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Analysis of Work Readiness Research Instruments for Vocational High School of the Mechanical Engineering Program

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ABSTRACT

Objective: One of the levels of education in Indonesia is Vocational High School (VHS). VHS provides various skills programs, and VHS's graduates should have greater opportunities to work based on their competencies. However, in East Java, most of the unemployed are VHS graduates. One of the skills programs at VHS is the Mechanical Engineering Skills program. The research purpose was to analyze the instrument research of work readiness vocational high school of the Mechanical Engineering program. **Method:** This research used a quantitative method. Instrument Work Readiness (WR) with variable problem-solving skills (PSS), Technology Skills (TS), Teamwork Skills (TWS) and Self-management Skills (SMS). Validity test of instrument used software Winstep Rasch analysis and reliability test of instrument used software Stata. The instrument, which has been validated by experts, was tested on 30 respondents. **Results**: aspect validity about test quality, model of legibility, and instrument sheet. Instrument validity of PSS was advisability 91.3%, CVR 0.92 and reliability 0.797, TS was advisability 93.6%, CVR 0.95 and reliability 0.491, TWS was advisability 90.3%, CVR 0.87 and reliability 0.798, SMS was advisability 92.6%, CVR 0.86 and reliability 0.941, WR advisability 95%, CVR 0.95 and reliability 0.946. **Novelty:** New model research instrument for measuring 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 together. Machining engineering specially measured Computer Numerically Controlled (CNC) competence likely design workpiece, CNC programming, programming simulation, and inputting CNC programming.

INTRODUCTION

The quality of research data is influenced by the quality of research instruments and the quality of data collection. Quantitative research collects data using instruments (Creswell, 2012). Instruments are tools that help someone achieve research goals. The quality of the instrument is influenced by validity and reliability. Validity is a measure that the variable is the correct variable to be studied. Instrument assessment by validators or judgment experts to assess aspects of the questionnaire's validity.

Research instruments in the form of questionnaires and performance tests. Questionnaires are used to measure changes in behavior related to students' affective aspects (Arivina & Jailani, 2020). Questionnaire to measure self-management skills variables and student work readiness variables (García-Aracil et al., 2019; McManus & Rook, 2021; Zhu et al., 2020). The essence of a test is special and systematic

procedure for assessing individual behavior described by numbers, scales, or classification systems. Performance tests measure problem-solving skills, technology skills, and teamwork skills (Bransford & Stein, 1993).

One of the levels of education in Indonesia is Vocational High School (VHS). VHS provides various skills programs, and VHS's graduates should have greater opportunities to work based on their competencies. However, in East Java, most of the unemployed are VHS's graduates. VHS's students must have work readiness and vocational competencies to reduce unemployment. This research analyzes research instruments for measuring problem-solving skills, technology skills, teamwork skills, self-management skills, and work readiness of students machining engineering Vocational High School in East Java.

RESEARCH METHOD

Variable work readiness with variable problem-solving skills, technology skills, teamwork skills, and self-management skills. Analyzed items by Ministep Winstep Rasch software for infit mean square (IMNSQ) and outfit mean square (OMNSQ). Reliability test of instrument used software Stata. The instrument, which has been validated by experts, was tested on 30 respondents.

The independent variables (exogenous) were technology skills, and teamwork skills, the variable moderating was problem-solving skills and the dependent variable (endogenous) was work readiness. The data collection technique used a questionnaire and performance test. Table 1 is the scoring for instrument validation.

Table 1. Answer scoring.

No	Alternative Answer	Score
1	Strongly agree	4
2	Agree	3
3	Disagree	2
4	Strongly disagree	1

(Saphira & Prahani, 2022)

Table 2. Problem-solving skills variable.

Indicators	Sub-Indicators	Items Number
Define the problem	▪ Define the type of CNC machine used ▪ Workpiece dimensions	1
Find alternative solution	▪ Design workpiece drawings ▪ Create CNC programs	2
Evaluate alternative solution	▪ Checking workpiece drawings with the CNC program	3
Implementation the solution	▪ Compatibility of workpiece drawings, CNC programs, and programming methods. ▪ The CNC program was ready to be simulated.	4

Table 2 shows problem solving is the act of defining a problem; determining the cause of the problem; identifying, prioritizing, and selecting alternatives for a solution; and implementing a solution. Assessment of cognitive skills (literacy, numeracy, and problem-solving in a technology-rich environment could apply cognitive strategies to unfamiliar contexts outside the adults' immediate life circumstances (Boeren et al,

2022). 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).

