

SOFT SKILLS AND HARD SKILLS NEEDED IN INDUSTRY 4.0 FOR ELECTRICAL ENGINEERING STUDENTS

Sukardi^{1*}, Nizwardi Jalinus², Syaiful Islami³, Rizki Hadian Sakti⁴, Husnuzhan⁵, Anggi Agni Zaus⁶, Mahesi Agni Zaus⁷

Vocational Research Center, Universitas Negeri Padang, Indonesia^{1,2,3,4,7}

Western Sydney University, Australia⁶

sukardiunp@ft.unp.ac.id

Received : 23 May 2023, Revised: 24 October 2023, Accepted : 31 October 2023

**Corresponding Author*

ABSTRACT

This paper investigates industry perceptions regarding the relevance of the courses in the curriculum provided by universities and whether they are in accordance with the demands that exist in the industrial world. This research uses a descriptive survey method. The sample taken from electrical engineering alumni who worked in industry was 242 people. This research uses a stratified random sampling technique. The instrument used is a 4-point scale. The assessment was rated Strongly Agree, Agree, Disagree, and Strongly Disagree with weights of 4, 3, 2, and 1, respectively. Three vocational education experts validated the instrument. Reliability was performed with Aiken-V. The questionnaire contains 34 questions. Research data was analysed by percentage, mean, and standard deviation. The findings show that the soft skills and hard skills achieved in each course in the curriculum are arranged in accordance with industry needs. Soft skills and hard skills in the curriculum can be provided to students so that they can look for related jobs.

Keywords: Soft Skills, Hard Skill, Industry Needs, Electrical Engineering

1. Introduction

TVET has a very significant role in increasing economic growth, creating jobs, improving the quality of work, and reducing poverty. The best approach to training professionals may include improving the current social and economic situation, improving educational institutions and professional training, and collaborating with industry (Sakti et al., 2021). Producing students who have high and sophisticated skills is an important element in efforts to improve vocational education and training (Moodie & Wheelahan, 2016)(Blattman & Ralston, 2017)(Brown & Koettl, 2015)(McKenzie, 2017). In the midst of the economic shift from the local to the global level that is occurring in today's global society, competition in the banking industry is increasing. Economic development also creates a need for highly skilled workers and large numbers of workers in various sectors of society, thereby triggering a new phase in improving vocational education. A trained workforce has a key role in economic progress and development in the global market (Cong & Wang, 2012). In countries around the world, governments are working to reform and improve their education and training systems (Ramadhan et al., 2021). This is done with the aim of meeting the demand for workers who have good skills, especially in developing countries (Nayab et al., 2021). Countries that compete at the global level face various pressures to improve the quality of their workforce (Daulay & Rahmi, 2022)(Rizal et al., 2019).

However, according to the Central Statistics Agency (BPS), in the last few decades, the open unemployment rate in Indonesia has varied and is unstable. This is influenced by fluctuations in the level of education achieved by individuals as well as by the uncertain economic conditions in the country. In 2016, among college and vocational high school graduates, in semester 1 (February), there were around 1.54 million unemployed, which then increased to 1.95 million in semester 2 (August). In 2017, in semester 1 (February), the number of unemployed increased to 1.55 million, an increase of 0.01 million people. Meanwhile, in semester 2 (August), there were around 1.91 million unemployed, a decrease of 0.04 million. Overall, based on BPS data, it can be concluded that the highest unemployment rate in Indonesia usually occurs among vocational and tertiary education graduates.

These raises concerns that the survey results show that vocational graduates are not ready for the industrial world because of the large number of unemployed in the data shown. The obstacles faced by students in career planning are largely caused by a lack of knowledge regarding

job information and limited understanding regarding individual interests and potential (Fjellström, 2017)(Schmid & Haukedal, 2022). As a result, it seems that students generally do not understand the steps they need to take to build their careers. In addition, lack of access to information about interesting jobs and lack of awareness of the advantages and disadvantages of future employment are also influencing factors (Ali et al., 2020)(Negru-Subtirica & Pop, 2018)(Albari et al., 2021).

