IJORER : International Journal of Recent Educational Research
Homepage : https://journal.ia-education.com/index.php/ijorer
Email : ijorer@ia-education.com

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 5, No. 1, January 2024
Page 182-192

Work Readiness of Competencies Machining Engineering's Student

Nur Aini Susanti[1*], Suparji[1], Tri Wrahatnolo[1], Hanna Zakiyya[2], Yuli Sutoto Nugroho[3]
[1]State University of Surabaya, Surabaya, Indonesia
[2]University of Miskolc, Miskolc, Hungary
[3]Queen Mary University of London, East London, England

DOI: https://doi.org/10.46245/ijorer.v5i1.441

Sections Info

Article history:
Submitted: November 15, 2023
Final Revised: January 02, 2024
Accepted: January 03, 2024
Published: January 07, 2024

Keywords:
Work Readiness;
Machining Engineering;
Vocational High School.

ABSTRACT

Objective: Vocational High School or Sekolah Menengah Kejuruan (VHS) is one of the levels of education in Indonesia. VHS provides various skills programs. VHS graduates should have more significant opportunities to work based on their competencies, but the most dominant unemployed were VHS graduates in East Java, Indonesia. VHS's students must have work readiness and vocational competencies to reduce unemployment. The mechanical Engineering program encourages students to operate machines and produce goods. Machine CNC is one of the manufacturing industries. The research aims to analyze the influence of problem-solving, technology, teamwork, and self-management skills on the work readiness of VHS students in the Mechanical Engineering program. **Method:** This research used quantitative methods with a causality approach. The population was students of the Mechanical Engineering program in East Java Province in Indonesia. The random sampling technique was used with 377 respondents. Analysis data used SEM. **Results:** Problem-solving skills were 36.7% influenced by technology, teamwork, and self-management. Work readiness was 54.6% influenced by problem-solving skills. **Novelty:** The significant positive influence of problem-solving skills, technology skills, teamwork skills, and self-management skills on the work readiness of students at Machining Engineering Vocational High School in East Java simultaneously.

INTRODUCTION

The world population is around 8.05 billion people. According to International Monetary Fund (IMF) data in 2023, Indonesia is 58th in the world with an unemployment rate of 5.300%. Vocational High School (VHS) graduates should have more significant opportunities to work based on their competencies, but the highest number of unemployed were VHS graduates in East Java, Indonesia. VHS is one of the levels of education in Indonesia that provides various skills programs. This is a challenge for us as vocational educators. Students must work readiness and vocational competencies to reduce unemployment (Pambayun et al., 2023; Sudarsono et al., 2022; Tajuddien & Faroh, 2021).

The Mechanical Engineering Program encourages students to operate machines and learn how to produce goods using various machines. Setting up CNC machines, programming CNC, and operating CNC machines are some of the competency standards and qualification levels of Machining Engineering expertise. However, CNC machine learning in vocational schools tends to be cognitive knowledge that must fully accommodate analysis skills and comprehensive product manufacturing skills (Susanti & Kurniawan, 2020).

Problem-solving skills are one of the ten most needed skills in the industry. The problem-solving ability of VHS students still needs to improve. It can be seen when the

CNC machine includes cutting tools falling off while operating, alarms sounding in production, and programming errors. Problem-solving skills are needed in operating CNC machines, how students can make products, and the suitability of workpiece designs with CNC programs (Abellán-Nebot, 2018; Fadzil & Ahmad, 2022; Lin & Lee, 2020). The main goal of engineering education is students' ability to solve problems because it helps improve competence, involves logic, arguing and looking for the cause of the problem, finding alternatives, analyzing, choosing a solution, and implementing the solution.

Technological devices are only meaningful if they are utilized. Competencies are interrelated with other competencies. Digitization, information data, and data visualization skills related to coding, presenting, and analyzing data are skills needed today (Binici, 2021; Szajna et al., 2022). Technology skills include design, using technological tools, and supervising related to the ability to operate CNC machines. Designing is one of the abilities needed by industry.

