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A Study on the Learning Relevance and Competency Model for Information Literacy Development in STEAM Education

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ABSTRACT

Competency models, as a means of clarifying learning goals and achieving steady results, are being used in Germany and other countries. Learning based on competency models has the potential to promote deeper problem-solving. In this study, we investigated the learning relevance and competency models of information literacy, one of the foundations of STEAM education. The results showed that there are specific trends in the learning relevance and competency models of information literacy. Whether students possessed accurate knowledge about copyright revealed a clear difference in the overall structure of their information literacy awareness. It can be inferred that the presence or absence of accurate knowledge in a specific field does not merely affect understanding of that field but also influences the resolution and structuring of the broader concept of information literacy as a whole. In other words, it is possible that the foundation of high-quality information literacy lies in the ability to organize knowledge in one's mind and clearly position each element as an individual component.

Keywords: Learning Relevance; Competency Model; Information Literacy; STEM/STEAM Education

1. Introduction

1.1 Information Literacy and Learning Relevance

ICT-based classes are rapidly being developed in all school types. Although there is no independent subject of information in Japanese elementary schools, programming education has become mandatory, and information literacy has become an indispensable national education in today's society. Information education covers a wide range of topics, including “basic operation of information equipment,” “learning activities for appropriate use of information,” and “information morality” at the elementary school level, and the scientific and cultural aspects of information at the junior high school level. Additionally, the development of computational thinking has been incorporated [1]. In Japan, curriculum management is being promoted to enhance cross-curricular learning and maximize the effectiveness of learning by looking at the goals and content of subject areas [2]. On the other hand, emotions, such as the attitude to engage in learning independently, are also considered important as one of the academic abilities, and the significance of learning as perceived by individual learners is greatly related to them. Aalsvoort identifies several types of learning relevance related to research on science education, including personal relevance, professional relevance, and social

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relevance [3]. Personal relevance holds significant meaning for students' problem-posing, and clarifying it can connect to guiding the problem-solving process. Social relevance connects students to recognizing the role of science and technology in society, holding important meaning for achieving development as citizens from both individual and societal perspectives. In this section, we focus on learning relevance (what meaning and significance they feel) and consider it in relation to the behavioral characteristics of learning.

1.2 Competency Model and Behavioral Characteristics

Competency models [4] have recently attracted international attention as an innovative educational approach for clarifying learning objectives and producing stable, high-quality results. In particular, Germany and other countries actively pursuing educational reform are vigorously promoting the introduction and utilization of competency models [5]. A competency model is not merely about the quantity of knowledge, but rather systematically organizes the behavioral characteristics (competencies) commonly observed in individuals who achieve high performance in specific situations, and presents them in a concrete and easily understandable manner. This model is composed of multiple elements, including specialized knowledge, practical skills, and the motivation and attitude toward learning and work, and is considered to function as an objective and fair standard in talent development and personnel evaluation. In the field of education, the introduction of this competency model makes the learning objectives that learners should ultimately achieve concrete and clear, making it easier for teachers and learners to share these goals. As a result, learners are able to objectively assess their own learning progress and achievement levels and engage in proactive skill development. Such a competency-based learning approach is expected to hold significant potential for cultivating advanced problem-solving abilities, enabling learners to think more deeply and comprehensively about complex and unpredictable challenges they may face and derive solutions. Unlike traditional knowledge-based education, competency-based learning focuses on how effectively learners can apply the knowledge and skills they have acquired in various real-world situations. For example, specific competencies such as teamwork and leadership are required when collaborating on projects that accurately identify hidden needs and make proposals that exceed expectations, or strategic thinking that analyzes the intertwined causes of complex problems and constructs logical solutions are set as concrete competencies. By setting specific behavioral goals in this way, learners can gradually develop essential problem-solving skills that go beyond superficial understanding through trial and error.

