Attitude Change in Learners Who Completed A Technology Management And Career Design Fusion Program As Part of A Liberal Arts Curriculum

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Abstract. This paper discusses models for the development of a technology management educational program in a liberal arts curriculum at the undergraduate level, and analyzes and evaluates the attitude changes in the learners who completed the program in 2014 and 2015. The developed programs were based on a fusion of technology management and career design. The research project's learning and educational objectives were as follows. Technology management is a framework that makes full use of technology to develop, maintain, and improve systems, products, and services that are useful for society and individuals. In this program, students learned mechanisms to promote novel value-creation activities, to select an industry and vocation that capitalizes on their own abilities, and to cultivate the ability to motivate themselves through self-management and industry/company research. The program combines a PDCA management cycle model with a Kaizen activity program, a learning process model for knowledge creation, and a value model for the co-creation of social value and individual value. These models were applied to develop an educational program within the liberal arts program at Kanazawa Institute of Technology in Japan. The results indicated that human resources who are able to change themselves and adapt to new environments can be cultivated.

Keywords: educational program for a liberal arts curriculum, technology management, career design, novel value creation activities, human resources

1. INTRODUCTION

This paper proposes several models for the development of technology management educational programs for a liberal arts curriculum at the undergraduate level, and discusses the results of a case study from the development of such a program at the Kanazawa Institute of Technology from 2011 to 2016.

A previous paper has discussed the models behind the research project, the program development concept, the educational tools, and establishment of the learning and educational objectives(Ishii and Nakano,2015). The models proposed in the previous paper combined a Plan Do Check Act (PDCA) management cycle Model with a Kaizen activity program, a learning process model for knowledge creation, and a value model for the co-creation of social value and individual value (Ishihara et al., 2014).

This paper designs an educational program using a flipped classroom(Bergmann and Sams,2012) through a cooperative learning method(Fink,2013) and discusses the attitude change in the learners who completed the program.

2. OVERVIEW OF MODELS AND TOOLS

2.1 Approach to Technology Management and Career Design Fusion

There have been some discussions on career design (Super,1976; Krumboltz,2010). In this research, career design is defined as the following cycle of activity:

(1) Decide the direction and objectives of a future professional life or formulate a "wish list" to that end.
(2) Create an action plan with set objectives and a timetable, or depict a vision with a tool sometimes referred to as a "road map" (Albright et al., 2003).
(3) Implement the plan and comprehend/evaluate the

differences between the plan and the results; in other words, create a record of the students in action.

The following two issues first need to be addressed before a learner proceeds with continuing efforts for self-improvement:

(a) The learner must consciously preserve a sense of management as a means of fulfilling their set dream. In other words, the learner must understand what they or their organization must overcome to grow (or to come one step closer to fulfilling their dream).

(b) The learner must upgrade their problem-solving know-how and skills and continue to develop mechanisms (systems) and tools to achieve this. Here mechanisms and tools refer to a unique continuous learning methodology.

2.2 Notation Tools for Career Design

Based on the proposed models, a "four screen" educational tool and procedures for drafting a career design were developed and applied to the program.

(1) A sketch of the learner's present state

This screen prompts a learner to list their acquired management resources, examine their efforts to accumulate knowledge, and write down the results; in other words, the learner is prompted to "know one-self."

(2) Sketch of the learner's wishes

In this screen, the wish list, the learner considers the following questions so as to envision themselves ten years from the present:

(a) In what type of business and in what industry will I be using my present strengths and weaknesses?

(b) What sort of work will I be doing?

(c) What sort of people will I be working with?

(d) What sort of people will I be working for? (i.e. target market and customers; whose approval does the learner seek?)

(e) What technological innovations are the products or services subject to that I wish to offer?

(3) Sketch of the learner's vision

Here, the learner compares their present state with their wish list. It is likely that the learner will observe a disparity between the two, as the absence of any disparity suggests that the learner's dreams have already been fulfilled. The learner proceeds under the premise that a disparity exists between their wish list and their present state. Once a disparity is confirmed, the next step is to devise a number of strategies to eliminate this disparity using a "strengths, weaknesses, opportunities, and threats" (SWOT) analysis (Andrews, 1980).

