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Article

Implementation of a CNC E-Module Integrating Pancasila Values at Angkasa Aviation Vocational High School, Malang

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CNC;
Pancasila;
Modul E;
Sekolah Menengah Kejuruan;
Pengembangan Karakter

Abstrak

Tingginya pengangguran lulusan Sekolah Menengah Kejuruan menunjukkan adanya kesenjangan antara kompetensi lulusan dan kebutuhan dunia kerja, khususnya pada bidang teknik pemesinan. Pendidikan vokasi juga masih cenderung menitikberatkan pada keterampilan teknis tanpa penguatan karakter dan nilai moral. Kegiatan pengabdian kepada masyarakat ini bertujuan mengimplementasikan e-modul Computer Numerical Control yang bermuatan nilai-nilai Pancasila untuk meningkatkan kompetensi teknis sekaligus pembentukan karakter peserta didik. Metode yang digunakan meliputi analisis kebutuhan, perancangan e-modul, implementasi pembelajaran, serta evaluasi. Subjek penelitian berjumlah 30 peserta didik, untuk mengetahui perbedaan penggunaan modul digunakan analisis a paired sample t-test dan the Mann–Whitney test. Hasil analisis pretest dan posttest menunjukkan peningkatan signifikan, membuktikan efektivitas e-modul dalam meningkatkan kompetensi CNC dan internalisasi nilai Pancasila.

Abstract

The high unemployment rate among Vocational High School graduates highlights a gap between their competencies and the workforce's needs, especially in mechanical engineering. Vocational education also tends to focus on technical skills without bolstering character and moral values. This community service activity aims to implement a Computer Numerical Control e-module that incorporates Pancasila values to improve technical skills while fostering student character. The methods include needs analysis, e-module design, learning implementation, and evaluation. The research involved 30 students. a paired sample t-test and the Mann–Whitney test were used to assess differences in the e-module. The pretest and posttest results showed significant improvements, demonstrating the e-module's effectiveness in enhancing CNC skills and Pancasila values.

KEYWORDS

CNC;
Pancasila;
E-module;
Vocational High School;
character development

1. INTRODUCTION

Every citizen has the right to decent work and a livelihood worthy of human dignity. In the context of mechanical engineering education—particularly CNC (Computer Numerical Control) learning—this constitutional mandate underscores the importance of equipping students with industry-relevant technical competencies. This responsibility is realized through public policies in education that aim to prepare human resources capable of accessing fair and decent employment. Vocational education, especially Vocational High Schools (SMK) with mechanical engineering programs, serves as a strategic instrument to achieve this objective, as it is specifically designed to prepare graduates for direct entry into the manufacturing workforce. The effectiveness of CNC learning in vocational education in improving graduate employability largely depends on the alignment between the curriculum, instructional practices, and current labor market needs (Agustian et al., 2024).

Empirical evidence shows that vocational high school graduates face serious challenges in absorbing the labor market. The Indonesian statistic (Badan Pusat Statistik, 2024) shows that the Open Unemployment Rate among vocational high school graduates reached 9.31%, higher than that of high school graduates (8.15%), diploma holders (4.79%), and university graduates (5.18%), with the Indonesian workforce totaling 212.59 million in 2024. The high unemployment rate indicates a gap between the competency of vocational high school graduates and the absorption capacity of the labor market (Dede Ridwan & Vina Dwiyanti, 2024).

One major factor exacerbating this gap is the limited availability of labor-intensive industries, particularly in the manufacturing sector that demands specific machining and CNC-related competencies (Andi M. Arief, 2021). According to data from the Ministry of Industry, the manufacturing sector absorbed approximately 18.7 million workers in 2021 (Kementerian Perindustrian Republik Indonesia, 2022). However, this capacity remains insufficient when compared to the total labor force, resulting in intense competition for positions that require CNC operation, programming, and precision machining skills. Consequently, many SMK graduates in machining engineering who lack industry-aligned CNC competencies are unable to enter the formal manufacturing sector and instead work in the informal sector, where labor rights protection is often inadequately fulfilled.