1.3 Cultivating Information Literacy

Information literacy is not merely the ability to search for information on the internet. It is an extremely advanced and complex concept that encompasses a series of abilities, including identifying reliable sources of information from a vast amount of information, critically evaluating the authenticity of information, ethically utilizing the information obtained, and creating new knowledge and ideas. In this study, we focused on “information literacy,” one of the key qualities and abilities that form the core of STEAM education, which aims to create new value by integrating science, technology, engineering, arts/liberal arts, and mathematics, which is an essential liberal art in modern society. We have conducted a detailed investigation and analysis to deeply explore the contemporary significance of this information literacy skill in modern learning and to determine the structure that a competency model for effectively cultivating this skill should have.

2. Methods

To investigate the awareness of information literacy among today's university students, a free-response web-based questionnaire survey was conducted in July 2025 among 105 first-year university students in Kyoto, Japan. The questionnaire consisted of two items: what aspects of information literacy are considered most necessary for personal life, and what actions are necessary to acquire a high level of information literacy. Additionally, we administered pre-test questions on copyright and copyleft and conducted a survey of each student's correct and incorrect answers. All responses were entered in text format, and a database was created. Subsequently, the data were analyzed using the text mining software KH-Coder [6]. KH-Coder is a tool designed to analyze various qualitative data, such as text, audio, and video, incorporating specific methods of content analysis while also enabling quantitative analysis of the data. The survey items are shown in Table 1.

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Table 1: Survey items

Test Type	Content
Pre-test	Questions on copyright and copyleft
Main-test	What aspects of information literacy are considered most necessary for personal life
Main-test	What actions are necessary to acquire a high level of information literacy

3. Results and Discussion

Fig. 1 shows a network diagram analyzing descriptions of the most essential content of information literacy for individuals' lives. Recognition of the content necessary for information literacy is thought to be closely related to each student's learning relevance. Elements that occupy a large area include social media, authenticity judgment, privacy, management, and viruses. A notable feature is the high level of recognition of content that is an issue in society, such as social media and fake news.

Fig. 2 shows a network diagram analyzing descriptions of actions necessary to acquire high information literacy. While elements are divided into several areas, the largest and second-largest elements are characterized by habits of thinking and verifying events rather than specific actions. Other elements include actions such as researching correct information and matters related to security. Some students also recognize that sharing information is related to information literacy.

