A New Framework of Technology and Engineering Education Proposed by the Japan Society of Technology Education

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INTRODUCTION

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- Worldwide Flourishing of STEM/STEAM Education: Increasing importance of Technology and Engineering Education.

- However, Underestimation of Technology and Engineering in STEM/STEAM Education: A Notable Issue in ITEEA's STEL

> STEL said
> "In spite of this recognition, the role that technology and engineering play, and should play, in the education of PreK-12 students is often narrowly defined and misunderstood."

- Importance of Clearly Defining Role of Technology and Engineering in STEM/STEAM Education

INTRODUCTION

- In Japan, Increasing Focus on STEAM Education Since 2019 by MEXT
- MEXT‘s Attention to STEAM Education: Integration of STEM and Arts (MEXT 2019)
- Importance of STEAM Education on Upcoming Revision of Japan’s National Curriculum

INTRODUCTION

- Uniqueness of Japan‘s Educational Reform Approach: The Imperative of Seamlessly Integrating Prior Reform History with New Concept such as STEAM Education

- Difficulty of Direct Application of ITEEA's STEL to Japan.

- It May Same Situation in Other Nations with Their Own National Curricula

INTRODUCTION

- Within the Japan's Context, Necessity of Academic Proposals instead of ITEEA's STEL.

- The Japan Society of Technology Education (JSTE) initiated a project to develop a new framework for technology and engineering education in Japan

INTRODUCTION

- JSTE Already Published "*Technology Education in the 21st Century*"
  - ✓First edition in 1999
  - ✓Revised edition in 2012
  - ✓Illustrative examples of contents in 2014

- From 2017, Project of Revision of "*Technology Education in the 21st Century*"

- "*The New Framework of Technology and Engineering Education for Creating Next Generation Learning*" was Developed.

CURRENT STATUS OF TECHNOLOGY EDUCATION IN JAPAN

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Current Technology Education in Japan(Revised in 2017)

- Technology education as general education in Japan

  - "Technology" as part of the subject area of "Technology and Home Economics" in junior high school curriculum.

  - In elementary school, some learning activities include hands-on activities for making things and computer programming activities in various subject areas. Not Systematized.

  - In senior high school, Subject called "Informatics“
  - No other subjects that deal with other physical technologies.

CURRENT STATUS OF TECHNOLOGY EDUCATION IN JAPAN

The number of lessons of "Technology" in junior high school

- ✓ 35 lessons per year (1 class is 50 minutes) in 7th and 8th grade (13-14 years old)
- ✓ 17.5 lessons per year in 9th grade (15 years old)

In the revised national curriculum of 2017, the objectives of "Technology" are as follows:

Objectives:
Fostering abilities that contribute to the creation of a better life and sustainable society through practical and experiential activities related to technology, utilizing a view-point and way of thinking of technology.

(i) To develop foundational understanding of material processing, biological cultivation, energy conversion, and information technologies that are utilized in daily life and society, to acquire skills related to these technologies, and to gain deeper understanding of relationship between technologies and daily-life, society, and the environment.

(ii) To develop technological problem-solving abilities such as to identify problems related to technology within daily life and society, set one's own task, finding solution, expressing through drawing or other forms, producing (or cultivating), and evaluating and improving.

(iii) To cultivate practical attitudes for appropriate and honest pursuit of technological devices and innovations to realise a better life and build a sustainable society.

CURRENT STATUS OF TECHNOLOGY EDUCATION IN JAPAN

Table 1.
Learning Contents in "Technology" subject

	Content A Material and Processing Technology	Content B Biological Technology	Content C Energy Conversion Technology	Content D Information Technology
1 (1)	Understanding the principles and mechanisms of technologies that supporting our daily life and society			
(2)	Reading ingenuity of technological problem-solving that embedded in existing products or systems.			
2 (1)	Skills for fabrication, production, and cultivation.			
(2)	Identifying problems, setting tasks, designing solutions and executing technnological problem-solving.			
3 (1)	Understanding the concepts of technology and the role of it in development of society.			
(2)	Thinking of Evaluating, selecting, managing, operating, improving, and applying technology, and cultivating creative attitude for actualization of sustainable development of society.			

