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Experiences with the Teacher Training Avatar Program and the Usefulness of the Program as Seen in the Discussion

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Abstract

In the recent world situation, our way of life has been drastically changing due to the remarkable development of technology, evolution of AI, and pandemics caused by a new type of coronavirus. In order for our students to survive in this changing environment, we need to change the way education is provided, so that students can acquire the newly required skills and adapt to the coming age. To this end, teachers are required to improve their classes so that the learning process becomes more fulfilling. This is also stated in the new Courses of Study announced for 2017. In Japan[1], from the viewpoint of "what is to be learned," classes have traditionally been taught mainly in a teaching-intensive manner. However, as mentioned above, education needs to be transformed in accordance with the changing times. This transformation of education is a departure from the traditional teaching-intensive classes, and classes that are conscious of proactive, interactive, and authentic learning (active learning). Therefore, it is an important issue for teachers to be able to acquire the ability to conduct such classes[2]. The research team led by Dr. Tosa conducts research on active learning[3] and is developing an avatar class program suited to the Japanese educational format, based on the "Teaching Avatar Program" that is being tried in Florida, USA. In this avatar space, lessons are given to students, and teachers can practice their lessons. This is an advanced attempt in this day and age of communication technology in the avatar space. As a test subject, I experienced the Law of Conservation of Mass lesson program. I discussed with other participants the insights and transformations I gained from this experience, and clarified the outcomes and challenges. This presentation will report on the outcomes and challenges, as well as the usefulness and future potential of the program. In addition, as a member of the team, I plan to develop a classroom program in the field of biology in the future.

Keywords: *Avatar, Teacher training, Proactive, interactive, and authentic learning (active learning)*

In 2017, the new Courses of Study were announced in Japan[1]. The new guidelines call for children to acquire the "ability to live" through learning activities that focus on the process of inquiry from the proactive, interactive, and authentic learning (active learning), using the viewpoints and ways of thinking of science. Currently, however, children are facing issues related to inquiry-based activities, such as their difficulty in examining the data obtained. This is the result of the National Survey of School Achievement and Learning conducted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan in 2022[4]. Teachers' support is indispensable to resolve this issue. As a way of support, teachers are required to conduct classes that are aware of the process of inquiry from the proactive, interactive, and authentic learning (active learning). However, the results of a survey of teachers indicate that the practice of teaching with an awareness of the process of inquiry has not fully penetrated the field[5]. One of the reasons for this is that teachers lack experience in teaching classes that are aware of the process of inquiry, and this lack of experience leads to a lack of confidence on the part of teachers, which makes it difficult for them to put it into practice. Therefore, I focused on a project to develop a training and development program for teachers that would provide them with opportunities to gain teaching experience and to practice teaching with an awareness of the process of inquiry from the perspective of active learning.

The Tosa-Style Avatar-based Teacher Training and Development Program allows participants who play the role of teachers to conduct online classes for students in a virtual space[6]. In this program, Professor Tosa of Niigata University converted the "Teach to Avatar" program that is being tried in Florida, U.S.A., into a Japanese version, developed avatars and teaching programs, and is conducting a series of trials and verifications. Current science teachers and students who wish to become science teachers in the teacher training stage are participating in the program.

Fig. Actual Avatar classes

Currently, the program includes a lesson program on the "action-reaction law" in high school physics and a lesson program on the "law of conservation of mass" in junior high school chemistry. All participants, including current science teachers, have found the program useful. Students are provided with the objectives of the unit in advance, and they are expected to work to achieve these objectives. The class period is 10 minutes. Afterwards, feedback from the class evaluation is given, and the student may repeat the lesson based on the feedback. Based on the findings of the RTOP study[7] at Arizona State University in the U.S., the evaluation of the class is based on objective perspectives such as the amount of time students spend interacting with each other and whether the class is designed with the teacher as the listener. The actual evaluation criteria used in this program is an evaluation rubric developed by Professor Tosa based on RTOP.