The learner considers some of the following points:

(a) Internal resources: the learner concentrates on listing their present strengths and weaknesses.

(b) External environment: the learner examines their opportunities and threats, concentrating on the following aspects of their wish list:

*conditions surrounding the business and industry;

*conditions surrounding the market and customers; and

*circumstances related to products and services.

Next, from the combination of the internal resources and the external environment, the learner cross-analyzes the fulfillment methods against the wish-list objectives. The learner should:

(i) set objectives that are specific, measurable, and attainable;

(ii) embrace values that are relevant to the organization's values, and ensure the organization does likewise for the learner's individual values; and

(iii) set a time limit to achieve those objectives.

Finally, the learner creates a road map by placing each of the strategies corresponding to the set objectives sequentially along a time axis.

(4) Sketch of the learner in action

In this screen, the learner creates an action plan for their vision, assembles their track record data, and evaluates their achievements to date. If the learner finds a large gap between their action plan and their track record, they must consider measures to correct these.

The dynamic relationships between the four sketches are shown in Figure 1.

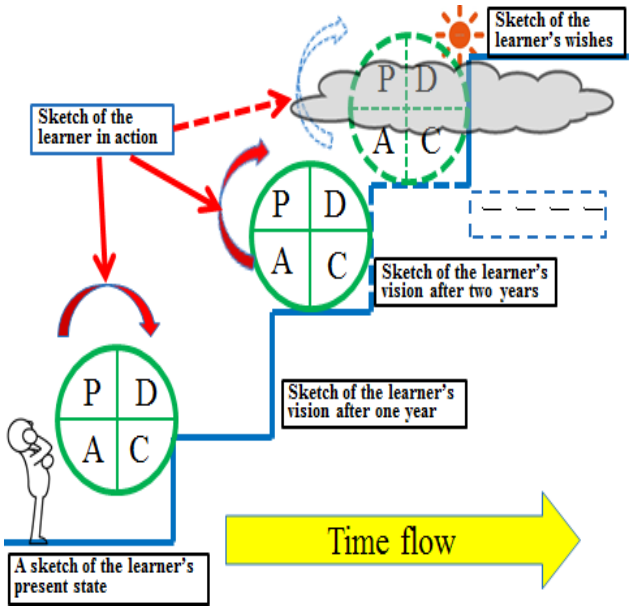


Figure 1: Dynamic model of "Four sketches"

3. PROCESS AND DEVELOPMENT RESULTS

3.1. Development Requirements and Policy

Kanazawa Institute of Technology (KIT) started developing a technology management educational program in 2011. The preliminary analysis resulted in the criteria shown below for the educational program development:

(1) Develop an original program at KIT, different from existing technology management programs.
(2) Include content about intellectual property (patent conflicts) and globalization.
(3) Have a career design education program within the curriculum.

After a year of development of the educational content and tools, the first program trial commenced in 2014.

Figure 2 shows the deployment process from the KIT founding principles to learning educational goal-setting.

Recognizing the problems within the educational resources that have been cultivated by KIT to date, program development was approached by combining the elements predominant at KIT in an effective and creative way (Wiggins and McTighe, 2007).

3.2. Educational Resources and Development Strategy Analyses

The educational resource and development strategy analyses were as shown in Figure 2.

(1) Educational programs and tools in undergraduate education to realize the school's funding principles.

KIT's ideal is specified in its three main founding principles: character formation, technological innovation, and industry–academia collaboration. In addition, KIT has KIT-IDEALS, which reflect how the KIT community values innovation and industry–academia collaboration. KIT IDEALS also reflect the school–community values that the students, board of directors, faculty members, and staff are expected to always be aware of, put into practice, and respect so as to further improve their campus activities. The two elements described below are practical methods to realize this ideal.

(i) Career Design Education

One method to realize the ideal of character development is the enrichment and development of career design education. This is specified as the main objective in the liberal arts curriculum. In addition, for this purpose, various learning and educational portfolios have been developed as educational tools.

