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Learning Effects of Problem-Identification and Problem-Solving Internships

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ABSTRACT

We aim to understand the features and educational impacts of problem-identification and problem-solving internships (hereinafter called 'problem-solving internships') at the National Institute of Technology, Toyama College. Problem-solving internship is a practical internship style that emphasizes experience in which intern students examine and propose solutions to actual business problems faced by a company. Thus, we qualitatively analysed the reports submitted by participating students using the steps for coding and theorisation (SCAT) method. The results of the qualitative analysis by SCAT indicate that problem-solving internships provide a variety of learning and growth opportunities for students. The analysis showed that students can acquire different perspectives by reaffirming their social roles and abilities and by collaborating with individuals who have different values. It was also found that overcoming anxiety and participating in a problem-solving internship provides a chance to reflect on one's own potential and future challenges. These findings highlight the significant influence of the internship's pre-design and implementation on student learning, suggesting possibilities for further improvement and application of the educational program.

Keywords: Problem-identification and problem-solving internship, Step for coding and theorisation (SCAT), Qualitative analysis, Theorisation.

INTRODUCTION

An internship is defined as a work experience within a company during a student's school years, designed to help his or her understand their aptitudes and the nature of the work [1]. This provides an excellent opportunity for students to quickly grasp their interests, career goals and

abilities by experiencing the company's work style and organisational atmosphere before officially joining the company.

Following the approval of the 'Action Plan for the Reform and Creation of Economic Structures' by the Cabinet in May 1997, the ministries of Education, Trade and Industry and Labor collectively announced the 'Basic Approach to Internships', in September 1997, leading to the formal commencement of internships [2]. The Ministry of Education, Culture, Sports, Science and Technology (MEXT), in its 'Basic Approach to the Promotion of Internships and Other Career Development Support Initiatives for Students', revised in June 2022, outlines the following:

The educational effects of such efforts and their effectiveness in supporting students' career development, including internships, can be expected to be substantial. It is an important initiative that can be fully expected to be effective in supporting students' career development [2].

The National Institute of Technology, Toyama College offers internship programs primarily during the fourth year, designed as a class for students to reflect on their career paths, develop their human qualities as members of society and evaluate their future aptitudes. In addition to these goals, the program includes problem-identification and problem-solving internships to promote student autonomy, encourage teamwork and communication skills and generate new ideas. This study identified some of characteristics and effects of the problem-solving internship through a qualitative analysis of reports submitted by students who participated in this program.

PROBLEM-SOLVING INTERNSHIPS

Typical internships usually offer experience in predefined tasks set by the company. Conversely, problem-solving internships focus on practical experience, where interns analyse and propose solutions to business challenges faced by the company. Our school's problem-solving internship program operates based on the following points, which are discussed and agreed upon with the company hosting the internship beforehand:

(1) Conducting in teams of three
(2) Identifying problems or addressing those presented to them whenever possible
(3) Gaining hands-on experience or conducting experiments to solve problems
(4) Engaging in discussions with company representatives whenever possible
(5) Presenting proposed solutions to problems

Students will form teams of three, with members from various departments, to participate in the internship. Initially, the students will gain work experience by 'actually doing the job'. Thereafter, the team will exchange opinions daily to identify problems at the company. They will discuss these issues with company representatives to identify problems and gain hints on how to solve them. Figure 1 shows the discussions with company representatives.

Fig. 1: Discussions with company representatives

The students may 'conduct experiments to solve problems' and, in some cases, gain work experience. They discuss proposed solutions to problems identified by the team and prepare presentation materials. In the situation of presenting in front of company personnel, students present the identified problems and their proposed solutions. This series of activities is expected to effectively cultivate business manners and fundamental skills required for collaboration with different generations, which are not typically experienced at school, as well as develop communication, teamwork, leadership skills, ingenuity and creativity.

ANALYSIS OF REPORTS USING STEPS FOR CODING AND THEORISATION (SCAT)

SCAT

SCAT is a data analysis method for qualitative research featuring a straightforward, step-by-step process, accessible to those new to coding (conceptualisation). It is well-suited for organising various aspects of qualitative data and generating theories, developed to address the challenges of analysing complex qualitative data. The method follows a structured, step-by-step process, enabling the analysis of information gathered from interviews and observations.

Specifically, the process is based on the transcribed text and includes the following steps:

(1) Extract noteworthy words (keywords or phrases) from the text.
(2) Rephrase the extracted word or phrase.
(3) Replace the rephrased words with extratextual concepts that explain them.
(4) Considering the context throughout, weave themes and construct concepts to describe the storyline and develop theories from it.