Avater Role Playnig evalution-"Laws of Action and Reaction"

Date :

Name :

・Trainees will do the following and help students examine concepts on their own and reach a scientific understanding.

	item	count	○×		item	count	○×
1	Ask students to explain what they mean by their statements			6	Encourage the use of diagrams, pictures, models, equations, etc		
2	Recapitulate, rephrase, or supplement student statements			7	Encouraging connection to previous learnings and experiences		
3	Encourage students to speak up			8	Encourage them to give examples		
4	Wait for the student to speak			9	Encourages multi-faceted thinking		
5	Encourage students to talk to each other			10	Praise, nod, and empathize with student statements		

・based on two points

		item	1	2	3
Lesson Design and Practice	1	Questioning that respects the learner's previous learning	Teacher states one-sidedly what has already been learned	Teacher asks learners to confirm what they have already learned by asking them questions	Learners talk to each other to confirm what they have already learned
	2	Directing learners to be part of a learning community	Teacher-led, teacher self-directed	Learner interaction encourages concept building, but the teacher gives the correct answer	Learners interact with each other to build concepts, and the teacher helps them
subject content knowledge	3	Lessons strongly promote coherent conceptual construction by the learners themselves	Teacher gives one-sided explanations No concept construction	Learner's conceptual construction is partially done, but insufficient	Learners construct concepts on their own through interactions with each other
	4	Emphasis is placed on connections to daily life	Does not include examples seen in daily life	Includes examples from everyday life, but does not discuss the relationship between everyday life and scientific concepts	The relationship of scientific concepts to examples found in everyday life is discussed
student-teacher relationships	5	Active learner participation is encouraged and emphasized	Learners answer teacher's questions	Learners are directed by the teacher to come up with a final explanation and evaluate its	Learners actively participate, come up with their own final explanations, and evaluate their justification

Fig. Tosa-developed rubric for evaluation criteria

Next, as a concrete example, we describe the "action-reaction law" lesson program in high school physics. The objective of this "Action-Reaction Law" lesson program is for the teacher to acquire the ability to ask questions that will make students aware of the subject in class. The unit of this lesson is the action-reaction law, and the students have previously watched an experimental video in which the magnitude of the force received by both sides when two carts collide is measured.

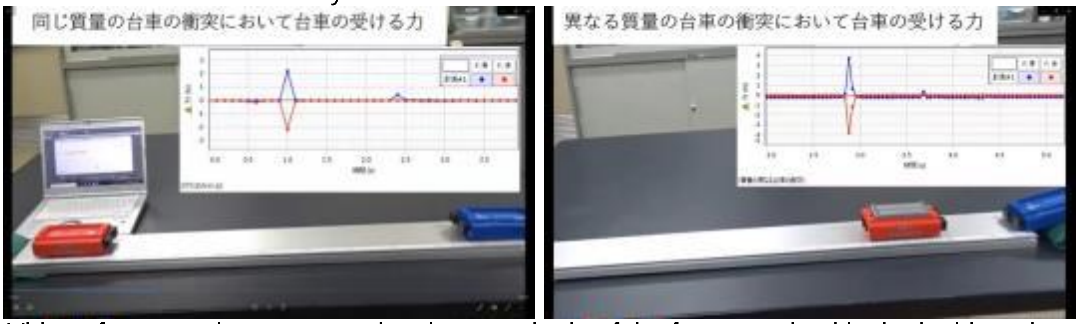


Fig. Video of an experiment measuring the magnitude of the force received by both sides when two carts collide.

The students have a superficial understanding of the action-reaction law, and this session begins with the scene shown in the figure above, where the students have finished watching the videos of the collision experiments of a cart of the same mass and a cart of a different mass. There are three students, each with a different personality, individuality, and level of learning achievement, and they are set to speak accordingly; as of 2023, they are not synthesized speech by the AI, but are performed behind the scenes by voice actors. While some students were satisfied with the results of the experimental video, others questioned the fact that the force received by each cart was equal in a collision between carts of different masses. In such a setting, the participant as the teacher asks questions that encourage students to understand the essential nature of the law of action-reaction, and supports the students in taking the initiative in acquiring the concepts of what they have learned.In addition, students who play the role of teachers are informed in advance of the scenario's scene setting and students' perspectives on the following.

