & Baek, 2009).

A teacher's question is one of the most valuable instructional skills to stimulate students' thinking, and serves several purposes, such as finding relevant things from learners, inferring relationships, facilitating the reasoning process, examining knowledge, and challenging thinking. It can be said that it is the most important skill among various teaching skills that a teacher must acquire, and it can be said to be one of the important factors to evaluate the professional competency of the teachers (Kim, 2015).

In the field of special education, as teachers' teaching expertise increased, research related to teacher questioning began to be conducted. For example, the special teachers' perceptions of the teacher questions were analyzed and the types of questions asked in the classroom situation were examined (Kim, Kim, & Shin, 2014). In this study, after transcribed the linguistic interactions that occurred in the topic-centered integrated class, the teacher's question types were analyzed through Gary's teacher response and interrogation analysis system and Blosser's question category system.

Hong Jae-young collected and transcribed 9 lessons of Korean language classes that were conducted in special schools with intellectual disabilities in order to examine the types of questions asked by special teachers in Korean language classes and the characteristics of teachers' questions in each class (Hong, 2018). In addition, studies analyzing teacher questions in math classes in special classes (Jeon et al., 2006) and studies analyzing the characteristics of linguistic interaction between teachers and students in classes at special schools for the deaf (Choi, 2012) have been conducted.

For this study, various aspects of teacher questions in order to find out whether the teacher in charge is performing the class according to the purpose of the class based on the actual STEAM class, which is expected to develop the problem-solving ability, creativity, and applying ability of students with intellectual disabilities. Contrary to the existing teaching method, researcher focuses on whether the class is being conducted according to the purpose of STEAM education, and in order to find out the direction to be taken to improve the quality of STEAM education in the field of special education in the future. Let's take a look at the situation firs. Based on this, it will be possible to prepare basic data necessary for improving the classes of teachers in charge of science class who want to use STEAM in special schools with intellectual disabilities.

Specific research questions to achieve the research purpose are as follows.

First, how are the types of questions asked by special schools' teachers for students with intellectual disabilities and what are their level of use in science classes using STEAM?

Second, according to the stage of science class using STEAM, how are the types of questions of special schools' teachers for students with intellectual disabilities?

2. Research Method

2.1 Participant

In this study, among special schools' teachers for students with intellectual disabilities, teachers who are conducting STEAM education were selected by purposive sampling. In order to select a teacher to participate in the experiment, it was selected with the recommendation of the special school administrator. The special school for students with intellectual disabilities in which the research participants are working is located in the Jeollanam-do region. The participants of this study are teachers J and K, who are in charge of science classes in one class in the second year of high school and one class in the first year of high school at a special school for intellectual disabilities located in K-city. There are 6 students with intellectual disabilities in the 2nd grade class in charge of teacher J. Most of the students have intellectual disabilities as the main disability, and there are many students with autism. There are a total of 7 students with intellectual disabilities in the high school 1st grade class that teacher K is in charge of, and most of them have intellectual disabilities, and there are many students who also have autism. The two teachers have been conducting play-centered STEAM classes since five years ago.

2.2 Data Collection and Data Analysis

Table 1. The Analyzed Science Class Contents

	Class topic	Sub-class topic	Teaching/learning activities
1st class	Natural Ecology Learning Center	Learning about the animals that live in the river	Activity 1: Get to know the animals that live in and near the river • Observe what kind of animals live in the river presented on the screen •Classify the animals that live in rivers and rivers Activity 2: Make a small river in the tank by group •Learn how to make a small river in a tank •Observe the materials provided by the teacher •Participate in play activities with the help of a group friend Activity 3: Discover the promises we must make to protect the ecosystem •Contaminate one tank with the provided preparations •Tell me what you felt when you saw the polluted water tank •Know the promises we must keep to protect the ecosystem
2nd class	Natural Ecology Learning Center	Proper using of various home appliances	Activity 1: Know the types of animals that live in the sea •Observe what kinds of animals live in the sea through video •Look at the pictures and freely tell the animals what they look like Activity 2: Curious secret box tactile play •Learn how to make a small river in a tank •Observe the materials distributed by the teacher and learn their names •Participate in play activities with friends Activity 3: Observing the characteristics of animals that live in the sea •Observe the sea creatures in the curious box and learn their characteristics •Observe pictures of sea turtles with straws in their noses and tell them what you think
3rd class	Natural Ecology Learning Center	How are rivers and seas different?	Activity 1: Comparing rivers and seas •Observe river photos and watch videos •Observe sea photos and watch videos •Explain the difference between river and sea Activity 2: Experiment with salt water •Observe and check the experimental preparations •Participate in experimental activities with friends in each group •Observe the experimental results and tell the difference •Knowing the difference between river water and seawater Activity 3: Coloring river and sea creatures and submitting group artwork •Coloring the drawings given by the teacher •Complete the work together with the team members and submit the work in each group