VHS students, including adolescents, are defined as a transitional developmental period between childhood and adulthood, in which biological, cognitive, and social-emotional changes; students are required to survive in facing challenges in completing tasks and clashing problems from the environment, school, community, and family. Self-management skills encourage oneself to progress, improve, and control one's abilities to develop one's potential optimally. Students are proven to be able to manage themselves by having inner motivation, excelling in CNC learning, being active in learning, paying attention to the teacher, completing assignments optimally, and presenting their assignments (Susanti & Kurniawan, 2020; Nurwijaya, 2019).

CNC machines involve much work, consisting of designing workpieces, selecting workpiece materials and workpiece sizes, setting workpieces, setting cutting tools, designing programming, simulating programs, inputting program data on CNC machines, operating machines, monitoring machines, repairing the program if there is trouble, cleaning the machine, repairing the machine, etc. The existence of teamwork makes the work of CNC machines easier and overcomes technical problems in projects. Solid teamwork performance improves outcomes, understands each other, and can solve problems. This research examines problem-solving, technical, teamwork, self-management, and work readiness skills. Novelty in this research is related to five variables in one research and the implementation of variables in mechanical engineering vocational school students in the curriculum related to CNC machines.

RESEARCH METHOD

Using quantitative research methods with ex-post facto research type. The causality approach used seeks to explain the causal relationship between several variables. The sampling technique used was purposive sampling. The population was VHS students of the Machining Engineering Program in East Java Province, Indonesia, with 377 respondents. The research instruments were a performance test and a questionnaire. The analysis data tool used structural equation modeling (SEM). The independent variables (exogenous) were technology and teamwork skills, the variable moderating was problem-solving skills, and the dependent variable (endogenous) was work readiness. Problem-solving skills variables are likely in Table 1, Technology skills variable in Table 2, Teamwork skills variable in Table 3, Self-management skills variable in Table 4.

Table 1. Problem-solving skills variable.

Indicators	Sub Indicators
Define the problem	▪ Define the type of CNC machine used ▪ Workpiece dimensions
Find alternative solution	▪ Design workpiece drawings ▪ Create CNC programs
Evaluate alternative solution	▪ Checking workpiece drawings with the CNC program
Implementation the solution	▪ Compatibility of workpiece drawings, CNC programs, and programming methods. ▪ The CNC program was ready to be simulated.

Table 2. Technology skills variable.

Indicators	Sub Indicators
Technology design and programming skills	▪ Workpiece Design ▪ Programming the CNC
Technology use and control skill	▪ Able to input program ▪ Able to check programs
Innovation skill	▪ Able to create work orders

Table 3. Teamwork skills variable.

Indicators	Sub Indicators
Communication	▪ Students grouped to discuss making workpieces, programming CNC machines, inputting programs, and simulating programs.
Responsibility	▪ Students in groups are responsible for completing assignments, making workpieces, programming CNC machines, inputting programs, and simulating programs.
Honesty	▪ Students work in groups to make workpieces, program the CNC machine without imitating the work of other teams, input the program, and simulate the program.
Empathy	▪ Students work in groups honestly, making work objects, programming CNC machines, inputting programs, and simulating programs.
Collaboration	▪ Students work in groups to make workpieces, program CNC machines, simulate programs, and input programs.

Table 4. Self-management skills variable.

Indicators	Sub Indicators
Self-motivation	▪ Personal desire to progress ▪ Not easily influenced by other people
Self-organization	▪ Good self-regulation ▪ Individual lives are more efficient
self-control	▪ Strong determination to do something ▪ Avoid negative behaviour
self-development	▪ Improve yourself to good things ▪ Be positive ▪ Try new things

RESULTS AND DISCUSSION

Results

The result of bootstrapping's process was score t-statistic, p-value, and original sample score likely in Figure 1. Figure 1 is SEM PLS analysis; the significance and direction of direct influence can be seen from the p-value, t-statistic, and path coefficient that connects endogenous to exogenous. If the p-value is < 0.050 and the t-statistic is > 1.650 (one tail t value), then it can be concluded that the exogenous variable has a significant effect on the endogenous variable with the direction of influence being by the sign attached to the efficiency of the path likey in Table 5.