Here, learners have the potential to acquire learning methods so as to achieve personal growth throughout their academic life and future planning experiences.

(ii) Project Design Education

One function of project design education is to allow learners to realize the ideals of technological innovation and industry–academia collaboration. KIT started developing this educational program in 1995 (Kubo et al. 2002). Here, through active learning to create novel value-creation with science and

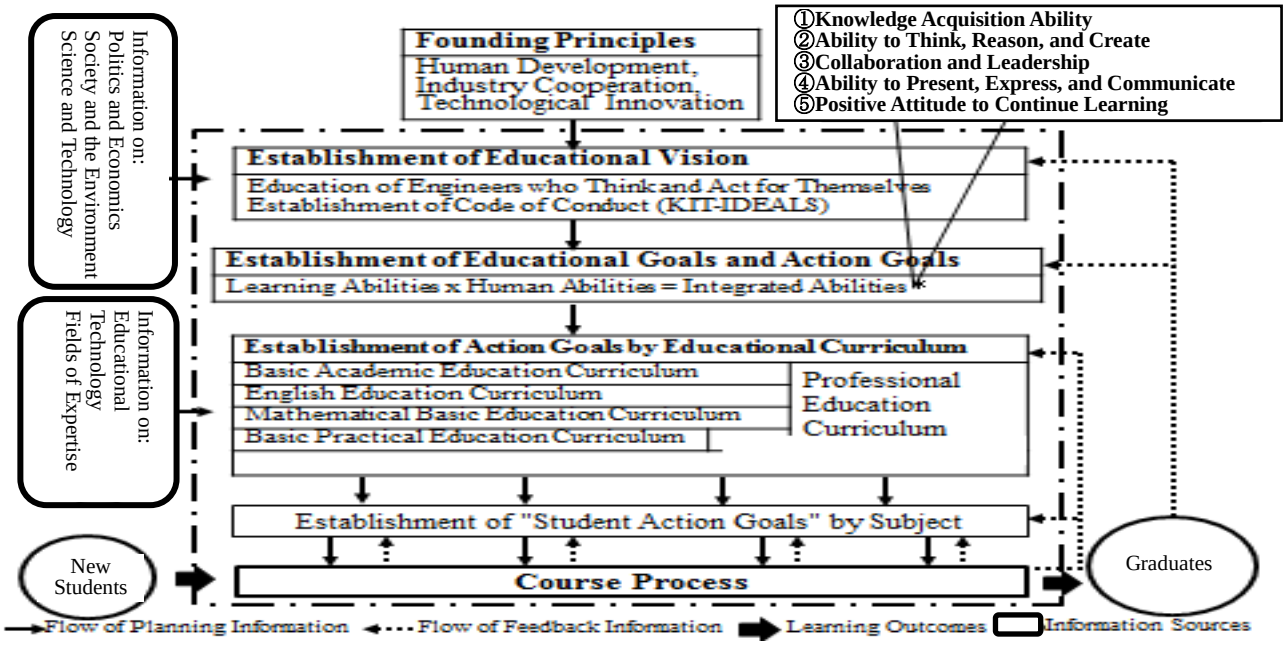


Figure 2: Deployment process from founding principles to learning educational goal setting

technology as the major, learners have the opportunity to experience realistic problem discovery and problem -solving in an industry–academia cooperative situation.

3.3. Establishment of Learning and Educational Objectives

For the program to be educationally effective in a technology-based liberal arts curriculum, the educational objectives were established using the educational resources above to confer competitive advantage at KIT. The main conceptual points are detailed below:

(1) The PDCA management cycle is a basic model in management and is a shared characteristic in career design and project design in KIT's undergraduate education. This element promotes coordination between professional education and the liberal arts education, so that the KIT-IDEALS in the educational program can serve as the criteria to guide the learners to realize their goals. As a result, learners are able to continuously create value that connects their liberal arts education to their professional education.

(2) By taking account of how a learner's field of study can be capitalized on, the program can promote coordination to cultivate management technological principles and to lead the students towards their future careers.