Note: In Content D, section 2(1)(2) in other contents are divided into 2(1)(2)"problem solving by programming with network technology" and 3(1)(2) "problem solving by programming with sensing and control technology". Therefore, 3(1) (2) in other contents is become 4(1)(2) in Content D.

Survey on actual status of students' awareness for learning "Technology"

Survey on actual status of students' awareness for learning "Technology"

- Subject

  1,656 7th to 9th grade students in Hyogo Prefecture, Japan.

- Question Items

  i. Students' awareness towards "Technology" learning

  ii. Status of learning activities in “Technology” classes

  iii. Status of students' problem-solving experiences

Survey on actual status of students' awareness for learning "Technology"

Table 2.
Students' awareness towards "Technology" learning

Items	*Mean*	*SD*
Importance of learning technology.	3.24	0.70
Joy of learning technology	3.35	0.66
Understanding of technology learning	3.08	0.71
Interest in technologies that support our daily life and society	3.05	0.69

N = 1656
4 point scale

- Positive awareness of the importance of “Technology” classes
- Enjoyable and Understandable
- Interest in technologies that support our daily lives and society

Survey on actual status of students' awareness for learning "Technology"

Table 3.
Status of learning activities

Items	*Mean*	*SD*
Active attitude for learning in technology classes	3.12	0.70
Collaborative learning in technology classes	3.25	0.72
To link own learning experiences with social issues	2.34	1.49

$N = 1656$
4 point scale

- Actively engaged in self-directed and interactive learning
- Weakness in awareness of linking their learning experiences to social issues

Survey on actual status of students' awareness for learning "Technology"

Table 4.
Status of students' problem-solving experiences

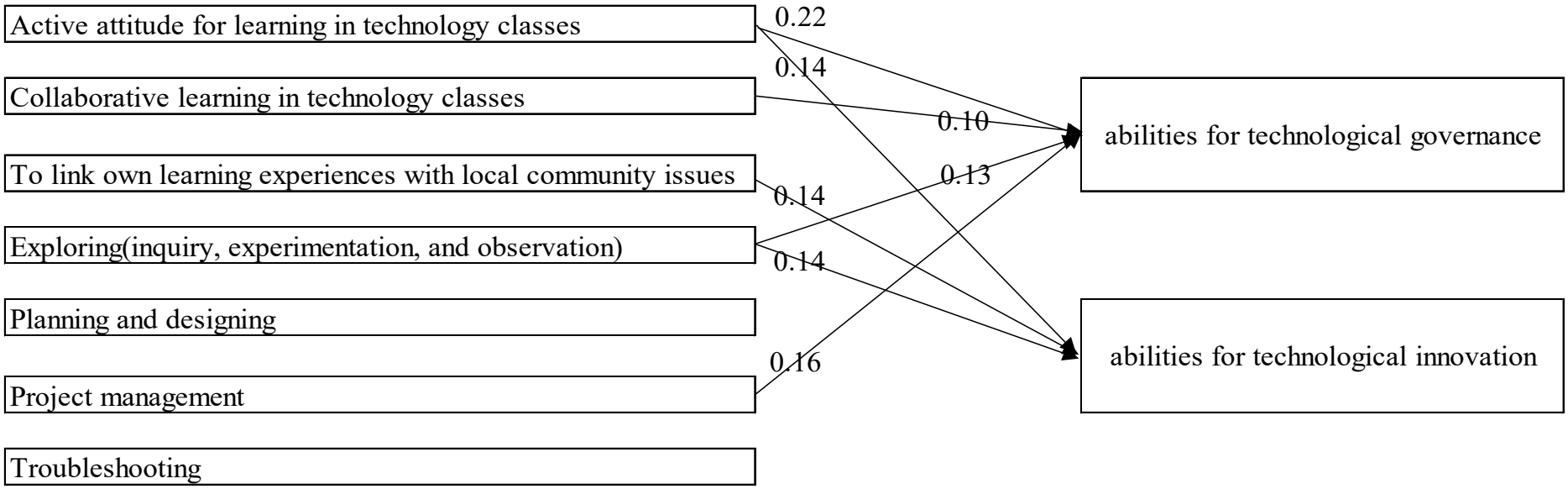
Items	*Mean*	*SD*
Exploring(inquiry, experimentation, and observation)	2.64	0.89
Planning and designing	3.18	1.34
Project management	3.22	0.67
Troubleshooting	3.18	1.34