Situation: You are a teacher of three students. You are a teacher of three students, and you want to teach them to understand the law of action-reaction. In the video, two carts of different masses are bumped against each other, and the forces on each cart are shown in a graph. At the beginning of the class, three students have finished watching the video. The class proceeds with a conversation with the three students based on the assumption that the results of the experiment shown in the video will be the same no matter how many times the experiment is conducted, and that the results are not wrong.

Student observation: The three students have already learned the following

1. "When there are two objects, object A and object B, and object A exerts a force on object B, object B exerts a force on object A that is identical to the force, opposite in direction, and equal in magnitude," which is called the law of action-reaction, a fundamental law of mechanics that they learned in their third-year junior high school science class. This law is called the law of action-reaction. In other words, all three of us are familiar with the statement of the law of action-reaction. (However, they only know the superficial meaning, but they have not examined whether it can be applied to all situations, and have not been convinced on that basis. There is no "deep understanding.")
2. I saw an experiment where there were two mechanics bogies A (red) and B (blue) of exactly the same mass (250g) and exactly the same shape placed on a straight rail, and bogie A, which was in motion, hit bogie B, which was stationary, causing bogie B to bounce off and move and bogie A to stop. (Note that the friction between the rails of both bogies is negligible.) In this case, each of the two bogies has a force sensor fixed to it facing the other bogie, and the magnitude of the force that each bogie received from the other during the collision can be measured.

The measurement results are displayed on a computer screen. The results confirm that the force received by bogie A from bogie B and the force received by bogie B from bogie A are exactly the same magnitude and opposite directions at all times. (This phenomenon is relatively "convincing" in the law of action-reaction in cases involving motion. The "action" of the same magnitude that stops one cart causes the other cart to begin moving at the same speed.)

Objective: To help students examine the elementary concepts on their own and reach a scientific understanding by watching the video material on action-reaction (when two carts of different masses are hit, the force received by each cart is of the same magnitude).

Next, as a concrete example, we describe the " law" lesson program in junior high school chemistry. This lesson scenario is designed to help the teacher develop questioning skills in the classroom so that students can set up problems and conceptualize experimental methods to overcome them. The class period is 10 minutes. The unit of study is the law of conservation of mass, and students have previously watched three experimental videos: (1) combustion of iron, (2) reaction of hydrochloric acid and sodium bicarbonate, and (3) precipitation reaction of sodium carbonate and calcium chloride.

Fig. Experimental videos of three chemical reactions

Students have a superficial understanding of the law of conservation of mass, and this session begins with the scene shown in the figure above, where students have finished watching the videos of the three chemical reactions. Although there are three students, each student has a different level of achievement. While some students are satisfied with the results of the experimental videos, others have doubts about the manipulation and results of the experiments. In this situation, the participant as the teacher asks questions that encourage the students to understand the essential law of conservation of mass, to notice the contradiction between the results of the experimental assimilation and the law of conservation of mass, and to conceive an experimental method that resolves the contradiction, in order to support the students in taking the initiative to acquire the concepts of what they have learned. This is

Situation: You are a second grade teacher at a junior high school with three students. In order to help these three students understand the law of conservation of mass, you will conduct a lesson based on the experiments conducted during the previous period and their results. At the beginning of the class, the students are asked to perform three experiments: 1) an iron combustion experiment (iron became heavier by combining with oxygen), 2) an experiment with hydrochloric acid and sodium bicarbonate (a mixture of hydrochloric acid and sodium bicarbonate became lighter as carbon dioxide escaped), 3) a precipitation reaction experiment between aqueous sodium carbonate and calcium chloride solutions (sodium carbonate aqueous solution and calcium chloride solution were mixed and precipitation was formed, but the mass did not change)) you have finished watching the review video material. You will now proceed with the class with three students. You will proceed with the conversation with the three students on the assumption that the results of the experiment shown in the video material will be the same no matter how many times you do the experiment, and that you are not mistaken.

