



ANALYSIS OF CRITICAL THINKING SKILLS AND COLLABORATION OF ELECTRONIC ENGINEERING EDUCATION STUDENTS IN ELECTRICAL MACHINERY COURSE

***Ihtiari Prastyaningrum¹, Nurulita Imansari², and Umi Kholifah³**

^{1,2,3}Universitas PGRI Madiun, Indonesia

*correspondence: ihitari.prastya@unipma.ac.id

<https://doi.org/10.24071/ijiet.v7i1.5091>

received 25 August 2022; accepted 28 January 2023

Abstract

The development of the 21st century is directed at the specialization of certain abilities. This certainly influences the goals of Indonesia's national education, where graduates must be equipped with 21st-century skills. These 21st-century skills we can call the 4Cs, namely critical thinking (critical thinking), collaboration (collaboration), creativity (creativity), and communication (communication). The ability to collaborate and think critically needs to be applied in the learning process, including in the Electrical Machinery course. In the Electrical Machines course, lectures are conducted using an electric machine trainer. The use of this trainer is intended to create a student-centered learning atmosphere. To analyze students' critical thinking and collaboration skills in the electrical machine course, we conducted a series of studies related to this. The research method used is a quantitative research method with a one-shot case study research design. From the research, it was found that learning activities using an electric machine trainer were able to optimize students' critical thinking skills. This is because learning using a trainer is student-centered learning, where students play an active role in the learning process. Besides being able to optimize student collaboration skills because the learning process is carried out in groups. Discussion activities carried out in groups provide experiences for students to develop collaboration skills.

Keywords: collaboration, critical thinking, electrical machinery, skills

Introduction

The living order of society has changed along with the development of science and technology (Sanjayanti, 2020). Various innovations have been developed by humans that cause the ability of human resources in a workforce to be decisive. They compete to enrich knowledge (Ester et al., 2017). The process of enriching knowledge can be easily done via the internet. Access to information from around the world can be done very quickly. If not used wisely, this development can hurt society and the environment (Lubis, 2018; Redhana, 2019). Therefore, we have to prepare our students to become reliable students, who are ready to face the challenges of 21st-century development (Andrian & Rusman, 2019; Nurulita et al., 2022).

The 21st century is marked by the rapid development of science and technology. This also demands developments in the world of education, especially higher education (Handajani et al., 2018). The assessment of 21st-century skills is one of the “hottest” topics in education in the past decade (Geisinger, 2016). Higher education which is one of the formal educational institutions has a very important role in preparing human resources who have skills according to the demands of the 21st century (learning and innovation skills). Besides being able to master science and technology in the field they are involved in (Zubaidah, 2018), they must also specialize in certain abilities. Therefore, the goal of national education in Indonesia must be directed towards efforts to equip students with 21st-century skills.

Promotions related to various skills to face the challenges of the development of the 21st century continue to be carried out by education personnel in higher education. This is intended to prepare 21st-century students to become reliable students in the future. These 21st-century skills are commonly abbreviated as 4Cs, namely critical thinking (critical thinking), collaboration (collaboration), creativity (creativity), and communication (Redhana, 2019; Yokhebed, 2019). In the New World of Work in the 21st Century, the team of experts recommends the 4C expertise as a fundamental expertise (Khoiri et al., 2020).

One of the educational institutions that are also required to prepare graduates who have 4C skills is the Electrical Engineering Education Study Program, Universitas PGRI Madiun. Graduates from the engineering education study program are required to have 4C skills. Where these skills can be obtained from various lecture activities. Lecture activities in the classroom should be able to make the learning process meaningful and fun (Prastyaningrum, 2019). Thus this 4C skill can be obtained maximally.

The subjects in the PTE Study Program that can be used to practice 4C skills are electric machines. The electrical machine course is a course that combines theory and practicum. Where an understanding of electrical machines used in various industries needs to be discussed in depth in this course.

The ability to collaborate and think critically needs to be applied in the learning process, including in the Electrical Machinery course. Collaboration is a process of sharing information, resources, and responsibilities to jointly plan, implement, and evaluate program activities to achieve a common goal (Putnik & Cruz-Cunha, 2008). While creativity is a person's ability to generate new ideas from existing ideas. Develop these ideas and be more responsive to new things and different views (Trilling & Fadel, 2009). This is done to support the learning process that carries 4C skills so that students have the skills of the 21st century. To grow collaboration skills and critical thinking, the support for practical equipment must also be adequate.

