



# Development of Robotic System Controller Textbook Based on Problem-based Learning (PBL) for Vocational High School XI Grade for Industrial Electronics Engineering

I Made Wirawan<sup>1,\*</sup>, Rizqy Luthfianto<sup>1</sup>, Dyah Lestari<sup>1</sup>, Dodik Septian Ferdiansyah<sup>2</sup>

<sup>1</sup> Department of Electrical and Informatics Engineering, Faculty of Engineering, Universitas Negeri Malang, Malang, Indonesia

<sup>2</sup> Electrical Engineering, Sekolah Tinggi Teknologi Industri Turen, Malang, Indonesia

\*Corresponding author. Email: [made.wirawan.fi@um.ac.id](mailto:made.wirawan.fi@um.ac.id)

## ABSTRACT

The research and development of textbooks for Robotic System Control classes in TEI class XI SMK Negeri 1 Kepanjen aimed to assist students who may not understand the material when taught through lectures. The Dick and Carey model was used for teaching material development, while the Sadiman development method was used for textbook development. The steps included identifying needs, formulating learning objectives, formulating material items, formulating success measuring tools, compiling media manuscripts/drafts, conducting tests/trials, and revisions. The resulting textbooks are in accordance with the Minister of Education and Culture's regulations and are divided into student and teacher textbooks. The reference used for the textbooks is the 2013 Curriculum with the Problem Based Learning (PBL) model. The development data analysis showed that the textbooks were very valid, with material experts scoring 90.85%, media experts scoring 92.53%, small group trials scoring 92.71%, and field trials scoring 90.35%, all exceeding the minimum validity limit of 70.01%.

**Keywords:** Development, Textbook, Robotics System Controller, Problem-Based Learning.

## 1. INTRODUCTION

Teaching materials are an essential element in the process of teaching and learning. They aim to fulfill the basic and core competencies of a subject. The National Education Standards Body (BSNP) has set a standard for the eligibility of books that must be adapted to the applicable curriculum, namely the 2013 curriculum.

In textbooks, various learning models can be applied to understand the material. However, at SMK Negeri 1 Kepanjen, the learning model still used is the lecture method. According to Muhibbin [1], the lecture method can be considered the easiest way to convey information and is more effective when teaching materials are not adequate. However, this method can make students passive and bored if used continuously, and it is difficult to assess their progress in absorbing the information. Based on observations of the learning process and interviews with teachers who teach the Robot System Control subject, it was found that a better method is needed to improve the teaching and learning process. One

such method and learning model that complements the lecture method is Problem-Based Learning (PBL), which is used in the developed book.

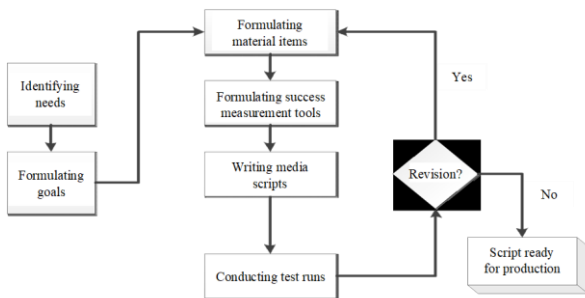
The use of PBL is based on observations made at SMK Negeri 1 Kepanjen, where students still lack mature problem-solving skills. Therefore, the PBL learning model is the most effective approach for teaching and learning at SMK Negeri 1 Kepanjen. With this model, teachers can help students improve their ability to identify and solve problems independently. PBL fosters independent learning, as students are able to choose appropriate learning strategies, control the learning process, and stay motivated to complete their learning.

A textbook was developed to address the problems identified earlier and implement the proposed solution at SMK negeri 1 kepanjen. Textbooks refer to books used for specific fields of study and are compiled by experts in those fields as instructional materials. They are equipped with facilities and infrastructure that are easily understandable by users in schools and colleges, making them essential to support the teaching process [2-4]. The

existence of textbooks enhances the effectiveness of teaching and learning activities in schools. Therefore, a research and development project was undertaken to create a textbook titled "development of textbooks for robotic system controllers based on problem-based learning (pbl) models for class xi vocational high schools department of industrial electronics engineering."

**2. METHOD**

The Sadiman method of Research and Development (R&D) is used as a reference for creating, producing, and testing learning resources. According to Sadiman, there are six steps involved in the research and development process [5]: 1) Identifying needs; 2) Formulating goals; 3) Formulating material items; 4) Formulating success measurement tools; 5) Writing media scripts; and 6) Conducting test runs and making revisions, as shown in **Figure 1**.