Lack of understanding of career information can result in students not being ready to build a solid career, and perhaps they are also immature in determining the career path they want to take (Tey et al., 2022). These career-related issues are very relevant to an individual's future. Actions taken now will shape their journey later. Therefore, to prepare yourself well for the future, it is important to have access to information related to the skills and career you will pursue. (Billett, 2018) (Sulistiobudi & Kadiyono, 2023) The information they receive and discover must align with their goals and interests to achieve future success.

These concerns also raise questions regarding the relevance of higher education curricula to the industrial world. A relevant curriculum should be related to the contextual realities of the world of work. In other words, if students follow the curriculum, then they must be able to utilize the skills they have acquired so far to create vacancies or get jobs. There are two components that form the basis of higher education. First, the curriculum prepares students to acquire skills to obtain work in their field of study. Second, students have an entrepreneurial spirit to create jobs. The fundamental problem identified regarding students' inability to find work and create jobs is influenced by several factors, such as political influences (Oluoch, 2019), cultural influences (Balarin & Benavides, 2010) and socio-economic influences. Several researchers found that student skill requirements and curriculum design are closely related (Noble, 2019)(Subramanya, 2019). However, most research focuses on the causes of unemployment without considering curriculum as a potential main cause

To overcome this challenge, it is necessary to carry out research related to the relevance of courses contained in the vocational education curriculum so that it can be seen that the existing curriculum can answer the competencies needed by the industrial world. In the context of this problem, this research was carried out to provide a deeper understanding of how the courses in the curriculum should provide provisions for students to face the industrial world.

2. Research Methods

This research investigates industry perceptions regarding the relevance of courses in the curriculum provided by universities and whether they are in accordance with the demands that exist in the industrial world. This research uses a descriptive survey design. The sample for this research was a total of 242 electrical engineering alumni who had worked in industry using a stratified random sampling technique. The instrument is arranged on a 4-point scale, namely Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD), with weights of 4, 3, 2, and 1, respectively. The instrument items were developed by researchers with insight obtained from the literature review. The validity of the instrument was carried out by two vocational education experts and analysed with Aiken-V. The questionnaire was then tested on 30 research subjects, and their responses were used to test its reliability using the Cronbach's alpha formula (Turan-Güntepe & Abdüsselam, 2022)(Candra et al., 2019). The overall alpha obtained was 0.826, which shows that the questionnaire is reliable. The questionnaire was analysed descriptively using percentages, means, standard deviations, and relevant statistics.

3. Results and Discussions

The existing EEVE curriculum content has been developed based on the existing needs and references, such as KKNI, tracer studies, and others. Technology has changed everything in today's life. In facing the 21st century, the Indonesians must be able to keep up with the challenges to develop and compete, and education development is one example of them. Furthermore, Angga et al. (2022) explains that 21st-century learning needs to develop several necessary aspects, such as: instructional should be student-centered, education should be collaborative, learning should have context, and school should be integrated with society. Therefore, the students will be the center of attention in the learning process and become subjects instead of objects. Students are

taught to know how to collaborate well with their peers and teachers. In addition, teachers can also provide meaningful learning for students so that they can implement new knowledges in real life and actively participate in their social environment. As a result, there is a skill that students need to have, which is called 4C skills (critical thinking, communication, collaboration, and creativity). The 4C skills are highly needed in the 21st century and can be trained through certain learning models. (Artanto et al., 2020)(Supena et al., 2021), the following table explains how to train and access 4C skills for students.

Table 1 - Training and Accessing the 4C Skills Strategy

Critical Thinking	1)	Teaching HOTS method (High Order Thinking Skills), specifically in the learning field.
	2)	Doing class discussion
	3)	Teaching the concept explicitly
	4)	Giving scaffolding
	5)	Implementing the HOTS method continuously
Communication	1)	Teaching students how to articulate thoughts and ideas
	2)	Teaching students to listen actively and effectively
	3)	Teaching students how to communicate with different particular goals
	4)	Teaching students in utilising different media and technology
	5)	Training students to communicate effectively in different situations
Collaboration	1)	Teaching students to work respectfully in different teams physically and psychology
	2)	Training and motivating students to take responsibility to work in a team
	3)	Teaching students to respect ideas and contributions of other members
	4)	Teaching flexibility and willingness to compromise
	5)	Emphasizing cooperative learning
Creative	1)	Giving questions and encouraging students to participate actively in class
	2)	Exploring the topic and materials with primary or random data
	3)	Thinking of a new way to inform the new findings

