

Analytical evaluation of lesson strategies focusing on the summary of power plants in electric power technology subjects for technical high schools

Kanyuma Jitjumnong, Pasapitch Chujai, Noritsugu Kamata and Kalayanee Jitgarun

Abstract— In the subject of electric power technology for electrical high school second year students in technical high schools, we think it is difficult to learn the contents of power generation with textbooks and limited class hours. In particular, learning the content of textbooks on hydropower, thermal power, nuclear power generation, and the content of power transmission would be extremely difficult. Therefore, in this study, a questionnaire on power generation and transmission was conducted before the class began. In order to examine the knowledge and understanding level of students who learned only with textbooks, we conducted a questionnaire in a free description format. After the class, the Internet was also used to conduct a questionnaire in the form of free description on the results of learning about the power generation and power transmission using the Internet. Rather than studying only with textbooks, it was reported that students were able to understand many more photos and videos using the Internet. An evaluation analysis was performed using a co-occurrence network. In the co-occurrence network, a stronger co-occurrence relationship is drawn with a thicker line, and a larger number of appearances are represented by a larger circle. The co-occurrence relationship that can be seen only in the second year of the electrical department is called “characteristic co-occurrence relationship”. This is a report of many characteristic words by students in the second year of electrical studies.

Keywords— Text mining, Co-occurrence, Network, Electric Power, Technology.

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I. Introduction

Currently, there are the Electric Power Technology A and Electric Power Technology B [1] subjects in the Electrical Engineering courses at Technical High Schools.

Power Technology A subject has the contents of power generation [2,3] in Chapter I, and every technical high school student receives explanations from teachers in the classroom using textbooks, writes the contents of lessons in notebooks, and when it is time for periodic examinations, We have been conducting classes based on various measures to improve the level of understanding of students by conducting tests based on the contents of textbooks and notes written on the board in class. However, it is difficult to understand specialized subjects of electricity by learning only textbooks. So far, the authors have studied the contents of power technology power generation only with textbooks in order to examine the level of understanding of learners [4]. We have compared it with students who have been studying and learning by using textbooks and personal computers [5] and using the Internet to see many power generation photos and videos. As a result of the test, students who learned by looking at many power generation photos and power generation videos on the Internet were able to obtain results with a high level of understanding.

Furthermore, a questionnaire was conducted before and after the class [6,7] to see what the students thought about power generation and power transmission, how they thought about learning only with textbooks, and photos and videos of power generation using the Internet. We collected what they had in mind about what they learned by looking at the text, and using the analysis software called *KH-Coder* [8], a text mining software, the students wrote power generation and power transmission. In terms of the content, we were able to find out what words came out more frequently and what words were used together, and succeeded in the network diagram of the co-occurrence relationship between the student's [9] characteristic words in the final report.

II. Research Methodology

In any specialized education or courses related to industry [10], it is often done after learning many contents through experiments and practical training. Therefore, we evaluated the ability to be cultivated during the study of electric power technology at the technical high school with second year students using text mining software *KH-Coder* [11,12] and performed an analysis using a co-occurrence network [13]. In the co-occurrence network, a stronger co-occurrence relationship was drawn with a thicker line, and a larger number of appearances were represented by a larger circle. The purpose was to analyze the co-occurrence relationship of professional education and to help improve the educational method.

III. Analysis Results

- **KH-Coder co-occurrence network “Summary of power generation” Conduct a questionnaire before class**

The program *KH-Coder* to analyze [11]. for use worksheets to understand how you have an image of electricity, understand the [power generation] content of the textbook, and to understand how much students understand electricity through experimental training. A questionnaire was conducted [6,7]. Figure 1 shows the results were analyzed using *KH-Coder*. First, the first question was a description of what electricity is and what kind of image it is. Students freely wrote about electricity.

