Study of Radio Waves at a Special Needs School
Construction of an IC radio through combined basic and work learning

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1. Introduction

Children with intellectual disabilities have a characteristic where their knowledge and skills received via learning tends to become fragmented, and it is difficult to leverage them in actual life situations. In order to adapt to these educational needs, a specific and hands-on approach to educational activities is a must, and it is important that these educational activities lead to a varied and rich school life. Basic learning is a type of teaching where fields and curriculum are combined to enable the students experience purpose activities as a group to process and resolve issues that occur during daily life, and is a type of teaching that is designed to enable the students to learn skills that are required for independent daily life. In task learning, the learning activity is focused on performing tasks and is designed to stimulate the student’s desire to work. The activity is designed to enable the student to comprehensively learn skills that are needed for them to hold a job and act as a member of society in the future. In the Special Needs Education School, many types of educational activities are provided according to the basics of educational support.

There is a need for manufacturing education in which content learned through foundational study is applied via task-based learning. Although articles describing integrated learning in technical high schools exist\(^{(1)}\), there is no description of integrated learning in special needs schools. In this study, we carried out a task-based learning situation in which students made use of their foundational study of radio waves to produce a radio capable of receiving radio waves. Namely, we proposed a hands-on education that takes into consideration a combination of foundational study and task-based learning. In this study, four students with mild disabilities applied the content learned during foundational study to construct an IC radio in a learning task, and attempted to learn the process of investigating radio waves.

2. Constructing an IC Radio\(^{(2)}\)

2-1 Preparation through foundational study

At the start of the second semester in the beginning of September, we used a computer to explain what radio waves are, and attempted to use a radio cassette player to receive FM and AM radios.
The radio was adjusted to AM, and a received a medium-wave broadcast (AM wave). We then confirmed that the sound was coming from a broadcasting station. Next, it was set to FM (FM wave), and we confirmed sound coming from the broadcasting station. After receiving from each broadcasting station and confirming the existence of radio waves, in an attempt to capture the actual radio waves moving through the air, we proposed creating a medium-wave (AM wave) radio. We demonstrated a polyurethane wire as the part that captures radio waves, and showed that it was part of the antenna. We then showed that a variable capacitor is the part of a tuning circuit that captures the radio waves of a specified broadcasting station, and showed the IC part of an amplification circuit, which enables the human ear to hear by amplifying the sound. Students viewed and confirmed each part. (Figure 1)

2-2 Assembly via Work Learning

The content from the foundational study was reviewed, and the dimensions, etc. were confirmed during the task-based learning time. In order to assure that electronic parts were connected correctly, symbols and numbers were written on each part to enable connection via matching. After the explanation of the radio, the electronic parts were shown to students and assembled. During the assembly of the radio, students encountered difficulty when attempting to solder the electronic parts. The circuit was complex and difficult to solder in places, and students found that installation was difficult because all parts appeared to be the same. We then switched to a method in which parts could be fastened via screws. In places where the screw could not be connected properly, the teacher performed soldering (Figure 2).

2-3 Explanation of Materials (Electronic Parts)

According to the radio design calculation software (3) (Figure 3), the polyurethane copper wire used as the antenna utilized a single poly-capacitor (approximately 30pF to 3300pF variable capacitance), so about L = 340 μH was appropriate to cover between 530 kHz and 1600 kHz. We
used a cotton swab case (diameter 72 mm), sold at a 100 yen shop, wound 70 times with 0.26 mm UEW wire. To start the winding, a hole was made in the case to secure the wire. About 20 mm of the end of polyurethane wire (coil) was sanded on the cylindrical case. The wire of a crystal earphone was tied through the hole. The purpose of the tie was to avoid the pulling and breaking of the crystal earphone wire. The insulation coating was removed about 1 cm from the end of the wire with a nipper. Then a crimp terminal was attached. When installing the parts, we made sure to remove the nuts.

Figure 2  Radio Assembly and Viewing

Figure 3  The radio design calculation software
3. Student Responses

During the experiment to select an AM broadcast station, the variable capacitor was used to choose a station with the largest volume, and the signal from the antenna was input into an oscillator (Figure 4).

![Figure 4](image)

Figure 4 Confirming AM wave shape with an oscilloscope

The broadcasting station where the loudest sound could be heard was chosen, and by capturing the signal from the antenna into the oscilloscope, students were able to confirm with their eyes the reception of the medium-wave broadcast from the radio we built. The students were very impressed that they were able to capture and hear radio waves on their own radios, while confirming the waves with their own eyes. They also learned that the ability to hear loud sounds, be tuned to the correct frequency, and have little interference are indicators of the radio's reception quality. Thus, in an experiment to confirm the performance of the radio we created, we conducted an analysis of the Fourier transform frequency for the AM waveform received, as a method of evaluating these three functions. That is, the maximum signal strength value was obtained by frequency analysis with a computer, and used as an evaluation of the manufactured radio's performance. A larger value was considered indicative of better radio performance. The analysis was performed through measurements using a PicoScope's spectrum analyzer transformation. The frequency represented by the maximum signal strength obtained through frequency analysis was the frequency of the broadcasting station that can be heard best.

PicoScope was used for electronic measurements in the former technical high school. Since data can be obtained via computer, it was often used for data acquisition in research publications. Results from the questionnaire revealed that it was understood that the numerical value (signal strength) in the frequency analysis corresponded to the magnitude of the sound that could be produced with the self-made radio. Most of the students understood the configuration and
principles of the radio. This outcome gives us confidence that if there were another opportunity to make a radio, all students would make a radio that sounded better than this time. We believe this is because having created a radio once, students understand the underlying principles. The students felt that creating the radio was worthwhile. Based on the various areas in which students expressed interest, we confirmed that it is necessary to develop a variety of teaching materials to satisfy students.

4. Conclusion

It was wonderful to see that as a result of making a radio by hand, capturing radio waves, and conducting experiments, students could achieve a variety of experiences through sight, sound, and touch while exploring one aspect of how radios are made. We feel this study achieved satisfying results regarding the benefits of the process of making things by hand. In the present study, there were several students who yearned to engage in hands-on creating, and it appears they were more engaged in the work.

In future studies, we wish to carry out task-based learning in which we perform time allocation more effectively, further enhance student's satisfaction and understanding of principles, and further deepen understanding of radio interference and results of frequency analysis, which are linked with engineering. One challenge is that it can be difficult to become hooked on this even if one is engaged during class. While this challenge is not easy to solve, we believe it is necessary to learn and improve gradually while carrying out a series of interesting and exciting lessons.

References

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