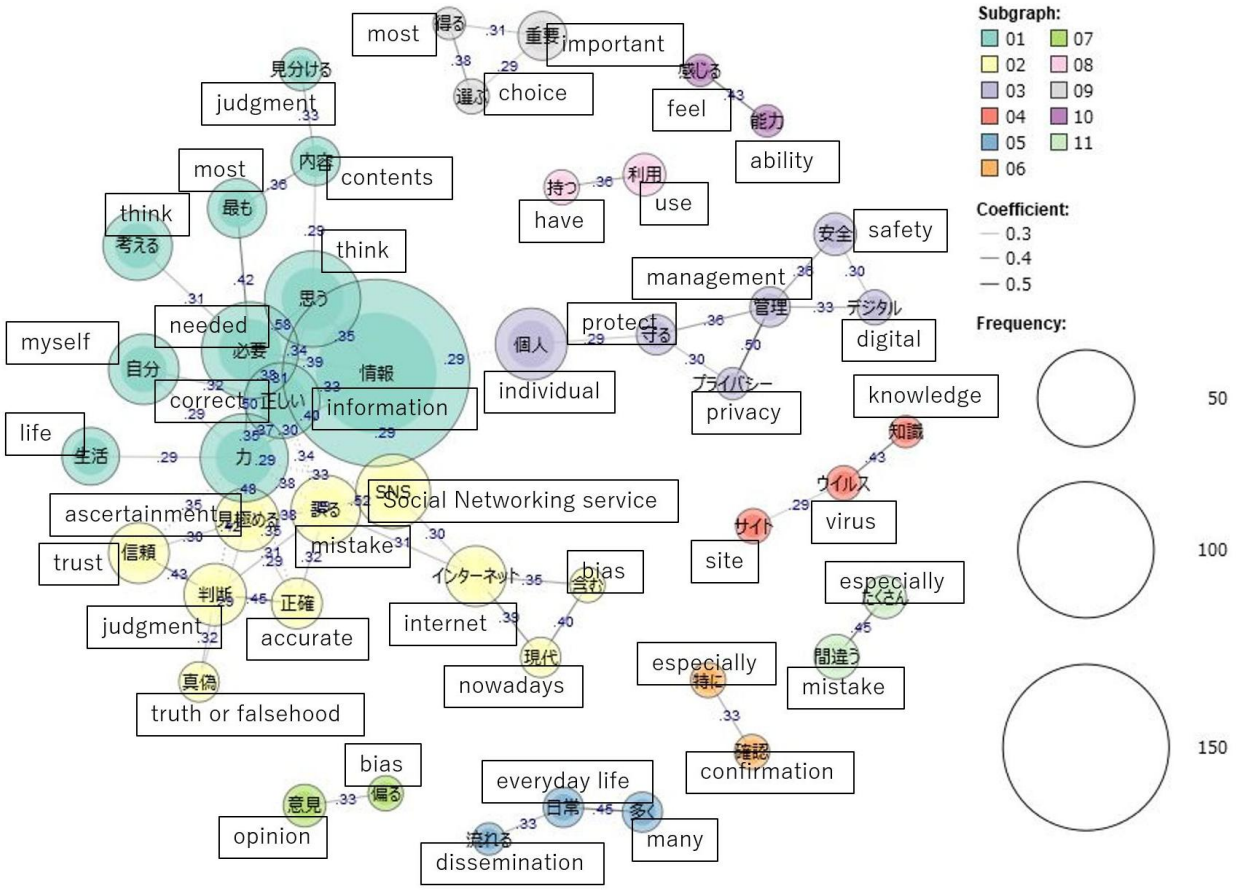

Fig. 1: Understanding the content of information literacy and overall analysis