SCAT is an analytical method that systematically organises and theorises qualitative data using these steps [3].

Problem-Solving Internship at Company A

For example, the SCAT analysis was performed on the report of a student (referred to as S) who participated in a problem-solving internship at Company A, a total environmental company. Table 1 presents the results of the SCAT analysis of the reports.

The initial step of the SCAT method involves extracting noteworthy words and phrases from the participants' reports. In this study, for example, the phrase 'experiment of detecting defective bottles' is used. Specific phrases from this report include the following: 'experimentation in detecting defective bottles', 'cooperation with students from the Department of Applied Chemistry and Chemical Engineering', 'ideas from a different perspective', and 'pursuit of questions for which it is difficult to find a destination'.

The next step involved rephrasing these words in a concise and abstract manner. For example, to abstract the data, 'experiments to detect defective bottles' became 'an experimental approach based on a problem', 'collaboration with students from the Department of Applied Chemistry and Chemical Engineering' was described as 'joint work sharing expertise in different fields', and 'pursuit of a question for which it is difficult to find a destination' was implied as 'inquiry into a problem for which no clear answer exists'.

Table 1: Company A Problem-Solving Internship Report Analysis by SCAT

Text	<1> Notable words and phrases in the text	<2> Rephrasing words in the text	<3> Extratextual concepts that explain the left	<4> Themes and compositional concepts
The experience of witnessing the workshop made me realise that I, who do not work for a recycling company, am one of the parties involved in the resource recovery process. The experiment to detect defective bottles was conducted in cooperation with students of the Department of Applied Chemistry and Chemical Engineering who participated in the same internship. Although the experiment sometimes came to a standstill, we were able to come up with ideas from different perspectives, and we were able to take advantage of the fact that we are from different departments. Through this internship, I learned that it is most important to have a variety of viewpoints when pursuing a question that is difficult to see the point of arrival.	Experiments of detecting defective bottles , cooperation with students from the Department of Applied Chemistry and Chemical Engineering, ideas from a different perspective, pursuit of questions for which it is difficult to find a destination	An experimental approach based on a problem, ideas from a different perspective, inquiry into a problem for which no clear answer exists	Project-based learning , problem-solving skills, interdisciplinary approach, teamwork skills, critical thinking, problem-solving skills	Circular economy: a sense of involvement in a sustainable society centred on resource recycling Cross-disciplinary collaboration: enhancing the ability to share diverse expertise and apply it to problem-solving
Seeing up-close efforts to address the SDGs, such as the reuse of wastewater, I became more interested in a recycling-oriented society. I was deeply impressed by the company's attitude of never being satisfied with the status quo and seeking further resource utilisation.	Reuse of wastewater, seeing up-close the efforts to address the SDGs, more interested in a recycling-oriented society	Specific practices for resource circulation , raising environmental awareness , attitude towards ambition,	Resource recycling society, environmental technology, environmental literacy, change of mindset, continuous improvement, challenging attitude,	Internal motivation and reconstruction of values, importance of a proactive approach to environmental issues

		pursuit of sustainability, change in values through internship	innovation orientation, internal motivation, restructuring	
Storyline	The internship participants gained a sense of contributing to a recycling-oriented society through wastewater reuse and SDG initiatives. By collaborating with other departments, they developed the ability to utilise diverse perspectives to address problems and adopted a challenging attitude through exposure to the company's approach to sustainable improvement. Additionally, their workplace experiences inspired them to enhance their internal motivation and restructure their values. These lessons fostered creative problem-solving skills and behavioural changes, promoting personal growth and social contribution.			
Theoretical descriptions	1. Developing an awareness of a recycling-oriented society 2. Enhancing problem-solving skills through diverse perspectives 3. Encouraging a challenging attitude and continuous improvement mindset 4. Boosting internal motivation through inspiring experiences 5. Nurturing creative problem-solving skills 6. Promoting social responsibility and behavioural change			

Additionally, we introduced the concept of extratextuality, which describes paraphrased words and phrases. The 'problem-based experimental approach' can be associated with broader concepts, such as 'project-based learning' and 'problem-solving skills', 'interdisciplinary approach' and 'teamwork skills' for 'collaborative work sharing expertise from different fields', and 'critical thinking' and 'problem-solving skills' for 'inquiry into issues for which there are no clear answers'. concrete experiences were abstracted and translated into a more theoretical framework.