What you have already learned: All three students have learned the law of conservation of mass in the previous lesson. (However, they only know the superficial meaning of the law, but they have not examined whether or not it can be applied to all cases, and have not been convinced on that basis. There is no "deep understanding.")

In this role play, begin with a review of how the experiment turned out. One student also sees a contradiction between the law of conservation of mass and the results of the experiment.

Objective: To help students plan for the precise experimental method in (2) with reference to (3), based on the basic premise that the law of conservation of mass holds true and that "the mass before the reaction and the mass after the reaction do not change".

In this study, participants actually experienced this Tosa-style avatar utilization teacher training/training program, reflected on their lessons and discussed student-centered lessons with other participants. The first lesson was a "Law of Conservation of Mass" lesson program in junior high school science chemistry. The content of the class was to help students construct the concept of the law of conservation of mass while allowing them to design their own experiments related to the law of conservation of mass. Some participants used a whiteboard to help students think of experimental methods. After the first class, the three students who participated in the program reviewed and discussed the class. Two main themes emerged from the discussion: 1) the allocation of time for learning activities to be conducted in the 10 minutes of class time, and 2) the positioning of concept building in the learning activities. We divided the learning activities into three major categories: (1) review, (2) concept building, and (3) planning of experimental methods, and exchanged opinions on the allocation of time for each learning activity. Throughout the discussion, all three participants agreed that they should not spend too much time reviewing the results of the experiments themselves. On the other hand, they also agreed that time should be spent on the main topics of the class, such as the construction of concepts and the conception of the experimental method. In the discussion, each of the participants expressed the idea of conceptualizing the experimental method and building concepts in the flow of learning activities based on their own ideas as follows.

Student1	Review the experiment and the law of conservation of mass (review) + concept building (3-4 minutes) Conceptualization of experimental method + concept building (6-7 minutes)
Student2	concept building (5-6 minutes) Conceptualization of experimental method(4-5 minutes)
Student3	Review the experiment and the law of conservation of mass (review) (1 minute) Student awareness + concept building (5-6 minutes) Conceptualization of experimental method + concept building (3-4 minutes)

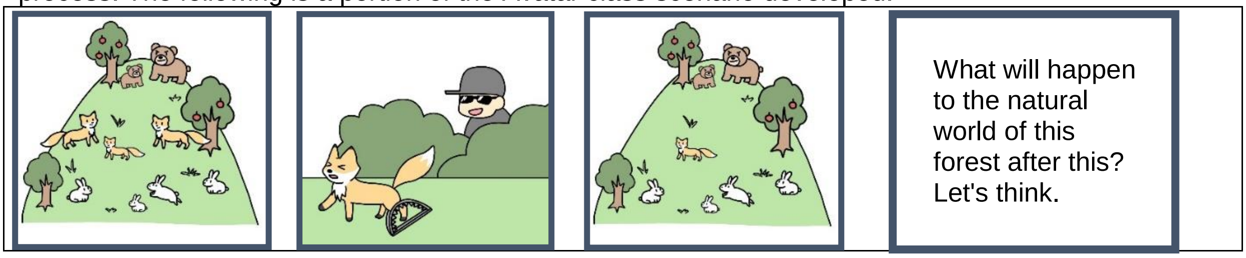
Fig. Three students' ideas for allocating class time

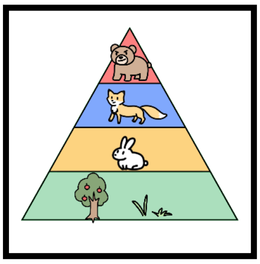
After reviewing and discussing the class, the three participants went to the second class, each having made improvements to the class based on their previous experiences. As shown in the table of class evaluations based on the aforementioned rubric, the scores of all three students were higher in the second class than in the first class. This result suggests that the class was improved to have more elements that allow students to engage in learning activities independently.The table shows that the scores of all three groups increased in Item 3, which is an item of concept construction. The main theme of the discussion after the first class was how to handle concept building in the class, and the fact that all three students increased their scores on this item can be considered an outcome of this program.