N = 1656
4 point scale

- Engaged in problem-solving activities such as project management, planning and design, and troubleshooting
- However, not sufficiently engaged in exploring activities such as inquiry, experimentation, and observation

Survey on actual status of students' awareness for learning "Technology"

Figure 1.
Causal relationship toward students' abilities for technological innovation and governance



- Weakness of influences of learning activities to the abilities for technological innovation and governance
- No contribution of planning and design, troubleshooting activities to develop the students' abilities

Survey on actual status of students' awareness for learning "Technology"

- Findings of the investigation
  - ✓Japanese students have positive perception of "Technology" classes
  - ✓Learning activities that involve exploring technology, and designing problem-solving is not adequately linked to the development abilities for technological innovation and governance.

- Technology education in Japan should focus on enhancing exploring activities and problem-solving related to ***Engineering Design Process.***

"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

- Establishment the "*Technology Education Ideathon*" session.
  - ✓ "*Ideathon*" = "*idea*" + "*marathon*"

- "*Ideathon*" on an annual basis since 2017
- Four symposiums during JSTE's annual conferences from 2019 to 2022

- "*the New Framework for Technology and Engineering Education to Create the Next Generation Learning*" (NGTE) published in 2021.

"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

- "***New Framework for Technology and Engineering Education to Create the Next Generation Learning***" (NGTE)

  - ✓Structural objectives
  - ✓Scope of learning contents
  - ✓Model of Engineering Design Process
  - ✓Model of STEAM Education
  - ✓etc

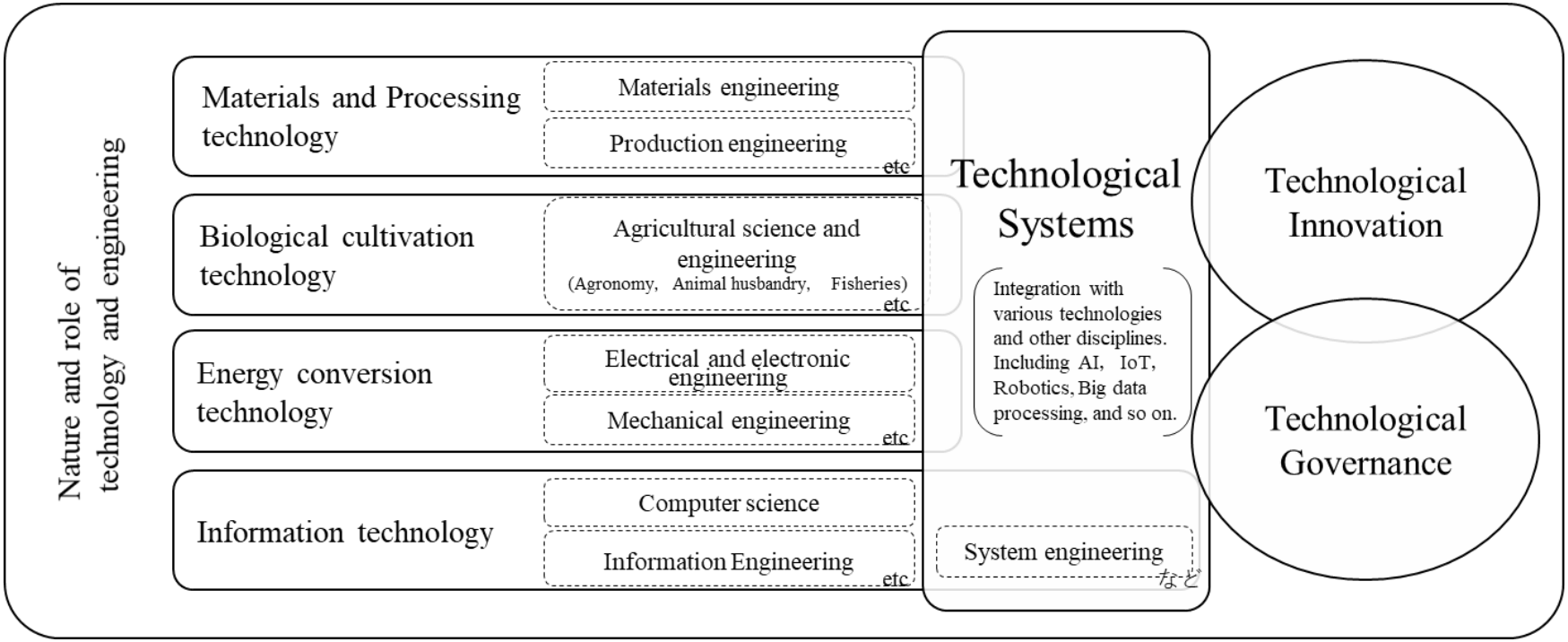
"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