Based on the concepts above, the learning and educational objectives of the program were set as follows: "Technology management is a framework that takes full advantage of technology to develop, maintain, and improve systems, products, and services that are useful for society. In this course, students will understand the mechanisms needed to develop novel value-creation activities, select an appropriate industry and vocation for their abilities, and cultivate motivation towards their chosen area, all while adapting the business organizations to the environment using technology management."

KIT established their educational vision as "The Education of Engineers Who Think and Act for Themselves." KIT also decided on the following educational goals and action goals:

(a) learning abilities;
(b) human abilities; and
(c) integrated abilities across five evaluation items.

Learning abilities are supported mainly by a professional education curriculum, and human abilities are nurtured in the basic academic education curriculum. The performances of both curricula are evaluated using the integrated abilities' criteria, which examine the following five abilities:

(a) knowledge acquisition ability;
(b) ability to think, reason, and create;
(c) collaboration and leadership;
(d) ability to present, express, and communicate; and
(e) positive attitude to continued learning.

The developed program is one of the courses in the basic academic education curriculum. The program establishes practical human abilities that correspond to the KIT-IDEALS and the learner's PDCA. The learning outcomes of the professional education curriculum are considered to be the management resources for the learners' career design, as well as for the human abilities outlined above. Therefore, the aim is to encourage effective coordination between the professional education and the liberal arts education.

3.4. Development Process using the ADDIE Model

Table 2 gives an overview of the process and the results of program development based on the ADDIE model. This model is in general use in Instructional Design (ID) (Ryder, 2008). ID design process models are generally divided into two categories: Analysis, Design, Development, Implementation, and Evaluation (ADDIE) models (Rothwell and Kazanas, 1998) and rapid prototyping models (Piskurich, 2000). Rapid prototyping models are based on ADDIE models, and ADDIE models are general models for the management of ID, and include ID activities as Analysis, Design, Development, Implementation, and Evaluation processes. This model is based on the management cycle model.

As shown in Table 2, the program had 11 lecture titles for each educational goal. Group work in each topic, which uses cooperative learning, ensures that learners have the opportunities to experience both self-enlightenment and mutual enlightenment processes, which cultivate metacognitive skills, as they need to think carefully about their own thinking and learning (Angelo and Cross, 1993). The work is classified into two types: the first is a question and answer session concerning knowledge associated with educational goals, and the second is a problem-solving approach that requires the application of knowledge and the collection and analysis of data and information. This program design intends to cultivate learners who can effect organizational change by thinking, behaving, and changing themselves. Therefore, to efficiently improve their learning effectiveness, learners must continually upgrade the methods and processes by which they go about learning. One way to do this is to use a PDCA

Table 1: Development trajectory and results for a ADDIE Model-based Technology Management Program

Process		Main Results
Analysis		Management education to cultivate technical professionals (unique to our Institution)
		Incorporation of intellectual property and globalization elements
		Career design education (partial)
		Differentiation from other present-day management professional education programs
Design		Course participants are third-year undergraduates from all departments; two-unit compulsory subject (90 min/wk; 16 wks)
		Group activities related to learning items are carried out in every lesson
		Course operation combines lectures and group work with e-learning materials
Development		Effective use of textbooks and learning material distribution system
		Design of worksheets for group work
		E-learning materials incorporate characteristics of each department, and have high audiovisual content.
		Rubric evaluation of reports and presentations
Implementation		Learner–teacher communications are an effective combination of interviews and outcomes (e-mail, portal, short test/quiz, report, group-work worksheets, etc.)
		In group activities, the leader rotates weekly; the leader receives a leadership skills evaluation in which the activity outcomes are mutually assessed by group members; the leader drafts a leadership skills improvement plan based on this, presents it to the teacher and receives feedback.
		Each student drafts a four-screen career design in a report; they circulate it among group members and mutually exchange evaluations and comments for improvement; each group presents on the best four screen recommendation; based on this, they improve and externalize the four screens through mutual development at each group and class-wide step.
Evaluation	Learners	1. Attainment Evaluation Items Listed on Syllabus 2. Self-evaluation centered on self-evaluation of KIT-IDEALS practical skills, PDCA practical skills, and professional skills, as well as a self-evaluation of improvement skills. KIT-IDEALS practical skills and PDCA practical skills are externalized through group-work and class-wide presentation. 3. Self-evaluation of attainment level at intermediate points during the course and a topics-for-improvement examination (PDCA practical skills improvement ability) in the second half.
	Program	1. Course Survey 2. Post-Lesson Attitude Change Survey

