A New Collaborative STEAM Education Initiative with a Local Plating Company

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This report describes a new collaborative STEAM education initiative conducted by Akita KOSEN in partnership with Azuma Denka Co., Ltd., a local plating company in Daisen city, Japan. The objective of this initiative is promotion of scientific curiosity among elementary school students and enhancement of awareness of local industries through a hands-on plating experiment. Numerous examples of school–industry collaborative STEAM education programs exist across Japan, but few involve local companies rooted in the community. This project is intended to fill that gap by engaging students with a real-world industrial application: electroless nickel plating.

Third-grade to sixth-grade students from Daisen city were invited to participate in the workshop held at Azuma Denka's facility. Using a simplified and age-appropriate instructional guide, students conducted electroless plating of *Enkianthus perulatus* leaves, a familiar natural material, under the guidance of Akita KOSEN students who served as Student Assistants. The experiment, using plating conditions at 30°C and 40°C for manageable durations, was designed based on preliminary trials to ensure safety and engagement. During the 30-min plating, the children toured the company's plating and analytical facilities, gaining further insight into the real-world application of scientific techniques.

Post-lecture questionnaires revealed that all participants enjoyed the experiment. Many were surprised by the transformation of green leaves into shiny, metallic ones. Most participants expressed increased interest in plating and science, a desire to learn more, and understanding of plating's role in high-tech applications. Furthermore, students recognized that electroless plating is applicable to various materials, indicating that using familiar, tangible objects facilitated knowledge acquisition.

This initiative demonstrated the effectiveness of a localized, school–industry collaborative STEAM program for promoting scientific engagement and understanding among young learners. It also provided valuable outreach experience for technical college students, helping bridge the gap separating education, community, and industry.

Keywords: *electroless plating, elementary school students, local plating company, STEAM education*

Introduction

In 2022, the National Institute of Technology, Akita College (Akita KOSEN) established the "Akita KOSEN Glocal Human Resource Development Council" to use global perspectives and experiences to foster "glocal" human resources capable of contributing to the regional community and economy. The council has launched initiatives such as the Career Plan Fes to promote local employment, along with industry research sessions and one-on-one meetings with companies for students, and internship programs for third-year students. Nevertheless, collaborative research with local companies remains limited. The number of students from Akita KOSEN gaining employment within Akita prefecture has not increased to any considerable degree, probably because of insufficient awareness of local companies among students and their guardians and a lack of knowledge of their strengths and appeal.

STEAM education is an integrated educational approach that encompasses five disciplines: Science, Technology, Engineering, Arts (including liberal arts), and Mathematics. Adding the "A" for Arts to traditional STEM education sets a goal of cultivating problem-solving skills that incorporate both logical thinking and creativity. A report from the Central Council for Education of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) emphasizes the importance of defining and promoting "Arts" broadly to include not only arts and culture, but also aspects of daily life, economics, law, politics, ethics, and other areas encompassed by liberal arts (Central Council for Education, 2021). Today, STEAM education is gaining attention in both school education and community collaboration as a method for nurturing talent that can respond to the rapid changes of contemporary society.

Nationwide, numerous examples can be found of STEAM education programs conducted through collaboration between schools and companies. For example, the "Modeling Education on 'Sleep × Technology'" class program was developed through collaboration between Satoe Gakuen Elementary School, the NTT East, and sleep-related companies affiliated with the virtual community ZAKONE (NTT East Japan Saitama Branch et al., 2022). Another example is the STEAM education program “Let’s Brighten the Future!” conducted by Hitachi Systems, Ltd. for students ranging from elementary school to technical college level (Hitachi Systems, Ltd., 2024). Many examples of school-led STEAM education also exist, such as the work of Ueda and colleagues (Ueda et al., 2022). Nevertheless, no clear cases of STEAM education conducted through collaboration between schools and local companies rooted in the community have been identified.