of the description

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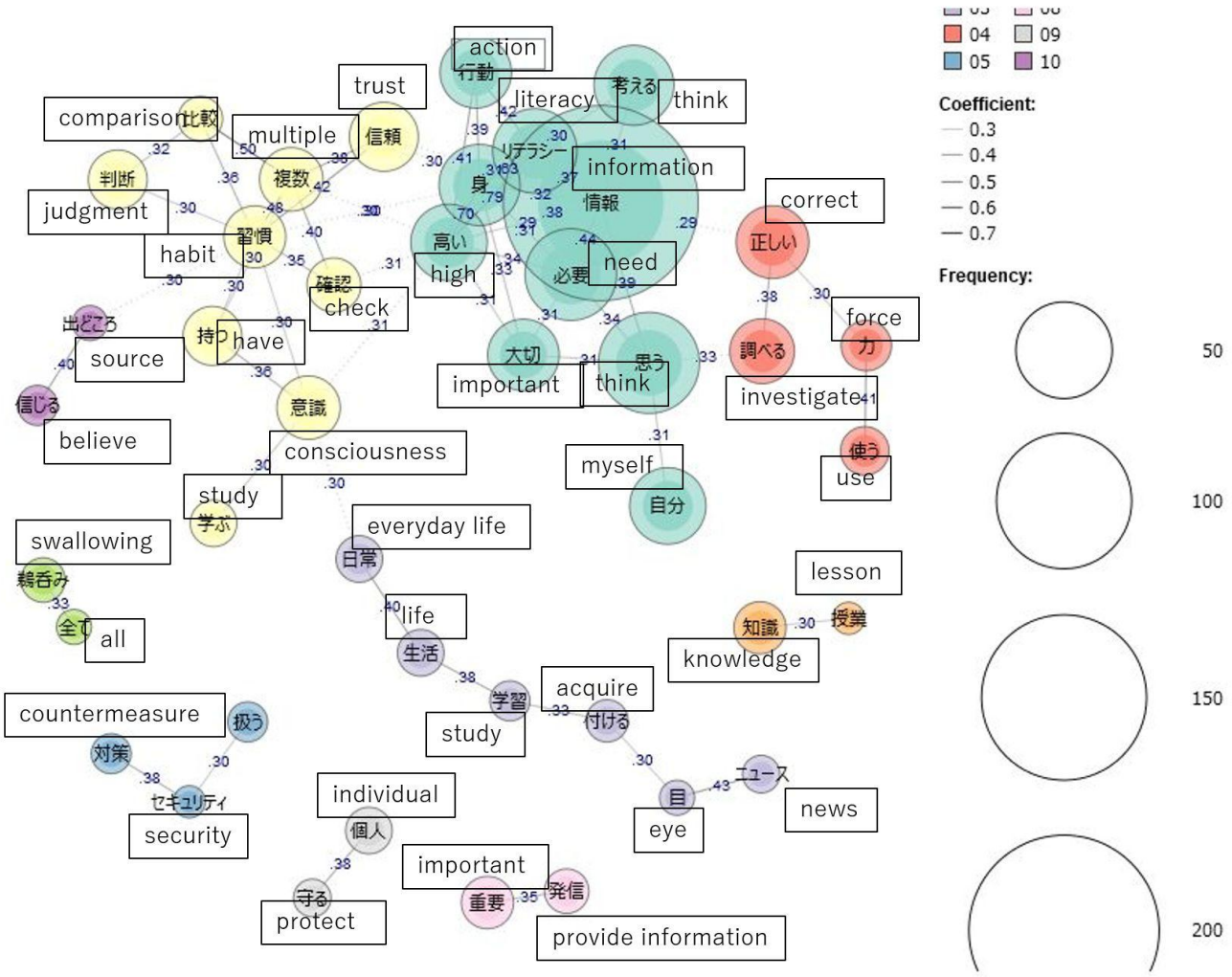