Table 3. Technology skills variable.

Indicators	Sub-Indicators	Items Number
Technology design & programming skill	▪ Workpiece Design	1
	▪ Programming the CNC	2
Technology use and control skill	▪ Able to input program ▪ Able to check programs	3
Innovation skill	▪ Able to create work orders	4

Digitization, information data, and data visualization skills related to coding, presenting, and analyzing data are skills needed today (Binici, 2021; Szajna et al., 2022) CNC machine operation is a process of modernizing machine-based production. Technology skills are needed in the learning process and industry (Sabura, 2020; Surekha et al, 2020; Danon et al, 2023). One of the skills needed by industry is technology skills (World Economic Forum, 2020). Students' 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). The teaching of soft skills in higher education by focusing on technological solutions was the best practice for work readiness (Rodriguez et al, 2021).

Table 4. Teamwork skills variable.

Indicators	Sub-Indicators	Items Number
Communication	▪ Students grouped to discuss making workpieces, programming CNC machines, inputting programs, and simulating programs.	1, 2, 3, 4
Responsibility	▪ Students in groups are responsible for completing assignments, making workpieces, programming CNC machines, inputting programs, and simulating programs.	1, 2, 3, 4
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	1, 2, 3, 4
Empathy	▪ Students work in groups honestly making work objects, programming CNC machines, inputting programs, and simulating programs.	1, 2, 3, 4
Collaboration	▪ Students work together in groups to make workpieces, program CNC machines, input programs, and simulate programs.	1, 2, 3, 4

Teamwork skills are good work skills and qualities for working with other people with a common goal (Keiling, 2023). Collaboration or teamwork skills influence work readiness. Collaborative teams help solve work problems. Individual engineering skills, including communication and teamwork, are related to solving problems (Stoeva & Stoev, 2022).

Table 5. Self-management skills variable.

Indicators	Sub-Indicators	Items Number
Self-motivation	▪ Personal desire to progress	▪ 1, 2, 3, 4
	▪ Not easily influenced by other people	▪ 5, 6
Self-organization	▪ Good self-regulation	▪ 7, 8, 9, 10
	▪ Individual lives are more efficient	▪ 11
self-control	▪ Strong determination to do something	▪ 12, 13, 14
	▪ Avoid useless things	▪ 15, 16
self-development	▪ Improve yourself to good things	▪ 17, 18, 19
	▪ Be positive	▪ 20, 21, 22
	▪ Try new things	▪ 23

Motivation helps students face their difficulties when studying (Nguyen et al., 2023). The role of work organizations plays in the career development of working students (Creed et al., 2022). Students' self-management can independently organize themselves, have personal visions and goals, and evaluate and monitor their own performance affects the career and life skills that the 21st century needs (Wrahatnolo & Munoto, 2018). Student's self-concept affects student achievement (Chalutz & Cohen, 2022); time management is self-organization and has the potential to produce productivity and progress (Nurwijaya, 2019; Olmedo-Navarro et al., 2023; Paumier & Chanal, 2023).

Table 6. Work readiness skills variable.

Indicators	Sub-Indicators	Items Number
Motivation to learn	▪ Factors from within oneself	▪ 1, 2, 4
	▪ Influenced by other people	▪ 3, 5, 6
Industry Practice	▪ Happy when Practicing Industry	▪ 7, 8, 9
Performance	▪ Work discipline	▪ 10, 11
Vocational guidance	▪ Able to create CNC programs	▪ 12, 13
	▪ Able to operate CNC machines	▪ 14, 15
Family's background	▪ Working family	▪ 16, 17, 18
	▪ Parental success	▪ 19, 20
Expectations the world	▪ Income when working	▪ 21, 22, 23
working	▪ Competency implementation	▪ 24, 25

Vocational guidance and practice in learning are factors that support work readiness (Zulfahmi & Andriany, 2021; Rogers et al., 2023). Teaching soft skills in higher education by focusing on technological solutions was the best practice for work readiness (Rodriguez et al., 2021). Student motivation types and achievement based on the specific school subject (Paumier & Chanal, 2023). The application of modules in CNC learning can increase student activity and learning outcomes (Susanti & Kurniawan, 2020). 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).

