VANOS
JOURNAL OF MECHANICAL ENGINEERING EDUCATION
http;//jurnal.untirta.ac.id/index.php/vanos
ISSN 2528-2611, e-ISSN 2528-2700
Volume 9, Number 1, May 2024, Pages 16 - 24

Development of Industry-Based Occupational Safety and Health Learning Aids for Automotive Vocational School Students

Bambang Sudarsono[1], Wegig Pratama[2]

[1]Automotive Technology Vocational Education Department, Faculty of Teacher Training and Education, Universitas Ahmad Dahlan, Indonesia
Kapas Street No.9, Semaki, Kec. Umbulharjo, Yogyakarta City, Daerah Istimewa Yogyakarta, Indonesia
[2]Ship Machinery Department, Sekolah Tinggi Maritim Yogyakarta, Indonesia
Magelang Street K.M. 4,4, Sleman District, Daerah Istimewa Yogyakarta, Indonesia

Corresponding author: bambang.sudarsono@pvto.uad.ac.id

Accepted: 15 January 2024. Approved: 29 March 2024. Published: 30 May 2024

ABSTRACT

Occupational Safety and Health (K3) is an important aspect for creating a safe and healthy work environment. K3 is a competency that all prospective workers, especially vocational school graduates, must have. K3 learning tools are needed that play an important role in presenting industry-based knowledge, as well as emphasizing K3 practices in an interactive and interesting way in learning. This research aims to develop K3 learning teaching aids and test their effectiveness in improving student competence. This research is research and development (R&D) which adopts the Four-D development model consisting of Define, Design, Develop, and Disseminate. The object of the research was carried out at SMK Muhammadiyah 2 Sleman with the research subjects consisting of 34 students, 2 teachers and 2 industrial practitioners. Data collection techniques use tests and non-tests with research instruments in the form of interviews, questionnaires and practical performance tests. The development of industry-based K3 teaching aids was carried out well and effectively increased K3 competency during two trials. The achievement of K3 competency can be seen from the increase in the average score of the competency test in the limited trial stage with a score of 68 and the score in the expanded trial of 88.

Keywords: Occupational Safety and Health, Industry-Based, Vocational School

INTRODUCTION

Based on data submitted by the Ministry of Manpower (Kemenaker), there were 370,747 cases of work accidents that befell workers in Indonesia, including wage earners, non-wage earners, and workers in the construction services sector. This figure has recorded an increase in the last three years since 2020 [1][2][3]. Rapid technological developments occur in the occupational safety and health (K3) sector. K3 competency is very important because it concerns the safety and health of workers, including students who will enter the world of work [4][5][6]. This problem is increasingly becoming a focus because a lack of understanding and implementation of appropriate K3 practices can potentially result in the risk of accidents and negative impacts on workers' health [7][8].

Vocational Schools (SMK), which function to create skilled and work-ready personnel, require the preparation of teachers' abilities to form students' K3 competencies [9][10][11]. However, the lack of quantity and suitability of learning media to industry needs is still a problem for teachers in teaching K3. Several efforts have been made by Vocational Schools to improve K3 competency, one of which is by developing learning media in the form of learning aids. So far, the development of K3 learning aids has only focused on K3 material [12][13]. Not many automotive engineering vocational schools have learning media related to K3 competencies [14][15][16]. Most of them are still conventional K3 tools that focus on understanding official material. K3 learning tools that are integrated with industry have not been developed [17][18].

The development of industry-based K3 learning tools is becoming increasingly important in efforts to increase students' understanding and awareness of K3 practices [19][20][21]. The development of industry-based K3 tools is expected to prepare vocational school graduates with the skills and knowledge needed to face K3 risks and challenges in the workplace [22][23].

RESEARCH METHOD

The research design used in this research is a 4D device development model which includes four development stages, namely: Define, Design, Develop, and Disseminate. The research stages can be seen in Figure 1.