The success of educational institutions is often measured pragmatically by indicators such as graduate employment rates or the number of industry partnerships. As a result, the broader constitutional purpose of education is frequently interpreted in a narrow, utilitarian manner. In the context of mechanical engineering education, particularly CNC learning, this perspective overlooks the role of instructional practices in shaping students' professional ethics and work attitudes. In fact, the goal of educating the nation extends beyond employability to include the formation of individuals who are intellectually competent, morally upright, and socially responsible. Educational objectives rooted in Pancasila emphasize affective outcomes—such as discipline, responsibility, cooperation, and respect for occupational safety—which can be concretely cultivated through project-based CNC machining tasks, adherence to workshop safety standards, and collaborative

problem-solving in production simulations (Genika & Dewi, 2024).

Philosophical perspectives emphasize that rational thinking and moral judgment are fundamental to human development and remain highly relevant for vocational students. For SMK learners, these capacities support character formation in the workplace, including responsibility, critical thinking, adaptability, and learning from failure. Similarly, the cultivation of positive work habits—such as proactivity, goal orientation, collaboration, effective communication, and continuous self-improvement—is essential in preparing students to meet the ethical and professional demands of the industrial environment (Covey, 2004).

Education is therefore responsible not only for equipping students with technical skills but also for instilling Pancasila's ideological values as a moral and ethical foundation for technological mastery (Rifky, 2020). In CNC and manufacturing learning contexts, these values can be reflected through practices such as fair task distribution during machining projects, responsible use of materials to minimize waste, and collaborative problem-solving that prioritizes safety and product quality. In particular, the fifth principle of Pancasila—social justice for all Indonesians—should be interpreted actively by encouraging students to innovate and develop creative manufacturing solutions that support equitable and sustainable industrial development.

Based on these conditions, this community service program implemented a Pancasila-based CNC e-module at SMK Penerbangan Angkasa Malang as an innovative approach to vocational learning. The e-module integrates CAD, CAM, and CNC instruction with Pancasila values to promote critical and creative thinking in manufacturing technology. Its novelty lies in embedding ethical and ideological reflection directly into technical learning activities, guiding students to apply CNC skills responsibly and in accordance with Pancasila principles. Through this approach, the program aims to develop vocational graduates who are technically competent, ethically grounded, and prepared to contribute positively to national industrial development.

2. METHODS

This community service program employed a descriptive–evaluative design with an implementative approach to apply, observe, and assess the effectiveness of a Pancasila-based CNC e-module in vocational learning. The program was conducted at SMK Penerbangan Angkasa Malang, involving 30 students of the Machining Engineering program as the participants. The implementation was carried out through four main stages, as described below.

A. Needs Analysis

The needs analysis stage was conducted to identify learning problems, competency gaps, and character-related challenges in CNC learning. Data were collected through semi-structured interviews with CNC teachers to explore instructional practices and difficulties in integrating character education, classroom observations to examine student engagement and learning activities during CNC sessions, and document analysis of the curriculum, lesson plans, and existing learning media. The analysis revealed that CNC learning was predominantly focused on technical competencies, with limited integration of character education and insufficient learning media to support independent and flexible learning. These findings served as the basis for developing a CNC e-module that integrates technical competencies with Pancasila values.

B. Design and Development of the Pancasila-Based CNC E-Module

Based on the needs analysis, a CNC e-module integrating Pancasila values was designed and developed using the ADDIE instructional design model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. At the design and development stages, the module content was aligned with Phase F Machining Engineering competencies, covering manufacturing technical drawing and non-conventional machining under the CNC learning theme.

The e-module was developed using digital media and consisted of learning outcomes, learning guidelines, structured learning materials, integrated Pancasila values, and self-development activities. To enhance learning effectiveness, the module was enriched with illustrations, narrated explanations, instructional videos, QR codes linking to supplementary materials, and interactive navigation features. The integration of Pancasila values emphasized diligence, appreciation of others' work, social justice, ethical use of technology, and responsibility in applying CNC skills.

C. Implementation of CNC Learning

The implementation stage involved the use of the developed e-module in CNC learning activities with 30 students of the Machining Engineering program at SMK Penerbangan Angkasa Malang. The implementation was conducted over two learning sessions within a two-week period, combining

individual learning and guided classroom activities.
Prior to implementation, students were administered a pretest consisting of multiple-choice and short-answer questions to assess their initial CNC competencies and understanding of Pancasila-related values in manufacturing contexts. After completing the learning activities using the e-module, a posttest with equivalent indicators was administered to measure competency improvement. In addition to cognitive assessment, students were encouraged throughout the learning process to think critically, explore CNC concepts, and reflect on ethical considerations related to responsible technology use.