RESULTS AND DISCUSSION

Results

Table 7. Validation from experts.

	Validation				
	Problem-Solving Skills	**Technology Skills**	**Team Work Skills**	**Self Management Skills**	**Work Readiness**
Aspects of Quality Indicators					
Materials	3.73	3.77	3.70	3.44	3.56
Construction	3.65	3.31	3.20	3.83	3.83
Aspects of Language					
Communicative	3.30	3.40	2.80	3.80	3.90
Language accuracy	3.28	3.60	3.36	3.88	3.92
Straightforward	3.45	3.55	3.75	3.45	3.85
Suitability to students	3.50	3.50	3.50	3.80	3.95
Coherence and integration of thought flow	3.93	3.93	3.60	3.47	3.73
Instrument Sheet Aspects					
Clarity	3.80	3.80	3.67	3.80	3.80
Rerata skor	3.58	3.13	3.44	3.68	3.81
Prosentase	91.33%	93.66%	90.33%	92.6%	95%

Table 8. Results of problem-solving skills trial instrument analysis.

Items	**INFIT**		**OUTFIT**		**Conclusion**
	MNSQ	**ZSTD**	**MNSQ**	**ZSTD**	
1	0.76	-0.74	0.39	-0.10	used
2	0.86	-0.63	0.44	-0.04	used
3	1.25	0.84	0.65	0.19	used

Table 9. Results of technology skills trial instrument analysis.

Items	**INFIT**		**OUTFIT**		**Conclusion**
	MNSQ	**ZSTD**	**MNSQ**	**ZSTD**	
1	1.19	0.68	1.49	1.22	used
2	0.81	-0.75	0.44	-0.64	used
3	0.73	-0.93	0.65	-0.98	used
4	0.92	-0.21	1.08	0.35	used

Table 10. Results of teamwork skills trial instrument analysis.

Items	**INFIT**		**OUTFIT**		**Conclusion**
	MNSQ	**ZSTD**	**MNSQ**	**ZSTD**	
1	0.71	-1.44	0.41	-0.28	used
2	1.07	0.41	0.63	-0.1	used
3	0.83	-0.76	0.53	-0.11	used
4	1.23	1.13	0.80	0.21	used

Table 11. Results of self-management skills trial instrument analysis.

Items	**INFIT**		**OUTFIT**		**Conclusion**
	MNSQ	**ZSTD**	**MNSQ**	**ZSTD**	
1	1.25	0.83	3.39	3.04	not used

2	0.05	-1.67	0.02	-1.04	used
3	0.39	-0.61	0.10	-0.65	used
4	0.05	-1.67	0.02	-1.07	used
5	0.05	-1.67	0.02	-1.08	used
6	0.38	-0.61	0.13	-0.59	used
7	0.39	-0.61	0.10	-0.65	used
8	0.05	-1.72	0.02	-1.06	used
9	0.38	-0.61	0.11	-0.64	used
10	0.39	-0.61	0.10	-0.65	used
11	0.05	-1.72	0.02	-1.06	used
12	0.38	-0.61	0.11	-0.64	used
13	1.01	0.32	0.64	0.18	used
14	0.05	-1.67	0.02	-1.08	used
15	0.38	-0.61	0.13	-0.59	used
16	0.39	-0.61	0.10	-0.65	used
17	1.01	0.32	0.64	0.18	used
18	0.38	-0.61	0.11	-0.64	used
19	1.01	0.32	0.64	0.18	used
20	2.63	1.53	6.10	2.24	not used
21	0.39	-0.61	0.10	-0.65	used
22	2.05	2.06	5.11	4.21	not used
23	1.94	1.92	7.19	5.13	not used

Table 12. Results of work readiness trial instrument analysis.