Fig. 2: Actions to acquire information literacy and overall analysis of the description

We analyzed the questions related to copyright and copyleft, dividing the respondents into those who answered correctly and those who answered incorrectly, and created network diagrams. Fig. 3 shows the network diagram related to the content of the group that answered correctly. Fig. 4 shows the network diagram of actions for high information literacy in the group that answered correctly. Fig. 5 shows the network diagram related to the content of the group that answered incorrectly. Fig. 6 shows the network diagram of actions for high information literacy in the group that answered incorrectly.

When comparing the network diagrams related to the content of the group that answered correctly and the group that answered incorrectly, the group that answered correctly tends to have fragmented content. The group that answered incorrectly has similar content that appears in a cohesive manner. When comparing the network diagrams related to the actions for high information literacy of the group that answered correctly and the group that answered incorrectly, although not as pronounced as the network diagrams related to content, there are some fragmented elements and cohesive elements.

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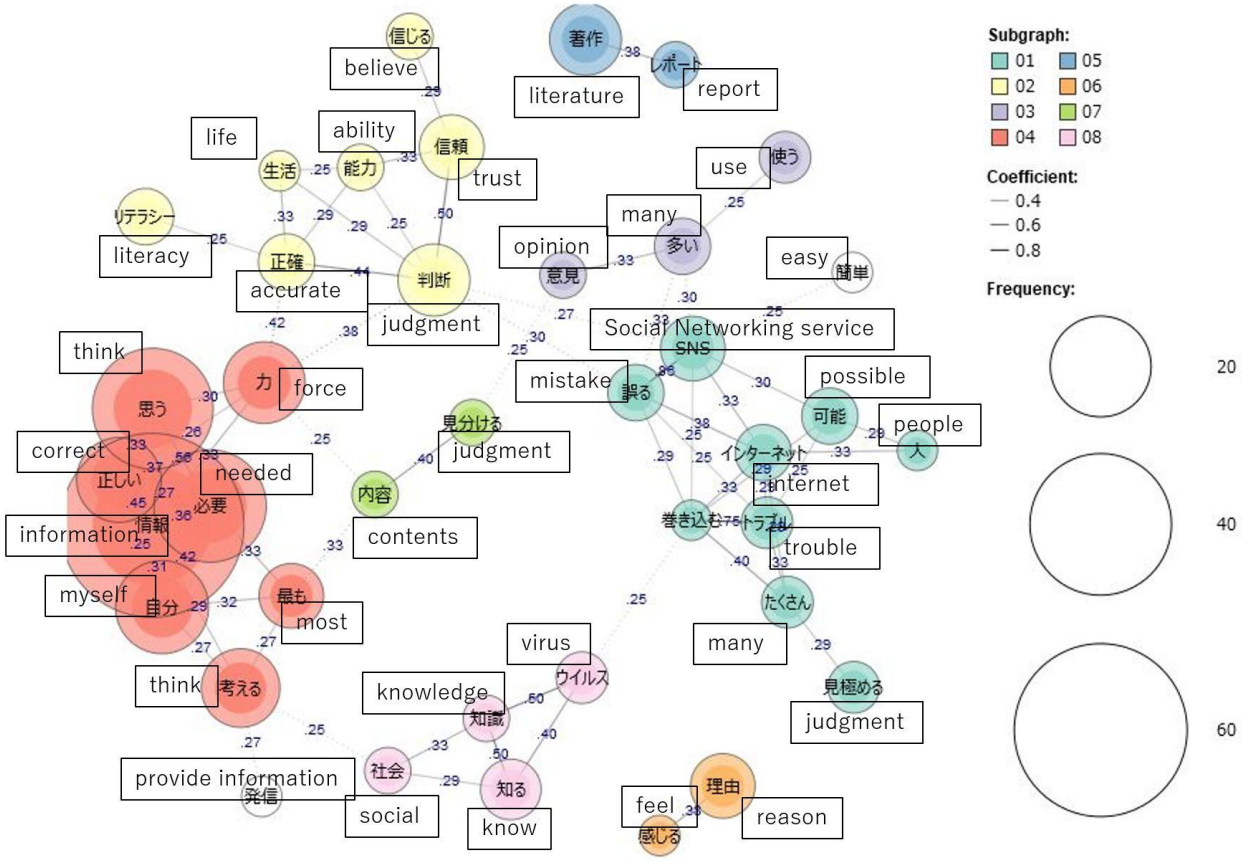

Fig. 3: Understanding the content of information, the correct answer to the copyright question analysis of the description