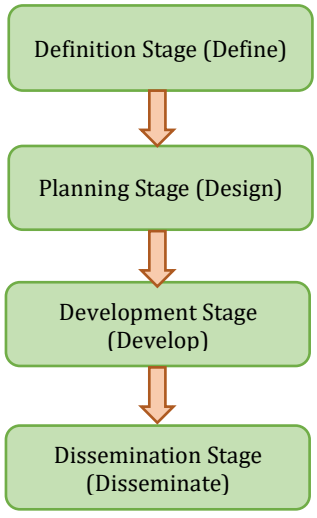

Figure 1. Stages four-D device development model [24]

The research object was carried out at SMK Muhammadiyah 2 Sleman with research subjects consisting of 34 students, 2 teachers and 2 industrial practitioners. Data collection instruments consist of interviews, questionnaires and practical performance tests. The questionnaire functions to gather input from K3 learning and scientific experts from industry. Meanwhile, the test functions to test the effectiveness of K3 learning aids in improving K3 competency

Table 1. Interview grid

Indicator	Item
a. Understanding of K3 in the Work Environment	1,2
b. Current use of learning media	3,4
c. Challenges in K3 Development	5,6
d. Specific Needs in Learning Media Development	7.8
e. Learning Media Preferences and Characteristics	9,10

Table 2. Questionnaire instrument grid

Indicator	Item
a. Suitability to Learning Objectives	1,2
b. Relevance of Material	3,4
c. Ease of Use	5,6
d. Interactivity	7.8
e. Suitability to Students' Cognitive Level	9,10

The grid for the practical performance test instrument can be seen in Table 3.

Table 3. Practice performance test grid

Indicator	Item
a. Attitudes in Facing the Risk of Work Accidents	1
b. Knowledge about the Use of Personal Protective Equipment (PPE)	2,3
c. Knowledge of Handling Hazardous Materials	4.5
d. First Aid Skills	7.8
e. Safety Communications	9,10

The type of data for this research is quantitative descriptive research. Quantitative data is used to analyze the results of filling out learning and industry expert questionnaire instruments. Quantitative data is obtained from numerical scores and then converted into a categorization formula. To calculate the results of the questionnaire instrument, the following formula is used:

$$\text{Value} = \frac{\text{Score Acquisition}}{\text{Maximum Score}} \text{ X } 100$$

To be able to provide meaning based on instrument assessments by learning and industry experts, we use the categorization conversion of the questionnaire instrument results in Table 4.

Table 4. Conversion of categorization of questionnaire instrument results [25]

Value Range	Category
3.01-4.00	Very good
2.01-3.00	Good
1.01-2.00	Enough
0-1.00	Not enough

RESULT AND DISCUSSION

Definition Stage (Define)

The Define stage is the initial stage which aims to identify problems or needs in developing K3 learning aids. The data collection technique used at this stage was interviews using the focus group discussion (FGD) method. FGD participants consisted of Automotive Engineering Vocational School teachers and industrial practitioners. This stage results in the conclusion that: (a) Students have so far studied K3 only to the extent of knowledge from books. Materials integrated with industry have not been implemented. (b) The increasing risk of work

accidents requires vocational schools to have K3 competencies required by industry. (c) The learning process requires learning tools that are appropriate to the industry.

Planning Stage (Design)

The Planning Stage (Design) aims to design or design the concept of K3 learning aids based on the information and understanding obtained at the definition stage. This stage contains two activities, namely designing K3 learning aids and compiling practical performance test instruments. The results of the design of K3 learning aids can be seen in Figure 2.

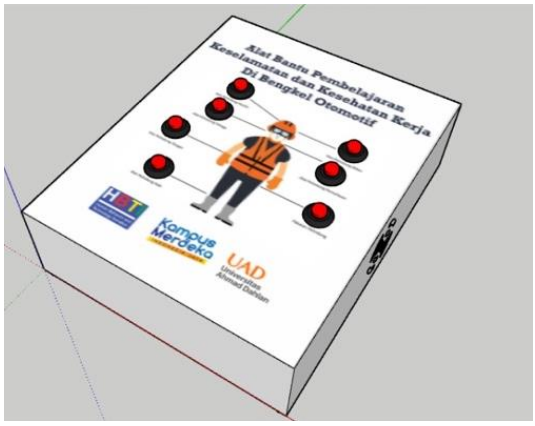

Figure 2. Design of K3 learning aids

Development Stage (Develop)

The aim of the development stage is to implement/make a product design for K3 learning aids into a product or prototype. The making of K3 learning aids was carried out by teachers, industrial practitioners and field assistants for 60 days. PrototypeK3 learning aids can be seen in Figure 3.

Figure 3. Prototype of K3 learning aids

After the K3 learning aid prototype has been created, the next step is to test the feasibility of the product and practical performance test instruments. The feasibility test is carried out by learning and material substance experts from the industry. The results of the instrument feasibility test can be seen in Table 4. Meanwhile the product feasibility test results can be seen in Table 5.