Item	INFIT		OUTFIT		Conclusion
	MNSQ	ZSTD	MNSQ	ZSTD	
1	0.89	-0.32	0.76	-0.58	used
2	0.95	-0.06	0.77	-0.56	used
3	1.62	1.74	2.11	2.43	not used
4	0.97	-0.05	1.56	1.05	used
5	2.35	3.19	2.55	3.11	not used
6	1.26	0.85	1.26	0.78	used
7	0.77	-0.76	0.72	-0.70	used
8	0.89	-0.32	0.76	-0.58	used
9	0.64	-1.18	0.65	-0.97	used
10	0.91	-0.24	0.99	0.09	used
11	0.83	-0.51	0.80	-0.46	used
12	0.82	-0.50	0.78	-0.51	used
13	0.46	-2.17	0.42	-1.92	used
14	2.54	3.51	2.35	2.82	used
15	1.19	0.77	1.18	0.59	used
16	0.75	-0.96	0.71	-0.73	used
17	0.61	-1.40	0.55	-1.32	used
18	0.91	-0.24	0.99	0.09	used
19	0.77	-0.76	0.72	-0.70	used
20	0.96	-0.07	0.98	0.08	used
21	0.46	-2.17	0.42	-1.92	used
22	0.89	-0.32	0.76	-0.58	used
23	0.96	-0.07	0.98	0.08	used
24	0.89	-0.34	0.89	-0.18	used
25	0.61	-1.40	0.55	-1.32	used

Discussion

Based on Table 7, the problem-solving skills instrument scored 3.58, and 91.33% was declared valid and very suitable for use to measure indicators of problem-solving skills. Cognitive skills measurement with Bloom's taxonomy (Boeren & Berrozpe, 2022). The technology skills instrument scored 3.13 and 93.66% was declared valid and very suitable for use to measure indicators of technology skills. The teamwork skills instrument scored 3.44 and 90.33% was declared valid and very suitable for use to measure indicators of teamwork skills. The self-management skills instrument scored 3.68 and 92.60% was declared valid and very suitable for use to measure indicators of self-management skills. The work-readiness skills instrument scored 3.81 and 95.00% was declared valid and very suitable for use to measure indicators of work readiness skills. Instrument needed validity before being used to measure the student skills (Ulker & Korkut, 2023; Kawaguchi & Toriyabe, 2022)

Table 8 was the result of problem problem-solving skills instrument analyzed in 3 questions. For questions number 1 and number 2, the OMNSQ value was less than 0.50, and should not have been used, but the Outfit ZSTD value was accepted, because the value was -2.0 to +2.00. Question number 3 can be used in research because the IMNSQ and OMNSQ values are between 0.50 to 1.50. Using Stata software, the problem-solving skills instrument has a reliability of 0.79. Table 9 was the result of the technology skills instrument analyzed 4 questions. Item number 2 should not have been used because the Outfit MNSQ was 0.44, not appropriate 0.50 < MNSQ < 1.50. However, the ZSTD value of -0.64 is accepted, because it refers to -2.0 < ZSTD < +2.0 accepted questions. Using Stata software the technology skills instrument has a reliability of 0.49. Teamwork skills were analyzed by Ministep Winstep Rasch software for IMNSQ and OMNSQ. Table 10 was the result of the teamwork skills instrument analyzed in 4 questions. Item number 1 had an OMNSQ value of less than 0.50, which should not have been used, but the ZSTD value was accepted, because -2.00 to +2.00. the teamwork skills instrument has a reliability of 0.79.

Table 11 was the result of the self-management skills instrument analyzed 23 questions. 19 items could be used. Meanwhile, 4 items could not be used, because did not have a value range of -2.00 < ZSTD < +2.00 and did not have a value range of 0.50 < MNSQ < 1.50. Using Stata software, the technology skills instrument has a reliability of 0.94. The instrument includes the concept social cognitive model should a valid and reliable (Zanten et al., 2023). Table 12 was the result of the work readiness instrument analyzed 25 questions. 23 questions could be used. Meanwhile, 2 items (3 and 5) could not be used, because did not have a value range of -2.00 < ZSTD < +2.00 and did not have a value range of 0.50 < MNSQ < 1.50. Using Stata software, the work readiness instrument has a reliability of 0.94.

CONCLUSION

Fundamental Finding: The research instrument's problem-solving skills, technology skills, teamwork skills, and self-management skills were declared valid, very suitable, and reliable for use to measure indicators for work readiness vocational school students' competency of Machining Engineering skills in East Java. **Implication :** (1) The research instrument's problem-solving skills, technology skills, teamwork skills, self-

management skills, and work readiness have implications for research about the work readiness students of vocational high school at Machining Engineering program in East Java Indonesia. (2) students can prepare themselves to work in the manufacturing 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 only. (2) **Future Research :** (1) **a**dding variables to 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.

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