Skills in the Curriculum with the Needs of the industrial world

Several studies show the needs of industries are implemented, such as changes in the Indonesian National Qualification Framework curriculum to the Independent Learning Curriculum. The objective is to plan and implement each proposed change while testing and evaluating how it responds to the context. Student-centered learning models have been widely implemented to let students' have relevant skills to meet industrial needs. Since vocational education involves a lot of practical work in laboratories and workshops, this is certainly for corporation interest to produce more qualified students to reduce unemployment.

The findings indicate that although the practical work is written in the syllabus, generally students with experimental work read about it in textbook.(Shana & Abulibdeh, 2020) Therefore, it is recommended that the atmosphere of practical activities should be in accordance with the real industrial world. Similar research findings also show that contextual reality is not considered at a higher level. It is considered only as far as they function as a reference for technically efficient program(Chin & Osborne, 2008)

Learning that is not student-centered results in a fundamental mismatch between teachers' and students' theoretical preparation and the contextual realities of the learning environment in schools (Syahril et al., 2021). Therefore, it is suggested that the relevance of cognitive skills acquired should be examined in relation to contextual reality. To emphasize, any curriculum or educational innovations in Indonesia that benefit students and equip them to shift context critically must include at least the following components: Redefining educational objectives, reorganizing educational partnerships, reinterpreting Indonesian history, rebuilding curriculum material, and reformulating education philosophy (Ameyaw et al., 2019; Jansen, 1988).

Skills Demanded by Industrial World

Table 2 - Questionnaire Responses

No	Type	Courses	T(37)					M	Std
			Pn (5)	Pn (4)	Pn (3)	Pn (2)	Pn (1)		
1	Basic	OHS and Labor Law	18 (48,6%)	14 (37,8%)	3 (8,1%)	2 (5,4%)	1 (2,7%)	7,6	7,83

2	Electrical Materials Science	10 (27,0%)	16 (43,2%)	9 (24,3%)	1 (2,7%)	1 (2,7%)	7,4	6,43
3	Microprocessor System	12 (32,4%)	14 (37,8%)	8 (21,6)	1 (2,7%)	2 (5,4%)	7,4	5,81
4	Electrical circuits	18 (48,6%)	15 (40,5%)	2 (5,4%)	2 (5,4%)	0 (0%)	7,4	8,41
5	Analog and Digital Electronics	13 (35,1%)	16 (43,2%)	5 (13,5%)	2 (5,4%)	1 (2,7%)	7,4	6,73
6	Measuring and Measuring Tools	11 (29,7%)	15 (40,5%)	8 (21,6)	2 (5,4%)	1 (2,7%)	7,4	5,94
7	Housing Installation	14 (37,8%)	18 (48,6%)	2 (5,4%)	2 (5,4%)	1 (2,7%)	7,4	7,99
8	Electrical Machines	10 (27,0%)	14 (37,8%)	9 (24,3%)	3 (8,1%)	1 (2,7%)	7,4	5,32
9	Transmission and Distribution of Electric Power	16 (43,2%)	17 (45,9)	2 (5,4%)	1 (2,7%)	1 (2,7%)	7,4	8,32
10	Power plant	11 (29,7%)	16 (43,2%)	7 (18,9%)	2 (5,4%)	1 (2,7%)	7,4	6,27
11	PLC and Pneumatic	16 (43,2%)	15 (40,5%)	3 (8,1%)	3 (8,1%)	0 (0%)	7,4	7,50
12	Power Electronics	13 (35,1%)	18 (48,6%)	4 (10,8%)	1 (2,7%)	1 (2,7%)	7,4	7,70
13	Setting System	10 (27,0%)	15 (40,5%)	7 (18,9%)	3 (8,1%)	2 (5,4%)	7,4	5,32
14	Electric Power Installation	11 (29,7%)	18 (48,6%)	6 (16,2%)	2 (5,4%)	1 (2,7%)	7,6	7,02
15	Electrical Power System Security	19 (51,4%)	17 (45,9)	0 (0%)	0 (0%)	1 (2,7%)	7,4	9,71
16	Maintenance of distribution substations and their equipment	18 (48,6%)	16 (43,2%)	2 (5,4%)	0 (0%)	1 (2,7%)	7,4	8,82

Referring to table 2, courses with basic, intermediate and advanced types are relevant to the needs of the industrial world. This can be seen from the mean of each subject approaching 8. The distribution of these courses is taken based on the existing term: basic type for term 1 and 2, intermediate type for term 3 and 4, and advanced type for term 5 and 6. The courses taken are study program compulsory courses according to the existing curriculum.

