IIAI Open Conference Publication Series
IIAI Letters on Informatics and Interdisciplinary Research
Vol.006, LIIR395
DOI: https://doi.org/10.52731/liir.v006.395

Case Study of UEC's Novel Learning Environment for Cultivating Engineering Talents

Kahori Ogashiwa [*], Tsuyoshi Okuno [*], Masanori Takagi [*], Akihiro Kashihara [*], Maomi Ueno [*], Masakazu Muramatsu [*], and Shunichi Tano [*]

Abstract

The present study introduces practical examples of the educational programs and learning support environments aimed at cultivating UEC's "Kō-gata" human resources—individuals equipped with solid foundational knowledge, specialized vertical expertise, and the capacity for horizontal expansion through innovation—at the University of Electro-Communications (UEC). Here, "Kō-gata human resources" are defined as individuals equipped with solid foundational knowledge, specialized vertical expertise, and the capacity for horizontal expansion through innovation, enabling them to respond flexibly to diverse societal challenges. To cultivate such talent, UEC has begun promoting an interdisciplinary minor program and educational digital transformation. The present paper highlights two key initiatives: the carbon neutrality minor that was established in 2024, and the UEC Learning Analytics Platform, which visualizes the students' learning progress. Although still in the early implementation stages, as these efforts have been successful in promoting student autonomy and enhancing teaching quality, they are expected to lay the groundwork for future educational innovations.

Keywords: Educational Digital Transformation, Engineering Education, Human Resource Development, Learning Analytics, Minor Program

1 Introduction

In recent years, in order to respond to rapid social changes and technological innovation, it is necessary to develop human resources who have not only specialized knowledge but also problem-finding and problem-solving abilities and collaborative practical skills. In order to meet modern demands, the University of Electro-Communications (UEC) aims to develop "Kō-gata" human resources, who embody a trinity of solid foundational knowledge, specialized vertical expertise, and the capacity for horizontal expansion through innovation. These individuals are expected to master foundational areas such as information, mathematics, data science, AI, and quantum technology (IMDAQ), along with interdisciplinary problem-solving abilities (see Figure 1). In the present paper, we will introduce practical efforts regarding the design of educational programs and the improvement of learning environments aimed at developing such human resources.