**Figure 1.** Sadiman Development Model [5]

The selection of development procedures, according to Sadiman, is based on the following reasons: 1) The steps in the method are clear and easy to apply; 2) There are design revisions and product revisions if the results are not appropriate; 3) The product is not mass-produced, as it is tailored to the needs of SMK Negeri 1 Kepanjen.

According to Sadiman, product testing can be carried out in several stages. The first stage involves a one-on-one trial with two people. The second stage involves small group trials with a minimum of 10-20 people who can represent the target population. This stage is used to assess the readiness of the product before it is tested on a larger scale. The third stage is a large-scale or field trial involving approximately 30 people as a sample that can be representative of population characteristics. If the test results are not appropriate or if the product receives a positive response of less than 81.26% of the accumulative value of validity given by product trial respondents [6], as shown in **Table 1**, revisions are made to the product. Once the manuscript is ready for production, the resulting product is ready to be used as the final product.

**Table 1.** Validity Criteria

No	Validity Criteria	Validity Effectiveness Level
1	81.26% - 100.00%	Very valid, very effective, very thorough, usable without improvement
2	62.51% - 81.25%	Quite valid, quite effective, quite complete, usable but needs minor improvements
3	43.76% - 62.50%	Less valid, less effective, or less complete, needs major improvement, is recommended not to be used.
4	25.00% - 43.75%	Invalid, ineffective, incomplete, unusable

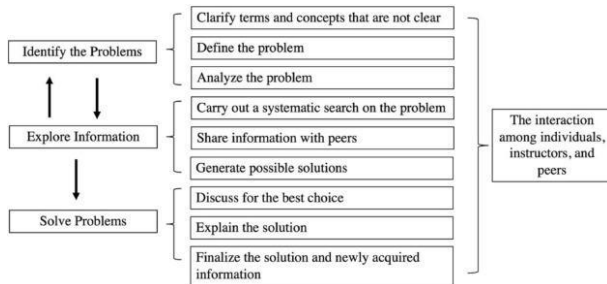
The structure of the textbook refers to the National Standards in Ministry of Education and Culture Regulation Number 8 of 2016 Article 3, which is adjusted to the needs of Vocational High School 1 Kepanjen. Several parts need to be considered in writing a textbook, namely the cover, the beginning, the content, and the end [7]. In the cover, there are several parts consisting of 1) front cover, 2) back cover, and 3) spine. The beginning consists of 1) title, 2) introduction, 3) table of contents, 4) table of tables, 5) table of figures, and 6) instructions for using the book. Meanwhile, the content consists of 1) chapters/units, 2) learning objectives, 3) material descriptions in each unit, 4) summary, and 5) formative

tests. The closing part consists of 1) a glossary, 2) a bibliography, and 3) about the author [8]. With the inovative content on the textbooks of robotics[9][10].

According to the learning objectives, the teaching materials for Robotic [11][12] System Controllers using the Problem Based Learning (PBL) model discuss core concepts and competencies. There are five primary learning objectives that must be met: 1) comprehension of basic physics concepts related to compressed air, 2) understanding of the process for providing dry and clean compressed air, 3) selection of pneumatic components used in machine operation, 4) application of cylinder speed regulation techniques, and 5) application of

electrical components for creating electro pneumatic circuits.

The PBL learning model emphasizes problem-based learning, which occurs in real-world contexts to encourage critical thinking and problem-solving skills in students [13-15]. The model consists of five steps: 1) presenting a problem to students, 2) students discussing the problem in small groups, 3) students working on solving the problem independently, 4) students sharing information with other groups and receiving guidance from the teacher, and 5) learners sharing their results and reflecting on the process. All participants share their solutions and confirm their correctness with the guidance of the teacher. More details are presented in Figure 2.



**Figure 2.** Stages of Problem-Based Learning [16]

The teaching materials that have been completed and undergone one-on-one trials are validated by media experts before being tested on respondents or students. A media expert is someone who specializes in creating learning materials in the form of textbooks. The media expert involved in this project is Mr. I Made Wirawan, S.T., S.S.T., M.T., who is highly skilled in creating and validating textbooks. A material expert is someone who is knowledgeable in the field of Robotic System Controllers. The material experts involved in this project are Mrs. Dyah Lestari, S.T., M.Eng. and Mr. Ari Prabowo S.Pd., who are proficient in the material and its validation. The respondents are a group of individuals who will be used as research subjects by the researcher. The number of respondents studied will be divided into two groups: small groups of 10 people and large groups of 30 people, who will be selected randomly.