cycle, perhaps with reference to the learning pyramid (Magennis et al., 2005), through which the learner can obtain an efficient learning method best suited to their situation, and which can challenge their status quo (Ishihara et al., 2014).

We instituted two activities to improve student knowledge and awareness of the designated learning items: group-work for students to teach and learn from each other and the creation and advance preparation of homework materials. Learners prepare for class using homework materials, list the questions they have, and address them in that day's lesson. Students discuss

Table 2: Lesson design of the program

Title	Educational Goal	Group Work Topic Goals
Business Activities & Decision-Making	To understand the relationship between enterprises and companies; to consider recognition techniques for corporate business activities and their relationship with profit.	To decide on and register an organization name; to confirm leadership responsibilities; to build consensus surrounding activity plans.
Business Organization	To understand the 5 principles of organizational design; to learn about line and staff responsibilities, regular and ad hoc duties, and organizational forms; to distinguish between organizational theories and management system theories.	To base topics of interest on learning outcomes to date; to choose industry type and company for robust and precise reasons; to build consensus in a group and organizationally determine topic-related tasks.
Management and Administration	To distinguish between management and administration; to understand the significance and applications of resource strategies in the context of administrative strategy, as well as status quo maintenance and disruption in the context of management.	To discuss an organization's philosophy and mission and seek solidarity with others, then to reach a mutual understanding; to apply personal management resource strategies to career design.
Intellectual Assets and Management	To understand the difference between fair market value and book value in an organizational evaluation; to understand intellectual asset characteristics, intellectual property patent strategies, and the challenges related to standardization strategies.	To analyze and assess an organization of interest having management resource superiority based especially on information related to R&D and patents; to think about organizational conditions that take advantage of expertise, and discuss these with others.
Management's Many Activities	To understand the meaning of QCD as value enhancement with the aim of increased revenue; to understand the various management activities and their interrelationships to combine the three process elements to create this meaning.	To think about the relationship of specific technology(as a professional skill) with the three QCD elements for each job and product of interest; to draw an image of a job that takes advantage of expertise; to explain these to a third party.
Career Design based on Management Cycles	To conceive of career design as the design and implementation of learning processes to realize one's dreams, as well as for continual improvement.	To illustrate the past and future in four screens; to explain so that a third party can understand; to continuously improve career design through mutual development, all in order to "know themselves."
Profit Management and Cost Management	To understand the properties of costs and recognize the necessity of cost management; to discuss cost management and cost maintenance for profit generation and the differences with cost reduction.	To explain personal thinking to a third party; to discover challenges to improve methods through mutual development (group activities).
New Product Development and Quality Function Deployment	To understand important points and challenges related to the necessity of new product development, the concept of product planning and quality control activities.	To recognize the relationship between quality requirements and quality characteristics in practical terms by using products and services; to exchange opinions with a third party.
International Management System Standards and Quality Management Sys.	To understand the significance, formulation, and verification of international management system standards; the history of the establishment of ISO9000; and an overview of the process models and requirements of management system models.	To understand the relationship between the quality management activities of ISO9000-certified companies with their superior product or service quality; to discuss the influence that international management standards have on future work.
Supply Chain and Lead Time Management.	To understand SCM components and challenges, the relationship between load and lead time, and the associated management techniques.	To consider techniques to shrink lead time; to discuss methods further
Supply Chain and Inventory Management	To understand the functions and types of inventories, and associated management techniques.	To evaluate inventory outcomes in terms of inventory turnover rate; to consider causes for these outcomes; to consider techniques for further improvement through mutual development.

their questions among themselves at the beginning of the lecture and develop a single answer. If no agreement or consensus on an answer is reached, the student leader asks the teacher and obtains the answer.