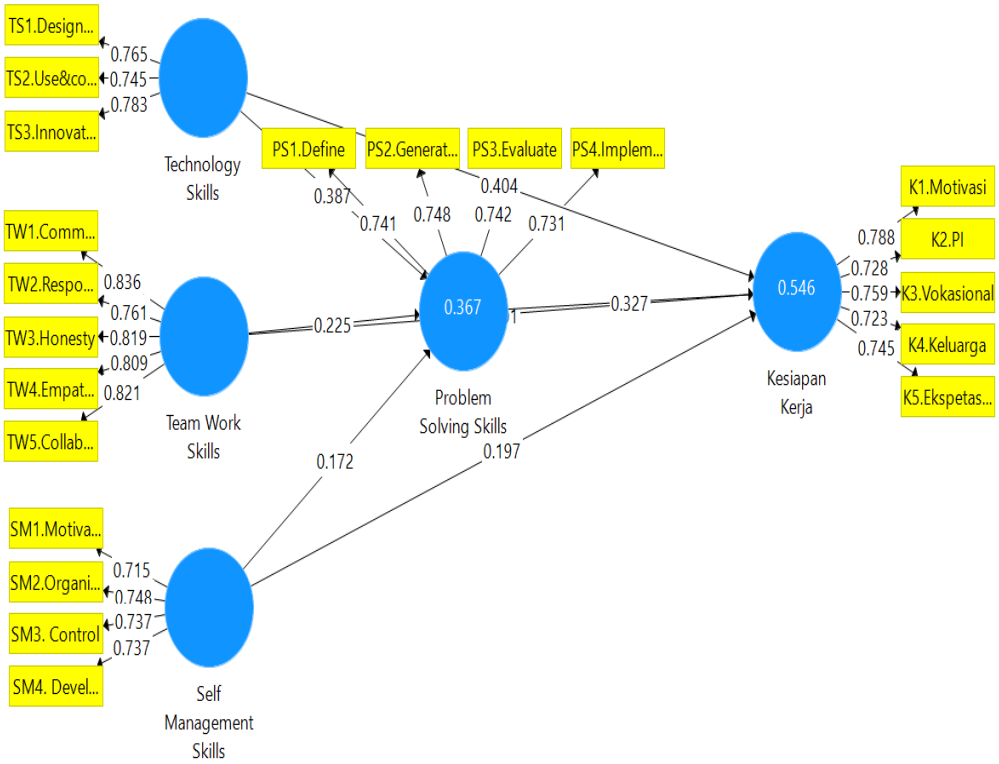

Figure 1. PLS model with bootstrapping.

Table 5. Work readiness variable.

Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV)	P Values
PS -> WR	0.327	0.322	0.059	5.531	0.000
SM -> PS	0.172	0.175	0.058	2.995	0.003
SM -> WR	0.140	0.141	0.057	2.459	0.014
TW -> PS	0.225	0.228	0.048	4.730	0.000
TW -> WR	0.228	0.230	0.046	4.959	0.000
TS -> PS	0.387	0.381	0.047	8.161	0.000
TS -> WR	0.278	0.276	0.044	6.332	0.000

PS : Problem-Solving Skills
TS : Technology Skills
TW : Team Work Skills
SM : Self Management Skills
WE : Work Readiness

Discussion

The Influence of Problem-Solving Skills on Vocational School Students' Work Readiness Machining Engineering in East Java

