Implementation of Regional Co-Creation Education: Fostering Innovative Talent and Advancing ICT Education through Government-academic Collaboration

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In an increasingly advanced information society, there is a growing demand for educational models that foster fundamental professional competencies—such as problem-solving and collaboration—particularly in regional contexts. This study examines the educational effectiveness of the Electrical Technology Innovation Practicum, a regional co-creation initiative in which students engage in project-based learning through virtual company activities. Since 2018, the practicum has enabled students to develop STEAM-related skills while addressing both hypothetical and real-world regional challenges. From 2021, the program also tackled the shortage of ICT educators by providing outreach programming lessons in local schools. Questionnaire surveys of participating students and pupils indicate progressive skill development and enhanced motivation, especially among upper-year students. The findings suggest that virtual company-based PBL is a promising model for cultivating core competencies and contributing to regional education reform.

Keywords: *Electrical Technology Innovation, Science and Engineering Talent Education, Regional Co-Creation, Programming*

Introduction

In recent years, the importance of collaboration and partnership between educational institutions and local communities has been increasingly emphasized, with a growing demand for the development of open education systems that foster regional connections and mutual support. Furthermore, the COVID-19 pandemic exposed the vulnerabilities of Japan's centralized social structure, in which intellectual, human, and material resources are heavily concentrated in urban areas. To survive in the "With/Post-COVID" era, a shift toward a more sustainable and resilient social structure is essential. In this context, regional decentralization and the development of innovation ecosystems that empower local communities to autonomously solve their own problems have become critically important (Ministry of Education, Culture, Sports, Science and Technology [MEXT] website).

Against this backdrop, educational approaches aimed at nurturing human resources capable of addressing regional challenges and contributing to the future of society—such as Project-Based Learning (PBL) and virtual company-based pedagogies—are gaining attention. For example, Thorsteinsson (1997) demonstrated the effectiveness of a virtual company model designed for educational purposes, showing that students were able to practically acquire teamwork and management skills. Similarly, Tuhkala et al. (2021) illustrated how a manufacturing simulation game can foster collaborative creativity and digital learning, while Goeser et al. (2018) reported that virtual environments and VR-based engineering education contribute to learning outcomes and the development of hands-on skills. These previous studies have mainly focused on internal learner development, such as creativity, technical understanding, and teamwork.

However, cases in which virtual company education is applied to solving regional issues or supporting local ICT education remain limited both in Japan and internationally. While the effects of digital and virtual educational environments on student learning have been explored, how these models can be utilized for regional collaboration and problem-solving has not been sufficiently examined. In this regard, the Electrical Technology Innovation Practicum, which has been implemented at Anan National College of Technology since 2018, stands out as a pioneering initiative. By leveraging the virtual company model, the program has established a sustainable framework for industry-government-academia collaboration (Komatsu, 2019; Kozai, 2020).

This study builds upon these previous efforts and re-evaluates the educational significance of the practicum from the perspectives of regional co-creation and the development of STEAM competencies. Rather than focusing solely on students' acquisition of skills, we aim to highlight broader educational impacts, including ripple effects on the local community, and to explore how the virtual company model can contribute to the development of a sustainable regional education model.

The purpose of this study is to answer the following two research questions:

1. Does a practical education program using virtual companies enhance students' basic professional skills (competencies), such as problem identification, problem-solving ability, and collaboration?

2. Does regional collaboration through virtual company activities contribute to improving the quality of programming (ICT) education in the local community?

To address these questions, this study analyzes student questionnaire results from the Electrical Technology Innovation Practicum, along with case examples of programming education support activities conducted at local elementary and junior high schools.

Materials and Methods or Pedagogy

This study aims to introduce and evaluate a practical initiative that seeks to enhance regional problem-solving capacity and foster the development of future STEAM professionals through a regional co-creation education model, realized through collaboration between educational institutions and local communities. At the center of this initiative is the Electrical Technology Innovation Practicum, implemented by the Department of Creative Engineering at Anan National College of Technology.