One study that proposed school, college, and job reforms was about facing the reality of the industrial world. The study was conducted for almost two decades. In this study, Barton (2006) reported on seven organizations: the National Association of Manufacturers (NAM) (2001), the National Employer Survey on Employee Quality (1995), the Department of Education Executive Survey (1988), the Committee for Economic Development Survey of Industry Needs (1984), the Conference Board Survey of Executives (1984), the Social Organization Centre of Johns Hopkins University (1984), and the San Francisco Industry Survey (1983). Employers anticipate that college graduates will be able to read, write, count, solve issues, collaborate with others, and possess a good set of employment skills, according to the National Association of Manufacturers Survey from 2001. They seek graduates with a range of employment alternatives who are close to the workplace. They also provide some justifications for rejecting candidates. The most frequent explanations are insufficient work experience (34%) and failing drug tests (27%), followed by poor attendance, punctuality, and work ethics (69%). Other factors include bad verbal communication, weak verbal math skills, poor recommendations from past employers, poor problem-solving skills, and poor technical and computer skills. (Ameyaw et al., 2019).

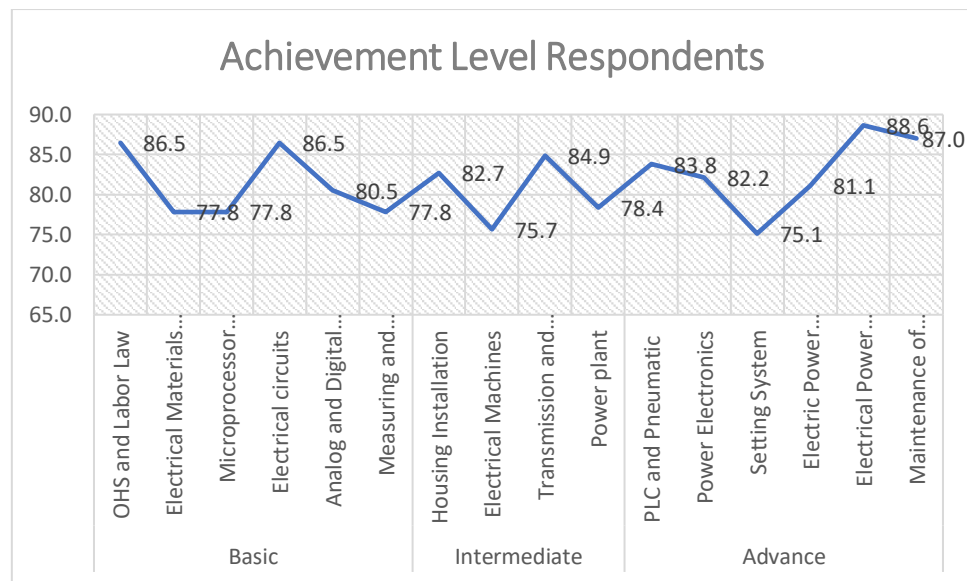


Fig. 1. Achievement Level Respondents

The data in figure 1 explains the percentage of achievement for each course based on the users' review. This achievement explains that each study program mandatory courses that have been analyzed are relevant to industrial needs even though there are still several courses with scores below 80. This is because the level of each industrial need towards the soft skills and hard skills achieved differently. For example, advanced type courses are very relevant to industrial needs because the course learning outcomes focus on the expected areas to be achieved.