A similar procedure is applied to other texts, organising extratextual concepts and then weaving themes and compositional concepts based on these ideas. The following are the included themes and concepts in the Company A Problem-Solving Internship Report:

(1) Circular economy: Fostering a sense of involvement in a sustainable society focused on resource recycling
(2) Cross-disciplinary collaboration: Enhancing the ability to share diverse expertise and apply it to problem-solving
(3) Environmental literacy: Deepening the understanding of environmental technologies and the SDGs
(4) Creative thinking: Encouraging flexible thinking and generation of new ideas

These themes are organised into more abstract concepts that reflect what students have learned through their internships.

Based on these themes and concepts, a storyline can be created to clarify the overall flow and relevance of the data. The following storyline serves to facilitate the interpretation of the data by connecting the themes and concepts, representing the overall experience of the participating students as a coherent narrative.

The internship participants cultivated a sense of contribution to a recycling-oriented society by engaging in wastewater reuse and SDG initiatives. By collaborating with other departments, they developed the capability ability to utilize diverse perspectives to solve problems and learned a challenging attitude through exposure to the company's approach to sustainable improvement. Additionally, by inspiring workplace experiences, they improved their internal motivation and underwent a transformation in their values. These learnings have fostered creative problem-solving skills and behavioural changes that promote personal growth and social contribution.

The analysis revealed that students who participated in the internship became more aware of their contributions to a recycling-oriented society and the SDGs and recognised the significance of problem-solving skills and cross-field collaboration. Furthermore, it is evident that the participants experienced a boost in their internal motivation and a transformation in their values through their emotional experiences in the workplace. These learnings were organised into the following theoretical concepts:

(1) Forming an awareness of a recycling-oriented society: Participating students recognised the significance of resource recycling and sustainability and acknowledged their social responsibility.
(2) Improving problem-solving skills through diverse perspectives: By collaborating with students from various fields, a multifaceted approach enhanced the effectiveness of problem-solving.
(3) Fostering a challenging attitude and a sense of continuous improvement: Inspired by the company's sustainable efforts, the participants learned to avoid complacency and strive for continuous improvement.
(4) Raising internal motivation through inspiring experiences: The on-site experience had a profound impact on the students, promoting their personal growth.
(5) Cultivating creative problem-solving skills: Students developed the ability to think flexibly about uncertain problems and generate original ideas.
(6) Promoting social responsibility and behavioural change: These learnings increased personal growth and motivation to contribute to society.

The results of the SCAT analysis indicate that internships might contribute to the students' overall development beyond just work experience. The emphasis on cross-disciplinary collaboration and understanding sustainability indicates that students are developing the ability to apply their field learning to real-world scenarios.

Problem-Solving Internship at Company B

Company B proposes a future-oriented recycling system based on an 'IT life cycle' business model and advances various businesses through IT and environmental initiatives. Student T and his team explored a solution to the company's problem of 'creating a tool to calculate the lifespan of a computer'. Table 2 presents the results of the SCAT analysis of 'What I learned from my internship' in the reports submitted by student T.

Student T's group was assigned by the company the task of 'creating a tool to calculate the lifespan of a computer'. After each day's work experience, the team held discussions to reflect on the project. The three main texts of student T's reports were analysed qualitatively using the SCAT method.

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The student's report included the following statement: 'I was very anxious about whether I, who had no technical knowledge, could contribute to solving the company's problem of 'creating a tool to calculate the life span of a computer'. Notable phrases extracted from this text were as follows: 'had no technical knowledge', 'creating a tool to calculate the lifespan of a computer', 'could I contribute to solving a company problem', and 'I was very anxious'.

Subsequently, the data were organised by abstracting and concisely rephrasing the extracted words and phrases. For example, 'my lack of technical knowledge' was abstracted as 'self-perception of my technical skills', 'creating a tool to calculate the life span of a computer' was abstracted as 'setting a task to utilise specialised technology', 'could I contribute to solving a company problem' was abstracted as 'difficulty in self-evaluation of problem-solving', and 'I was very anxious' was abstracted as 'psychological barrier in facing an unknown problem'.

Relevant extratextual concepts were introduced to supplement the paraphrased words. 'Self-awareness of technical skills' can be associated with concepts such as 'self-awareness' and 'growth mindset', 'setting tasks that utilise specialised skills' with 'practical learning' and 'technical problem-solving skills', 'difficulty in self-evaluation of problem-solving' with 'self-efficacy' and 'psychological resistance to challenge', and 'psychological barriers in facing unknown problems' with 'anxiety about the unknown' and 'challenging attitudes'. Additionally, 'psychological barriers' can be associated with concepts such as 'anxiety about the unknown' and 'challenging attitudes'.