In response, as part of Akita KOSEN’s collaborative STEAM education efforts, a public lecture for elementary school students was conducted in collaboration with Azuma Denka Co., Ltd., a local plating company based in Daisen city. The goals were to raise awareness and interest in local companies, products, and technologies among local elementary school students and their guardians, and to increase awareness among Akita KOSEN students themselves, using third-year students as Student Assistants (SAs), with the further aim of promoting future internship participation and local employment.

The lecture was designed to cultivate scientific interest among children through a hands-on experiment involving electroless nickel plating on leaves, a familiar natural object. Electroless plating is a technique that deposits metal evenly onto a substrate without the use of an external power source. It is useful not only for deepening students' understanding of chemical reactions, but also as an illustrative practical example of industrial technology. Particularly using leaves, a natural material familiar to children, the lecture was intended to help participants recognize the close connection between science and everyday life.

This report describes the outcomes of this collaborative STEAM education initiative.

Recruitment of Elementary School Students

Elementary school students of grades 3–6 living in Daisen city, where Azuma Denka Co., Ltd. is located, were invited to participate in the lecture. To raise awareness among local children, we requested and received the endorsement of the Daisen City Board of Education to distribute flyers. As a result, flyers were distributed to 1,583 students in grades 3–6 attending 22 elementary schools in Daisen city. Figure 1 shows the flyer. Although 17 students applied, because of limitations in the company’s laboratory and tour logistics, participation was limited to 10 students. Each student was allowed to bring one guardian. On the day of the event, three students were unable to attend, leading to final participation of seven students. The lecture was conducted inside the main building of Azuma Denka Co., Ltd. Figure 2 portrays the exterior of the company building. The company is a specialist in functional plating, particularly for electronic components, printed circuit boards, and ceramic substrates.

Figure 1: Flyer distributed to elementary school students in Daisen city.

Figure 2: Exterior view of the main building of Azuma Denka Co., Ltd.

Schedule and Experiment

The schedule for the elementary school students on the day of the lecture was the following.

1. Explanation of plating and company introduction by engineers
2. Experiment conducted by the students
3. Tour of the company’s plating facilities and analytical equipment
4. Packaging of the plated leaves
5. Summary and post-experiment questionnaire

The lecture was held during 10:00 AM – 12:00 PM, with care taken to ensure that the children remained engaged throughout.

Figure 3 shows the instructional handout used for the lecture. Because the lecture was designed for elementary school students, complex chemical names were omitted. Visual aids such as illustrations of the experiment apparatus were included for better understanding by all participants.

In preliminary experiments conducted at Akita KOSEN, conditions were studied to ensure that the electroless nickel plating of leaves could be done safely at lower temperatures and within a short time, to avoid burns and to maintain students’ concentration. Leaves of various types were tested. Those of *Enkianthus perulatus* produced the most silvery and glossy results. Results confirmed the safety of thermostatic baths at 30°C and 40°C, and showed that the plating process required approximately 15 min of hands-on activity and 30 min of unattended processing. To keep the students engaged, a company tour was conducted during the unattended time.


国立 秋田高専 物質・生物系　　夏休み 自由研究道場2024

第1回 夏休み！ 自由研究道場 in 大仙市
（葉っぱをキラキラにしてみよう…?）

高専のカガク

実験テキスト

学校名
学年　　年
氏名

国立 秋田高専 物質・生物系　　夏休み 自由研究道場2024

金属について

金属の性質
身のまわりの金属は，線路に使われている"鉄"や，電線に使われている"銅"や，アルミ缶や1円玉に使われている"アルミニウム"などがあります。

熱と電気
金属は，熱がよく伝わり，電気をよく通します。
お鍋やフライパン，電線，電気回路などに使われます。

磁石につくかな…？
"鉄"は磁石につきます。でもでも"アルミニウム"は磁石につきません。

磨くと光り光沢をもつ
金属は磨くと光沢が出て光ります。そのため、アクセサリーにも使われます。

"ニッケル"について
光沢がありサビにくいため、装飾用のめっきに用いられます。
日本の「五十円硬貨」および「百円硬貨」は，"銅"と"ニッケル"を溶かして混ぜた金属です。