4th class	Natural Ecology Learning Center	Learning how animals move in water	Activity 1: Get to know the animals that live in the sea •Observe the pictures of animals living in the sea presented on the screen •Remember what you learned last time and say the names of animals •Look at the pictures of the animals presented and answer the teacher's question which animal they are Activity 2: Knowing the means of transport of animals in seawater •Observe and talk about people's types of transportation •Predicting the means of movement of animals in seawater •Knowing and observing the means of transport of animals in seawater Activity 3: Playing Ozobot •Draw the path of Ozobot on the drawing paper given by the teacher •Experiment with Ozobot with your crew
5th class	Chemistry and my life	Knowing the properties of the chemicals you need to wash your body	Activity 1: Know the chemicals you need to wash your body •Know the products produced by the chemical industry •Chemical fertilizers produced by the chemical industry Activity 2: Know the characteristics of using chemical toiletries •Know the difference between using and without chemicals • Know the chemicals used in toiletries Activity 3: Soap making •Introduce the ingredients needed to make soap • Add soap ingredients according to the improvement • Complete with melted soap in the mold
6th class	Chemistry and my life	Knowing chemicals in everyday life	Activity 1: Get to know the chemicals you can see around you •Watch videos related to chemical products that you can see around you •Talk about chemicals you know •Talk about the chemicals you use Activity 2: Know the dangers of chemicals you see around you • Know the hazards of chemicals • Talking about precautions when using chemicals Activity 3: Play a quiz about chemicals • Quiz about chemical products around me • Quiz about how to use chemicals
7th class	Chemistry and my life	Learn about chemical seasonings	Activity 1: Knowing what a chemical seasoning is •Knowing the types of chemical seasonings •Knowing the process of making chemical seasonings Activity 2: Knowing the health effects of chemical seasonings • Knowing the difference between chemical seasoning and natural seasoning • Knowing why chemical seasonings are bad for your health Activity 3: Comparing chemical and natural seasonings •Distinguishing between chemical and natural seasonings. •Quiz about chemical seasonings and natural seasoning
8th class	Chemistry and my life	Learning about chemical cosmetics that take care of you	Activity 1: Get to know various cosmetics •Learn about basic cosmetics •Learn about color cosmetics Activity 2: Get to know the use cases of cosmetics • Comparison before and after using cosmetics • Describe the changes after using cosmetics Activity 3: Decorate your friends with cosmetics • Play a song to decorate your partner's face until the song is over • Reinforce the most impressively decorated friend

The data collected for this study are video recordings of the 8th class of STEAM class conducted by two special education teachers. The specific contents of science class analyzed for this study are as follows in Table 1. Before the

start of classes, the purpose and procedure of the study were sufficiently explained through several meetings with the teachers. When the data collection was completed, the researchers and research assistants began to analyze the data.

The collected class data were analyzed according to the procedure of the class analysis. Researchers and research assistants transcribed all verbal interactions that appeared in class. Second, the transcribed data were reviewed by researchers and research assistants for possible errors in the transcription process. Third, the researcher read the transcription data line by line and analyzed the type of questions.

2.3 Data Analysis Criteria and Reliability Between Analysts

The analysis criteria used in this study were established through the following process. In order to examine the question types of special teachers in science classes based on STEAM education for students with intellectual disabilities, the analysis framework suggested in the study of Jae-Young Hong was modified and used (Hong, 2018). Table 2 shows the specific frame of reference for the analysis of the special teachers' question types.