In this practicum, students operate virtual companies as a means to cultivate an entrepreneurial mindset and essential professional competencies. These virtual companies, centered around electrical technology, explore a wide range of technical fields—including power systems, electronic circuits, robotics, AI, IoT, and entertainment. Within a hypothetical social context, students examine how these advanced technologies can be applied to real-world business scenarios. The ultimate goal is to nurture individuals capable of leading emerging industries and contributing to regional revitalization.

This practicum also places project-based learning (PBL) at its core and emphasizes collaboration with local companies and municipalities. Students engage directly with regional issues and are encouraged to analyze problems independently and propose solutions through group discussions.

The program aims to establish a sustainable educational model that integrates entrepreneurship education, PBL, and early-stage STEAM education, thereby contributing to both the cultivation of innovation-oriented human resources and the advancement of regional communities.

This report seeks to clarify whether the core competencies required in STEAM education—such as creativity, collaboration, and problem-solving—are effectively developed through student-driven experimental and practical activities. The main focus is on the Electrical Technology Innovation Practicum conducted by the Department of Creative Engineering, in which students organize virtual companies and work in teams to design and execute projects related to electrical engineering. These projects incorporate advanced technologies such as AI, IoT, and robotics in hands-on, project-based learning environments.

To understand how students recognize and demonstrate these competencies, a post-practicum questionnaire was conducted to assess their self-perceived growth and acquisition of skills.

Among the various activities conducted during the practicum, this report highlights outreach programming lessons delivered at local elementary and junior high schools as an initiative aimed at returning educational outcomes to the community. In these lessons, students utilized teaching materials they developed themselves, supporting the early development of STEAM talent while promoting ICT and programming education in the region. After the lessons, a follow-up questionnaire was administered to participating students to evaluate changes in their interest in programming education.

Through these integrated efforts, this report examines how student-led learning contributes to the development of key competencies and how these skills are applied in ways that are socially meaningful and impactful.

Overview of the Electrical Technology Innovation Practicum

The Electrical Technology Innovation Practicum is a long-term educational program conducted over three academic years (2nd to 4th year) as one of the themes in the Electrical and Electronic Engineering Laboratory at the Department of Creative Engineering, Anan National College of Technology. The practicum is held biweekly and includes 8–10 themes annually.

In this practicum, students establish and manage virtual companies, taking the lead in year-long, project-based learning activities. The process begins with student leaders recruiting members and forming teams. Each team creates an annual activity plan and presents it through posters and oral pitches to acquire virtual currency (ANET), used to simulate corporate funding for materials and salaries—enhancing the realism of company operations.

The teams then proceed with projects aimed at internal events such as open campuses for junior high school students and the school festival Sōasai, while some prepare for external competitions like the KOSEN GCON (Girls × SDGs × Technology Contest).

Midway through the academic year, teams present their progress in a midterm presentation session, receiving objective feedback from faculty. During Sōasai, they also engage in outreach by showcasing their work to local residents and visitors. At the end of the year, final presentations are conducted, and students reflect on their growth by maintaining continuous activity reports.

Through this structured process, students systematically cultivate key STEAM-related competencies, including creativity, planning, collaboration, and execution. The practicum serves as a practical educational model, promoting both regional co-creation and real-world problem-solving skills through a virtual company framework.

Initiatives for Solving Real-World Challenges

This section introduces a programming education support initiative carried out by one of the mock companies, targeting elementary and junior high schools in Anan City. The students involved took this opportunity to apply the project management and presentation skills they had developed through the practicum in a real educational setting. This case demonstrates that the Electrical Technology Innovation Practicum has played a central role not only as an on-campus educational program but also in improving the quality of ICT education in the local community.