The path that shows the influence of problem-solving skills on work readiness, the p-value was 0.000 with a t statistic of 5.531, and the path coefficient was 0.327 because the p-value < 0.050, t statistic > 1.960, and the path coefficient. It can be concluded that problem-solving skills have a significant influence on work readiness; this means that problem-solving skills define the problem, generate alternative solutions, evaluate and select an alternative, implementation and follow up on the solution, so the work readiness of vocational high school students also increases (Arivina & Jailani, 2020; Caeiro-Rodríguez et al., 2021; Divayana et al., 2021; Szabo et al., 2020; Toheri et al., 2020). Problem-solving includes: a) Students determine the problem and discuss what material the unit will use with all involved. What is the size of the work unit, and what kind of CNC machine will be used? b) students determine in which process the problem is; c) avoid the finishing problem without data; d) create a CNC program according to the workpiece; the CNC program must match the workpiece drawing; e) simulate the CNC program. In this process, if there is a discrepancy between the workpiece and the CNC program, it will be visible. Students should find the problem and solve it until the simulation runs well. Work readiness sub-indicators are studying motivation, internship experience, and vocational guidance. Motivated students create CNC programs, trying to solve problems. Student motivation types and achievement based on the specific school subject (Paumier & Chanal, 2023). Students who have practiced in the CNC machining industry feel familiar with operating CNC machines and have work readiness if those students work in the CNC machining industry. The job market requires skills graduates forged by units and education systems. Perception and problem-solving abilities and increasing cognitive levels are related to students' future motivation (Kirn & Benson, 2018; Chalutz, 2022; Stoeva, 2022; Tsai et al., 2023; Sabura, 2020; Hooijdonk et al., 2023).

The Influence of Self-Management Skills on Vocational School Students' Problem-Solving Skills Machining Engineering in East Java

The path that shows the influence of self-management skills on problem-solving skills, the p-value was 0.003 with a t statistic of 2.995, and the path coefficient was 0.172 because the p-value < 0.050, t statistic > 1.960, and the path coefficient, can be concluded that self-management skills have a significant influence on problem-solving skills, this means that better the self-management skills, higher the problem-solving skills of vocational high school students. Teachers should help students push themselves (self-motivation) and self-development by holding discussions to resolve problems. Self-regulation skills by discussing problem-solving, collecting feedback from parties involved, and then determining problem-solving steps reflect the students' personalities, which is one of the most important things. Students' Self-management skills are self-motivation, self-development, self-organization, and self-control. Students active during CNC learning, students enthusiasm to solve the problem, carry out the task, design the workpiece, create a CNC program, discuss problems, generate the solution, and choose the solution step (Ali, 2023; Macías-García et al., 2020; Pernia-Espinoza et al., 2020; Wang et al., 2023).

The Influence of Self-Management Skills on Vocational School Students' Work Readiness Machining Engineering in East Java

The path that shows the influence of self-management skills on work readiness, the p-value was 0.014 with a t statistic of 2.459 and a path coefficient of 0.140; because the p-value < 0.050, t statistic > 1.960 and the path coefficient, it can be concluded that self-management skills have a significant influence on work readiness, this means that better the self-management skills, higher the work readiness of vocational high school students. Students' self-management skills are self-motivation, self-development, self-organization, and self-control. Self-control helps students prepare for working under pressure. Working in the manufacturing industry, there is always a target to produce products according to consumer demand. Self-management skills in terms of self-motivation encourage students' activities to achieve goals. Self-motivation fosters interest and the desire to progress, learn, and learn new things, influencing student readiness to work. Student's self-concept affects student achievement; time management is self-organization and has the potential to produce productivity and progress (Paumier & Chanal, 2023). Self-management means students can independently manage themselves, have personal visions and goals, evaluate and monitor their performance, and influence their careers.

The Influence of Team Work Skills on Vocational School Students' Problem Solving Skills Machining Engineering Skills Competency in East Java

The path that shows the influence of teamwork skills on problem-solving skills, the p-value, was 0.000 with a t statistic of 4.730 and a path coefficient of 0.225; because the p-value < 0.050, t statistic > 1.960 and the path coefficient, it can be concluded that teamwork skills' indicators are communication, responsibility, honesty, empathy, and collaboration have a significant influence on problem-solving skills, this means that higher teamwork skills, higher the problem-solving skills of vocational high school students. CNC work requires precision, solving problems by making workpieces, designing workpieces, creating CNC programs, and data input programming on a CNC lathe; all work is completed quickly if done in a team. There is communication between team members, and students are responsible for completing assignments. The existence of teamwork makes the work of CNC machines easier and overcomes technical problems in projects. Solid teamwork performance improves outcomes, understands each other, and can solve problems. Collaboration builds common goals and provides an understanding of problems, problem-solving, and improving learning achievement (Sulistyowaty et al., 2019). Collaborative teams help solve work problems. Individual engineering skills, including communication and teamwork, are related to solving problems (Stoeva & Stoev, 2022; Pollock et al., 2023; Futterer et al., 2023).