For data analysis, a researcher and a research assistant participated. Research assistants are teachers with more than 10 years of experience teaching students. Training for analyzing question types was conducted to secure inter-reliability. In the process of the analysis, each other's analysis process and contents were frequently shared.

Table 2. Criteria for Analysis of Special Teacher's Question Types

Questioning Types		Sub-category	Detailed explanation
Closed Question	Cognitive & memorial question	1. memory	•Repeat the previously presented information
		2. Confirmation, naming, observation	•Questions that require the recall and reproduction of facts, formulas, and procedural information through recognition, memory, recall, etc.
	Convergent thinking question	1. Connection, discrimination, classification	•Questions related to the analysis and integration of presented or memorized material
		2. Reconstruction	•Questions that promote mental activities such as interpreting information, connecting, explaining, and drawing conclusions
		3. Application	
		4. Comprehensive	
		5. Closed Prediction	
		6. Critical Judgment	
Open-ended Question	Divergent thinking question	1. Present opinion	•Question to enable spontaneous data generation, refinement, diffusion connection and synthesis
		2. Probability prediction	
		3. Inference or suggestion	•Question that promote the ability to devise and refine creative answers
	Evaluative thinking question	1. Justification	•Questions that require value judgment, criticism, and opinions
		2. plan	
		3. Judgment	•Questions that encourage you to choose your position, justify it, and make a judgment about value issues

3. Result

3.1 The Analysis of Question Types

3.1.1 Cognitive and Memorial Question

Among the questions in the STEAM class of special schools' teachers for students with intellectual disabilities, cognitive and memorial question accounted for the largest proportion of the total questions. In the class, it allows the student to simply recall the information necessary for science learning, to check whether or not they actually know the information, to check the conditions given in the process of solving a problem, to ask the learner to do something

related to the class. The reason that the proportion of cognitive and memory questions is the highest overall is that both the questions that simply remind students of what students have already learned and the questions that check whether they remember what they have already learned are all included in the cognitive and memory questions. At the same time, this result can be seen because teachers did not give students an opportunity to solve problems on their own during class, but lecture-style classes in which teachers directly solve problems. The typical cognitive and memory inquiry are shown in Figure 1.

① Are crayfish an animal that lives in river water? Is it an animal that lives by the river?

② What kind of creatures lived in the sea?

③ You experimented with floating eggs in salt water and salt-free water. In which water did the eggs float well?

④ How many legs did the flower dog have?

⑤ When did people start using cosmetics?

Figure 1. Example of Cognitive and Memorial Question

3.1.2 Convergent Thinking Question

Teachers were using question type of convergent thinking to find out whether the concepts learned could be applied to other related parts in order to inquire the relationship between the given materials or the conditions presented in the problem-solving process in class. In other words, in the case of directly asking the learner about the relationships between the conditions of various phenomena in the science class, convergent thinking question is used to find out whether the previously learned concepts can be applied to the related contents currently being studied. Some teachers replied that the most important thing in class is to allow the content they are teaching to be integrated with real life. If the contents learned through the class cannot be incorporated into real life, the contents are not functional learning, so teachers always have tried to integrate the contents of the class with real life. The typical convergent thinking questions are shown in Figure 2.

① What are the characteristics of animals that can live in river water?

② This time, you touched abalone and conch. How was the feeling different?

③ Why does the abalone feel slippery to the touch?

④ Are the chemical seasonings that taste the food harmful to the body? Would it be harmful?

⑤ Are cosmetics included in chemical products?

Figure 2. Example of Convergent Thinking Question

3.1.3 Divergent Thinking Question

Divergent thinking questions were used for inducing to freely express opinions in a situation where data is scarce, or allows for comprehensive thinking. Divergent thinking questions that induce students' creative thinking are not an easy question type, but due to the nature of the STEAM class, it is judged that it appears at a rather high rate as it contains content to ask for convergence knowledge in various fields. The example of divergent thinking questions are shown in Figure 3.

① Does our body float well in river water? Will it float well in sea water?

② How can you easily distinguish between octopus and squid?