D. Reflection and Evaluation
The evaluation stage aimed to assess both the quality of the e-module and its impact on students' competency achievement. Evaluation was conducted using two instruments:

i. Media Feasibility Questionnaire
The questionnaire evaluated the e-module across five aspects: content quality, media appearance, audio features, media usability, and the learning process. The instrument was adapted from existing learning media evaluation questionnaires commonly used in vocational education and was reviewed by subject-matter experts to ensure content relevance and clarity. Basic validation was conducted through expert judgment, while reliability was assessed using internal consistency analysis.
Student responses were collected using the Mentimeter platform with a five-point Likert scale ranging from strongly disagree to strongly agree. The questionnaire results were then used to identify the strengths and areas for improvement of the developed e-module.

ii. Analysis of Competency Achievement
The effect of the e-module on students' competencies was analyzed by comparing pretest and posttest scores obtained from the same participants. Data were collected using Quizizz and analyzed using Minitab software. A normality test was first conducted to determine the appropriate statistical procedure. For normally distributed data, a paired sample t-test was applied, while the Mann–Whitney test was used for non-normally distributed data. These analyses were conducted to determine whether there were statistically significant differences between students' pretest and posttest scores following the implementation of the e-module.
The reflection process was conducted based on evaluation findings to identify necessary improvements, particularly related to audio quality and learning process effectiveness, to support further development of the CNC e-module.

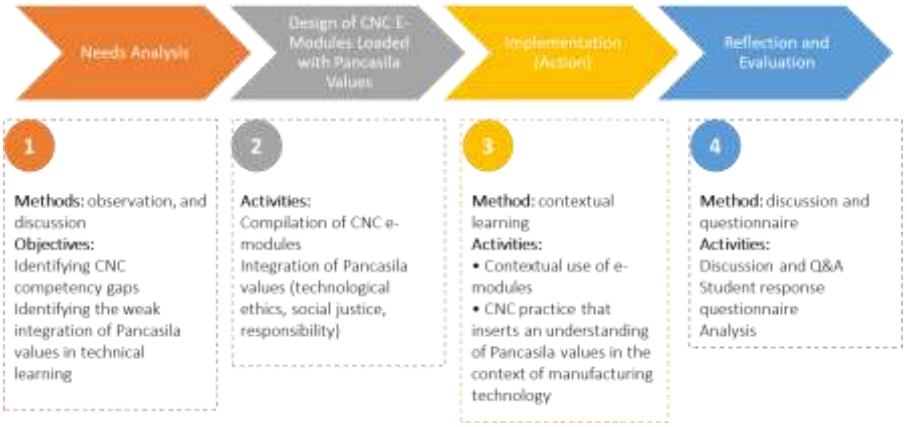

Fig. 1. The implementation service activity of a CNC e-module

3. RESULT AND DISCUSSION

The outcome of this community service activity is a The CNC e-module was implemented at SMK Penerbangan Angkasa Malang and designed to directly support targeted learning outcomes in CNC learning. Interactive navigation, instructional videos, and illustrated explanations facilitated students' understanding of CAD, CAM, and CNC concepts, which was reflected in the improvement of posttest scores. QR codes linking to supplementary materials encouraged independent learning and deeper exploration of machining topics.
In addition, reflective activities embedded in the e-module supported students' awareness of ethical considerations and the application of Pancasila values in manufacturing contexts, as indicated by positive student responses in the evaluation questionnaire. Overall, the integration of these features contributed not

only to improved technical competencies but also to students' responsible and value-oriented use of CNC technology. The CNC e-module can be accessed via the following link: (https://www.canva.com/design/DAGTjVyT3R0/cxnXARYDI_t2UReDHkPmyA/watch?utm_content=DAGTjVyT3R0&utm_campaign=designshare&utm_medium=link2&utm_source=uniquelinks&utlId=hb61e94edd5).

Fig. 2. Cover Page, Overview, Table of Contents, and E-Module Narrator

The cover design of this e-module features an illustration of the Indonesian flag above a modern civilization, symbolizing a society that has successfully implemented the fifth principle of Pancasila in everyday life. The use of green and blue on the cover represents Indonesia as a nation with advanced technology, modern urban development, and the ability to maintain environmental balance. The module's color theme uses soft pastel tones, conveying a sense of calmness and gentleness, which is well suited for learning.

The module is equipped with a speaking narrator. The table of contents includes hyperlinks in each chapter, making it easier for readers to locate specific topics. Both the table of contents and each chapter are provided with a home icon to facilitate quick access to the main menu. In addition, the module includes a barcode that links to supplementary information accessible outside the module.