Table 4. Instrument feasibility test results

Indicator	Average Score	
	Teacher	Industry
Suitability to Learning Objectives	3,4	3,2
Relevance of Material	3,2	3,2
Ease of Use	3,4	3.6
Interactivity	3,2	3,4
Suitability to Students' Cognitive Level	3,2	3,2
Total Score	16.4	16.6
Average Score	**3.28**	**3.32**

Table 5. Product feasibility test results

Indicator	Average Score	
	Teacher	Industry
Attitudes in Facing the Risk of Work Accidents	4	4
Knowledge about the Use of Personal Protective Equipment (PPE)	3.6	3,4
Knowledge of Handling Hazardous Materials	3,4	3,4
Total Score	11	10.8
Average Score	**3.6**	**3.6**

From the feasibility test of performance test instruments and K3 learning aid products, experts/experts concluded that they had very good feasibility. After feasibility testing, the performance test instruments and K3 learning aid products were tested to determine their effectiveness. The trial was carried out twice and resulted in an increased average score of practical performance. The test results can be seen in Figure 4.

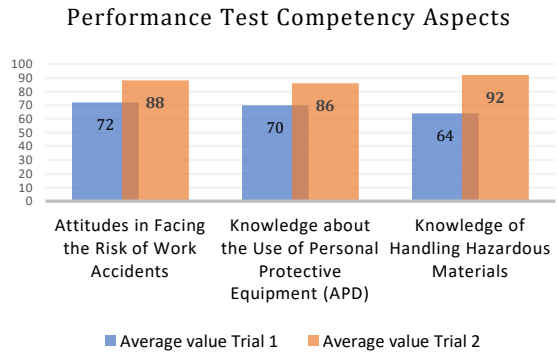

Figure 4. Practical performance tests

Dissemination Stage (Disseminate)

The aim of the Dissemination Stage is to ensure that K3 learning aid productscan provide maximum impact for K3 learning in vocational schools. The form of this stage which has been implemented is promotion in two vocational schools and 2 industries in the Special Region of Yogyakarta.

Development Industrial integrated K3 learning aids are very useful for teachers as learning infrastructure. Benefits are proven by increasing K3 attitudes, knowledge and skills [26][27][27]. Not only that, by implementing industry-integrated K3 learning tools, it is easier for teachers to introduce the real conditions of K3 needs in industry [28][29][13]. For industry, development Industrial integrated K3 learning tools are one solution for industrial practitioners to provide input regarding K3 competencies in industry [30][31][32].

The development of industry-based occupational safety and health learning has several main characteristics that reflect the needs and realities of the industrial world. First, occupational safety and health learning materials are prepared based on occupational safety and health standards and regulations applicable in industry, with case examples and field studies taken from real incidents as well as the use of occupational safety and health tools and equipment commonly used in the workplace. A practical and interactive approach is also characteristic, involving simulations, role plays and practical exercises according to real work situations, as well as the use of simulation devices or occupational safety and health tools to enable students to experience and transmit occupational safety and health measures directly. Continuous

evaluation is carried out through a continuous and comprehensive assessment system, with feedback from industry to improve learning materials. With these characteristics, the development of industry-based K3 learning can be more effective in preparing students to meet the demands and challenges of the world of work.

CONCLUSION

The development of industrial integrated occupational safety and health (K3) learning aids was successfully developed with the 4D research and development stages (Define, Design, Develop, and Disseminate). K3 learning aids and practical performance test instruments are very suitable for use as instruments to increase K3 competency for Automotive Engineering Vocational School students. This is proven by an increase in the average value of the practical performance test.

ACKNOWLEDGEMENT

We would like to express our thanks to LPPM UAD who has funded our research with contract number: PIPP-315/SP3/LPPM-UAD/VIII/2023. I would also like to convey my thanks to the automotive vocational education study program, Muhammadiyah Vocational School 2 Sleman, IO Robotic and Human Behavior Technology and Innovation (HBTI) School.

REFERENCES

[1] B. Plawgo and A. Ertman, "Competency Needs of Industry 4.0 Companies," *Cent. Eur. Manag. J.*, vol. 29, no. 4, pp. 172–195, 2021, doi: 10.7206/cemj.2658-0845.64.

[2] B. Sudarsono, F. Tentama, F. A. Ghozali, and P. Listyaningrum, "Industry-Oriented Experiential Learning Model to Enhance Vocational High School Students' Job Readiness," *J. Educ. Res. Eval.*, vol. 7, no. 3, pp. 380–390, 2023, doi: 10.23887/jere.v7i3.54224.

[3] N. Fakhrunnisaa and S. Munadi, "Relevance of Multimedia Expertise Competency in Vocational Schools toward the needs of Business/Industrial World," *J. Educ. Sci. Technol.*, vol. 5, no. 1, pp. 58–66, 2019, doi: 10.26858/est.v5i1.6923.