The data collection tool used in this study is a survey. Surveys can measure indicators of a program that fall into categories such as education, technical quality, and program presentation. Expert survey tools can be used to assess and gather data on the suitability of a product as a tool and resource for learning. Additionally, user response surveys will be tested through individual, small group, and field trials. The Likert scale is the type of scale used in crafting the survey. According to Arikunto, the Likert scale is structured as a statement followed by four response levels indicating the level of approval [17].

The formula utilized for processing data from experts and respondents is referred to as Akbar's formula [18].

$$V_{ah} = \frac{T_{Se}}{T_{Sh}} \times 100\% \quad (1)$$

Information:  $V_{ah}$  is Expert Validation,  $T_{Se}$  is the Total empirical score achieved, and  $T_{Sh}$  is the Expected total score.

### 3. RESULTS AND DISCUSSION

Teaching materials have been developed in the form of textbooks for both teachers and students. The developed textbooks contain material that discusses the controller of robotic systems in Class XI, Semester 1 of the Industrial Electronics Engineering expertise program, with five basic competencies. These are: 1) Understanding the basic physics concepts related to pressurized air, 2) Understanding the process of supplying dry and clean compressed air, 3) Choosing pneumatic components to operate a machine, 4) Applying how to adjust the cylinder speed, and 5) Applying electrical components used to make an electromagnetic circuit. The front cover of textbooks for teachers and students is shown in Figure 3.



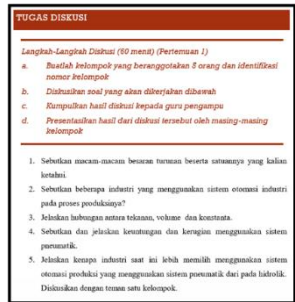
**Figure 3.** Front cover of Textbook for Teachers and Student

The development of textbooks based on Problem-Based Learning presents the material by providing problems in the form of case studies, such as Figure 4, to be analyzed and hypotheses to be formulated before proceeding to the core material.

**Figure 4.** Case study is the first stage of PBL

Stage 2 of PBL involves organizing students into several groups. Stage 3 involves conducting research based on questions formulated from the case study, as depicted in Figure 5. Stage 4 involves presenting the

results of the discussion in the form of a report. Stage 5 involves analyzing and evaluating the solutions formulated in the report.



**Figure 5.** Discussion about resolving the case study.

The level of achievement in writing a textbook can be ascertained through the use of an evaluation tool consisting of assessment questions aligned with the textbook's learning objectives. This tool can be in the form of a formative exam, which may include multiple-choice and essay questions, along with an associated grading rubric.

Based on Sadiman's research model, one-on-one trials were conducted to validate media experts, material experts, and respondents/students in small group trials of 10 students and field trials of 30 students chosen at random. The results of the validation and trials were highly valid, with media expert validation for teacher textbooks achieving 92.05% and student textbooks achieving 94.57%, while material expert validation for teacher textbooks achieving 90.7% and student textbooks achieving 91%. Product trials were conducted in small groups with textbooks achieving 92.71% and field trials achieving 90.35%.

#### 4. CONCLUSION

Textbooks for the subject of Robotic System Control by applying the Problem Based Learning (PBL) learning model for Class XI Semester 1 Vocational Students Industrial Electronics Engineering Expertise Program has been developed and made in accordance with the learning objectives and revised 2013 curriculum syllabus.

This textbook has gone through an expert validation process in material and media and has been tested on respondents with the conclusion that it is feasible to be used as teaching material for Robotic System Control subjects.