The Influence of Team Work Skills on Vocational School Students' Work Readiness Machining Engineering in East Java.

The path that shows the influence of teamwork skills on work readiness, the p-value was 0.000 with a t statistic of 4.959 and a path coefficient of 0.228; because the p-value < 0.050, t statistic > 1.960 and the path coefficient, it can be concluded that teamwork skills with indicator communication, responsibility, honesty, empathy, and collaboration have a significant influence on work readiness, this means that higher the teamwork skills, also higher the work readiness of vocational high school students. Teamwork skills in terms of collaboration prove that cooperation improves student

activity, CNC practical performance, and mastery of knowledge can be used to work. Collaboration or teamwork skills influence work readiness (Sulistyowaty et al., 2019; Navarro et al., 2023)

The Influence of Technology Skills on Vocational School Students' Problem Solving Skills Machining Engineering in East Java.
The path that shows the influence of technology skills on problem-solving skills, the p-value was 0.000 with a t statistic of 8.161 and a path coefficient of 0.387; because the p-value < 0.050, t statistic > 1.960 and the path coefficient, it can be concluded that technology skills have a significant influence on problem-solving skills, this means that better technology skills, higher the problem-solving skills of vocational high school students. Understanding the problem requires creativity. Indicator technology skills are technology design and programming, technology use, monitoring and control, and innovation skills. Technology skills in CNC learning, ability to create new workpiece designs, and CNC programming according to the contour workpiece. Process CNC programming encounters many problems, including work sequence programming, facing, roughing, and finishing. The correct order of tool selection is adjusted to the tool's command. The chisel is adapted to the process with the program's G code. Students must be able to find solutions. Work must be completed within a specific time. Competence in making CNC programs and operating CNC machines benefits industry manufacturers. Company resources include technology and the ability to develop products, which increase the company's profits.

The Influence of Technology Skills on Vocational School Students' Work Readiness Machining Engineering Skills Competency in East Java. The path that shows the influence of technology skills on work readiness, the p-value was 0.000 with a t statistic of 6.332 and a path coefficient of 0.278; because the p-value < 0.050, t statistic > 1.960 and the path coefficient, it can be concluded that technology skills have a significant influence on work readiness, this means that better technology skills, higher the work readiness of vocational high school students. Indicator technology skills are technology design and programming, technology use, monitoring and control, and innovation skills. Students can design products and do CNC programming, operate CNC machines, monitor CNC machines, and create new products. Technology skills related to analytical thinking are the ability to conceive the problem and create a product innovation. 81.170% of companies carry out product innovation, while 37.980% develop product innovation with other parties. This means companies in Indonesia are active in innovation (BPS, 2022). Students with technology skills are better prepared to work in industry (Borg & Scott-Young, 2020; Rogers et al., 2023). Through science and innovation to shape the technology and knowledge infrastructure to create future energy (Magistretti et al., 2020). Vocational teaches technology skills to prepare for work in the future (Surekha et al., 2020; Zulfahmi & Andriany, 2021; Vuchkovski et al., 2023; Lee et al, 2023).

CONCLUSION

Fundamental Finding: Problem-solving, technology, teamwork, and self-management skills significantly influence work readiness. It means higher problem-solving skills, technology skills, teamwork skills, self-management skills, and higher work readiness of vocational high school students in the Mechanical Engineering program.