According to the National Employer Survey about employee educational qualification, attitudes and communication skills are the top priority. Then came details about prior experience and recommendations. Additionally, despite the fact that education-related skills may have a significant impact on younger workers, factors directly related to education were near the bottom of the list. The Department of Education Study of 101 Executives found that the most desired qualities in applicants were reading and writing proficiency, as well as competence in computation, communication, and problem-solving. The paper recommends that business executives stress the value of good habits like self-control, reliability, persistence, taking responsibility, and respect for others in education. The most desirable skills included attempting to work hard, learning how to learn, prioritizing, and communicating in the Council for Economic Development Study of Employer Needs' 500 major and 6,000 small enterprises. The most sought-after qualities among young applicants, according to both respondents, are hard to find. The results of the Executive Conference Board Survey revealed that companies were concerned about college graduates' incapacity to communicate effectively. The primary issue facing the sector is how people feel about their jobs and the workplace. Strong character reference letters, strong written exam scores, strong interview personal impressions, strong recommendations from managers at companies who know the candidate personally, and strong school grades were all thought to be extremely praiseworthy.

According to the results of a poll of personnel officers conducted by Academic reasons were among the lowest on the list, according to the Institute for Social Organization of Schools at Johns Hopkins University. A strong result on a written test, a strong letter of recommendation from a supervisor who is familiar with the applicant, a strong letter from a prior employer, and a strong first impression during an interview are all things that employers look for. These are the same things that the Conference Board Survey of Executives wants. According to the most recent survey by San Francisco Employers, employers are looking for candidates who seem serious about the position and are very eager to land it; they want people who are intelligent, alert, polite, and engaging, who appear to be able to pick up new skills quickly, who have a neat appearance and appropriate clothing, good reading and numerical skills, and the least they want is a track record of academic success in school.

The seven organizations revealed many skills that the industry requires from employees. However, there are many similarities in what the industry asks for from job seekers. Important

and common skills that emerge through various surveys are attitude, first impression, and recommendations. The capacity to work effectively with others, understand how to learn, make priorities, and communicate are some of the most desirable abilities, according to the Economic Development assessment Committee for Workforce Needs' assessment of 6,000 small and 500 large businesses. Both respondents indicated that it is challenging to discover young job applicants who possess the most desirable traits. The study's primary goal of identifying a set of job skills that businesses need from employees has been accomplished, notwithstanding some survey discrepancies. These types of skills are called "soft skills." However, research conducted by Rosenbaum (2005) shows that although soft skills are often the top priority for the industry, they are rarely taught in college. The lowest thing is seen by the industry in school achievement. A study conducted by Carnevale & Hanson (2015) also shows that students who perform well in college would also perform well in their jobs, but that there is little correlation between academic material covered in college and the advanced knowledge needed for jobs.

4. Conclusion

Based on the research results, it can be concluded that the soft skills and hard skills achieved in each subject in the curriculum are arranged according to industrial needs. Soft and hard skills in the curriculum can be given to students so they can find related jobs or create their own vacancy. The soft skills are the 4C skills of the 21st century while hard skills are the ability to comprehend the field being studied. The industrial perspective towards the skills on higher education curriculum is a reference for future curriculum development.

Acknowledgment

The authors would like to thank Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Padang for funding this work with contract number: 1759/UN35.13/LT/2022.

References

- Albari, F. B., Abulkhoir, M. A., Augustianingrum, N. K., & Ananda, R. (2021). Potensi Kompetensi Keahlian Baru di Bidang Game pada Tingkat SMK. *Jurnal Pendidikan Teknologi Kejuruan*, 4(3), 90–94. <https://doi.org/10.24036/jptk.v4i3.15423>
- Ali, M., Mardapi, D., & Koehler, T. (2020). *Identification Key Factor in Link and Match Between Technical and Vocational Education and Training with Industry Needs in Indonesia*. January. <https://doi.org/10.2991/assehr.k.200521.053>
- Ameyaw, J., Turnhout, E., Arts, B., & Wals, A. (2019). Creating a responsive curriculum for postgraduates: lessons from a case in Ghana. *Journal of Further and Higher Education*, 43(4), 573–588. <https://doi.org/10.1080/0309877X.2017.1386285>
- Angga, A., Abidin, Y., & Iskandar, S. (2022). Penerapan Pendidikan Karakter dengan Model Pembelajaran Berbasis Keterampilan Abad 21. *Jurnal Basicedu*, 6(1), 1046–1054. <https://doi.org/10.31004/basicedu.v6i1.2084>
- Artanto, D., Budi Cahyono, E. A., Siswoyo, A., & Effendi, S. M. (2020). The effectiveness of learning in vocational education in mechatronics through making a simple simulation program. *Journal of Physics: Conference Series*, 1516(1). <https://doi.org/10.1088/1742-6596/1516/1/012034>
- Balarin, M., & Benavides, M. (2010). Curriculum reform and the displacement of knowledge in Peruvian rural secondary schools: Exploring the unintended local consequences of global education policies. *Compare*, 40(3), 311–325. <https://doi.org/10.1080/03057920903374440>
- Barton, P. E. (2006). *High school reform and work: Facing labor market realities*. Princeton, New Jersey: Educational Testing Service.
- Billett, S. B. (2018). *Improving the image of TVET*. July, 1–20. <http://www.unesco.org/open-access/terms-use->
- Blattman, C., & Ralston, L. (2017). Generating Employment in Poor and Fragile States: Evidence from Labor Market and Entrepreneurship Programs. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2622220>
- Brown, A. J., & Koettl, J. (2015). Active labor market programs - employment gain or fiscal