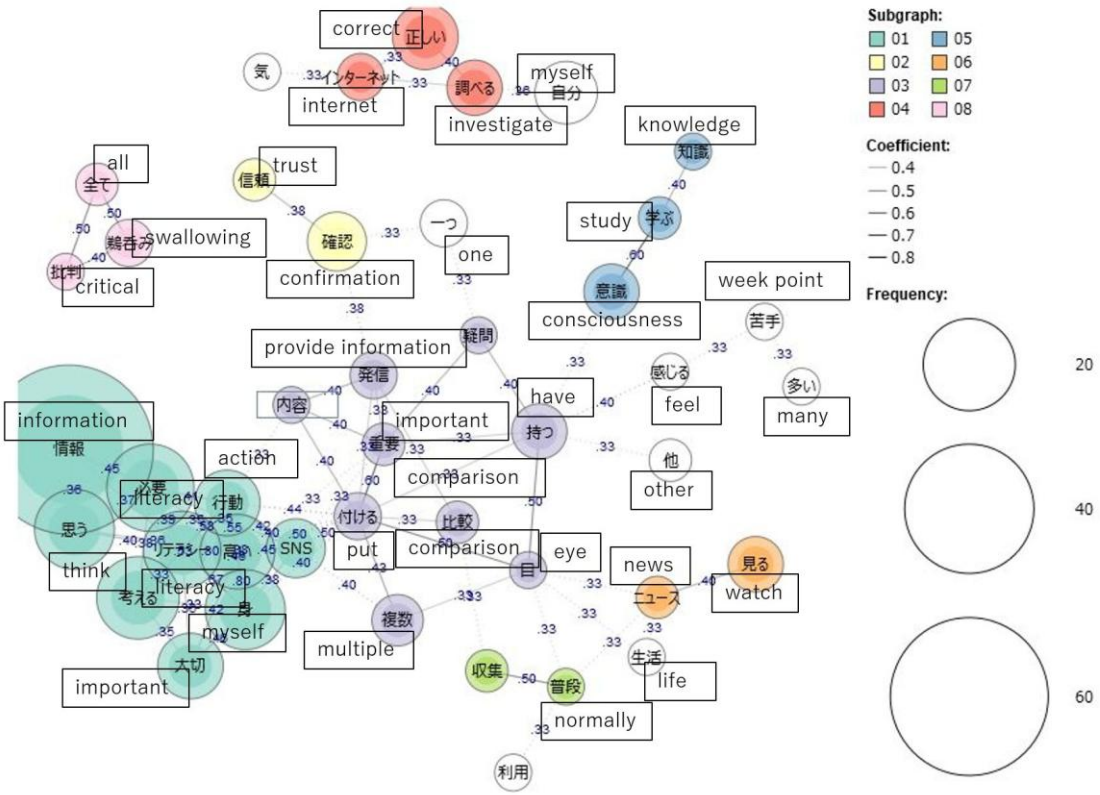

Fig.4: Actions to acquire information literacy, correct answer to copyright question, analysis of the description

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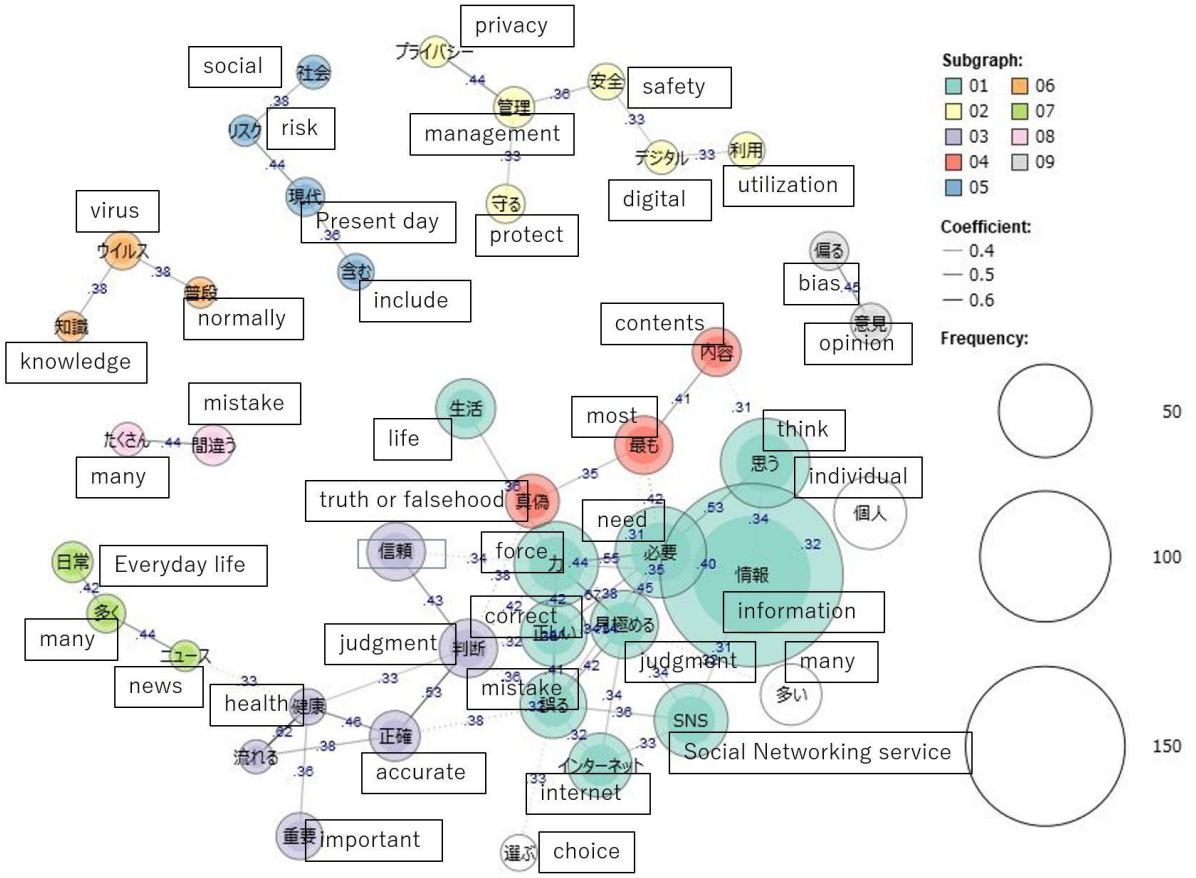