めっき とは

めっきとは，金属やプラスチックなどの表面に別の金属を薄くかぶせる技術のことを言います。めっきには，次のような効果があることから，いろいろな場所で使われています。

◇外観を美しくみせる　アクセサリーや自動車部品など
◇サビないようにする　自動車部品や自転車など
◇すべりをよくする　コピー機等の紙送り部分など
◇電気伝導をよくする　ｺﾝﾋﾟｭｰﾀｰ基板や電子機器など
◇薬品から守る　水回りの部品や機械部品など
◇抗菌性をアップする　水道蛇口など

1

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内容物

実験で用いる道具などを確認してみましょう。

つつじのはっぱ　わりばし　シャーレー　ビーカー　ほごめがね
はくい　ペーパータオル　ピンセット　てぶくろ　こうおんそう

実験

⓪ 消毒用エタノール（70%エタノール）に 30分間 浸して葉の油分をとり除きます。
① 白衣を着て，保護メガネと手袋を着けよう。
② ドウダンツツジの枝の部分を割りばしで挟みます。
③ ドウダンツツジの葉を恒温槽にある A溶液（銅溶液）のビーカーに 3分間浸します。
④ 3分間たったら，A溶液（銅溶液）のビーカーから取り出して，次に蒸留水のビーカーに移して，2,3回上下に動かして洗浄します。

A　温度　時間　気が付いたこと

2

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⑤ 次にドウダンツツジの葉を恒温槽にある B溶液（ジメチルアミンボラン（DMAB）溶液）のビーカーに 3分間浸します。
⑥ 3分間たったら，B溶液のビーカーから取り出して，次に蒸留水のビーカーに移して，2,3回上下に動かして洗浄します。

B　温度　時間　気が付いたこと

⑦ ③から⑥の操作を，さらに 2 回繰り返します。
⑧ 次にドウダンツツジの葉を恒温槽にある C溶液（ニッケル溶液と DMAB溶液をまぜたもの）のビーカーに 30分間浸します。
⑨ 30分間たったら，C溶液（めっき液）のビーカーから取り出して，次に蒸留水のビーカーに移して，2,3回上下に動かして洗浄します。

C　温度　時間　気が付いたこと

⑩ めっきした葉は，ペーパータオルの上で水気をとってシャーレの中にいれてください。

※ 時間がたつと，めっきがはがれる場合があります。最初に写真などをとっておくことをおすすめいたします。

3

Figure 3: Instructional handout used during the lecture.

Preparations made at Akita KOSEN the day before the lecture were the following:

After *Enkianthus perulatus* leaves were collected from the school garden, they were soaked overnight in a 70% ethanol aqueous solution as pretreatment. Figure 4 shows an *Enkianthus perulatus* tree. Solutions of 0.1 M $CuSO_4$, 0.1 M dimethylamine-borane (DMAB), 0.1 M $NiSO_4$, and 1 M NaOH were prepared. For every 300 mL of 0.1 M $NiSO_4$ solution, 9.1 g of trisodium citrate dihydrate was added and dissolved thoroughly. The pH was adjusted to 9–10 using 1 M NaOH. These solutions were poured into bottles. The DMAB solution was stored in an ice-filled cooler. Other solutions were transported at room temperature to Azuma Denka Co., Ltd.

Figure 4: *Enkianthus perulatus* tree in the Akita KOSEN garden.

Preparations conducted at Azuma Denka Co., Ltd. on the day of the lecture were the following.

Thermostatic baths were set up in the company's laboratory at 30°C and 40°C. A 100 mL beaker containing $CuSO_4$ solution and another containing DMAB solution were prepared. The DMAB beaker was placed in the 30°C bath. A separate 100 mL beaker containing 50 mL of $NiSO_4$–citrate solution, adjusted to pH 9–10, was placed in the 40°C bath. Another beaker with 50 mL of DMAB solution was also placed in the 40°C bath.

