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ENHANCING VOCATIONAL LECTURERS' TECHNICAL DRAWING COMPETENCE THROUGH CERTIFIED SOLIDWORKS ASSOCIATE (CSWA) CERTIFICATION: A PROJECT-BASED APPROACH IN PART AND ASSEMBLY DESIGN

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Abstract
The development of technical drawing competence for vocational lecturers is an urgent necessity to meet the increasingly complex demands of the industry, particularly in utilizing design software such as SolidWorks. This development program is supported by the Ministry of Education and Culture through the Vocational Lecturer Competency Development Program (NDPKD), which offers training and certification for the Certified SolidWorks Associate (CSWA). The training was conducted at Politeknik Perkapalan Negeri Surabaya, involving 20 lecturers from various polytechnics across Indonesia. The program lasted four days and concluded with an international certification exam on the fifth day. The implementation methods included simulations, hands-on part and assembly modeling, and the CSWA competency test. The training results indicated that all participants successfully passed the certification with scores ranging from 175 to 240, demonstrating the program's effectiveness in enhancing lecturers' competencies. This achievement not only provides professional recognition but also boosts lecturers' confidence in applying technical design skills in classroom instruction. The CSWA training serves as a significant solution for lecturers to integrate technical design skills aligned with industry standards, contributing to the improvement of higher education performance indicators.
Keyword: *Vocational lecturers' competence; SolidWorks certification; technical competency development; CSWA training; industrial design*

INTRODUCTION

The development of vocational lecturers' competencies, particularly those teaching technical drawing and design software such as AutoCAD, CAD CAM, Catia, and SolidWorks, is crucial to aligning educational outcomes with the ever-evolving industry demands. The rapid advancement of design technology requires lecturers not only to master the latest skills but also to engage in continuous professional development to ensure students are well-prepared for the dynamic job market (Abdullah et al., 2023; Wibisono et al., 2020). In this context, the Vocational Lecturer Competency Development Program (NDPKD) plays a strategic role by providing training that enhances lecturers' expertise in design software, ensuring that the skills taught remain relevant and aligned with career pathways in industrial design (Nurtanto et al., 2021; Samidjo, 2019; Yoto, 2018).

The NDPKD program, organized by the Ministry of Education and Culture (Kemdikbud), serves as a key initiative to improve the knowledge and technical skills of vocational lecturers, particularly in technical drawing and design software. The program aims to keep lecturers' competencies aligned with dynamic industry requirements, ensuring that vocational graduates are well-equipped for competitive work environments (Munastiwi, 2015). One of the flagship training programs under NDPKD is the Certified SolidWorks Associate (CSWA) certification, which serves as a fundamental certification in 3D design software and is highly relevant for engineering lecturers. The training, held at Politeknik Perkapalan Negeri Surabaya (PPNS), was conducted over 40 hours and concluded with an international certification exam, providing formal recognition of lecturers' expertise in SolidWorks. Beyond enhancing professional credibility, this certification enables lecturers to effectively apply the latest design techniques in the classroom, enriching students' learning experiences with practical, industry-relevant approaches (Campanario et al., 2020).

Vocational lecturers specializing in technical drawing and design often face challenges in transferring technical skills to students. A key challenge is building confidence and obtaining professional recognition for their expertise in technical drawing, which is essential for strengthening their identity as competent educators (Andersen et al., 2020; Davis & Dunn, 2019). The complexity of software like SolidWorks also presents a challenge, as its industry-standard functionalities require an in-depth understanding. These challenges not only affect teaching effectiveness but also demand additional effort from lecturers to explain advanced features to students who are still in the learning phase (Ikechukwu Oguejiofor et al., 2021; Wajdi & Kusmasari, 2023).