Since 2021, Anan National College of Technology has continuously implemented programming education support activities for local elementary and junior high schools. A distinctive feature of this initiative is that students take the lead in developing teaching materials and delivering lessons, applying their specialized knowledge and technical skills to contribute to regional education. From 2021 to 2023, students conducted interviews with elementary school teachers to identify classroom needs, particularly the importance of experiential learning and alignment with textbooks. Based on these insights, they developed programming materials tailored to upper elementary and junior high school students. After conducting lessons for around 30 pupils, they revised the materials based on feedback. Additionally, students reported their progress directly to the Mayor of Anan City and organized public programming events at local shopping malls—demonstrating both outreach and community engagement.

In 2024, the focus shifted to addressing the lack of standardized programming materials in junior high schools. Leveraging the skills acquired through the Electrical Technology Innovation Practicum, students developed and promoted unified teaching materials. Specifically, they created practical lessons using microcontrollers to control 8×8 LED panels, and conducted multiple sessions across junior high schools to support standardization efforts. Teacher training seminars were also held, with over 50 elementary and junior high school teachers participating. These workshops provided practical, classroom-ready teaching materials and offered guidance on implementation in actual lessons.

Furthermore, in collaboration with the Anan City Youth Invention Club, a local science education organization, students led hands-on programming workshops for approximately 30 elementary and junior high school students. Participants, ranging from 4th graders to 2nd-year junior high students, engaged in activities such as controlling electric fans and using water level sensors. Outreach programming classes in 2024 also introduced foundational IoT concepts. Using single-chip microcontrollers, students taught lessons involving LED control and environmental sensing (e.g., temperature and humidity), enabling participants to experience emerging technologies firsthand.

Through these efforts, student-led initiatives have significantly contributed to the promotion of programming education in the region and the early development of STEAM talent. The activities demonstrate how practical, project-based engagement by students can foster both personal growth and meaningful social impact.

Results and Discussion

Student survey

To evaluate whether the practical education program based on virtual companies contributed to the improvement of students' fundamental professional skills—such as problem-finding ability, problem-solving ability, and collaboration—we conducted a questionnaire targeting students who participated in the Electrical Technology Innovation Practicum.

Specifically, students were asked to respond to items related to the following eight competencies.:

1. Problem-Solving Skills (Fig. 1, 2)
   Q1 : When faced with a new problem, are you able to analyze the situation and come up with a solution?
   Q2 : Do you have confidence in staying calm and finding solutions even in difficult situations?

2. Critical Thinking (Fig. 3, 4)
   Q3 : When judging whether information is correct, do you consider other perspectives and evidence?
   Q4 : Are you able to think deeply about the background and reasoning behind things, not just surface-level information?

3. Management Skills (Fig. 5, 6)
   Q5 : When working in a group, can you facilitate smooth progress while integrating others' opinions?

   Q6 : Are you able to plan efficiently by prioritizing within limited time and resources?

4. Creativity (Fig. 7, 8)
   Q7 : Can you generate new ideas by combining existing concepts and ways of thinking?
   Q8 : Do you enjoy thinking from different perspectives and coming up with original ideas?

5. Implementation Skills (Fig. 9, 10)
   Q9 : Are you able to take action to bring your ideas into concrete form?
   Q10 : Do you believe that it is important not only to make plans but also to actually try things out?

6. Self-Inquiry (Fig. 11, 12)
   Q11 : Do you reflect on how your own way of thinking and values were formed?

Q12 : Do you try to objectively reflect on and understand your emotions and behavioral tendencies?

7. Self-Acceptance (Fig. 13, 14)
   Q13 : Do you accept yourself as you are, including both your strengths and weaknesses?
   Q14 : Are you able to acknowledge failures and shortcomings positively, without denying them?

8. Self-Regulation (Fig. 15, 16)
   Q15 : Do you adjust your actions and learning methods in a planned manner to achieve your goals?
   Q16 : When your motivation drops, do you think about how to recover it and take action?