Table5
Objective of Technology and Engineering Education in NGTE

Technology and Engineering Literacy	Competencies enhanced by technology and engineering literacy		
	as individual	Engaging with others	Life and social development
✓Scientific understandings of technology and engineering ✓Understandings of interconnection between technology and society,	Integrative recognition and application abilities in both STEM and Arts	logical communication (expression, share, argument)	Career development and self-actualization
✓Development of abilities to technological problem-solving and engineering.	design thinking critical thinking logical thinking computational thinking system thinking GRIT etc	cooperative skills collaborative skills menbership leadership followership etc	Abilities to move various projects forward in lifelong
✓Development of abilities to participate in technological governance in society.	Jadgment abilities Decision making abilities Fairness Citizenship etc	Abilities to engage in democratic and constructive dialogue	Abilities for building democratic and sustainable societies
✓Development of abilities to participate in technological innovation in society.	Creativity Proposal skills etc	Open mind Reciprocal relations etc	

"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

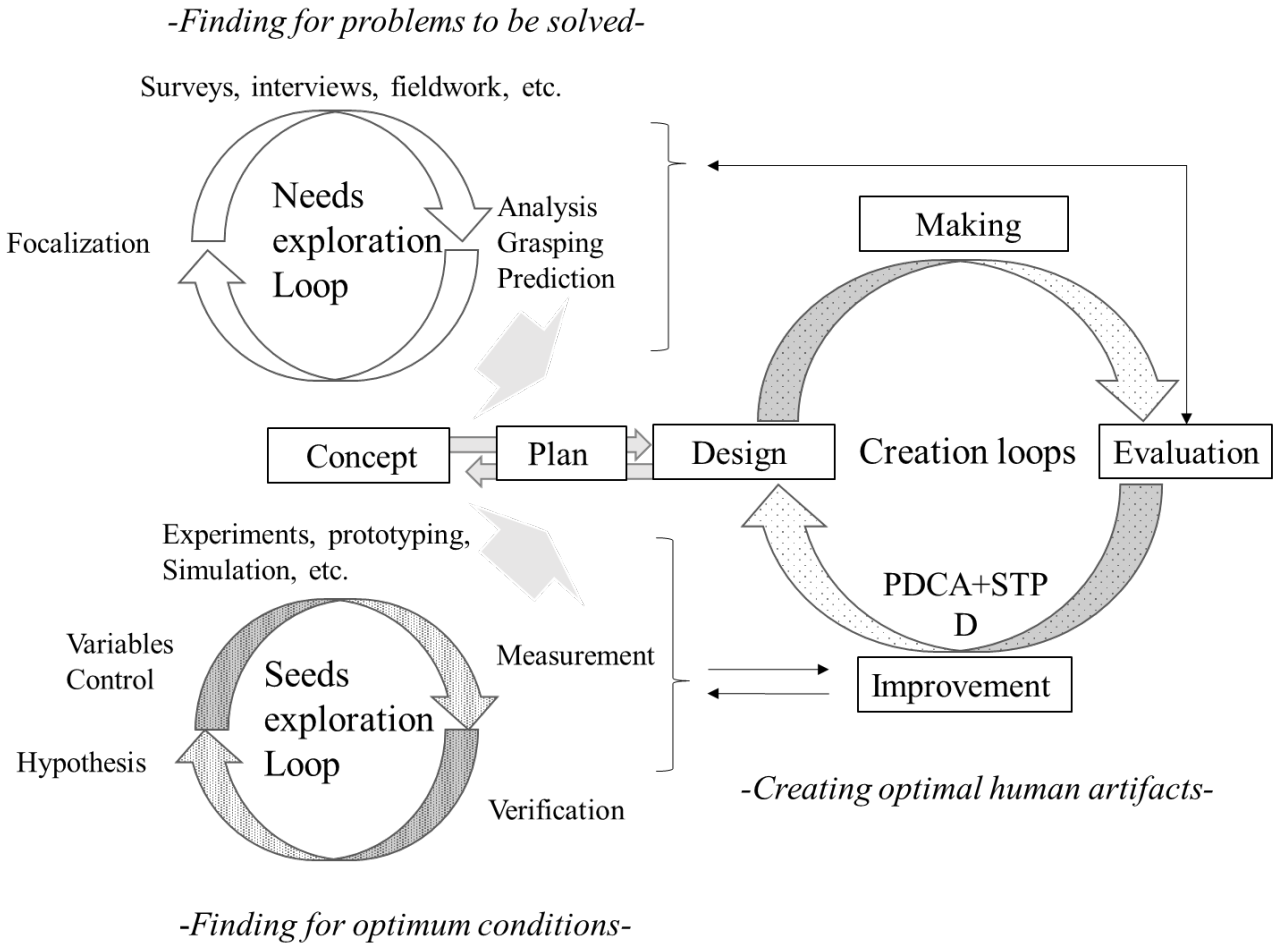
Figure 2.
Scope of Technology and Engineering Education in NGTE