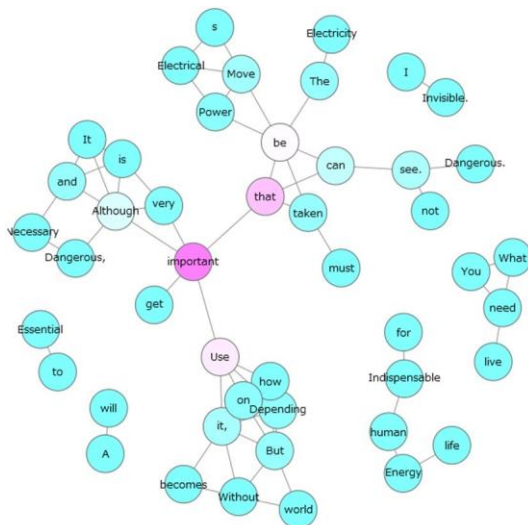


Fig.1 Using the co-occurrence network [14] for the question 1 before the power technology class

Figure 1, every second-year student in the electrical department freely answered a question about what kind of image they had about electricity before class. The results were evaluated and analyzed using the *KH-Coder* co-occurrence network [8]. In a co-occurrence network [15], a stronger co-occurrence relationship was drawn with a thicker line, and a larger number of appearances were represented by a larger circle. In the following, the co-occurrence relationship that can be seen only in the second grade of the electrical department would be referred to as “characteristic co-occurrence relationship [16]”. Many of the characteristic words of students in the electrical department were “important”, “That”, “use”, “be” and “electric”, “power”. “It can't be seen by the eyes that can be made by various power generation methods firepower, hydropower, nuclear power, etc. The equipment can be moved. “It is very important and convenient to live, but if you use it incorrectly, people may be injured or it may lead to death, so it is important to use it correctly with correct knowledge I think”.

- **KH-Coder co-occurrence network “Transmission summary” Conduct a questionnaire before class**

The program *KH-Coder* to analyze [11]. for use worksheets to understand how you have an image of electricity, understand the contents of [power transmission] in the textbook, and to understand how much students understand electricity through experimental training. A questionnaire was conducted [6,7]. Figure 2 shows the results were analyzed using *KH-Coder*. Next, I was able to freely describe what power transmission is.

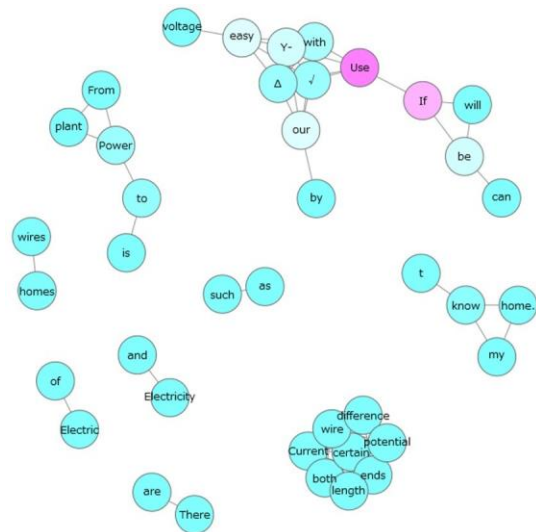


Fig. 2 Using the co-occurrence network for the question 2 before the power technology class

In Figure 2, second year students of the electrical department wrote freely about the power transmission before class. We asked them to write a question. The results were evaluated and analyzed using the *KH-Coder* co-occurrence network [8]. In a co-occurrence network [15], a stronger co-occurrence relationship was drawn with a thicker line, and a larger number of appearances were represented by a larger circle. The characteristic co-occurrence relationship [16] that can only be seen in the second year of the electrical department was that many of them were “if”, “use”, “easy”, and “voltage”. Some of the students’ answers were “Electricity can be transmitted through the transmission line”, and “The substation changes depending on the voltage”, some are mobile. The tower is designed to withstand lightning strikes. The same thing is used everywhere, such as carrying electricity from the power plant to the home, and electric wires of trains. There are power transmission and power reception [17]. Electricity at the power plant is sent to our homes by doing things like power transmission and transformation. When sending from the power station, it is sent by $\Delta - Y$ connection, and at the receiving end, it is received by $Y - \Delta$ connection. $\Delta - Y$ boosts the voltage to $1/\sqrt{3}$. $Y - \Delta$ steps down the voltage by $\sqrt{3}$ times. From this, power transmission sends electricity, it is easy to send if the voltage is large, and it becomes easy to use if the voltage is small. Some students explained about transmitted power.