The experiment procedures followed by the elementary school students are explained below.

First, the *Enkianthus perulatus* leaves were catalyzed with copper. Each student selected a pretreated leaf, clamped the base of the stem with unbroken disposable wooden chopsticks, and immersed the leaf in $CuSO_4$ solution for 3 min. The leaf was then rinsed lightly with water. Next, the leaf was immersed in 30°C DMAB solution for 3 min; it was again rinsed lightly. This $CuSO_4$–DMAB immersion process was repeated once for a total of two cycles. Figure 5 shows a photograph of *Enkianthus perulatus* leaves during the copper catalyzation process.

Next, electroless nickel plating was done. The $NiSO_4$–citrate and DMAB solutions, each preheated to 40°C, were mixed. The leaf, clamped in chopsticks, was immersed in the mixture and was left undisturbed for 30 min. Figure 6 depicts the process of electroless nickel plating on *Enkianthus perulatus* leaves.

After plating, the leaf was removed, rinsed with water, and placed on a paper towel to dry. Figure 5 shows the nickel-plated leaf. Finally, the leaf was placed in a petri dish lined with cotton, covered with a lid, and sealed with cellophane tape. Figure 7 presents images showing *Enkianthus perulatus* leaves before and after electroless nickel plating.

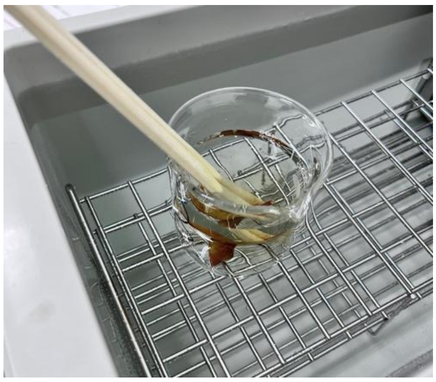

Figure 5: Applying a copper catalyst to *Enkianthus perulatus* leaves.

While waiting 30 min for the nickel plating process, children were given a tour of the company's plating site and analytical equipment. During the tour, the company's engineers explained the work processes and the function of each analytical instrument.

After the company tour and completion of the plating experiment, a summary session of the lecture was conducted, followed by a questionnaire survey. Details of the questionnaire are described hereinafter.

Figure 6: *Enkianthus perulatus* leaves undergoing electroless nickel plating.

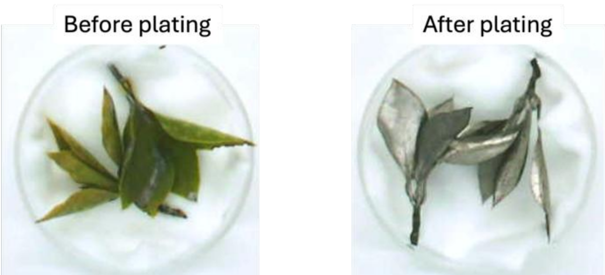

Figure 7: *Enkianthus perulatus* leaves before and after electroless nickel plating.

Responses to Questionnaires

Although no formal questionnaire survey was administered before the lecture, the SAs from Akita KOSEN casually asked the elementary school students some questions during ice-breaking conversations at the beginning of the lecture. Although the students had heard the word "plating," they were not familiar with its applications or effects.

Figure 8-13 shows the aggregated results of questions Q1–Q9 from the questionnaire survey conducted after the lecture.

Figures 8 and 9 show that all the elementary school students enjoyed the experiment, and that the electroless nickel-plated *Enkianthus perulatus* leaves evoked not so much a sense of accomplishment as a sense of surprise. This surprise likely derived from the unexpected result of placing the leaves into a green plating solution containing nickel ions, later to see them emerge with a silvery metallic luster.