Implication: (1) problem-solving skills have implications for students in learning and interacting with friends, family, and the future when working on problems; students can define problems, find solutions and make critical decisions in their lives, (2) technology skills in vocational school students, the competency of Machining Engineering skills in East Java implies the ability to design, use and innovate in using technology when working in the future, (3) teamwork skills for Vocational School students, the competency of Machining Engineering skills in East Java has implications for getting students to work in teams and training students to become individuals who dare to take risks, (4) self-management skills in vocational school students, the competency of Machining Engineering skills in East Java has implications for students' ability to control themselves, good attitude and develop themselves in their life when they work in the future. (5) Planning CNC learning is the relevance of competence alignment between VHS learning, vocational educational study programs, and industry. **Limitation:** Application of the variable's problem-solving skills, technical skills, teamwork skills, and self-management skills in one unit in CNC Machine learning. **Future research:** (1) **a**dding variables that are not yet in this research, such as the ability to design work objects using Mastercam software, CAD/CAM integrated with CNC machines, school facilities and infrastructure, teachers' pedagogical abilities, and students' entrepreneurial abilities, (2) researching the influence of teachers' abilities in learning CNC machines on student competence.

ACKNOWLEDGEMENTS

Thanks to Universitas Negeri Surabaya, Sekolah Pascasarjana, Department of Vocational Education and Mechanical Engineering Education Program, the author gives excellent support. Thanks to vocational high school machine engineering, where data was taken.

REFERENCES

Ali, M. A. (2023). Creating positive learning experience for freshmen students through engineering workshop. *Journal of Positive School Psychology, 7*(1), 373-382.

Arivina, A. N., & Jailani, J. (2020). Development of trigonometry learning kit with a STEM approach to improve problem solving skills and learning achievement. *Jurnal Riset Pendidikan Matematika, 7*(2), 178–194. https://doi.org/10.21831/jrpm.v7i2.35063

Binici, K. (2021). What are the information technology skills needed in information institutions? The case of "code4lib" job listings. *Journal of Academic Librarianship, 47*(3), 1-12. https://doi.org/10.1016/j.acalib.2021.102360

Borg, J., & Scott-Young, C. M. (2020). Employers' perspectives on work readiness in construction: are project management graduates hitting the ground running? *International Journal of Managing Projects in Business, 13*(6), 1363–1379. https://doi.org/10.1108/IJMPB-10-2019-0238

Caeiro-Rodríguez, M., Manso-Vázquez, M., Mikic-Fonte, F. A., Llamas-Nistal, M., Fernández-Iglesias, M. J., Tsalapatas, H., Heidmann, O., Carvalho, C. V. De, Jesmin, T., Terasmaa, J., & Sørensen, L. T. (2021). Teaching soft skills in engineering education: An european perspective. *IEEE Access, 9*, 29222–29242. https://doi.org/10.1109/ACCESS.2021.3059516

Chalutz, H. B. G., & Cohen, Y. (2022). The "new Fit": Skills and competencies for the future of work. *IFAC-PapersOnLine, 55*(2), 511–515. https://doi.org/10.1016/j.ifacol.2022.04.245

Divayana, D. G. H., Suyasa, P. W. A., & Widiartini, N. K. (2021). An innovative model as evaluation model for information technology-based learning at ICT vocational schools. *Heliyon, 7*(2), 1-12. https://doi.org/10.1016/j.heliyon.2021.e06347

Fadzil, M. N., & Ahmad, Z. (2022). The development of project-based learning pedagogical module for CNC EDM die sinking for industrial machining technology course. *Research and Innovation in Technical and Vocational Education and Training*, *2*(2), 328–335.

Futterer, T., Scherer, R., Scheiter, K., Sturmer, K., & Lachner, A. (2023). Will, skills, or conscientiousness: What preditcs teachers' intentions to participate in technology-related profesional development? *Computers & Education, 198*, 1-23. https://doi.org/10.1016/j.compedu.2023.104756.

Hooijdonk, M.V., Mainhard, T., Kroesbergen, E. H., Tartwijk, J. V. (2023). Creative problem solving in primary school students. *Learning and Instruction, 8,* 1-12. https://doi.org/10.1016/j.learninstruc.2023.101823.

Kirn, A., & Benson, L. (2018). Engineering students' perceptions of problem solving and their future. *Journal of Engineering Education, 107*(1), 87–112. https://doi.org/10.1002/jee.20190

Lee, Y. F., Altschuld, J. W., Tseng, P. K., & Hung, H. S. (2023). Asessing study skill needs for information technology and computer science studdents in technical and vocational universities. *Heliyon*, *9,* 1-15. https://doi.org/10.1016/j.heliyon.2023.e20915

Lin, Y. T., & Lee, I. J. (2020). *Development of an Augmented reality system achieving in cnc machine operation simulations in furniture trial teaching course*. Springer International Publishing.