Subsequent group-work, consisting of practical prob lems that reinforce learning items, enhances learner affectivity and gives them experience with applied techniques for the knowledge and skills they have acquired. The aim is to create a place that encourages a deeper understanding of the learning items.

The course was developed based on the ADDIE model of instructional design (ID), and also reflected the University's founding principles and code of conduct. The flipped classroom-learning model is also employed, with a focus on cooperative learning. Table 3 shows the standard learning process for each lecture, while Table 4 shows the process by which learners create and improve the four-panel career design exercise and how it relates to their creation of a learning portfolio as part of the group-work.

3.5. Learner Attitude Changes

Figure 5 shows the changes over the three years in the student self-evaluation results for the practical abilities that corresponded to the KIT-IDEALS. These students were from a sophomore class, a junior class, and a senior class after course completion. As can be seen, all classes improved in integrity and in the self-realization of their ability to develop the values prized by the school community. This hypothesis was tested with a significance level of 5%.

Figure 6 shows the self-evaluation results for the practical abilities corresponding to the PDCA of the junior and senior class students. These results could not identify their changes in the learners for two years by statistical hypothesis test.

Figure 7 shows the types of attitude changes derived from taking this course. These are average levels for the learners' integrated abilities in 2014 and 2015. All abilities were significantly different between 2015 and 2014, at a significance level of 5%.

Figure 8 shows the attitude change of the learners who completed the course in 2015. This survey was taken in the final lecture of the course. Over 90% of the learners indicated that they had changed their own attitudes about their future.

4. CONCLUSIONS AND SUMMARY

The program has been run from 2014 as a two-unit, compulsory subject for third-year undergraduates. It has been four years since the initial planning and

Table 3: A standard learning process for a lecture

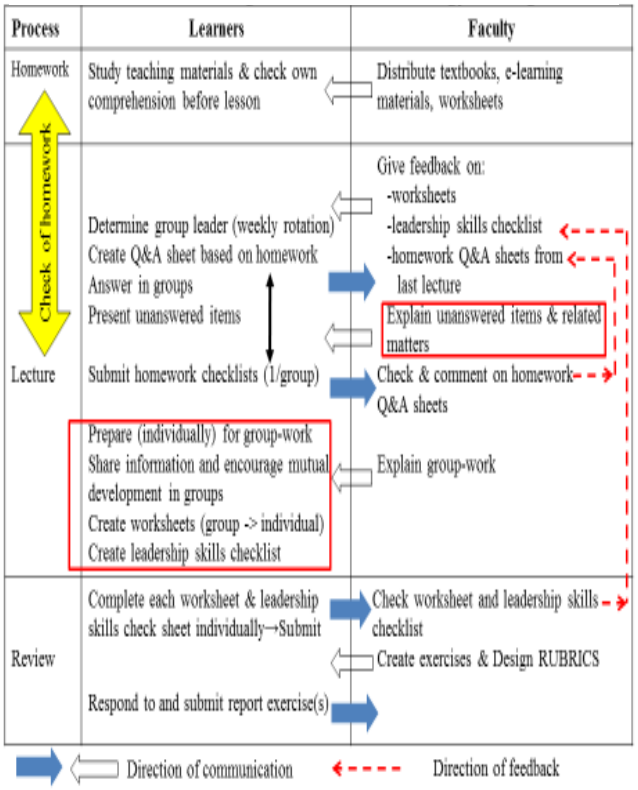
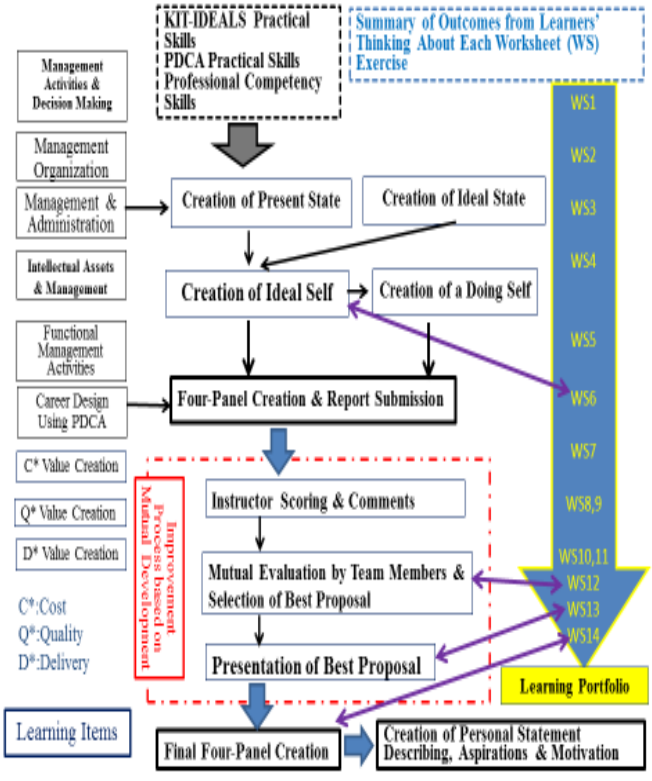