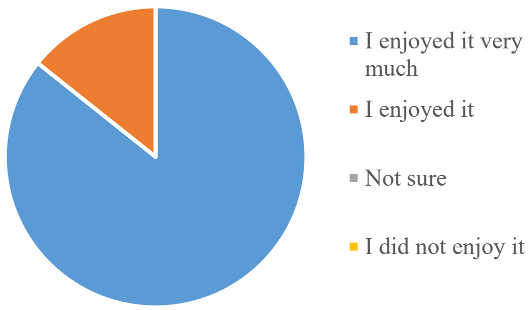

Figure 8: Responses to Q1: *Did you enjoy this event?*

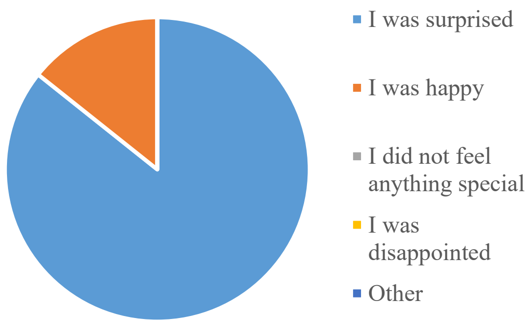

Figure 9: Responses to Q2: *How did you feel when you finished plating the leaves yourself?*

Figures 10–12 show that, as a result of the lecture, the elementary school students became more interested in plating and developed a desire to learn about it in greater depth. They also came to understand where plating is used and its expected effects.

Figure 13 shows that the elementary school students came to understand that plating is also used for high-tech materials. This knowledge is likely to have been intuitive because the lecture was held at Azuma Denka Co., Ltd., a company specializing in functional plating, which helped students recognize the close relation between functional plating and advanced materials.

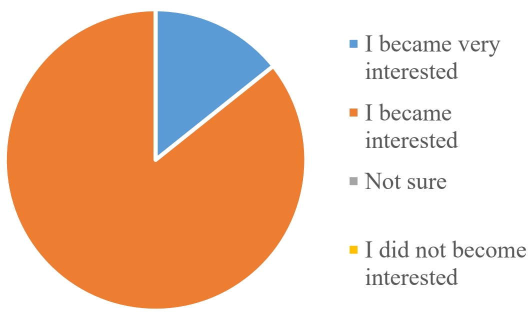

Figure 10: Responses to Q3: *Did this make you more interested in plating?*

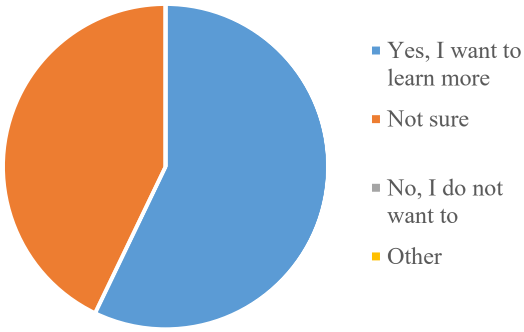

Figure 11: Responses to Q4: *Would you like to learn more about plating?*

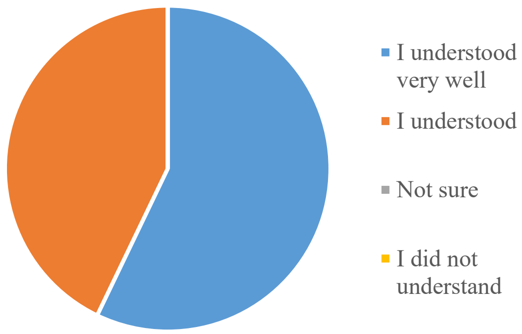

Figure 12: Responses to Q5: *Did you understand where plating is used?*

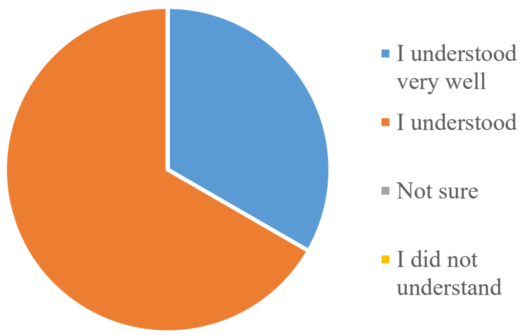

Figure 13: Responses to Q6: *Did you learn that plating is important for high-tech things?*

The results shown in Figure 14 indicate that the elementary school students recognized that electroless plating can be applied to various materials. This outcome is likely attributable to their hands-on experience with electroless plating using familiar and approachable materials, in this case leaves, as substrates for the experiment, which helped them accept new knowledge without resistance.