[4] O. Candra, A. Putra, S. Islami, D. T. P. Yanto, R. Revina, and R. Yolanda, "Work Willingness of VHS Students at Post-Industrial Placement," *TEM J.*, vol. 12, no. 1, pp. 265–274, 2023, doi: 10.18421/TEM121-33.

[5] G. Aydın and O. Mutlu, "Project-Based Learning and Flipped Classroom Model Supported Project-Based Learning's Impact on Academic Success, Retention, and Individual Innovation Competence," *Int. J. Contemp. Educ. Res.*, vol. 10, no. 4(Online First), pp. 823–833, 2023, doi: 10.52380/ijcer.2023.10.4.532.

[6] A. Colim, P. Carneiro, J. D. Carvalho, and S. Teixeira, "Occupational Safety & Ergonomics training of Future Industrial Engineers: A Project-Based Learning Approach," *Procedia Comput. Sci.*, vol. 204, no. 2021, pp. 505–512, 2022, doi: 10.1016/j.procs.2022.08.119.

[7] F. Ekaputra, "Effectiveness of Project-Based Learning Model on Improving Critical Thinking Skills and Student Creativity," vol. 3, no. 5, pp. 0–4, 2023.

[8] B. Tjahjadi, N. Soewarno, T. El Karima, and A. A. P. Sutarsa, "Business strategy, spiritual capital and environmental sustainability performance: mediating role of environmental management process," *Bus. Process Manag. J.*, vol. 29, no. 1, pp. 77–99, 2023, doi: 10.1108/BPMJ-11-2021-0718.

[9] B. Sudarsono *et al.*, "Development of Integrated Project-Based (PjBL-T) Model to Improve Work Readiness of Vocational High School Students," *J. Pendidik. Vokasi*, vol. 12, no. 3, pp. 222–235, 2022, [Online]. Available: https://doi.org/10.21831/jpv.v12i3.53158.

[10] M. Setiyo *et al.*, "Industry 4.0: Challenges of Mechanical Engineering for Society and Industry," *Mech. Eng. Soc. Ind.*, vol. 1, no. 1, 2021, doi: 10.31603/mesi.5309.

[11] A. Firman, "Implementation of Occupational Safety and Health (K3) for Increasing Employee Productivity," *J. Econ. Resour.*, vol. 5, no. 2, pp. 365–376, 2022.

[12] Sinollah Sinollah and Achmad Zaki, "the Effect of Occupational Safety and Health Management (K3) on Work Productivity of Employees," *Int. J. Econ. Manag. Res.*, vol. 1, no. 1, pp. 46–52, 2022, doi: 10.55606/ijemr.v1i1.19.

[13] S. Gultom, Baharuddin, D. Ampera, B. K. Amal, and A. S. Purba, "Implementation Of Occupational Safety And Health (K3) For Students In Facing Pandemic," *Nat. Volatles Essent. Oils*, vol. 8, no. 4, pp. 2633–2648, 2021.

[14] H. Purnomo, B. Santosa, F. Tentama, M. Mungkid, C. Java, and U. A. Dahlan, "Implementation of Problem Based Learning and Group Investigation (PBL Go-In) to Improve Vocational Students ' Competence," vol. 2, no. 1, pp. 47–54, 2019.

[15] B. Sudarsono, F. Tentama, F. A. Ghozali, U. Ahmad, and D. Yogyakarta, "Development of Android-Based Student Performance Tool (Tunersindro) to Improve Work Readiness of Vocational High School Students," *J. Iqra' Kaji. Ilmu Pendidik.*, vol. 7, no. 2, pp. 271–285, 2022.

[16] B. Sudarsono, "Industrial-based practical learning development for teacher competence of automobile technology," *J. Phys. Conf. Ser.*, vol.

1446, no. 1, p. 12062, Jan. 2020, doi: 10.1088/1742-6596/1446/1/012062.

[17] Bambang Sudarsono, "Pelatihan Kesehatan Dan Keselamatan Kerja (K3) Sebagai Upaya Pencegahan Resiko Kecelakaan Kerja Bagi Calon Tenaga Kerja Otomotif di Era Pandemi," *JURPIKAT (Jurnal Pengabdi. Kpd. Masyarakat)*, vol. 2, no. 3, pp. 566–577, 2021, doi: 10.37339/jurpikat.v2i3.763.