#### REFERENCES

- [1] S. Muhibbin, Psikologi pendidikan dengan pendekatan baru, 12th ed. Bandung: Remaja Rosda Karya, 2006.
- [2] A. Prastowo, Panduan Kreatif Membuat Bahan Ajar Inovatif: Menciptakan Metode Pembelajaran Yang Menarik Dan Menyenangkan, Edisi 2013. Yogyakarta: Diva Press, 2013.
- [3] M. Ibrahim, F. Rachmadiarti, M. Nur, and Ismono, Pembelajaran Kooperatif . Surabaya: UNESA-University Press, 2000.
- [4] H. Irawati, The Development of Textbook For A Course of Pengembangan Bahan Ajar Biologi (Biology Teaching Material Development) For Biology Education Department Students of Universitas Ahmad Dahlan, Indonesian Journal of Biology Education, vol. 2, no. 1, Apr. 2019, DOI: 10.31002/ijobe.v2i1.1247.
- [5] A. S. Sadiman, Harjito, A. Haryono, and Rahardjo R, Media pendidikan: pengertian, pengembangan, dan pemanfaatannya, 18th ed. Depok: Rajagrafindo Persada, 2018.
- [6] A. Arsad and A. Rahman, Media pembelajaran, 20th ed. Jakarta: Rajawali Press, 2017.
- [7] D. Atkinson and S. Corbitt, 'To discipline my writing process': How newcomers to open textbook development moderate affective states and sustain momentum while writing, Social Sciences & Humanities Open, vol. 7, no. 1, 2023, p. 100461, doi: 10.1016/j.ssaho.2023.100461.
- [8] Menteri Pendidikan dan Kebudayaan RI, Peraturan Menteri Pendidikan dan Kebudayaan Nomor 8 Tahun 2016 tentang Buku yang digunakan oleh satuan pendidikan. <https://jdih.kemdikbud.go.id/sjdih/siperpu/dokumen/salinan/Permendikbud%20Nomor%208%20Tahun%202016.pdf>, 2016.
- [9] Muttaqin, Membuat Bahan Ajar Inovatif, Muttaqin ID, Jun. 2016. <https://www.muttaqin.id/2016/06/membuat-bahan-ajar-inovatif.html> (accessed Jul. 02, 2023).
- [10] M. S. Zuhrie, Ekohariadi, M. Samani, and Munoto, Pengembangan Modul Ajar Plus Kit Robotika Berbasis Contextual Teaching And Learning Sebagai Pengetahuan Dasar Model Public Private Partnership Bagi Siswa Smk Melalui Lomba Kompetensi Siswa, Prosiding Seminar Nasional UNS Vocational Day, C. Budiyanto, Muslim Riyadi, V. L. P. Sutrisno, and P. Hatta, Eds., Surakarta: Open Journal System, 2017. Accessed: Jul. 01, 2023. [Online]. Available: <https://jurnal.uns.ac.id/uvd/article/view/15874>

- [11] D. E. Ramadhani, Y. S. Nugroho, F. Achmad, and L. E. C. Ningrum, Pengembangan Bahan Ajar Sar (Stamp Automatic Robot) Sebagai Pendukung Pembelajaran Kurikulum 2013 Di Smk Negeri 1 Tambelangan, *Jurnal Pendidikan Teknik Elektro*, vol. 11, no. 03, pp. 359–368, Jun. 2022, doi: 10.26740/jpte.v11n03.p359-368.
- [12] B. P. Saputro, Pengembangan Modul Pembelajaran Robot Nao Sebagai Media Pembelajaran Robot Humanoid Pada Pembelajaran Robotika Di Universitas Negeri Jakarta, Thesis, Universitas Negeri Jakarta, Jakarta, 2017. Accessed: Jun. 22, 2023. [Online]. Available: <http://repository.unj.ac.id/25312/>
- [13] F. Su'udiah, I. N. S. Degeng, and D. Kuswandi, Pengembangan Buku Teks Tematik Berbasis Kontekstual, *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, vol. 1, no. 9, Sep. 2016, Accessed: Jul. 02, 2023. [Online]. Available: <http://journal.um.ac.id/index.php/jptpp/article/view/6743>
- [14] S. R. Harahap, F. Harahap, and H. Hasruddin, Pengembangan Bahan Ajar Mikrobiologi Pangan Berbasis Masalah, *Jurnal Pendidikan Biologi*, vol. 5, no. 3, Aug. 2016, DOI: 10.24114/jpb.v5i3.4319.
- [15] W. Muga, B. Suryono, and E. L. Januarisca, Pengembangan Bahan Ajar Elektronik Berbasis Model Problem Based Learning dengan Menggunakan Model Dick and Carey, *Journal of Education Technology*, vol. 1, no. 4, pp. 260–264, 2017, DOI: <https://doi.org/10.23887/jet.v1i4.12863>.
- [16] Y. Liu and A. Pásztor, Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis, *Think Skills Creat*, vol. 45, p. 101069, Sep. 2022, DOI: 10.1016/j.tsc.2022.101069.
- [17] S. Arikunto and R. Damayanti, *Dasar-dasar evaluasi pendidikan*, 1st ed. Jakarta: Bumi Aksara, 2018.
- [18] S. Akbar and A. Holid, *Instrumen perangkat pembelajaran*, 2nd ed. Bandung: Remaja Rosdakarya, 2013.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