- **KH-Coder co-occurrence network
 “Summary of power generation”
 Questionnaire conducted after
 class**

The program *KH-Coder* to analyze [11]. for use worksheets to understand how you have an image of electricity, understand the content of [power generation] in the textbook, and to understand how much students understand electricity through experimental training. A questionnaire was conducted [6,7]. Figure 3 shows the results were analyzed using *KH-Coder*. What do you think about learning more about power generation and using audiovisual equipment? Rather than studying textbooks, you can use audiovisual equipment to understand a lot of information and knowledge and learn by watching the Internet, videos, and photos. We used *KH-Coder* to analyze the number of students we understand. I was able to explain in a free form how much I understood about power generation.

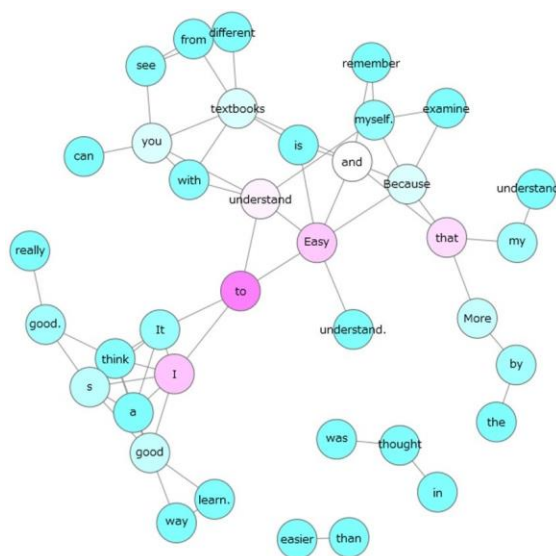


Fig. 3 Using the co-occurrence network for the question 1 after the power technology class

Figure 3 shows the frequent words for the question, “What do you think of studying power transmission after the class for second-year students in the electrical department and further learning using audiovisual equipment?”. We asked them to freely answer the question [18]. The results were evaluated and analyzed using the *KH-Coder* co-occurrence network [8]. The characteristic co-occurrence relationship [16] that can only be seen in the second year of the electrical department is “I understand”, “easy”, “textbook”, “because”, “that”, “I”, etc. were cited. Some of the students’ answers were “It’s easy to understand with photos.”, “It’s easy to understand because you can see the video.”, “What you can’t understand with textbooks is easy to understand if you use the Internet.”, “Because I am trying to learn by myself, it is different from a class that I just listen to. More images are easier to understand than textbooks. You can find a site that suits your thoughts.”, “I knew it well because it was colored and there were videos and explanations. I think that it was easier to remember and understand by studying and writing by myself.”, “I think it was a great success.” Students answered that it was easy to understand about learning using audiovisual equipment.

- **KH-Coder co-occurrence network
 “Transmission summary”
 Questionnaire conducted after class**

The program *KH-Coder* to analyze [11]. for use worksheets to understand how you have an image of electricity, understand the contents of [power transmission] in the textbook, and to understand how much students understand electricity through experimental training. A questionnaire was conducted [6,7]. Figure 4 shows the results were analyzed using *KH-Coder*. What do you think about learning more about power transmission and using audiovisual equipment?

- **Summary of power transmission, Conducted questionnaires during regular examinations “Free description”**

The program *KH-Coder* to analyze [11]. for use worksheets to understand how you have an image of electricity, understand the contents of the textbook [Summary of Power Transmission], and understand how much students understand electricity through experimental training. A questionnaire was conducted [6,7]. Figure 6 shows the results were analyzed using *KH-Coder*. Finally, regular testing was free to explain what power transmission is.

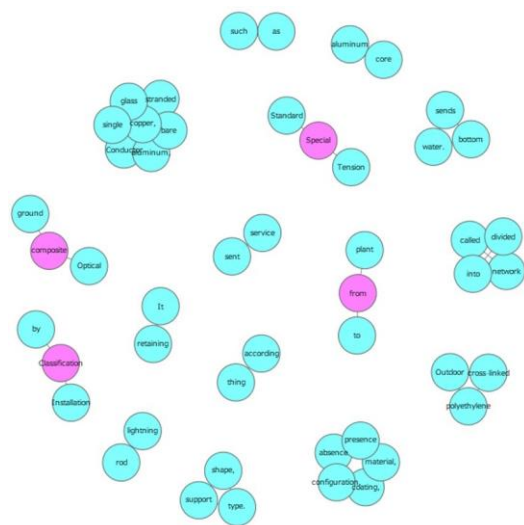


Fig. 6 Using the co-occurrence network with the contents of the periodic examination 2 of electric power technology