Macías-García, M. E., Cortés-Pérez, A. A., & Izaguirre-Alegría, A. R. (2020). Cyber-physical labs to enhance engineering training and education. *International Journal on Interactive Design and Manufacturing (IJIDeM), 14*(4), 1253–1269. https://doi.org/10.1007/s12008-020-00704-6

Magistretti, S., Dell'Era, C., & Verganti, R. (2020). Searching for the right application: A technology development review and research agenda. *Technological Forecasting and Social Change, 151*, 1-17. https://doi.org/10.1016/j.techfore.2019.119879

Navarro, O. A., Fuentes, C. K., Vasquez, L. A., Utreras, J. J., Arrieta-Barrios, T., & Corrales-Paternina, A. (2023). Conforming work teams within SMEs using fuzzy logic and analytic network process (ANP). *Procedia Computer Science, 220*, 952–957. https://doi.org/10.1016/j.procs.2023.03.131

Nurwijaya, S. (2019). Hubungan manajemen diri dengan prestasi belajar matematika siswa kelas VIII SMP negeri 3 watampone kabupaten bone. *DIDAKTIKA : Jurnal Kependidikan, 12*(1), 88–102. https://doi.org/10.30863/didaktika.v12i1.178

Pambayun, N. A. Y., Munadi, S., Arifin, Z., Setiawan, C., & Retnawati, H. (2023). Industrial work culture education in Indonesian vocational high schools: Teachers' perceptions and practices. *Issues in Educational Research, 33*(2), 713–732.

Paumier, D., & Chanal, J. (2023). The differentiated mediation effect of academic autonomous and controlled motivation in the relation between self-concept and achievement. *Learning and Motivation, 83*, 1-24. https://doi.org/10.1016/j.lmot.2023.101918

Pernia-Espinoza, A., Sanz-Garcia, A., Martinez-de-Pison-Ascacibar, F. J., Peciña-Marqueta, S., & Blanco-Fernandez, J. (2020). Technical projects with social commitment for teaching-learning intervention in STEM students. *2020 IEEE Global Engineering Education Conference (EDUCON),* 579–586. https://doi.org/10.1109/EDUCON45650.2020.9125176

Pollock, M., Schmulian, A., Coetzee, S. A. (2023). Do team-based written or video explanations of course content enhance accounting students' knowledge, communication, and teamwork skills? *Journal of Accounting Education, 65*, 10-26. https://doi.org/10.1016/j.jaccedu.2023.100873

Rogers, S., Lai, J., Walker, A., Rawson, H., & Redley, B. (2023). Development of work readiness in graduate nurses during a Transition to Practice Program: A survey study. *Collegian, 30*(4), 595–601. https://doi.org/10.1016/j.colegn.2023.05.007

Sabura, B. U. (2020). Technical skill upgradation by project based learning and exposing to state-of-art technologies. *Procedia Computer Science, 172*, 950–953. https://doi.org/10.1016/j.procs.2020.05.137

Stoeva, M., & Stoev, P. (2022). Educational concept of integrated project-oriented learning for the formation of "problem solving" competence in electrical engineering disciplines. IFAC-PapersOnLine, 55(39), 187–191. https://doi.org/10.1016/j.ifacol.2022.12.053

Sudarsono, B., Tentama, F., Mulasari, S. A., Sukesi, T. W., Sulistyawati, Ghozali, F. A., Yuliansyah, H., Nafiati, L., & Sofyan, H. (2022). Development of integrated project-based (PjBL-T) model to improve work readiness of vocational high school students. *Jurnal Pendidikan Vokasi, 12*(3), 222–235. http://dx.doi.org/10.21831/jpv.v12i3.53158

Sulistyowaty, R. K., Kesumah, Y. S., & Priatna, B. A. (2019). Peningkatan kemampuan representasi matematis melalui pembelajaran collaborative problem solving. *Jurnal Pendidikan Matematika, 13*(2), 153–162. https://doi.org/10.22342/jpm.13.2.6829.153-162