Fig. 5: Understanding the content of information, incorrect answer to the copyright question analysis of the description

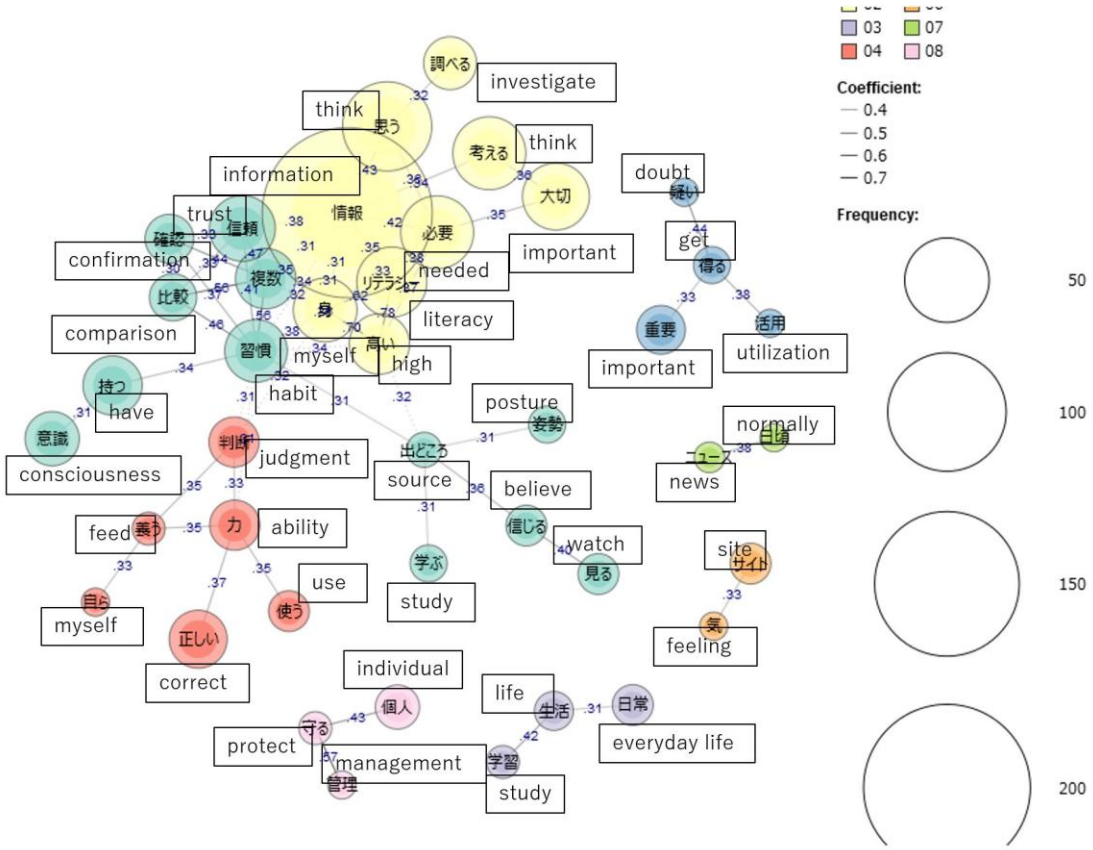

Fig.6: Actions to acquire information literacy, incorrect answer to copyright question analysis of the description