Fig. 3. *Learning Guide, Learning Content, Pancasila Values Integration, and Self-Development in the CNC E-Module*

This module is equipped with features covering learning outcomes, learning guidelines, learning content, Pancasila values integration, and self-development. The learning content consists of vocational subjects in Machining Engineering for Phase F, including manufacturing technical drawing and non-conventional machining techniques. When combined into a single module, these elements are summarized under the title CNC. The materials are supported by illustrations, videos, video links provided via QR codes, and extended learning resources that can be accessed through QR codes. The use of QR codes is intended to facilitate users who wish to print the e-module, while still enabling access to broader and more comprehensive learning materials related to the topics presented.

The Pancasila values embedded in the module include: (1) diligence and a strong work ethic; (2) appreciation of others' work that contributes to shared progress and welfare; (3) engagement in activities that promote equitable progress and social justice; (4) responsible use of technology that does not conflict with or harm the public interest; and (5) ethical awareness amid rapid technological development. These values were

reflected in observable student behaviors during learning activities, such as increased discipline in completing CNC tasks, greater respect for peers' design outputs during group discussions, and more responsible decision-making in selecting machining processes and materials. In addition, student reflections indicated a growing awareness of the ethical implications of CNC technology, particularly regarding its potential social and environmental impacts.

The self-development activities guided in this module include: (1) participating in training sessions with external instructors; (2) completing independent jobsheets; and (3) taking part in competitions aligned with the learning themes. The implementation of this module is illustrated in the figure below.

Fig. 4. Activities in Using the Pancasila-Based CNC E-Module

The evaluation of the activities was conducted using: (1) a media feasibility questionnaire; and (2) an analysis of the media's effect on students' competency achievement. The table below presents the questionnaire framework used to assess the e-module in terms of content quality, media appearance, audio features, media usability, and the learning process. Data collection was facilitated through the Mentimeter website.

Table 1 *questioner Content*

Observed Data	Evaluation Aspects	Questionnaire Items
Content	Suitability of the content of the material with learning outcomes.	In your opinion, can the content of the material be clearly understood?
		In your opinion, is the content of the material in accordance with the competencies/majors/learning objectives?
	The material follows the times.	In your opinion, is the content of the material in accordance with the times?
	The material can encourage students to experiment and explore.	Can the content of the material encourage you to develop your potential?
		Can the content of the material encourage you to experiment?
		Can the content of the material encourage you to explore?
Media Display	Accurate selection of typeface and font size so that it is attractive and easy to read	Does the media display use an easy-to-read font size?
		Does the media display use an easy-to-read typeface?
		Does the media display use easy-to-read font colors?
	The accuracy of the use of color in the place of the material attracts the interest of students	Does the media display use an attractive color design?
	Accuracy of material layout elements, drawings and illustrations	Does the media display use an attractive layout?
		Does the media display use attractive images?
	Compatibility of the image with the material	Does the media display use images that match the material?
Audio Media	Clarity of audio, narrative and suitability of language and communication styles with audience characteristics	Does audio media use narrative and language that can be understood?
	Accuracy in the use of intonation, tempo and rhythm with the purpose and content of the material	Does audio media use understandable intonation?

Media Usage	Students can easily access anytime and anywhere	Is the media accessible anytime and anywhere?
	Media with instructions for useIs the media accessible anytime and anywhere?	Does the media come with instructions for use?
	Media for students to use	Is the medium easy to use?
	Possible levels of students' interest and motivation when used in learning both individually and in the classroom	Can the media increase your interest and motivation?
	Likelihood Level can be used for individual learning by students and/or teaching aids for teachers	Can the media improve your learning?
	The degree of likelihood encourages students' ability to think critically and solve problems	Can the media improve your critical thinking skills? Can the media improve your problem-solving skills?
Learning Process	A level of contextuality with real-life application	Can media science be used in the real world?

The conclusion of the questioner results is that the module is classified as medium so it needs to be developed. In more detail, you can see in the image below, What needs to be fixed is the audio and the learning process.