[*] The University of Electro-Communications, Tokyo, Japan

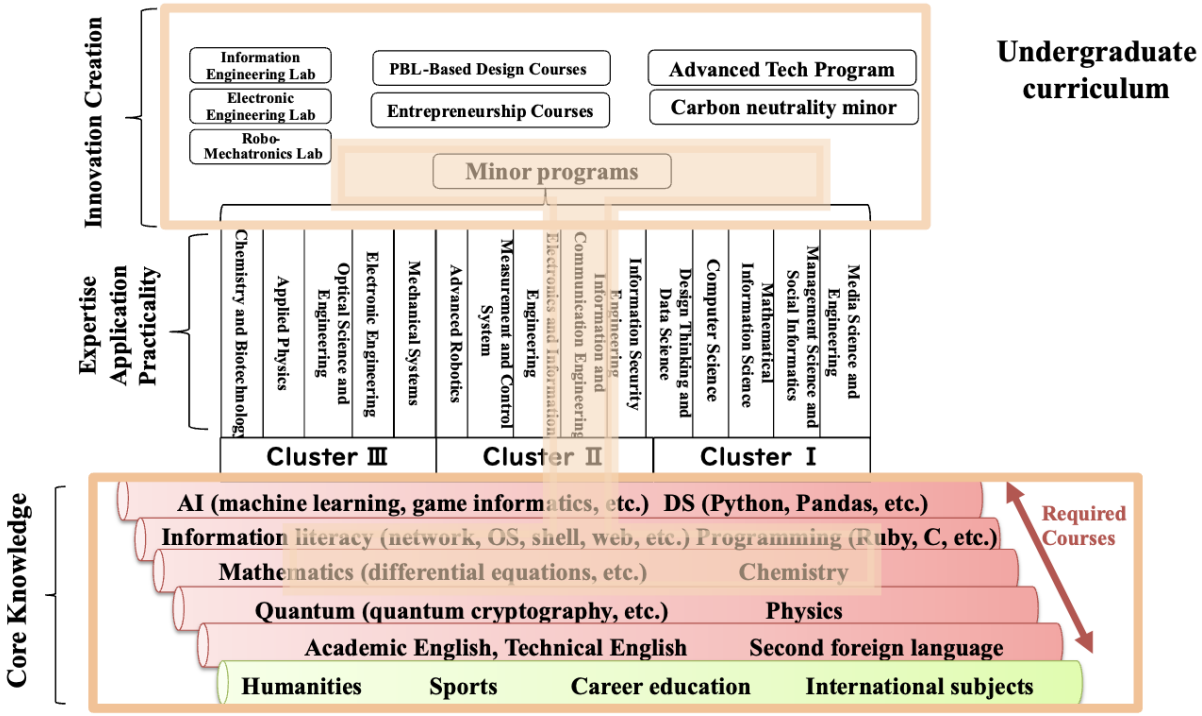

Figure 1: The skill set structure of UEC's "Kō-gata" human resources, symbolized by the Japanese kanji "工," representing foundational knowledge, specialized expertise, and innovation capabilities.

2 Designing Educational Programs

2.1 Carbon Neutrality Minor as an Interdisciplinary Minor

Several Japanese universities have implemented interdisciplinary minor programs to cultivate human resources capable of addressing complex societal challenges. For instance, Niigata University offers the "NICE Program," which allows students to pursue minors across various disciplines, fostering a broad-based educational experience [1]. Similarly, Osaka University provides "Graduate Minor Programs" and "Graduate Programs for Advanced Interdisciplinary Studies," enabling graduate students to acquire knowledge beyond their primary fields of study [2].

In our university, students have their own majors such as Media Science and Engineering as is shown in the middle of Figure 1. In addition to this major, students have an option to choose one of nine different minor programs that are designed to allow students to systematically approach a variety of themes, including languages, artificial intelligence, and the carbon neutrality introduced here. These will enable them to immediately contribute on a practical level to solving contemporary social problems, regardless of their major.

To develop "Kō-gata human resources" at UEC, it is essential to acquire interdisciplinary knowledge in addition to deepening specialized expertise. From this perspective, we have established a new carbon neutrality minor in 2024 as a way for students to study interdisciplinary environmental and energy fields. The carbon neutrality minor was designed and introduced as a

part of these efforts. In this minor, cutting-edge courses like "Introduction to Info-Powered Energy" are incorporated into the curriculum so that important issues in modern society, such as energy and environmental issues can be learned from multiple angles (Table 1). This minor is also significant from the perspective of interdisciplinary integration and functions as a means of gaining a practical perspective beyond the boundaries of specialized fields. This program is positioned as a pillar of human resource development in UEC's fourth medium term plan[3], and an overview is available on the university's website [4] (Figure 2).

3 Improvement of Learning Environments

3.1 Developing a Supportive Learning Support Environment

From the perspective of educational digital transformation, or educational DX, we are promoting the introduction and operation of UEC's Co-creative Evolution Smart Education System (UEC-eDX) and Learning Analytics Platform (UEC LAP). These systems visualize students' learning status, history, grades, and other information in real time and support both the faculty's teaching improvement and students' learning improvement.

UEC LAP makes it possible to grasp students' activities and understanding of each lecture in real time, and feedback to students' questions or concerns can be provided more quickly. In addition, through the introduction of computer-based testing (CBT) to the entrance examination and its expansion into the UEC Certification (mandatory tests on basic mathematics and sciences before enrollment), we are building a system for measuring and supporting learning outcomes from admission until graduation. The technical background and construction philosophy behind the design and operation of the UEC LAP are described in detail in Takagi's commentary [5], and a practical example of the UEC-eDX and hybrid classroom as related systems has been reported by Kashihara and Shimazaki [6].

3.2 Educational DX Using UEC LAP: Introduction to Physics

The UEC LAP, which was introduced as part of UEC's educational DX efforts, is one of the key measures in the fourth medium term plan [3], and its development and operation are being carried out mainly at the e-Learning Center [7]. A representative example of its practical application is its use in the general education "Introduction to Physics II" course offered during the second semester of the first year (Figure 3). In this graph, the blue line indicates the student's scores and the green and gray bars respectively show the class and overall averages. These visual comparisons enable students to track their performances across lectures. As supplementary materials for classes, quizzes are made available on the LMS. Students can independently complete these quizzes and compare their results with the overall and class averages, enabling them to identify their strengths and areas for improvement. While "Introduction to Physics I" in the first semester is a compulsory subject for all first-year students, "Introduction to Physics II" is not compulsory for students in the information sciences. Nevertheless, the number of students taking this course is increasing annually, and it has become one of the important foundational courses in the first year. Physics is a core area of foundational education at UEC, and all students are required to understand their own strengths and weaknesses in the subject. Under these circumstances, the visualization of one's learning status using UEC LAP provides students with the opportunity to reflect on their own level of understanding and approach to learning, which provide guidance to improving the quality of their learning. It is particularly effective for cultivating an independent

learning attitude during the first year. Finally, it supports feedback between faculties and students, making it a model case of data-based learning support.