③ What is a good way to keep the river clean?

④ Why does my face look pretty when I use cosmetics?

⑤ Do you want to use natural seasonings in future cooking? Do you want to use chemical seasoning?

Figure 3. Example of Divergent Thinking Question

3.1.4 Evaluative Thinking Question

Among the question types of special education teachers, evaluative thinking question were very low. Even within the open question type, it was significantly lower compared to the divergent thinking question, which is because special education teachers are not good at asking questions that require value judgment, reasons, or opinions for students with intellectual disabilities who have cognitive difficulties. The example of evaluative thinking question are shown in Figure 4

① What do you think of when you see a picture of a straw that has been thrown away by a tortoise?

② How do you feel when you see a dirty river?

③ What should I do with the leftover garbage after I go to the river? Why?

④ Is it good for people to use a lot of cosmetics?

⑤ We learned about chemical seasoning and natural seasoning, which one is better for our body?

Figure 4. Example of Evaluative Thinking Question

3.2 Question Analysis According to the Class Level

The STEAM class of special education teachers with intellectual disabilities were divided into introduction, development, and arrangement stages. As a result of analyzing teacher question according to the each stage, the development stage occupies the largest proportion of questions in the entire class. The reason for this is that in the development stage, the contents of learning are explained to students, inducing discussion among students, or problem-solving activities are performed the most. In the introduction stage, it is considered that the questionnaire was used with the high weight after the development stage because the questionnaire was made to confirm and motivate the prior learning. On the other hand, in the organizing stage, since teachers spend a lot of time explaining to students by organizing the learning content covered in class rather than using the question, the ratio of the use of question is significantly lower than the other stage.

3.2.1 Introduction Stage

In the introduction stage, it was found that cognitive & memorial questions accounted for the largest proportion. This is because in order to recall the contents of the exhibition at the beginning of the class and to connect them to the learning contents of the main contents of the developmental stage. In addition, it was found that this is because cognitive & memory question is used to guide learning goals. In addition, it can be seen that a number of divergent thinking questions are used in the process of encouraging students to make predictions on their own or to connect the contents of pre-learning with the contents to be learned in the development stage. It can be seen that other question types do not occupy a high proportion due to the characteristics of the class in the introduction stage. Figure 5 shows a example of questions that appears in the introduction stage.

① What organs did the fish use to move?

② I told you about chemical products yesterday. What kind of products did you say are chemical products?

③ Can anyone tell me about the chemical seasonings you learned last time?

Figure 5. Example of a Question in the Introduction Stage

3.2.2 Development Stage

Since the target students who participate in special school class have cognitive difficulties, it induces them to continuously recall the content they learn through the class and teaches them to master the content they have learned repeatedly. Due to the nature of STEAM, it induces students to think creatively on their own, and connects prior knowledge with what they are learning, so the rate of divergent thinking question is relatively high. However, due to the cognitive difficulties of the students, there were few evaluative questions that induce value judgments or critically present their opinions.

However, in order to improve the quality of the class and enhance students' thinking ability, evaluative thinking question that encourage students to make their own value judgments should be used more often. Figure 6 shows an example of questions that appears in the development stage.

① Why do eggs float in salted water?

② What things can be made of plastic?

③ What was the difference between washing your hands using toiletries and not washing your hands?

Figure 6. Example of a Question in the Development Stage

3.2.3 Wrap-up Stage

In the wrap-up stage, only cognitive and memory questions were used. This seems to be because in the wrap-up stage, the content learned in the development stage is repeated, the learned content is recalled again, and the focus is on recalling the facts and procedural information learned through the prior class. However, it is necessary to use an open-ended question that allows students to make a value judgment based on what they have learned or to present a critical opinion based on what they have learned in the development stage. Figure 7 shows an example of questions that appears in the wrap-up stage.

① Today, we learned about various cosmetics. What were the types of cosmetics?

② Did you say that sugar is made from what kind of raw material?

③ What were the advantages of using cosmetics?

Figure 7. Example of a Question in the Wrap Stage

3. Discussion and Conclusion

This study intends to suggest implications for questions in implementing STEAM classes in school class by analyzing the question types of special schools' teachers for students with intellectual disabilities that appeared in classes using STEAM.