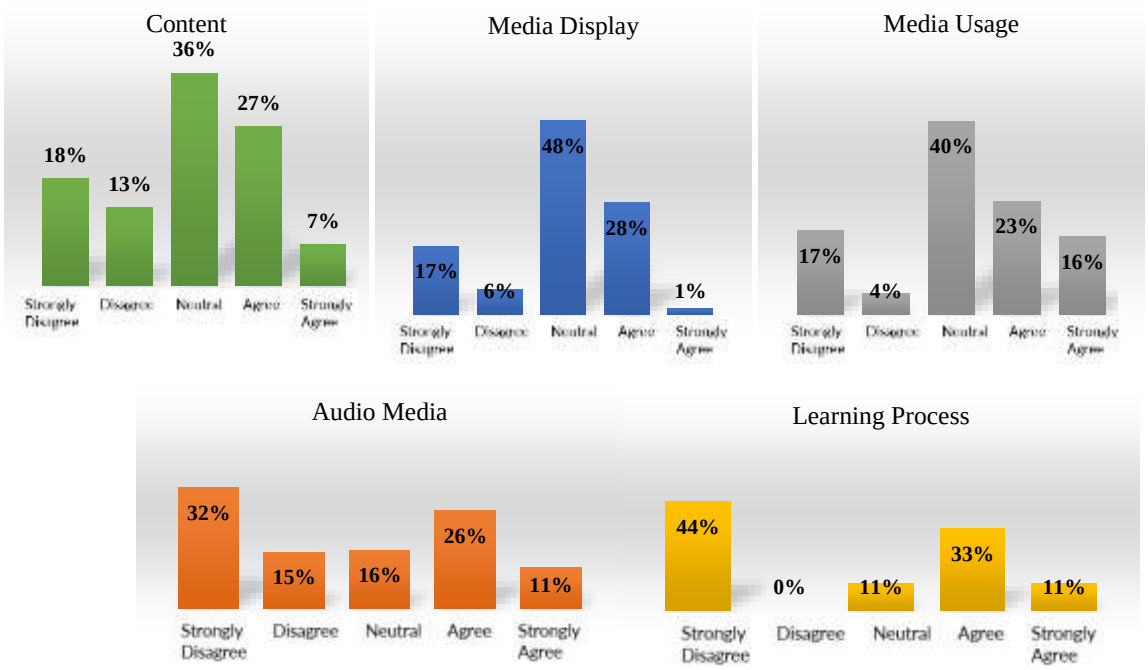

Fig. 5. Conclusion of questioner results

The influence of media on the achievement of students' competencies can be seen by using a comparison of pretest and posttest results, where the use of modules is carried out after conducting the pretest. Data collection was done using quizzes and analyzed with Minitab software. The data on the results of the pretest and posttest test was carried out for normality tests, a summary of the normality test can be seen in the table below.

Table 2. summary of the normality test

Data Name	P-Value	Conclusion	Actions
Pretest Pancasila	0,259 > 0,05	Normal distributed data	Independent sample t test
Postest Pancasila	0,209 > 0,05	Normal distributed data	Independent sample t test
Pretest CNC	0,038 < 0,05	Abnormal distributed data	Uji mann whitney (np)
Postest CNC	0,017 < 0,05	Abnormal distributed data	Uji mann whitney (np)

Independent sample t test is carried out because the data is normally distributed, this test aims to find out the difference between the results of the pretest and the posttest. The man Whitney (np) test is carried out because the data is distributed abnormally, this test aims to find out the difference between the results of the pretest and the posttest. The results of the independent sample t test and the man Whitney (np) test show that there is a difference between the results of the pretest and posttest, and it is proven that the e-module can improve CNC competence and the content of Pancasila.

4. CONCLUSION

Based on the results of this community service program, several conclusions can be drawn. First, from the aspects of material content, media appearance, and overall media usability, the CNC e-module obtained moderate evaluation results, indicating that further refinement is required. For vocational teachers, this finding suggests the importance of continuously updating learning materials and improving visual design to better align with students' learning characteristics and industry developments.

Second, the evaluation of audio media and the learning process indicates the need for deeper improvement, particularly in terms of narration clarity, pacing, and alignment with classroom learning activities. Practically, vocational teachers are encouraged to adapt audio explanations to students' comprehension levels and to combine e-module use with guided instruction and discussion to maximize learning effectiveness.

Third, the implementation of the CNC e-module contributed to an improvement in students' technical competencies, as evidenced by the difference between pretest and posttest scores. This result implies that Pancasila-based CNC e-modules can serve as an effective supplementary learning resource in vocational education. For future development, it is recommended that e-modules incorporate more interactive simulations, contextual industrial cases, and reflective activities to further strengthen both technical skills and ethical awareness in CNC learning.

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