This procedure was used to organise extratextual concepts for the other texts, and then themes and compositional concepts were derived based on these concepts. Themes and concepts in the Company B Problem-Solving Internship Report include the following:

(1) Self-understanding and psychological growth through challenge
(2) Creating value and exerting social influence
(3) Awareness and action towards the realisation of a sustainable society

Table 2: Company B Problem-Solving Internship Report Analysis by SCAT

Text	<1> Notable words and phrases in the text	<2> Rephrasing words in the text	<3> Extratextual concepts that explain the left	<4> Themes and compositional concepts
Before participating in this internship, I was very concerned about whether, with no technical knowledge, I would be able to contribute to solving the company's problem of 'creating a tool to calculate the lifespan of a computer'.	With no technical knowledge , creating a tool to calculate the lifespan of a computer , would be able to contribute to solving the company's problem, very anxious	Self-perception of technical skills, setting tasks that utilise specialised technologies, difficulty in self-evaluation of problem-solving and psychological barrier in addressing uncertain problems	Self-awareness, growth mindset, practical learning, technical problem-solving skills, self-efficacy, psychological resistance to challenge, anxiety about the unknown and challenging attitudes	Self-understanding and psychological growth through challenges

I was able to think carefully about what I can do and what is required of me. I realised that we can play an active role not in the process of creating one from zero, but in the process of expanding the one we have created to many more people.	What I can do, what is required of me, I was able to think carefully, not in the process of creating 1 from 0, the one we have created for many more people	Exploration of one's own role and potential, recognition of the expectations of others, deepening self-reflection, focus on application and development, actions that increase social influence and role in the dissemination of knowledge and value	Career development, self-efficacy, awareness of social roles, social expectations and responsibilities, critical self-evaluation, efficient resource use, shared values and culture formation, sustainable use of knowledge	Creating value and social impact through challenges
During this internship, I became interested in the circular economy. I felt that the economy in which people continue to use and repair things they have used, rather than using new things, is a theme that will become very important in the future in order to create a sustainable society.	I was interested in the circular economy, an economy in which people continue to fix and use what they have used, rather than use something new, making a sustainable society, a theme that will become very important in the future	Developing an interest in the circular economy, practicing resource reuse and sustainability, a proactive approach to environmental issues, awareness of social issues and suggestions for future directions in career and learning	Circular economy, self-formation of interests, sustainability practices, resource efficiency, sustainability, environmental ethics, future orientation, prioritisation of social issues	Awareness and action towards the realisation of a sustainable society
Storyline	Through the internship, students faced the challenge of addressing unknown problems, overcoming their fears, deepening their self-awareness, and developing a growth mindset and problem-solving skills. Consequently, students gained an understanding of their societal roles and the ability to employ critical thinking and innovation to create value and extend their learning to broader contexts. Finally, they became aware of the circular economy and sustainability and developed the capability to proactively address social issues with a future-oriented approach. Through these processes, the educational benefits of personal growth and social contribution were evident.			
Theoretical descriptions	1. Promoting self-understanding and psychological growth 2. Creating value and exerting social influence 3. Deepening sustainability awareness and action 4. Integrating personal growth and social contribution.			

These themes and compositional concepts are a comprehensive expression of the learning gained by the participating students through the internship. The following story line was obtained from the above themes and compositional concepts.

Through the internship, students took on the challenge of unknown problems and overcame their fears while deepening their self-understanding and developing a growth mindset and problem-solving skills. Next, students gained an awareness of their role in society, and the ability to use critical thinking and innovation to create value and extend their learning to society. Finally, they developed an awareness of the circular economy and sustainability, and the ability to take proactive actions in addressing social issues with a future-oriented approach.

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This series of processes clarified the educational benefits of both personal growth and social contribution.

Finally, the following theory was derived from the storyline:

(1) Promoting self-understanding and psychological growth through challenges
(2) Creating value and exerting social influence
(3) Deepening sustainability awareness and action
(4) Integrating personal growth and social contribution

We believe that these theories indicate that internships go beyond merely providing work experience; they also serve as crucial platforms for students' comprehensive development and social contribution.