Furthermore, the high cost of software licenses, such as SolidWorks, poses a significant financial barrier for educational institutions. The one-year software license provided through the Certified SolidWorks Associate (CSWA) training offers substantial benefits by alleviating financial burdens and enabling lecturers to gain practical experience with the software (Adegbenro et al., 2023; Sanchez et al., 2020). Participation in the CSWA training has proven to be an effective approach for lecturers to update their knowledge, sharpen their technical skills, and obtain internationally recognized professional certification (Cecotti et al., 2017; Friesen & Cicek, 2017).

Through this professional development initiative, vocational lecturers not only enhance their confidence and teaching capabilities but also enrich students' learning experiences with skills that are more relevant to industry demands.

The success of the Certified SolidWorks Associate (CSWA) training is reflected in the international certification achievements of participating lecturers, who are now globally recognized for their proficiency in SolidWorks. This certification is the entry-level stage in a series of SolidWorks certifications, which also include Certified SolidWorks Professional (CSWP), Certified SolidWorks Professional Advanced (CSWPA), and Certified SolidWorks Expert (CSWE). Each certification level represents increasing proficiency in using SolidWorks, a crucial competency in technical and vocational design fields (Liwiński, 2020; Nurlaela et al., 2019). The CSWA training aims to equip lecturers with a comprehensive understanding of the SolidWorks interface and fundamental features while fostering efficient and innovative design techniques. Through this program, lecturers are not only prepared for the CSWA certification exam, administered by Dassault Systèmes (the developer of SolidWorks), but also enhance their professional capabilities in 3D design (Desselle et al., 2019). This certification adds significant value to lecturers seeking to strengthen their professional profiles in the design and manufacturing industries, helping them remain competitive in an industry that increasingly demands high technical expertise (Schmid et al., 2022; Zhu et al., 2023).

Additionally, this certification enables lecturers to tackle more complex design challenges, which can be directly applied to classroom teaching. With the skills gained, lecturers can leverage their experience in Computer-Aided Design (CAD) courses and other training programs to improve teaching quality, making learning more interactive and effective. Planned competency development programs like this are essential for lecturers to stay ahead of technological advancements and evolving industry demands.

METHOD

This program was conducted at the Politeknik Perkapalan Negeri Surabaya (PPNS), Surabaya – Indonesia, located at the Institut Teknologi Sepuluh Nopember, Jl. Teknik Kimia, Keputih, Kec. Sukolilo, Surabaya, East Java 60111, in the Postgraduate Building Computer Laboratory. The training and international certification exam involved 20 lecturers from various vocational institutions, including: Politeknik Negeri Batam, Politeknik Negeri Banyuwangi, Politeknik Perkapalan Negeri Surabaya, Akademi Komunitas Negeri Pacitan, Politeknik Bosowa, Politeknik Negeri Jember, Politeknik Negeri Ujung Pandang, Politeknik Manufaktur Negeri Bangka Belitung, Politeknik Negeri Lhokseumawe, Politeknik Negeri Media Kreatif, Pokiteknik Pertanian Negeri Payakumbuh, Politeknik Negeri Bali, Politeknik Negeri Semarang, Politeknik Negeri Medan, Politeknik Hasnur, Politeknik Negeri Jakarta, Politeknik Negeri Banjarmasin, Politeknik Negeri Malang, Politeknik Negeri Sriwijaya, Politeknik Negeri Padang. Each participating institution was represented by one lecturer specializing in mechanical engineering, automotive engineering, or technical drawing and design.

The CSWA training was conducted over four days, followed by a one-day international certification exam, from September 30, 2024, to October 5, 2024. The details of the activities are outlined in Table 1.

Table 1. Training Schedule

No	Date	Training Activities
1	Monday, September 30, 2024	SolidWorks Basic and User Interface, and Introduction to Sketchins
2	Tuesday, October 1, 2024	Basic part modeling, Symmetry and Draft Revolved Features, and Example part
3	Wednesday, October 2, 2024	Shelling and Pattern, Design Change and Editing, and Plane & Example
4	Thursday, October 3, 2024	Global Variables & Equations, Example Part, Using Drawing, Assembly, and Example Part

The training consisted of three main stages: simulation, hands-on part and assembly modeling, and a competency test (Figure 1).