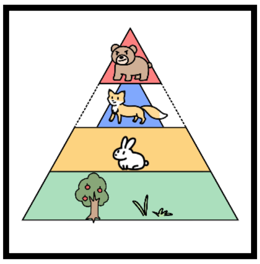
item		Student1		Student2		Student3	
		First time	Second time	First time	Second time	First time	Second time
1	Questioning that respects the learner's previous learning	1.75	1.75	1.75	2.25	1.75	2.25
2	Directing learners to be part of a learning community	1.75	2.25	1.75	1.75	1.75	1.75
3	Lessons strongly promote coherent conceptual construction by the learners themselves	1.25	1.75	1.25	1.75	1.25	1.75
4	Emphasis is placed on connections to daily life	1.25	1.25	1.25	1.25	1.25	1.25
5	Active learner participation is encouraged and emphasized	1.25	1.50	1.25	1.50	1.50	1.75
Score		7.25	8.50	7.25	8.50	7.50	8.75

Fig. Class evaluations of three students

Although there had been examples of lesson scenarios for physics (law of action-reaction) and chemistry (law of conservation of mass) as part of this program, there had been none for a unit on biology. Therefore, as part of this research, I was involved in the drafting and development of a lesson scenario in the biology field (balance of ecosystems). In developing the Avatar lesson scenarios, it was necessary to clarify the purpose of the lesson scenarios while keeping in mind that this is a teacher training program. The new scenario developed for this study was designed to help students acquire the skill of "facilitating students' acquisition of concepts without deviating from the essence of the learning process. The following is a portion of the Avatar class scenario developed.







What will happen to the ecological pyramid?

☆ This session will develop a fourth panel to make you think

Avatar's situation

Student 1: He understands the basics, but only speaks up a few times during class.
When the teacher asks a question about the increase or decrease of the pyramid, he/she responds with something like "the number of bobcats will decrease. If the teacher or other students ask further questions about what he/she has answered, he/she answers only what was asked in short sentences. At first, the students do not think that the decrease in rabbits will increase the number of plants and trees, but when the teacher asks a question such as, "What is the impact on plants and trees?" the student answers, "The number of plants and trees will increase.
Student 2: The playful type. He speaks up as soon as he thinks of something. Basically agrees with what other students say. If the teacher asks a question like "What do you think will happen? he will say something unrelated to the increase or decrease of the pyramid, such as "the bobcat is the strongest. When the teacher reiterates the question without denying what he or she said, the student says, "Well, will the number of bobcats decrease?" and return to the topic of pyramid increase/decrease.
Student 3: After the teacher asks his/her opinion or after other students have spoken, he/she makes a statement about an irregular situation. For example, "Will they continue to decrease and become extinct?" Talk about the If the teacher denies it or ignores it, ask, "Will there be an overall decrease due to wildfires or something?" or other more irregular statements. If the teacher affirms the statement and then asks questions such as, "What if there was no such possibility in this case? When the teacher affirms the statement and asks questions like, "What if there were no such possibility this time?

Perspectives of the Avatar Session

Is the learning method designed to help students notice the increase or decrease of each creature?
Is the learning process designed to encourage students to understand the relationship between the pyramid and the natural world, and to encourage them to move back and forth between concretization and abstraction?
Is the study developed in a way that encourages students to focus on the increase or decrease of biomass (population) and to describe the increase or decrease with evidence?
Is the development of the course designed to encourage the convergence of arguments so that students can visualize the final form of the ecosystem?

Fig. Draft program of lessons in the field of biology

Based on my hands-on experience with teacher training and classroom development, I saw the potential for this Tosa-style Avatar Utilization Teacher Training and Development Program. It is a cutting-edge experiment in the use of avatars, and allows teachers to gain more practical experience in classes that are aware of the process of inquiry from the perspective of active learning. With further development, it will be possible to develop a variety of class programs, such as conducting science experiments with avatars.

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