In the Electrical Machines course, lectures are conducted using an electric machine trainer. The use of this trainer is intended to create a student-centered learning atmosphere. The use of trainers is also expected to be able to grow 21st-century skills. Based on this, researchers need to conduct an in-depth analysis of the effect of using electric machine trainers on the critical thinking skills and collaboration of Electrical Engineering Education students. This analysis is important because it can be used as a basis for evaluating the implementation of learning that is currently taking place, especially to equip students with 21st-century skills. This is so that students of Electrical Engineering Education when they

graduate have 21st-century skills that are by the demands of the world of work and the times.

Method

The research method used is quantitative research methods. The research design uses a one-shot case study. In this design, treatment (X) is only given to one group of subjects. Setyosari (2020) states that the one-shot case study research design can be represented as follows:

X O Information:

X: treatment (only once)

O: the result of observation (test)

The treatment in this study was the implementation of the electric machine trainer in the Electrical Machine course.

The instruments used in this study were questionnaires and observations. Questionnaires were filled out by students to explore students' perceptions of critical thinking and collaboration skills. The questionnaire used uses a scale of 1-5 with categories of strongly agree, agree, quite agree, disagree, and strongly disagree (Riduwan, 2015). Furthermore, the observation sheet is filled out by the lecturer in charge of the course. Observations were made to record student behavior.

Findings and Discussion

Assessment of critical thinking and collaboration obtained from the results of questionnaires that have been filled out by students obtained the following data:

Table 1. Results of questionnaires

4C	P21 Skills	Result	Interpretation
Critical Thinking	Using inductive reasoning or deductive reasoning	4,2	Good
	Analyzing the interrelationships of each part of the whole to produce a complex system	4,3	Good
	Analyze and evaluate the facts.	4	Good
	Draw conclusions based on the results of the analysis	4	Good
	Solve unusual/common problems in conventional or innovative ways	4	Good
Collaboration	1. Demonstrate the ability to work effectively in groups	4,3	Good
	2. Accept the division of responsibilities and contribute to completing group assignments	4	Good
	Provide input and show mutual respect for fellow friends	4,2	Good

Based on the questionnaire data and the results of observations made by the lecturer in charge of the course, it was found that for critical thinking skills, students were able to use inductive reasoning or deductive reasoning for various problems related to electric machines. The students are also able to think systemically and are

also able to make decisions to overcome problems that occur during the process of practicum activities. This can be seen when students begin to prepare practicum activities and check on trainers and how they overcome problems related to errors in circuit analysis.

The second indicator in the subsequent assessment of critical thinking skills is when students analyze the interrelationships of each part of the whole to produce a complex system. This takes place when students identify each component as well as practicum tools and materials until they operate the trainer and carry out practicum activities. The results of the questionnaire on the second indicator have the highest score of 4.3. This can also be seen from the results of observations where students do master the operation of the trainer and can carry out practicum well.

Furthermore, the third indicator analyzes and evaluates the facts. The achievement of this indicator has a score of 4 and is still in the good category. The achievement of this indicator can be seen from student activities in reviewing the results of practicum activities that have been obtained. This third indicator is still related to the fourth indicator, namely the ability to draw conclusions based on analysis. The achievement on the indicator obtained the same value as the third indicator, namely 4, and was included in the good category. This achievement can be seen from the results of the formulation of conclusions made by the students based on the results of the practicum activities and the analysis carried out.

The last indicator is problem-solving ability. The achievement of this indicator can be seen in the ability of students to overcome problems when experiencing obstacles in carrying out practicals. The obstacle encountered during the practicum was an error in wiring, but they could overcome this error when they checked the circuit and they were immediately able to correct the error.

Based on the description of the five indicators above, it was found that learning activities using an electric machine trainer went well and were able to optimize students' critical thinking skills. This is because learning using trainers is student-centered learning, where students play an active role in the learning process. The active role of these students can improve students' critical thinking skills. This is in line with research conducted by Ariyanto, et al. (2020) which states that learning directed at active learning activities is very effective in improving critical thinking skills. Furthermore, Hidayah, et al. (2017) also mentioned that growing critical thinking skills, it must be done by applying student-centered learning and syntax provides opportunities for students to play an active role in learning. In carrying out the practicum, students are also more intense in discussions with their groups, according to Wulandari and Sofiyah (2018), these activities have a positive impact on developing critical thinking competencies.