CONSIDERATION

A qualitative analysis, using the SCAT methods, was conducted on the report by a student who participated a problem-solving internship at Company A. The theoretical description derived from this analysis was evaluated from the perspective of its characteristics and educational effectiveness as follows:

(1) Creation of circular society awareness: By observing corporate sustainability activities, students became aware of their impact on society and the environment and grasped the significance of resource circulation. This process is thought to have been the foundation for students to enhance their environmental literacy and cultivate a sense of active social contribution.
(2) Improving problem-solving skills through diverse perspectives: Through collaboration with students and experts from various disciplines, the capability to creatively address complex problems using a multifaceted perspective was developed. This interdisciplinary approach is thought to equip students with the skills necessary to handle the multifaceted challenges of modern society and is regarded as an internship with significant educational value.
(3) Fostering a challenging attitude and a sense of continuous improvement: Through their workplace experience, students learn about companies' initiatives for continuous improvement, leading them to adopt a mindset of pursuing innovation rather than settling for the status quo. We can assume that this experience will cultivate a positive attitude in students, encouraging them to address challenges even in difficult situations.
(4) Improving internal motivation through emotional experiences: The emotions and shifts in values that students encounter in the field will increase their internal motivation, fostering a desire to learn and encouraging behavioural changes. This process is thought to strengthen their learning initiative and deepen their awareness of sustainable behaviour.
(5) Fostering creative problem-solving skills: Through the aforementioned process, it can be assumed that students have cultivated the ability to discover new solutions and have acquired the skills to adapt flexibly, even in uncertain situations. We believe that this ability is a essential for contemporary working adults who are addressing complex problems.
(6) Promoting social responsibility and behavioural change: It can be inferred that the experience of problem-solving internships will change students' values and behaviour and encourage an attitude of proactively addressing environmental and social issues.

This change will not only contribute individuals growth but also enhance the overall sustainability of society.

Similarly, we examined the characteristics and educational impacts regarding the theoretical description of the SCAT analysis from the report of student T, who participated a problem-solving internship at Company B, as follows:

(1) Promoting self-understanding and psychological growth: Problem-solving internships provide students with an educational setting where they can confront unfamiliar problems and technical challenges. Through this experience, we believe that students can enhance their self-awareness and develop the ability to overcome anxiety and psychological resistance. By fostering a growth mindset and a challenging attitude, we believe that students will be able to learn proactively, even in unfamiliar situations and develop their capacity to solve technical problems through hands-on learning.

(2) Creating value and demonstrating social influence: Internships provide students with the chance to identify their social role and apply the knowledge and skills they have acquired to create value. Through a foundation in critical thinking and the innovation process, students will work to address problems and disseminate the outcomes of their work to society through value propagation. Throughout this process, we believe that students will be able to increase their sense of self-efficacy, recognise the social impact of their actions, and understand that learning can contribute to societal betterment.

(3) Deepening awareness and action towards sustainability: During the latter part of the internship, students increased their interest in social issues such as the circular economy and sustainability. With a focus on the future, we will explore actions that consider environmental ethics and resource efficiency, nurturing the ability to address problem-solving from a long-term perspective. Through this process, we believe that students will be able to understand the priorities of social issues and strengthen their ability to take independent action.

(4) Integrating personal growth and social contribution: By beginning with self-awareness, students will develop the ability to integrate personal growth with social contribution through initiatives focused on value creation and sustainability. The educational advantages of internships are based on a process that integrates these elements into stages and it is thought that this also supports students' career development and behavioural transformation.

CONCLUSION

The student who participated in the problem-solving internship at Company A was able to reaffirm their role as a citizen concerning resource recycling. As a team member, they actively participated and experienced the advantages of generating diverse ideas through collaboration with individuals who have different perspectives. This outcome is attributed to Company A's focus on total environmental solutions and the internship being conducted by a team of three people from different departments, exchanging opinions with each other.

Meanwhile, student T, who participated in internships at Company B, initially felt anxious about the company's challenges. However, through the internship experience, they were able to discover their potential, understand their role and reflect on future challenges. Although everyone has some level of anxiety before an internship, engaging in it as a team is believed to help individuals self-reflect, understand their roles and consider future concerns.

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This study suggests that focusing on problem-solving provides participating students with various opportunities for learning and personal development. Notably, students can develop a comprehensive viewpoint by reaffirming their social roles and capabilities and collaborating with individuals who hold different values. Additionally, it was confirmed that overcoming anxiety and tackling implementation challenges gave students a chance to reflect on their potential and future challenges. These results suggest that the pre-design and implementation of internships significantly influence student learning and point to possibilities for further improvement and application of educational programs.

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