"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

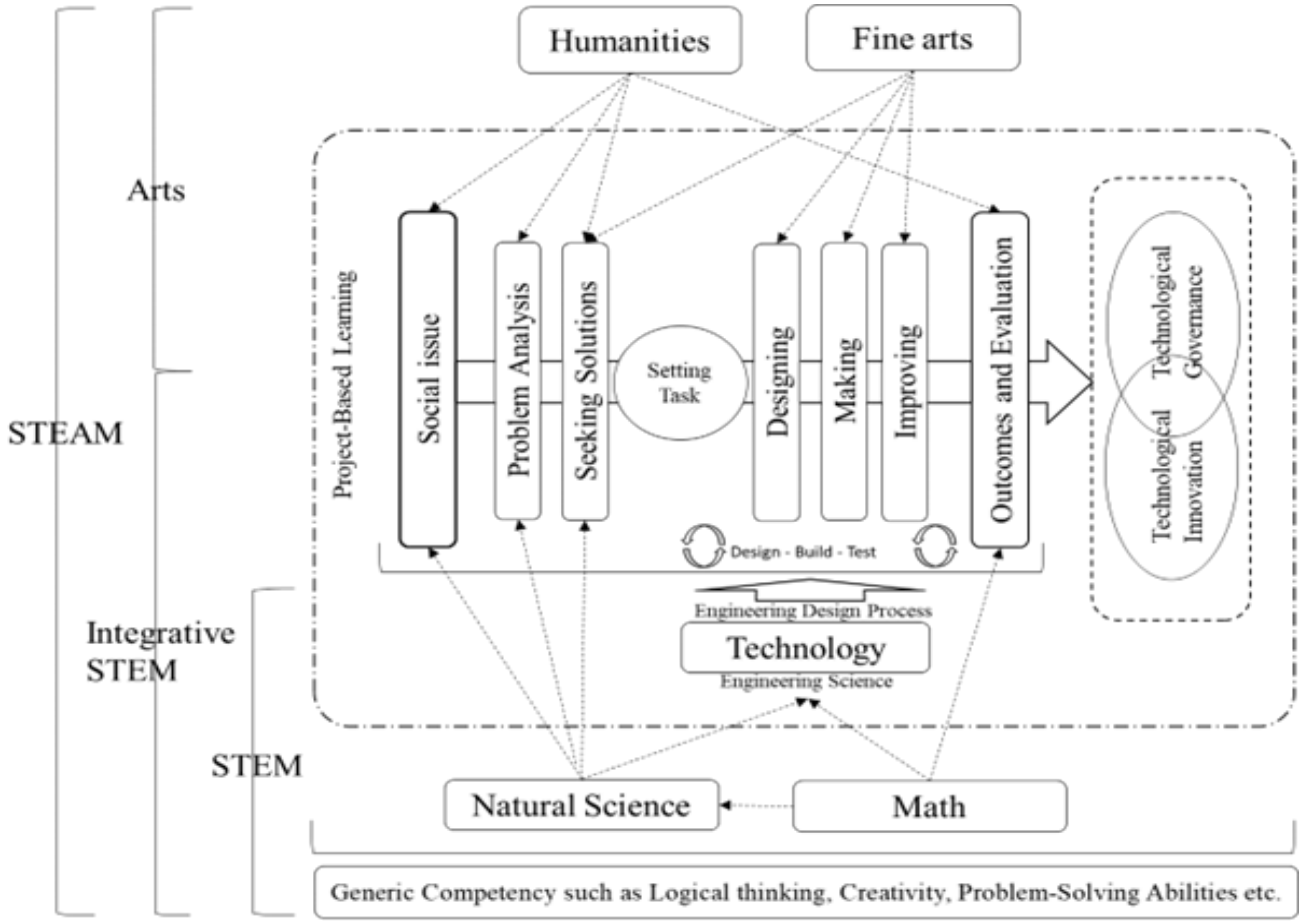
Figure 3.