First, special school teachers used the questions in the order of cognitive & memory questions, divergent thinking questions, convergent thinking questions, and evaluative thinking questions during class. This is a previous study showing that special education teachers use closed questions more often than open ended question in class, and mainly use low-level of questions in class (Kim, Kim, & Shin, 2014; Hong, 2018; Jeon et al., 2006), it can be seen that the results are similar. According to literature (Kim et al., 2014), special education teachers have a low level of knowledge about questions, and about 30% of special education teachers feel the limitations and difficulties in asking questions due to the lack of knowledge. However, compared to the previous study that showed that divergent thinking questions hardly appeared in general classes for students with intellectual disabilities, this study showed that the proportion of divergent thinking questions was relatively high due to the characteristics of STEAM classes.

However, in STEAM classes for students with intellectual disabilities, closed questions such as cognitive & memorial questions were found to be predominant. Special school teachers for students with intellectual disabilities mainly used cognitive & memorial questions in consideration of the cognitive characteristics of students. It can be seen that special education teachers need to provide a balance between high-level and low-level question (Lee, 2012).

More specifically, among the questions in the STEAM class of special school teachers for students with intellectual disabilities, cognitive/memory questions accounted for about 70% of the total questions, it means that the most frequently used question is to check whether or not the information is actually known, to check what conditions are given in the process of solving a problem, and to suggest some action or activity related to the lesson to the learner. Among the questions of special schools' teachers for students with intellectual disabilities, convergent thinking questions were the lowest among all question types. Teachers use convergent thinking question to inquire about the relationship between given material or presented conditions in the course of problem-solving in class, or to find out whether a learned concept can be applied to other related parts. However, in this class, in the case of directly asking the learner about the relationships between the conditions of various phenomena during the science class, convergent

thinking questions are asked to find out whether the previously learned concepts can be applied to the related contents currently being studied.

Among the questions of special education teachers, divergent thinking questions accounted for about 23% of the total questions, which was rather high. Divergent thinking question are used to induces or predicts opinions freely in a situation where data is scarce, or allows a person to think comprehensively. Divergent thinking questions that induce students' creative thinking are not an easy question type, but due to the nature of the STEAM class, it is judged to have appeared at a rather higher rate as it contains content to ask for convergence knowledge in various fields. Among the questions of special education teachers, evaluative questions were very low of all questions. Among the open question types, it was significantly lower compared to the divergent thinking question, because special education teachers are not asking questions that require value judgment, reasons, or opinions for students with intellectual disabilities who have cognitive difficulties.

Second, the STEAM class could be divided into introduction, development, and wrap-up stages. In the introduction stage, it can be seen that cognitive & memorial questions account for the largest proportion. This is because cognitive & memorial questions were given a high proportion in order to recall the contents at the beginning of the class and connect them to the learning contents of the main contents of the development stage. In other words, it was because cognitive & memory question were used to guide learning goals. In addition, it can be seen that a number of divergent thinking questions are used in the process of encouraging students to make predictions on their own or to diffusely connect the pre-learning content with the content to be learned in the development stage. In the development stage, since the target students participating in the class have cognitive difficulties, it induces them to continuously recall the content newly learned through the class (Shim et al., 2021; Park, 2021)

The STEAM class encourages students to think creatively, and connects the prior knowledge with the content they are learning through class, so the ratio of divergent thinking questions is also relatively low. However, due to the cognitive difficulties of the students, there were hardly any evaluative questions that induce value judgments or critically present their opinions. However, in order to improve the quality of the class and enhance students' thinking ability, evaluative questionnaires should be used frequently. This seems to be because in the wrap-up stage, the content learned in the development stage is repeated, the content learned is to be recalled last, and the focus is on recalling the facts and procedure information learned through the experiment. However, it is necessary to use an open-ended question that allows people to make a value judgment based on what they have learned or to present a critical opinion.