The questionnaire focused on competencies required in STEAM education.

The survey items are listed below, and the response options were: “Yes,” “Probably yes,” “Probably no,” and “No.”

The number of valid responses was as follows:

2nd-year students: 29
3rd-year students: 25
4th-year students: 29
5th-year students: 25

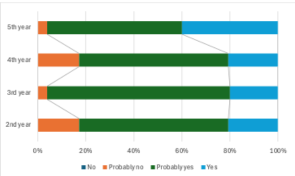

Fig. 1 The response results for Q1.

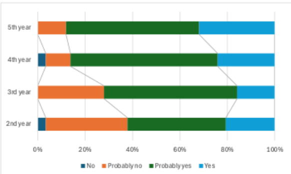

Fig. 2 The response results for Q2.

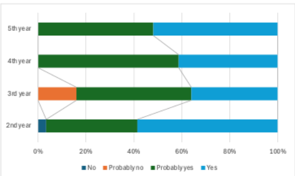

Fig. 3 The response results for Q3.

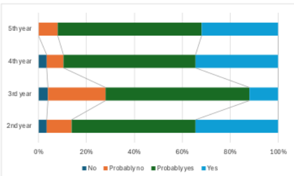

Fig. 4 The response results for Q4.

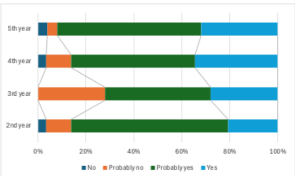

Fig. 5 The response results for Q5.

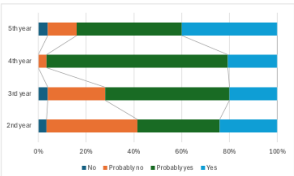

Fig. 6 The response results for Q6.

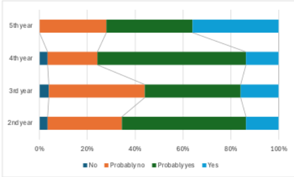

Fig. 7 The response results for Q7.

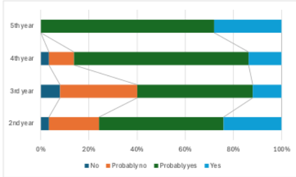

Fig. 8 The response results for Q8.

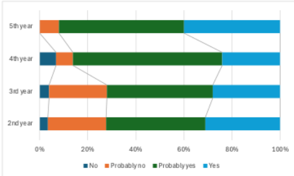

Fig. 9 The response results for Q9.

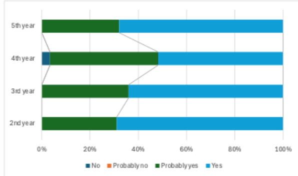

Fig. 10 The response results for Q10.

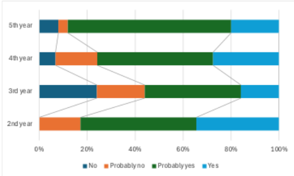

Fig. 11 The response results for Q11.

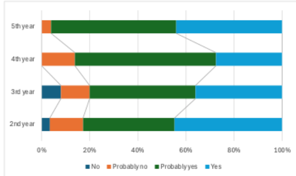

Fig. 12 The response results for Q12.

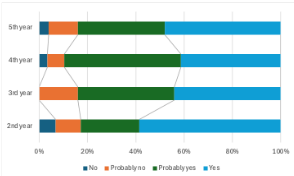

Fig. 13 The response results for Q13.

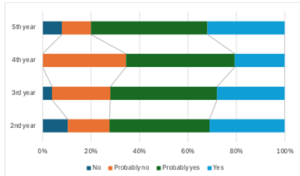

Fig. 14 The response results for Q14.

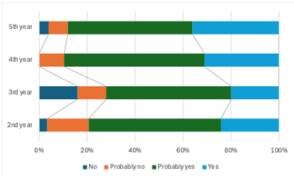

Fig. 15 The response results for Q15.