The Triple Loop Model of engineering design process in NGTE



"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

Figure 4.
Learning Model of STEAM education that centred engineering design process in NGTE



CONCLUSION AND FUTURE TASKS

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- In this presentation

✓An overview of the status of technology education in Japan

✓Introduction of the proposed framework for new technology and engineering education by JSTE.

- Finally, as all the documents we introduced in this presentation are written in Japanese, we hope that through this presentation, the NGTE will be made known to technology and engineering educators in other countries.

Thank you for your attention!

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Multiple Regression Analysis

- Multiple Regression Analysis is a statistical method used to investigate how multiple independent variables (predictors) collectively influence a single dependent variable (outcome). By using Multiple Regression Analysis, we can quantify and assess the causal relationships between several predictor variables and a target variable.

Society 5.0

- In recent years, there has been increasing emphasis on the Fourth Industrial Revolution, Connected Industries, highlighting the integration of new technologies such as AI, IoT, robotics, Big Data processing and so on with traditional industries such as agriculture, manufacturing, and so on.
- In Japan, this type of new society is called as Society 5.0. Society 5.0 refers to a concept that the Japanese government aims to achieve, which represents a new type of society.
- Society 1.0 represents the hunting society, 2.0 represents the agricultural society, 3.0 represents the industrial society, and 4.0 represents the information society. Society 5.0 envisions a society where Society 1.0 to 3.0 are highly integrated with Society 4.0, aiming for sustainable development and the resolution of social challenges.
- In order to actualize society 5.0, it is important to connect and integrate of cyber technologies and physical technologies.
- These changes in society have necessitated a reform of education.

"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

- NGTE has strengthened the following two points, considering the content structure of Japan's previous technology education.
- First, NGTE incorporated elements of engineering science, in order to emphasize problem-solving through the exploration of technology by establishing the relevance between each content and its underlying academic discipline.
- Secondly, NGTE has enhanced the connections between technology and other diverse areas of expertise to enable students to create new value in a VUCA (Volatile, Uncertain, Complex, Ambiguous) society.
- This has been incorporated into the learning content as "Technological Systems," emphasizing the interplay between technology and technology, or various other domains in society.
- Especially, we addressed the integration of cyber technologies and physical technologies based on the concept of Society 5.0. We thought these contents are linked to the abilities for technological innovation and governance. The proposed scope of technology and engineering education in NGTE is shown in Figure 2.

"TECHNOLOGY EDUCATION IN THE 21ST CENTURY" PROJECT

- NGTE divides technology and engineering education into two categories for discussion: professional education for cultivating technological experts such as engineers, technologists, etc., and general education for fostering technology and engineering literacy among all citizens.
- And particularly, NGTE focuses on technology and engineering literacy education.
- NGTE defined that acquiring the abilities for technological innovation and governance is considered as final goal of technology and engineering literacy.

Technology and engineering literate students

- The envisioned future shape of students who have leant technology and engineering education are
  - "Technologically literate citizens"
  - "Responsible users of technology"
  - "Creative individuals as engineering problem-solver "
  - “Lifelong learners about technology and engineering"
  - "Decision-makers related to technology in society"
  - "Eggs of engineers"
  - "Promotors of culture to actively support of technological development in society"
- These images represent the desired outcomes from students in technology and engineering education.