Learning activities carried out by students in the Electrical Machinery course provide opportunities for students to construct their knowledge and interpret their knowledge. These activities make students think critically. This is in line with research conducted by Wijaya, et al. (2017) which states that critical thinking skills are needed when learning is carried out independently by constructing knowledge. This independent learning activity makes students feel challenged. Learning experiences like this can encourage students to develop critical thinking skills. The results of research conducted by Mukaromah, et al. (2020) show that challenges in learning have a significant effect on increasing critical thinking skills. In addition, to the concept of self-learning in the Electrical Machinery course, students are also

required to be able to solve problems independently. This is in line with research conducted by Ardiyansah, et al. (2022) which states that problem-solving can develop critical thinking skills.

In addition to critical thinking skills, learning using a trainer in this Electrical Machine course can also optimize student collaboration abilities. This is because the learning is carried out in groups. Discussion activities carried out in groups provide experiences for students to develop collaboration skills. This is in line with research conducted by Ardiyansah (2022) which states that group discussions can provide collaborative experiences. Research conducted by Ariyanto (2020) states that the more intense discussion activities are carried out in groups, the more positive impact is on the development of collaboration skills.

Furthermore, in this Electric Machine learning, students learn independently so students have challenges that must be solved. The process of solving these challenges can also optimize students' collaboration skills. This is in line with research conducted by Cheung, et al. (2011) which states that learning that contains challenges can provide opportunities for students to develop collaboration skills. Furthermore, Christensen, et al. (2021) in their research also mentions that challenge-based learning is also able to increase interdisciplinary capacity and ethos such as collaboration. Another study conducted by Malmqvist, et al. (2015) also states that challenge-based learning is very effective for training collaboration skills.

Electrical Machine Learning using a trainer is carried out by carrying out the concept of student-centered learning where the emphasis of learning is placed on the active role of students, which can also improve collaboration skills. This is in line with research conducted by Darmawan (2018) which states that students who play an active role in student-centered learning have a significant increase in collaboration skills. The active role of students in learning Electrical Machines using trainers is also seen in task completion and problem-solving activities. Where this problem-solving can also improve collaboration skills. This is in line with research conducted by Fadilah, et al. (2015) which states that problem-solving carried out in group learning can improve collaboration skills.

Conclusion

Based on the results of the analysis, it can be concluded that learning using a trainer in the Electrical Machine course can optimize students' critical thinking and collaboration skills. Critical thinking skills and student collaboration can improve this because learning using trainers is student-centered learning so students do independent learning and play an active role in learning. In addition, learning using trainers carried out in groups also challenges students to complete tasks and problems through group collaboration and group discussions.

References

- Andrian, Y., & Rusman, R. (2019). Implementasi pembelajaran abad 21 dalam kurikulum 2013. *Jurnal Penelitian Ilmu Pendidikan*, 12(1), 14-23. <https://doi.org/10.21831/jpipfip.v12i1.20116>
- Ardiansyah, A. S., Agung, G. H., Cahya, N. D., & Dinasari, A. (2022). Upaya mengembangkan keterampilan 4C melalui challenge based learning. *PRISMA, Prosiding Seminar Nasional Matematika*, 5, 627–637. <https://journal.unnes.ac.id/sju/index.php/prisma/>.