Surekha, T. P., Shankar, S., & Sadashive, G. B. (2020). Enhancing the quality of engineering learning through skill development for feasible progress. *Procedia Computer Science, 172*, 128–133. https://doi.org/10.1016/j.procs.2020.05.019

Susanti, N. A., & Kurniawan, W. D. (2020). Penerapan modul CNC I menggunakan pembelajaran berbasis proyek untuk meningkatkan aktivitas dan hasil belajar mahasiswa teknik mesin unesa. *Journal of Vocational and Technical Education (JVTE), 2*(2), 45–53. https:/doi.org/10.26740/jvte.v2n2.p45-53

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of problem-solving strategies in mathematics education supporting the sustainability of 21st-century skills. *Sustainability, 12*(23), 1-10. https://doi.org/10.3390/su122310113

Szajna, A., Stryjski, R., Wozniak, W., Chamier-Gliszczynski, N., & Królikowski, T. (2022). The Management of digital data using innovative technologies. *Procedia Computer Science, 207,* 3143–3152. https://doi.org/10.1016/j.procs.2022.09.535

Tajuddien, R., & Faroh, W. N. (2021). 21st century skill grouping in public vocational school students in indonesia. *European Journal of Interactive Multimedia and Education, 2*(2), 1-15. https://doi.org/10.30935/ejimed/11133

Toheri, T., Winarso, W., & Haqq, A. A. (2020). Where exactly for enhance critical and creative thinking: The use of problem posing or contextual learning. *European Journal of Educational Research, 9*(2), 877–887. https://doi.org/10.12973/eu-jer.9.2.877

Tsai, C. A., Song, M. W. S., Lo, Y. F., & Lo, C. C. (2023). Design thinking with constructivist learning increases the learning motivation and wicked problem- solving capability- an empirical research in taiwan. *Thinking Skills and Creativity, 50,* 1-30. https://doi.org/10.1016/j.tsc.2023.101385

Vuchkovski, D., Zalanik, M., Mitrega, M., & Gregor, P. (2023). A look at the future of work: The digital transformation conventional to virtual. *Journal of Business Research, 163*, 113-126. https://doi.org/10.1016/j.jbusres.2023.113912

Wang, S., Meng, J., Xie, Y., Jiang, L., Ding, H., & Shao, X. (2023). Reference training system for intelligent manufacturing talent education: Platform construction and curriculum development. *Journal of Intelligent Manufacturing, 34*(3), 1125–1164. https://doi.org/10.1007/s10845-021-01838-4

Zulfahmi, A., & Andriany, D. (2021). Kematangan vokasional dengan kecemasan dalam menghadapi dunia kerja pada mahasiswa tingkat akhir. *Cognicia, 9*(2), 64–75. https://doi.org/10.22219/cognicia.v9i2.15728

* **Dr. Nur Aini Susanti** (Corresponding Author)
Department Vocational Education, Sekolah Pascasarjana,
Universitas Negeri Surabaya,
Jl. Lidah Wetan, Surabaya 60231, Indonesia
Email: nursusanti@unesa.ac.id

Prof. Dr. Suparji
Department Vocational Education, Sekolah Pascasarjana,
Universitas Negeri Surabaya,

Jl. Lidah Wetan, Surabaya 60231, Indonesia
Email: suparji@unesa.ac.id

Prof. Dr. Tri Wrahatnolo
Department Vocational Education, Sekolah Pascasarjana,
Universitas Negeri Surabaya,
Jl. Lidah Wetan, Surabaya 60231, Indonesia
Email: triwrahatnolo@unesa.ac.id

Hanna Zakiyya
Institute of Metallurgy and Foundry Engineering,
University of Miskolc
Miskolc, Egyetem ut 1, 3515 Hungary
Email: zakiyya.hanna@student.uni-miskolc.hu

Yuli Sutoto Nugroho
Electronic Engineering and Computer Science,
Queen Mary University of London,
Westfield College ·1887 – East London College/Queen Mary College
Email: nugroho@qmul.ac.uk