Figure 6. shows the contents of the use of the *KH-Coder* co-occurrence network [8] to indicate that the types and characteristics of transmission lines and the types of towers should be examined using the Internet during periodic inspections. As a result, the characteristic co-occurrence relationship [16] that can only be seen in the second year of the electrical department was “Composite”, “Classification”, “from”, “Special” and many others were cited. Some of the students’ answers were “There are many other types of towers, such as standard towers and square towers, which are often seen. It is a structure in which equilateral mountains or steel pipes are joined with bottles.” “Standard towers, special towers, suspension towers, Zhang iron tower, straight iron tower, angle iron tower, retaining iron tower, security iron tower, square iron tower, quadrilateral iron tower, bird hat type iron tower, gate type iron tower, environmentally friendly iron tower, self-supporting steel tower, branch line type steel tower, roof tower, panza mast, crank-up tower”, “Electric power cables” overhead power transmission lines, power cables, power distribution / wiring wires, and other services “Communication cable” Telephone cable, optical fiber cable,

coaxial cable, submarine optical cable, “classification by shape” square steel tower, rectangular steel tower, bird cap steel tower, “installation form” power transmission tower, standard steel tower, special steel tower Tensile tower, straight tower”, “Electric power lines are electric power equipment that includes electric wires for carrying electric power and supporting / ancillary equipment. Of the electric wires forming the electric line, those in the transmission network are those in the transmission line / distribution network. A steel tower is an elongated structure composed of an iron frame structure. The steel tower for the purpose of grounding a transmission line can be divided into many types such as a standard tower, a special tower, and a suspended tower. Can do it.” “Transmission lines are electric wires that send power from the power station to the consumption area. Depending on the location of the facility, there are many types such as those that are suspended in the air or installed in the ground or at the bottom of the water. There is a transmission line that sends power to me.”, “It is the power transmission lines that send power from the power plant to the consumption area”, “Classification by installation type standard tower, special tower, suspension tower, tension tower, straight tower, angle tower, retention tower, security tower”. Students who studied from the Internet about the types and characteristics of transmission lines and the types of steel towers gained more knowledge than students who studied only with textbooks.

IV. Research Results

As a result of the survey, a survey on power generation and power transmission summary [19] was conducted before the class in the electric power technology subjects of the second year students of the electrical department. A questionnaire on power generation and transmission was conducted after class. Before and after class [20], and even during regular examinations, questionnaires on power generation and power transmission were conducted in the same way, and then analysis evaluation was performed using text mining software called *KH-Coder*. At first, we conducted a questionnaire in the free description format for the contents of the results of learning using the Internet. Rather than studying only with textbooks, it was reported that students were able to see many more photos and videos using the Internet and they were able to understand more. As a result of the evaluation analysis using the co-occurrence network, what kind of words are more likely to exist by learning using the Internet than by learning only with textbooks by diagramming the co-occurrence network? By using the internet on a personal computer, students' understanding increased.

V. Conclusion and Discussion

In order to improve the learning method of the subject of electric power technology [21], the Internet was used to improve learning. It was found that learning with textbooks alone did not improve students' understanding and it was difficult to acquire knowledge of power generation. By using textbooks and a personal computer and learning the contents of power generation and power transmission over the Internet, students' knowledge and understanding of power generation increased. We used the text mining software *KH-Coder* and co-occurrence to learn [8] how students understood power generation and power transmission before and after class.