- Ariyanto, S. R., Lestari, I. W. P., Hasanah, S. U., Rahmah, L., & Purwanto, D. V. (2020). Problem based learning dan argumentation sebagai solusi dalam meningkatkan kemampuan berpikir kritis siswa SMK. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, 6(2), 197-205. <https://doi.org/10.33394/jk.v6i2.2522>
- Cheung, R. S., Cohen, J. P., Lo, H. Z., & Elia, F. (2011). Challenge-based learning in cybersecurity education. *Proceedings of the International Conference on Security and Management (SAM)*, 1.
- Christensen, J., Ekelund, N., Melin, M., & Widén, P. (2021). The beautiful risk of collaborative and interdisciplinary research. A challenging collaborative and critical approach toward sustainable learning processes in academic profession. *Sustainability*, 13(9), 4723. <https://doi.org/10.3390/su13094723>
- Darmawan, R., & Dewanto, D. (2018). Penerapan kurikulum 2013 untuk meningkatkan kemampuan kolaborasi, hasil belajar dan respon siswa kelas X TKR 1 pada mata pelajaran pekerjaan dasar teknik otomotif di SMKN 1 Kalianget. *Jurnal Pendidikan Teknik Mesin*, 6(03), 53-58.
- Fadilah, I., Kardi, S., & Supardi, I. (2015). Pengembangan perangkat pembelajaran biologi berbasis inkuiri materi sistem ekskresi manusia untuk melatih keterampilan berpikir kritis dan kerjasama siswa SMA. *Pendidikan Sains Pascasarjana Universitas Negeri Surabaya*, 5(1), 779-787. <https://doi.org/10.26740/jpps.v5n1.p779-787>
- Geisinger, K.F. (2016). 21st century skills: What are they and how do we assess them?, *Applied Measurement in Education*, 29(4), 245-249. <https://doi.org/10.1080/08957347.2016.1209207>
- Handajani, S., Pratiwi, H., & Mardiyana, M. (2018). The 21st century skills with model eliciting activities on linear program. *Journal of Physics: Conference Series*, 1-7. <https://doi.org/10.1088/1742-6596/1008/1/012059>
- Hidayah, R., Salimi, M., & Susiani, T. S. (2017). Critical thinking skill: Konsep dan inidikator penilaian. *Taman Cendekia: Jurnal Pendidikan Ke-SD-An*, 1(2), 127-133.
- Imansari, N., Prastyaningrum, I., Pratama, F.Y.D., & Kholifah, U. (2022). Optimizing 4C skills through team based projects using product oriented modules for electrical engineering education students. *SAR Journal*, 5(2), 87-94.
- Khoiri, A., Evalina, E., Komariah, N., Utami, R.T., Paramarta, V., Siswandi, S., Janudin, J., & Sunarsi, D. (2020). 4Cs analysis of 21st century skills-based school areas. *Journal of Physics: Conference Series*, 1-10. <https://doi.org/10.1088/1742-6596/1764/1/012142>
- Lubis, A. H. (2018). Integrasi TIK dalam pengajaran Bahasa Inggris di Indonesia abad ke-21: Mitos dan realita. *Cakrawala Pendidikan*, 37(1), 11-21. <https://doi.org/10.21831/cp.v37i1.16738>
- Malmqvist, J., Rådberg, K. K., & Lundqvist, U. (2015, June). Comparative analysis of challenge-based learning experiences. *Proceedings of the 11th International CDIO Conference, Chengdu University of Information Technology, Chengdu, Sichuan, PR China*, 87-94.

- Mukarromah, M. A., Budijanto, B., & Utomo, D. H. (2020). Pengaruh model challenge based learning terhadap kemampuan berpikir kritis siswa SMA pada materi perubahan iklim. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 5(2), 214-218.
- Prastyaningrum, I., and H. Pratama (2019) The application of Project Based Learning method in learning micro-hydro electrical power. *Journal of Physics: Conference Series*, 1171, 1-6. <https://doi.org/10.1088/1742-6596/1171/1/012031>
- Putnik, G.D., & Cruz-Cunha, M.M. (2008). *Encyclopedia of networked and virtual organizations*. Hersey: Information Science reference.
- Redhana, I. W. (2019). Mengembangkan keterampilan abad ke-21 dalam pembelajaran kimia. *Jurnal Inovasi Pendidikan Kimia*, 13(1), 2239–2253..
- Sanjayanti, N. P. A. H., Darmayanti, N. S., Qondias, D., & Sanjaya, K. O. (2020). Integrasi keterampilan 4C dalam modul metodologi penelitian. *Jurnal Pedagogi dan Pembelajaran*, 3(3), 407-415. <https://doi.org/10.23887/jp2.v3i3.28927>
- Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Fransisco: Jossey-Bass.
- van Laar, E., van Deursen, A.J.A.M., van Dijk, J.A.G.M., & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*. 72, 577-588.
- Wijaya, U. R. B., Sumarni, W., & Haryani, S. (2017). Pengembangan instrumen penilaian berpikir kritis pada pembelajaran kimia berpendekatan sets (Science, environment, technology, and society). *Chemistry in Education*, 6(2), 35-41.
- Wulandari, F. E., & Shofiyah, N. (2018). Problem-based learning: Effects on student's scientific reasoning skills in science. *Journal of Physics: Conference Series*. <https://doi.org/10.1088/1742-6596/1006/1/012029>
- Yokhebed, Y. (2019). Profil kompetensi abad 21: Komunikasi, kreativitas, kolaborasi, berpikir kritis pada calon guru biologi profile of 21st century competency: Communication, creativity, collaboration, critical thinking at prospective biology teachers. *BioPedagogi: Jurnal Pembelajaran Biologi*, 8(2), 94-97. <https://doi.org/10.20961/bio-pedagogi.v8i2.36154>
- Zubaidah, S. (2018). *Mengenal 4C: Learning and inovation skills untuk menghadapi revolusi industri 4.0*. Paper presented at the 2nd Science Education National Conference at Trunojoyo University, Madura.