Results presented in Figure 15 were predictable at the time the students applied for the lecture. However, as Figure 16 shows, most participants expressed a desire to conduct additional experiments, which indicates that the collaborative STEAM education practiced with a local company clearly enhanced the elementary school students' interest in science.

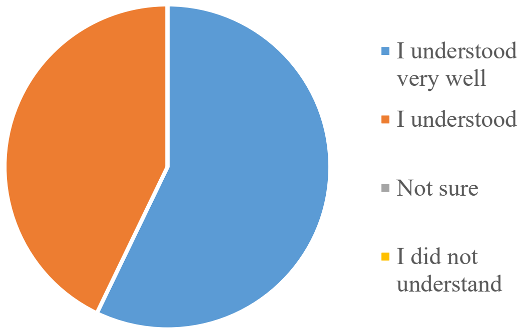

Figure 14: Responses to Q7: *Did you learn that plating can be done on many kinds of materials?*

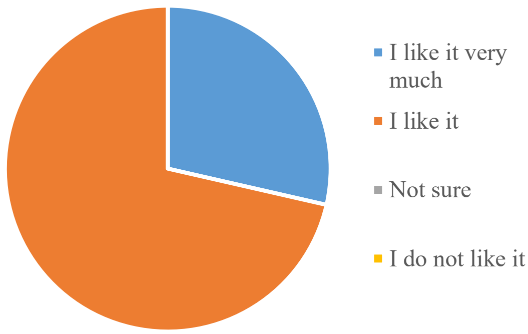

Figure 15: Responses to Q8 *Do you like science?*

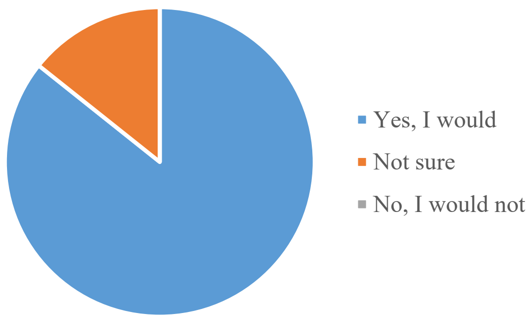

Figure 16: Responses to Q9: *Would you like to try other experiments?*

Conclusions

This collaborative STEAM education initiative, conducted in partnership with Azuma Denka Co., Ltd., ehnanced elementary school students' understanding and interest in science through a hands-on electroless nickel plating experiment. Students initially had limited knowledge about plating, but reported increased curiosity and comprehension related to its applications, including that for high-tech materials. Students engaged with complex scientific concepts in an accessible and enjoyable manner because familiar natural objects, in this case leaves, were used as substrates for plating. Due to constraints of the venue provided by the company, it was not feasible to accommodate a large number of elementary school students in the STEAM education program. Moving forward, similar programs will continue to be implemented on a regular basis, and their educational effectiveness will be systematically evaluated.

Questionnaire results revealed that the lecture not only sparked interest in plating; it also encouraged students to learn more about science and to participate in additional experiments. The collaborative setting within a local company specializing in functional plating helped students to connect industrial technologies clearly to their everyday lives. This approach also provided Akita KOSEN students serving as Student Assistants with valuable teaching and leadership experience, further enhancing their understanding of community engagement and science communication.

Overall, this initiative demonstrated the effectiveness of school–industry collaboration in STEAM education and highlighted its potential for fostering scientific curiosity, community awareness, and future career interest among young learners.

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