References

- [1] B. Zhang, R. B. Carlson, J. G. Smart, E. J. Dufek, and B. Liaw, "Challenges of future high power wireless power transfer for light-duty electric vehicles technology and risk management," *eTransportation*, vol. 2, 100012, 2019.
- [2] N. Jenkins, "Embedded generation," *Power engineering journal*, vol. 9, no. 3, pp. 145-150, 1995.
- [3] J. H. Scott, "The development of fuel cell technology for electric power generation: From NASA's manned space program to the "hydrogen economy",," *Proceedings of the IEEE*, vol. 94, no. 10, pp. 1815-1825, 2016.
- [4] H. Zheng, Y. Zhang, J. Liu, H. Wei, J. Zhao, and R. Liao, "A novel model based on wavelet LS-SVM integrated improved PSO algorithm for forecasting of dissolved gas contents in power transformers," *Electric Power Systems Research*, 155, pp. 196-205, 2018.
- [5] K. H. Lau, T. Lam, B. H. Kam, M. Nkhoma, J. Richardson, and S. Thomas, "The role of textbook learning resources in e-learning: A taxonomic study," *Computers & Education*, 118, pp. 10-24, 2018.
- [6] Y. Tohda, S. Hozawa, and H. Tanaka, "Development of a questionnaire to evaluate asthma control in Japanese asthma patients," *Allergology International*, vol. 67, no. 1, pp. 131-137, 2018.
- [7] S. Hozawa, H. Tanaka, F. Mori, and Y. Tohda, "Development Of A Questionnaire To Evaluate Asthma Control In Japanese Asthma Patients: A Pilot Study," *In A36. CLINICAL PROBLEMS IN ASTHMA AND ALLERGY*, pp. A1399-A1399, American Thoracic Society, 2016.
- [8] K. Takamatsu, Y. Kozaki, A. Kishida, K. Bannaka, K. Mitsunari, and Y. Nakata, "ANALYZING STUDENTS' COURSE EVALUATIONS USING TEXT MINING: VISUALIZATION OF OPEN-ENDED RESPONSES IN A CO-OCCURRENCE NETWORK," *PEOPLE: International Journal of Social Sciences*, vol. 4, no. 3, pp. 142-153, November 2018.
- [9] J. A. Bullinaria, and J. P. Levy, "Extracting semantic representations from word co-occurrence statistics: A computational study," *Behavior research methods*, vol. 39, no. 3, pp. 510-526, 2007.
- [10] C. Lang, "Sequential attrition of secondary school student interest in IT courses and careers," *Information Technology & People*, vol. 25, no. 3, pp. 281-299, 2012
- [11] N. Y. Yun, and S. W. Lee, "Analysis of effectiveness of tsunami evacuation principles in the 2011 Great East Japan tsunami by using text mining," *Multimedia tools and applications*, vol. 75, no. 20, pp. 12955-12966, 2016
- [12] H. Shimodaira, and S. Fukuda, "Popularization of Classical Economics: The text-mining Analysis of David Ricardo, James Mill, and Harriet Martineau," *Research Group of Economics and Management*, 2014
- [13] O. Ylijoki, and J. Porras, "Conceptualizing big data: Analysis of case studies," *Intelligent Systems in Accounting, Finance and Management*, vol. 23, no. 4, pp. 295-310, 2016
- [14] R. J. Tijssen, "A quantitative assessment of interdisciplinary structures in science and technology: co-classification analysis of energy research," *Research policy*, vol. 21, no. 1, pp. 27-44, 1992.
- [15] K. Faust, and J. Raes, "Microbial interactions: from networks to models," *Nature Reviews Microbiology*, vol. 10, no. 8, pp. 538-550, August 2012.
- [16] K. Faust, J. F. Sathirapongsasuti, J. Izard, N. Segata, D. Gevers, J. Raes, and C. Huttenhower, "Microbial co-occurrence relationships in the human microbiome.," *PLoS computational biology*, vol. 8, no. 7, e1002606, July 2012.
- [17] C. Höller, and B. M. Gibbs, "Source substitution method for obtaining the power transmission from vibrating sources in buildings," *Applied Acoustics*, 141, pp. 240-249, 2018
- [18] S. Metzler, S. Günnemann, and P. Miettinen, "Stability and dynamics of communities on online question-answer sites," *Social Networks*, 58, pp. 50-58, 2019.
- [19] I. Oishi, and K. Nishijima, "Summary of development of 70 MW class model superconducting generator—research and development of superconducting for electric power application," *Cryogenics*, vol. 42, no. 3-4, pp. 157-167, 2002.
- [20] A. H. Grummon, K. E. Hampton, A. Hecht, A. Oliva, C. E. McCulloch, C. D. Brindis, and A. I. Patel, "Validation of a brief questionnaire against direct observation to assess adolescents' school lunchtime beverage consumption," *Journal of nutrition education and behavior*, vol. 49, no. 10, pp. 847-851, 2017.
- [21] [3] S. W. Jin, Y. P. Li, S. Nie, and J. Sun, "The potential role of carbon capture and storage technology in sustainable electric-power systems under multiple uncertainties," *Renewable and Sustainable Energy Reviews*, vol. 80, pp. 467-480 2017.

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