Table 1: Course structure of the carbon neutrality minor program.

Group of Basic Courses	**Group of Advanced Courses**
Ethics A	Environmentology
Ethics B	Ethics for Engineers
Ethics	Science and Technology in Japan A
Science, Technology and Human	Topics in Informatics II
Economics A	Socio-Information
Economics B	Mathematical Programming
Chemistry and Energy	Machine Mechanism Design
Thermodynamics	Content security
Physics II	Control Engineering, Theory and Practice
Principles of Chemistry II	Environmental Engineering
	Applied Thermodynamics
	Statistical Physics : Basic course
	Those Who Created Modern Physics
Required Eligible Course Group	
Special Lecture on Informatics and Engineering B(Introduction to Info-Powered Energy)	

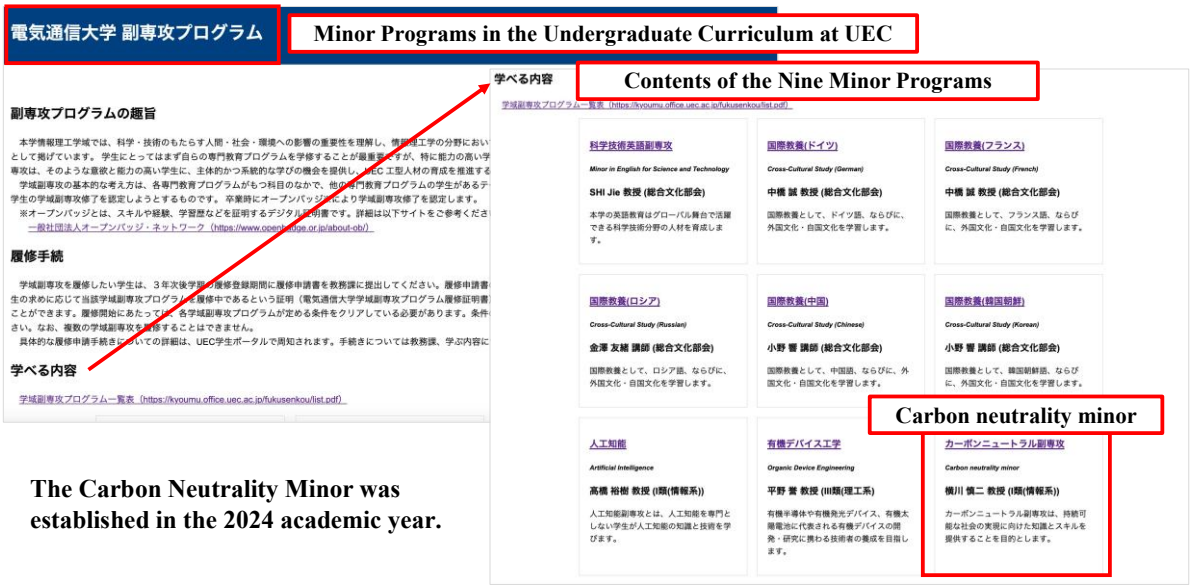

Figure 2: Minor programs incorporated within the undergraduate curriculum at the University of Electro-Communications. The figure is adapted from an official diagram published on the UEC website [4], with the English names of the minor programs added by the authors for clarity.