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Students strongly recognize the importance of information literacy in addressing contemporary societal challenges, such as social media, verifying the authenticity of information, and privacy. They believe that developing critical thinking habits, such as “thinking” and “verifying” is essential for acquiring these skills, rather than focusing solely on technical operational skills. This suggests that they understand the inherent risks of the information society and the universal attitudes necessary to address them. What is even more interesting is that there are clear differences in the overall structure of information literacy perception depending on whether students have correct knowledge of copyright. In the group of students who correctly understood copyright, each element of information literacy was recognized as independent and “segregated” on the network diagram. This reflects their ability to clearly distinguish between individual concepts and organize their knowledge systematically. On the other hand, in the group of students who answered incorrectly, various contents were recognized as a single “unit,” suggesting that the concepts were not sufficiently differentiated and were instead perceived as a vague, unified concept.

From this, it can be inferred that the presence or absence of accurate knowledge in a specific field does not merely affect understanding of that field but also influences the resolution and structuring of the broader concept of information literacy as a whole. In other words, it is possible that the foundation of high-quality information literacy lies in the ability to organize knowledge in one's mind and clearly position each element as an individual component.

As a result of our research and analysis, we found that there are several clear and specific trends in the educational significance of information literacy required in today's digital society and in the competency model for measuring and evaluating this ability. For example, there was a clear tendency to emphasize more advanced and social aspects, such as critical thinking skills to discern fake news and misinformation, ethical values and responsible behavior in the digital space, and the ability to collaborate effectively with diverse people online to co-create new value, rather than basic skills such as information gathering and technical proficiency. This strongly suggests that information literacy education is evolving toward fostering more practical and higher-level thinking skills that are essential for surviving in a rapidly changing society.

4. Conclusion

In the context of the present academic investigation, we have undertaken a comprehensive examination of the learning relevance and associated competency models pertaining to information literacy, which is widely recognized as one of the foundational pillars supporting the interdisciplinary framework of STEAM education. The conclusive results of our study have compellingly indicated that there are distinct and observable patterns and trends within the learning relevance and competency models of information literacy.

A particularly significant differentiating factor that emerged was whether or not students possessed a precise and accurate understanding of copyright principles; this single variable revealed a demonstrably clear and substantial difference in the overall architecture and composition of their awareness concerning information literacy. Consequently, it can be reasonably inferred from this evidence that the presence or absence of accurate, detailed knowledge in a specific, specialized field does not merely have an isolated impact on the comprehension of that particular subject matter. Instead, it also profoundly influences the resolution, organization, and structuring of the much broader and more encompassing concept of information literacy as a whole. To put it another way, it is highly plausible that the fundamental basis for cultivating a superior, high-quality level of information literacy is intrinsically linked to the cognitive capacity to meticulously organize vast amounts of knowledge internally and to clearly situate each distinct element as an individual, yet interconnected, component.

References

[1] Ministry of Education Culture Sports Science and Technology Japan. Learning Standards for Elementary Schools: Explanation. 2017;83

[2] Sunada M. Curriculum Management and Practice of STEAM Education in Primary Schools. Jpn Soc Sci Educ Study Group Rep, 2020;35(3):103-108

[3] Van Aalsvoort J. Logical positivism as a tool to analyse the problem of chemistry’s lack of relevance in secondary school chemical education. Int J Sci Educ, 2004;26(9):

eISSN Number: 3036-017X

[4] Yoshida N. Lehrplan- und Unterrichtsreform durch die Kompetenzmodelle: Perspektive der Länderübergreifenden Rahmenlehrplänen in Berlin. Bull Grad Sch Educ Hiroshima Univ Part 3 Educ Hum Sci, 2010;56:11-20
[5] Okawa S, Otaka I. Historical Development of Project-Based Instruction in German Science Education. J Sci Educ Res, 2021;62(2):377-386
[6] Higuchi K. Quantitative Text Analysis for Social Research: Aiming for the Continuation and Development of Content Analysis. Nakanishiya Publishing, 2014:1-16

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