- drain? *IZA Journal of Labor Economics*, 4(1), 12. <https://doi.org/10.1186/s40172-015-0025-5>
- Candra, O., Islami, S., Syamsuarnis, Elfizon, Hastuti, Habibullah, & Eliza, F. (2019). Validity of development on authentic assessment tool of curriculum 2013 based in information technology. *International Journal of Scientific and Technology Research*, 8(12).
- Carnevale, A. P., & Hanson, A. R. (2015). Learn and earn: connecting education to careers in the 21st century. In *Transforming US Workforce Development Policies for the 21st Century*. Georgetown University Center on Education and the Workforce.
- Chin, C., & Osborne, J. (2008). Students' questions: A potential resource for teaching and learning science. *Studies in Science Education*, 44(1), 1–39. <https://doi.org/10.1080/03057260701828101>
- Cong, S., & Wang, X. (2012). A perspective on technical and vocational education and training. *Advances in Intelligent and Soft Computing*, 141 AISC, 67–75. https://doi.org/10.1007/978-3-642-27948-5_10
- Daulay, S., & Rahmi, R. (2022). Prediction of Material Requirements For Vocational Practices Using The Monte Carlo Method (Case Study at SMK Dwi Sejahtera Pekanbaru). *Journal of Applied Engineering and Technological Science (JAETS)*, 4(1), 74–83. <https://doi.org/10.37385/jaets.v4i1.936>
- Fjellström, M. (2017). Vocational learning in a Swedish post-secondary apprenticeship. *Empirical Research in Vocational Education and Training*, 9(1). <https://doi.org/10.1186/s40461-017-0051-6>
- Jansen, J. D. (1988). Curriculum change and contextual realities: an analysis of recent trends in Black South African education. *International Review of Education/Internationale Zeitschrift Für Erziehungswissenschaft/Revue Internationale de l'Education*, 34(3), 378–387.
- McKenzie, D. (2017). Identifying and Spurring High-Growth Entrepreneurship: Experimental Evidence from a Business Plan Competition. *American Economic Review*, 107(8), 2278–2307. <https://doi.org/10.1257/aer.20151404>
- Millar, C. (1984). Curriculum Improvement or Social Innovation? *Journal of Curriculum Studies*, 16(3), 297–310. <https://doi.org/10.1080/0022027840160307>
- Moodie, G., & Wheelahan, L. M. (2016). (PDF) Global trends in VET: a framework for social justice. A contribution by Education International. *Qualifications, the Link between Educational and Occupational Pathways, and Labour Market Outcomes Authors*., November. <https://doi.org/10.13140/RG.2.2.21452.82561>
- Nayab, D. e, Fatima, G., & Jahanzaib, M. (2021). Teaching Strategies Employed by Teachers in teaching Skills to Students of Vocational Training Institutes of Punjab Pakistan. *Sustainable Business and Society in Emerging Economies*, 3(4), 605–616. <https://doi.org/10.26710/sbsee.v3i4.2093>
- Negru-Subtirica, O., & Pop, E. I. (2018). Reciprocal Associations between Educational Identity and Vocational Identity in Adolescence: A Three-wave Longitudinal Investigation. *Journal of Youth and Adolescence*, 47(4), 703–716. <https://doi.org/10.1007/s10964-017-0789-y>
- Noble, D. (2019). *Collaborative competencies: Moving from “soft skills” to a legitimate descriptor* [Southern Cross University]. <https://doi.org/https://doi.org/10.13140/RG.2.2.30434.27841>
- Oluoch, G. (2019). A Review of the Status of TVET Institutions in the Revitalization of the Collapsed Textile Industry in Kenya. *Africa Journal of Technical & Vocational Education & Training*, 4(1), 77–83. <https://www.afritvetjournal.org/index.php/Afritvet/article/view/83>
- Ramadhan, M. A., Handoyo, S. S., & Cahyati, W. (2021). Trends of Vocational Education and Training Research in Building Construction Engineering. *Jurnal Pendidikan Teknologi Kejuruan*, 4(2), 47–52. <https://doi.org/10.24036/jptk.v4i2.20723>
- Rizal, F., Jalinus, N., Syahril, Sukardi, Zaus, M. A., Wulansari, R. E., & Nabawi, R. A. (2019). Comparison of ICT Using in Learning between Indonesia and Malaysia. *Journal of Physics: Conference Series*, 1387(1). <https://doi.org/10.1088/1742-6596/1387/1/012133>
- Rosenbaum, J. (2005). Educational opportunity in American society: A research agenda for