[18] F. Tentama, B. Sudarsono, and F. A. Ghozali, "Pelatihan dan Penerapan Alat Bantu Penilaian Kinerja Untuk Akselerasi Kesiapan Kerja Siswa Menengah Kejuruan (SMK) Teknik Otomotif m," *Sinar Sang Surya (Jurnal Pus. Pengabdi. Kpd. Masyarakat)*, vol. 6, no. 1, pp. 143–151, 2022.

[19] G. Spöttl and L. Windelband, "The 4th industrial revolution–its impact on vocational skills," *J. Educ. Work*, vol. 34, no. 1, pp. 29–52, 2021, doi: 10.1080/13639080.2020.1858230.

[20] I. Calero López and B. Rodríguez-López, "The relevance of transversal competences in vocational education and training: a bibliometric analysis," *Empir. Res. Vocat. Educ. Train.*, vol. 12, no. 1, 2020, doi: 10.1186/s40461-020-00100-0.

[21] N. A. Yunikawati, P. H. Prayitno, M. P. Purboyo, N. Istiqomah, and E. Yunika, "Causes and solution to reduce unemployment vocational school graduate in Indonesia," *UNEJ e-Proceeding*, vol. 3, no. November 2017, pp. 200–207, 2018.

[22] D. A. Sudjimat, A. Nyoto, and M. Romlie, "Implementation of Project-Based Learning Model and Workforce Character Development for the 21st Century in Vocational High School," *Int. J. Instr.*, vol. 14, no. 1, pp. 181–198, 2020, doi: 10.29333/IJI.2021.14111A.

[23] H. Rintala and P. Nokelainen, "Vocational Education and Learners' Experienced Workplace Curriculum," *Vocat. Learn.*, vol. 13, no. 1, pp. 113–130, 2020, doi: 10.1007/s12186-019-09229-w.

[24] D. Kurniawan, S. V. Dewi, and L. Kerja, "Seri Pendidikan ISSN 2476-9312 PENGEMBANGAN PERANGKAT PEMBELAJARAN DENGAN MEDIA SCREENCAST- O-MATIC MATA KULIAH KALKULUS 2 MENGGUNAKAN MODEL 4-D ISSN 2476-9312," *J. Siliwangi*, vol. 3, no. 1, 2017.

[25] D. Mardapi, *Teknik Penyusunan Instrumen Tes Dan Non Tes*. Yogyakarta: Mitra Cendikia Offset, 2008.

[26] G. Katunge *et al.*, "Maintaining Health and Safety at Workplace: Employee and Employer's Role in Ensuring a Safe Working Environment," *J. Educ. Pract.*, vol. 7, no. 29, pp. 1–7, 2016, [Online].

Available: www.iiste.org.

[27] N. C. Iswanto, Soerahman, A. Naim, and R. Saputra, "The Influence Of Occupational Safety And Health (K3) On Employee Work Productivity With Multiple Linear Regression Methods At Pt. Udm," *Int. J. Sci. Soc.*, vol. 5, no. 5, pp. 39–52, 2023, doi: 10.54783/ijsoc.v5i5.866.

[28] M. Munir, S. A. Dewanto, and B. Wulandari, "The Implementation of Occupational Safety and Health (OSH) in Practical Courses of the Electronics Engineering Education Study Program, Faculty of Engineering, Yogyakarta State University," *J. Phys. Conf. Ser.*, vol. 1140, no. 1, 2018, doi: 10.1088/1742-6596/1140/1/012015.

[29] R. Arthur, A. Anisah, I. Wijayanti, and J. Sidik, "Occupational Health and Safety Animated Learning Videos: Validity and Feasibility," *JPI (Jurnal Pendidik. Indones.*, vol. 10, no. 1, p. 1, 2021, doi: 10.23887/jpi-undiksha.v10i1.25192.

[30] K. I. Ismara, A. Suharjono, and D. Supriadi, "Ubiquitous learning in occupational health and safety for vocational education," *Int. J. Eval. Res. Educ.*, vol. 10, no. 1, pp. 285–292, 2021, doi: 10.11591/ijere.v10i1.20823.

[31] A. M. Vukićević, I. Mačužić, M. Djapan, V. Milićević, and L. Shamina, "Digital training and advanced learning in occupational safety and health based on modern and affordable technologies," *Sustain.*, vol. 13, no. 24, 2021, doi: 10.3390/su132413641.

[32] E. Berhan, "Prevalence of occupational accident; and injuries and their associated factors in iron, steel and metal manufacturing industries in Addis Ababa," *Cogent Eng.*, vol. 7, no. 1, 2020, doi: 10.1080/23311916.2020.1723211.