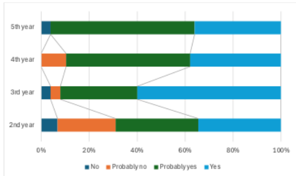

Fig. 16 The response results for Q16.

Trends by Question

The analysis of survey responses revealed several notable trends across academic years. Many questions demonstrated a positive correlation between grade level and the proportion of affirmative responses. For example, in Q1 （When faced with a new problem, are you able to analyze the situation and come up with a solution?） and Q2 (Do you have confidence in staying calm and finding solutions even in difficult situations?), 5-year students reported significantly higher rates of positive responses. This suggests that hands-on experience gained through practicum and virtual enterprise activities contributed to the enhancement of students’ self-efficacy in problem-solving.

Similarly, questions related to management competencies—such as Q5 (When working in a group, can you facilitate smooth progress while integrating others’ opinions?) and Q6 (Are you able to plan efficiently by prioritizing within limited time and resources?)—showed increasing affirmative responses among upper-grade students. These results imply that as students assume more complex roles within the virtual enterprise structure, their management and coordination skills are further developed.

With regard to creativity, Q7 and 8, which assessed students' abilities to generate novel ideas and to enjoy thinking from alternative perspectives, also demonstrated upward trends with academic advancement. These findings support the idea that creativity is fostered through the iterative and open-ended nature of virtual enterprise and project-based learning.

Conversely, items related to self-reflection—such as Q11 (Do you reflect on how your own way of thinking and values were formed?) and Q12 (Do you try to objectively reflect on and understand your emotions and behavioral tendencies?)—showed more varied responses across years, indicating that these attributes may be influenced more strongly by individual characteristics than by academic progression alone.

An analysis of the skills developed through the practicum, categorized by competency area, revealed the following trends:

First, in terms of problem-solving skills, students improved their ability to identify and resolve issues through hands-on experience with real-world challenges in the virtual company activities. Positive responses increased with academic year, indicating the practical effectiveness of the program in enhancing these abilities.

Second, regarding critical thinking skills, students across all academic years consistently demonstrated a strong awareness of the importance of evaluating information accuracy and considering multiple perspectives. This suggests that a foundational level of information literacy has already been cultivated.

Third, management skills showed remarkable improvement particularly in the 4th and 5th years. Through experiences in project management and leadership within the virtual company setting, students strengthened their capacity to prioritize tasks and coordinate within teams.

Fourth, in the area of creativity, opportunities for free thinking and prototyping nurtured students' originality. Especially among senior students, there was a noticeable increase in both idea generation and the willingness to take action, suggesting the practicum effectively supports the development of creative thinking.

Fifth, with regard to implementation skills, all year levels showed a strong emphasis on moving from planning to testing and refinement. In the 5th year, a higher level of execution ability was observed, indicating that repeated practice contributed to improved capability in realizing ideas.

Sixth, for self-inquiry and self-acceptance, individual variation was significant, and clear trends by academic year were limited. Deepening self-understanding and reflection will likely depend on continued use of reflective reports and dialogic support in the future.

Lastly, in self-regulation, there was progressive maturity observed in students' planning and adjustment of learning strategies as they advanced in academic years. Notably, 5th-year students demonstrated greater self-awareness in behavior management and improved their ability to evaluate the feasibility of their actions.

These results suggest that the practicum—particularly the virtual company-based activities—serves as an effective educational method for fostering multidimensional competencies in engineering education.

Questionnaire Survey for Students Who Participated in the Outreach Programming Lessons

To examine whether the virtual company activities contribute to improving the quality of ICT education and fostering a sense of community engagement, a survey was conducted with students who participated in outreach programming classes for elementary and junior high schools.

The survey used a 5-point scale and collected 266 valid responses.

- Did you have an interest in programming before attending the class?
- After attending the class, did you become more interested in programming?
- Do you want to continue learning programming in the future?