- studying transitions. *Learning Point Associates, a Paper given at the Institute of Education Science Conference on Research for Improving High Schools*.
- Sakti, R. H., Yetti, W., & Wulansari, R. E. (2021). Technopreneurship and It-Preneurship in Vocational Education Perspective: Perspective Theory. *Jurnal Pendidikan Teknologi Kejuruan*, 3(4), 194–198. <https://doi.org/10.24036/jptk.v3i3.10423>
- Schmid, E., & Haukedal, C. L. (2022). Identifying resilience promoting factors in vocational education and training: a longitudinal qualitative study in Norway. *Empirical Research in Vocational Education and Training*, 14(1), 1–18. <https://doi.org/10.1186/s40461-022-00139-1>
- Shana, Z., & Abulibdeh, E. S. (2020). Science practical work and its impact on students' science achievement. *Journal of Technology and Science Education*, 10(2), 199–215. <https://doi.org/10.3926/JOTSE.888>
- Subramanya, S. R. (2019). Curricula Challenges in Computing / IT Disciplines in the Wake of Rapid Technological Advances, Changing Jobs Landscape, and Demands of Societal Needs. *European Journal of Engineering Science and Technology*, January. <https://doi.org/10.33422/ejest.2019.09.36>
- Sulistiobudi, R. A., & Kadiyono, A. L. (2023). Employability of students in vocational secondary school: Role of psychological capital and student-parent career congruences. *Heliyon*, 9(2), e13214. <https://doi.org/10.1016/j.heliyon.2023.e13214>
- Supena, I., Darmuki, A., & Hariyadi, A. (2021). The Influence of 4C (Constructive, Critical, Creativity, Collaborative) Learning Model on Students' Learning Outcomes. *International Journal of Instruction*, 14(3), 873–892. <https://doi.org/10.29333/iji.2021.14351a>
- Syahril, S., Nabawi, R. A., & Safitri, D. (2021). Students' Perceptions of the Project Based on the Potential of their Region: A Project-based Learning Implementation. *Journal of Technology and Science Education*, 11(2), 295–314. <https://doi.org/10.3926/JOTSE.1153>
- Tey, T. C. Y., Moses, P., & Cheah, P. K. (2022). Media Exposure and Students' Attitude as Mediators Between Subjective Norms and Choice Intention for Science, Technology, Engineering, and Mathematics Careers. *30th International Conference on Computers in Education Conference, ICCE 2022 - Proceedings, 1*, 629–638.
- Turan-Güntep, E., & Abdüsselam, M. S. (2022). A Valid and Reliable Scale for Education 4.0 Competency Determination (E4CD). *Informatics in Education*, 21(4), 675–694. <https://doi.org/10.15388/infedu.2022.28>