Table 4: The course flow focused on a career design



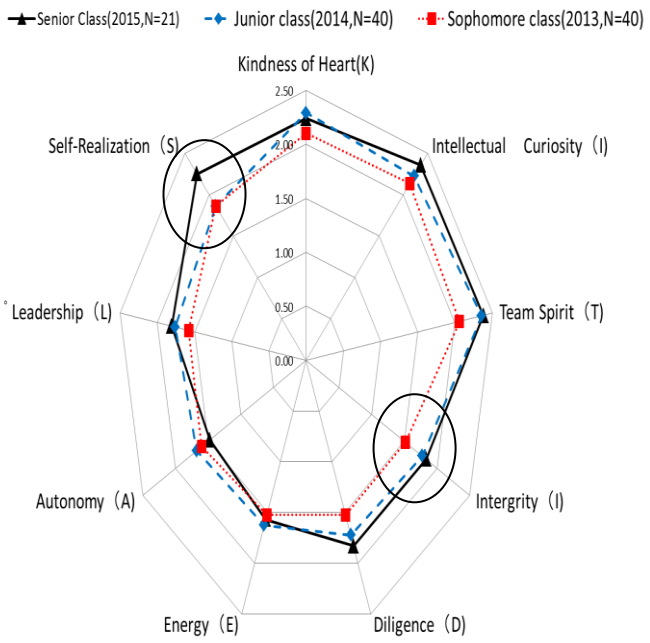


Figure 5: Average scores of KIT-IDEALS evaluated by learners

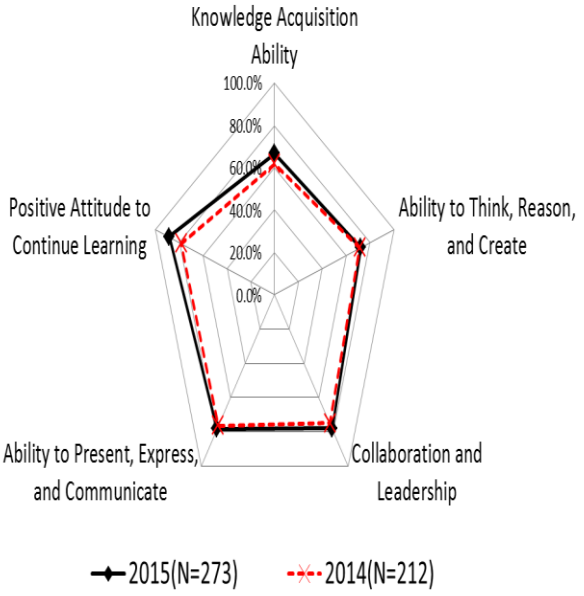


Figure 7: The changes in the integrated abilities of learners

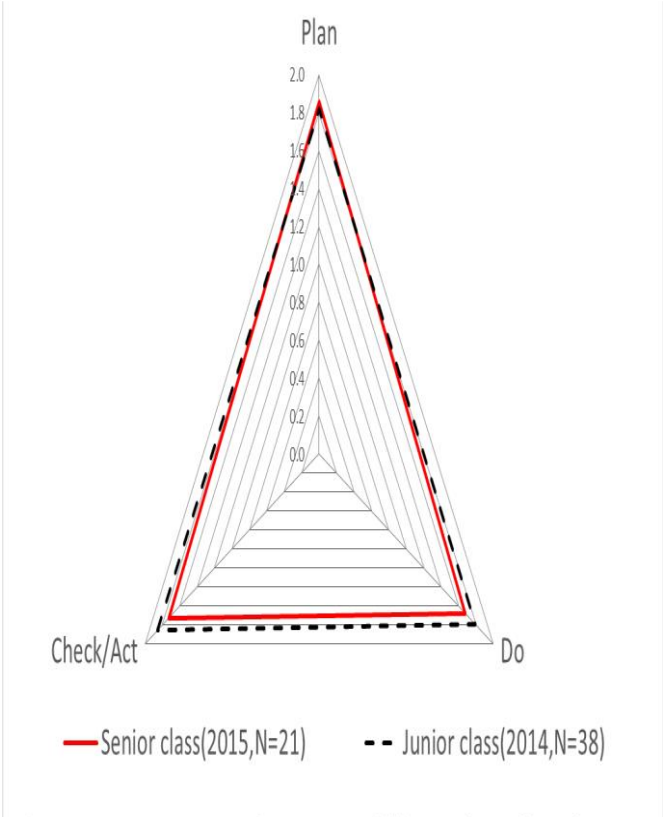


Figure 6: Average scores of PDCA capability evaluated by learners

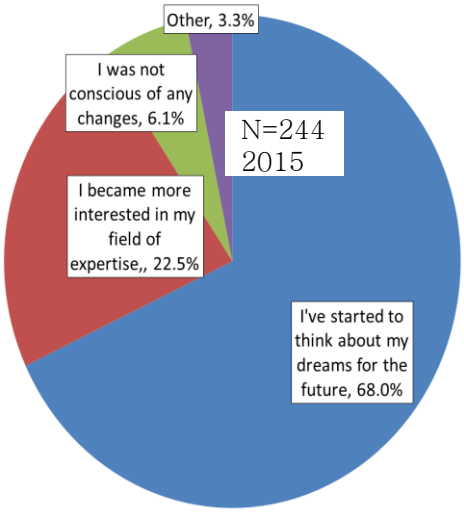


Figure 8: The attitude changes of the leaners who completed the course in 2015

demonstration lectures for this program. Nonetheless, we continue to make improvements to the program to this day. Over these four years, increased satisfaction has been visible over time in the survey data from learners after program completion. The program has additionally had positive effects on the practical skills related to our school's code of conduct, as well as on attitude changes.

Cooperative learning was incorporated from the first year, through the design, development, and improvement of the group-work worksheets. Efforts to develop e-learning materials proceeded from 2015; we analyzed the effects of homework conditions on learn -ing outcomes and made improvements to the educational materials based on the results. Based on these efforts, we trialed two kinds of group-work - homework comprehension check and group exercises – in the first half of the lecture and endeavored to confer flipped-classroom qualities to the lecture. In addition, we proceeded to develop rubrics for reports and presentation exercises (i.e., joint presentation of the four-sketches exercise).

The above efforts have developed a mechanism to provide learners with a place to experience learning and teaching. This has allowed them to improve their abilities to foster both their own personal development and the development of their peers, which in turn improves the desire to learn in a self-directed way. These activities can serve as a model for "learning through work" as improvement activities are done in small groups, which has been found to be a factor that can ensure competitive superiority in Japanese industries.

The above findings suggest that our program development successfully achieved the designated outcomes. One future challenge is to evolve the program so that it provides learners with a place they can proactively endeavor to realize their dreams, continually acquire learning skills, and seek personal happiness.

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