In conclusion, the fact that special schools' teachers for students with intellectual disabilities considered the cognitive ability of students when asking questions, and that the lack of understanding of students' questions was recognized as a limitation of the questions. Among the studies, there are studies that show that even students with disabilities can answer the somewhat high level of open-ended questions such as divergent and evaluative thinking questions. In particular, since this class was a science class using STEAM, it can be said that open ended questions need to occupy a higher proportion than closed questions due to the nature of the class. In the future, special education teachers for students with intellectual disabilities who plan to use STEAM to conduct science classes will need to consciously use more open-ended questions to nurture creative thinking in students despite their cognitive characteristics.

References

Choi, S. B. (2012). Analysis on flanders verbal interaction in classes of the school for the deaf. *The Journal of Special Children Education, 14*(1), 27-43. https://doi.org/10.21075/kacsn.2012.14.1.27

Hong, J. Y. (2017). A case analysis of study on verbal interaction during the math class of a special classroom. *Journal of the Korea Convergence Society, 8*(8), 215-224. https://doi.org/10.15207/JKCS.2017.8.2.001

Hong, J. Y. (2018). Case study of teacher questioning and feedback in Korean language classes at schools for students with intellectual disabilities. *The Journal of Special Children Education, 20*(3), 189-208.

Im, T. M., & Baek, S. Y. (2009). Feedback types and learner`s responses with in elementary mathematics class. *The Journal of Korea elementary education, 20*(1), 37-54. https://doi.org/10.20972/kjee.20.1.200907.37

Jeon, B. W., Nam, Y. S., & Lee, M. E. (2006). An analysis of teachers` questioning in mathematics lessons of

self-contained classroom. *Journal of Special Education, 13*(2), 3-25

Kim, J. O. (2015). *A comparative study of teacher questions (used in the classroom) and the feedback given to students by the teacher when analyzing advanced and general classes in an elementary school*. M.S. thesis, Department of education, Pusan University, Pusan, South Korea, 2015

Kim, M. J. (2016). *Study of Arts subject-centered instruction method utilizing STEAM: focused on primary high-grade students*. M.S. thesis, Department of education, Jeju University, Jeju, South Korea, 2016

Kim, S. S., Kim, H. G., & Shin, H. K. (2014). Analysis of special education teachers' questioning and prober category and research on perception. *Korean Journal of Special Education, 49*(3), 145-165. https://doi.org/10.15861/kjse.2014.49.3.145

Kwon, M. Y., & Cha, K. I. (2020). Qualitative study on STEAM-based economic education for students with disabilities. *Journal of Special Education & Rehabilitation Science, 59*(3), 235-254. https://doi.org/10.23944/Jsers.2020.09.59.3.11

Lee, C. H. (2012). Smart learning strategy of STEAM education. *Journal of Korean practical arts education, 25*(4), 123-147.

Park, E. J. (2020). The effects of the STEAM-based inquiry oriented science method course on pre-service early childhood teacher's STEAM literacy, science teaching efficacy, and science teaching competency. *Journal of Learner-Centered Curriculum and Instruction, 20*(2), 255-283. https://doi.org/10.22251/jlcci.2020.20.2.255

Park, Y. K. (2021). The special school teachers' perception on implementing STEAM education for students with intellectual disabilities. *Journal of Education and Social Science, (2),* 23-28. https://doi.org/10.46410/jess.2021.1.2.03

Shim, J. H. Y., Lee, Y. R., & Kim, H. K. (2015). Understanding STEM, STEAM education, and addressing the issues facing STEAM in the Korean context. *The Korean Association for Science Education, 35*(4), 709-723. https://doi.org/10.14697/jkase.2015.35.4.0709

Song, S. C., Hong, B. R., Kim, N. H., Han, H. J., & Shim, K. C. (2012). Study on perceptions of high school students and science teachers about high school fusing science. *Journal of the Korean Association for Science Education, 36*(1), 130-138. https://doi.org/10.21796/jse.2012.36.1.130

Song, S. C., Kim, J. M., & Shim, K. C. (2021). Analysis on the convergence types of STEAM elements & science field presented in STEAM-based research projects for high school students. *Journal of Learner-Centered Curriculum and Instruction, 21*(2), 509-534. https://doi.org/10.22251/jlcci.2021.21.2.509

Copyrights