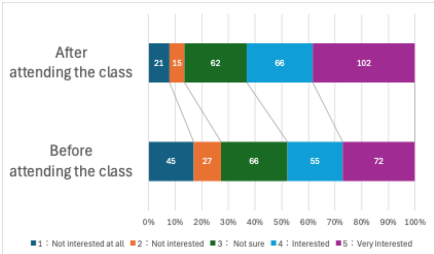

Fig. 17 Changes in Students' Awareness of Programming After the Lesson

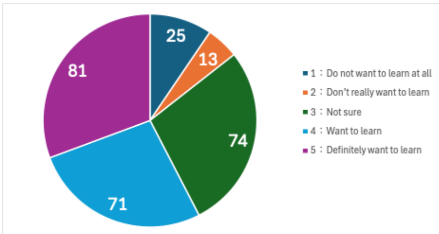

Fig.18 Motivation to Learn Programming

Based on the above results, it became clear that the proportion of students who answered "interested" before the lesson increased after the lesson, and more students reported feeling "very interested." Furthermore, a high percentage of students indicated that they "want to continue learning programming," showing a clear increase in their motivation to learn.

From the perspective of addressing regional issues through virtual company activities, students took the initiative in developing teaching materials, conducting lessons, and providing teacher training. In doing so, they played a role in supplementing on-site challenges such as a shortage of materials and a lack of skilled ICT teachers. In collaboration with Anan City, the initiative also produced ripple effects throughout the region, such as reporting to the mayor and holding public events at commercial facilities.

The management skills, teamwork, and presentation abilities cultivated through the practicum and virtual company activities were applied to real-world educational support efforts, demonstrating a virtuous cycle between student growth and regional contribution. This initiative thus served not just as an on-campus project, but as a practical program that made a tangible impact on community education.

It is evident that virtual company activities are not only effective in fostering students' professional competencies but also contribute significantly to improving the quality of ICT education and expanding the base of programming education in the region. Moving forward, further collaboration with more schools and local governments is expected to lead to the development of a sustainable educational support model.

Future Improvements and Educational Strategies

Regarding Self-Inquiry and Self-Acceptance, the survey revealed no clear upward trend across academic years, with significant individual variation. Since these skills are essential for autonomous professional growth, it is necessary to incorporate mechanisms into the educational design that foster deeper self-understanding. This can include the regular use of reflection sheets, portfolio assessments, and individual interviews.

The virtual company activities represent an exemplary model of practice-based education connected to real-world contexts. In particular, among fifth-year students, the full cycle of problem identification, resolution, execution, and reflection was shown to have a positive effect on skill development. Moving forward, collaboration with multiple regional stakeholders and industrial partners, along with the introduction of interdisciplinary practicum themes, will aim to cultivate a broader range of skills and enhance students' adaptability to society.

Conclusions

This study examined how the Electrical Technology Innovation Practicum and virtual company activities contributed to both student skill development and practical solutions to regional challenges. Through the practicum, students progressively cultivated a wide range of competencies—including problem-solving, creativity, management, collaboration, and implementation skills. Notably, upper-year students showed a marked increase in confidence and ability to take action, indicating the effectiveness of the hands-on learning approach.

In the virtual company activities, students took initiative in developing teaching materials, conducting outreach classes, and providing teacher training. These efforts directly addressed real-world issues in regional ICT education, such as the shortage of instructional materials and qualified educators. Moreover, collaboration with the local government (e.g., Anan City) led to wider community impact, including official reports to the mayor and public events held in commercial venues, demonstrating the ripple effects of student-led initiatives.

These findings indicate that the program functioned not merely as an educational project but as a practical model of engineering education that simultaneously fosters student growth and addresses social issues. Moving forward, further expansion of partnerships with schools and municipalities, along with the establishment of a continuous support system, will be key to developing a sustainable, community-integrated educational model.

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