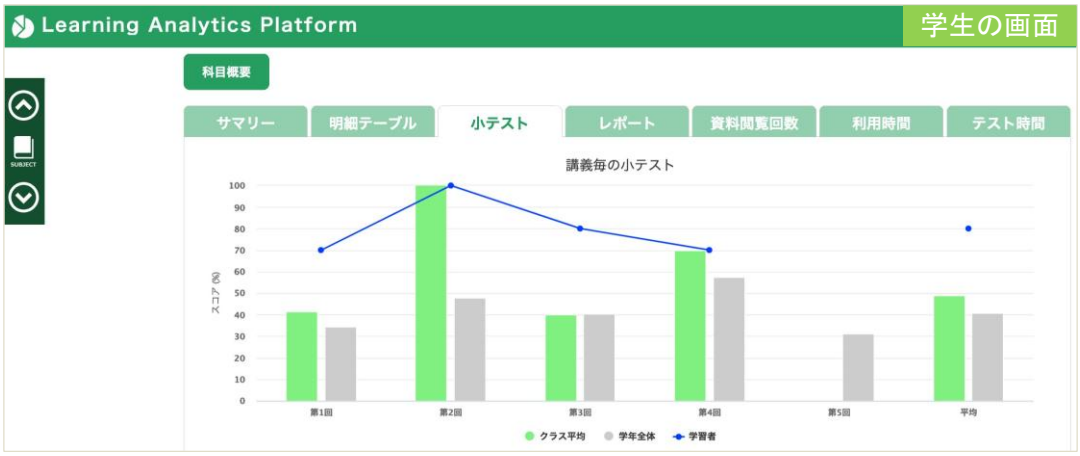

Figure 3: Example screen from the UEC Learning Analytics Platform (LAP) used in "Introduction to Physics II." The graph shows a comparison of individual quiz scores (blue line), class average scores (green bars), and overall course average scores (gray bars) over multiple lecture sessions.

4 Conclusion

The initiatives introduced in the present paper are still in the early stages. However, the fact that we have moved to the phase of concretely proceeding with the implementation of these educational programs and the development of a learning environment with the mid-to-long-term educational goal of cultivating "Kō-gata human resources" is itself a major step. Carbon neutrality remains a global social issue, and efforts are being made in many fields to address climate change and environmental issues. Our university is thus working to cultivate human resources with advanced knowledge related to carbon neutrality by utilizing expertise in information, communication, and energy technologies. It is expected that these human resources will be immediately useful at the forefront of society in the future, and the establishment of this minor is expected to form a foundation for valuable change.

In addition, the UEC LAP provides new faculty and student feedback methods through the learning progress visualization. It has been introduced in popular university-wide classes like "Introduction to Physics II" and is establishing a basis for the further possibilities of data use in the educational field. Through the construction and operation of this system, a culture around and awareness of using educational data are gradually spreading among faculty members, which will be a valuable foundation for its continued development in the future.

Regarding future prospects for interdisciplinary educational programs like the carbon neutrality minor, it is necessary to increase the number of students enrolled and to develop a system to visualize and evaluate the results of learning after enrollment. To advance UEC LAP, it is essential to strengthen faculty and student support in the effective use of the platform. It is expected that this learning visualization system will be used as an especially valuable introductory tool for "learning how to learn" for first-year students. Going forward, an important educational mission at our university will be to embody the idea of UEC's "Kō-gata human resource" development

through flexible educational design and a practical focus that meets both the needs of society and the everyday learning needs of students.

Acknowledgement

We would like to express our deepest gratitude to Professor Shinji Yokogawa for his invaluable support in the establishment of the carbon neutrality minor program. We are also sincerely grateful to Professor Naruo Sasaki and Professor Nobuhito Kokubo for their valuable advice regarding the use of UEC LAP to support student learning in the physics fundamentals course.

References

[1] Niigata University, Interdisciplinary Creative Education (NICE) Program Overview. Available at: https://www.iess.niigata-u.ac.jp/niceprogram/ (accessed April 29, 2025).

[2] Osaka University, Graduate Minor Programs and Graduate Programs for Advanced Interdisciplinary Studies. Available at: https://www.osaka-u.ac.jp/en/education/fukusenkou/index.html (accessed April 29, 2025).

[3] Ministry of Education, Culture, Sports, Science and Technology (MEXT), The 4th Medium-term Plan for the University of Electro-Communications (FY2022–FY2027), April 2024. Available at: https://www.mext.go.jp/content/20250408-mxt_hojinka-000041590_27.pdf (accessed April 27, 2025) (in Japanese).

[4] The University of Electro-Communications, Minor Programs within the Undergraduate Curriculum, UEC Website. Available at: https://kyoumu.office.uec.ac.jp/fukusenkou/gakuikiminor.html (accessed April 27, 2025) (in Japanese).

[5] M. Takagi, "Towards Evidence-Based Learner-Centered Teaching and Learning Support," Transactions of Japanese Society for Information and Systems in Education, vol. 41, no. 3, pp. 197–199, 2024. doi: 10.14926/jsise.41.197 (in Japanese).

[6] A. Kashihara and S. Shimazaki, "Designing an Advanced Hybrid Classroom Bridging Remote and In-Person Learners," Transactions of Japanese Society for Information and Systems in Education, vol. 41, no. 4, pp. 293–302, 2024. doi: 10.14926/jsise.41.293 (in Japanese).

[7] The University of Electro-Communications, e-Learning Center, UEC Website. Available at: https://www.cdel.uec.ac.jp/index.shtml (accessed April 27, 2025) (in Japanese).