1. Simulation: A trainer from SolidWorks conducted demonstrations on part modeling.
2. Hands-on Practice: Participants followed step-by-step instructions to create products based on the demonstration. Discussions and Q&A sessions were held throughout the process.

3. Competency Test: Participants took the Certified SolidWorks Associate (CSWA) international exam at the end of the training.

Figure 1. CSWA Training Implementation Stages

The implementation of CSWA training follows the competency test requirements, progressing from basic techniques to assembly modeling. The training curriculum covers drafting competencies, basic part creation and modification, intermediate part creation and modification, advanced part creation and modification, and assembly modeling using various tools (Azzam et al., 2020; Gallagher et al., 2012). A detailed breakdown of the training curriculum is presented in Table 2. The primary objective is to facilitate participants' understanding throughout the training process. However, some participants may apply more practical and efficient approaches based on their prior experience.

Table 2. CSWA Training Curriculum

Competency	**Training Material**
Drafting Functionality	Basic knowledge of drafting and technical drawing
Basic Part Creation and Modification	Sketching, Extrude Boss, Extrude Cut, and modification of key dimensions
Intermediate Part Creation and Modification	Sketching, Revolve Boss, Extrude Cut, and Pattern
Advanced Part Creation and Modification	Sketching, Sketch Offset, Extrude Boss, Extrude Cut, modification of key dimensions, and complex geometry
Assembly creation	Placing base parts, applying mates, and modifying key parameters in assembly models

After completing the four-day training, participants proceeded to take the Certified SolidWorks Associate (CSWA) international certification exam, which is a basic-level certification. The exam was conducted online through the TesterPro Client application and had a time limit of 180 minutes (3 hours). Participants who achieved a minimum score of 165 were considered passing or certified. This result confirms that the CSWA training program had a positive impact on improving participants' competencies.

RESULTS AND DISCUSSION

1. Participant Biography

A total of 20 vocational lecturers from various polytechnics and academies across multiple cities and provinces participated in the training (Table 3). To maintain participant privacy, their identities have been anonymized using specific codes, as some evaluation data are confidential. The participants' ages ranged from 29 to 59 years old, and they specialized in mechanical engineering and automotive engineering, teaching courses related to technical drawing and design.

Table 3. Description of CSWA Training Participants

No	Name of code	Age	Affiliations	City
1	ASP	36	Politeknik Negeri Batam	Batam
2	AFH	36	Politeknik Negeri Banyuwangi	Banyuwangi
3	APU	36	Politeknik Perkapalan Negeri Surabaya	Surabaya
4	AAT	29	Akademi Komunitas Negeri Pacitan	Pacitan
5	ASg	49	Politeknik Bosowa	Makassar
6	ATZ	31	Politeknik Negeri Jember	Jember
7	Arf	36	Politeknik Negeri Ujung Pandang	Makassar
8	BRn	41	Politeknik Manufaktur Negeri Bangka Belitun	Sungailiat Bangka
9	Buk	47	Politeknik Negeri Lhokseumawe	Lhokseumawe
10	HSo	39	Politeknik Negeri Media Kreatif	Jakarta Selatan
11	Hen	43	Pokiteknik Pertanian Negeri Payakumbuh	Sumatera Barat
12	IBIP	48	Politeknik Negeri Bali	Bali

No	Name of code	Age	Affiliations	City
13	IMo	54	Politeknik Negeri Semarang	Semarang
14	JFHS	37	Politeknik Negeri Medan	Medan
15	MAAB	35	Politeknik Hasnur	Barito Kuala
16	MNo	34	Politeknik Negeri Jakarta	Jawa Barat
17	RNr	31	Politeknik Negeri Banjarmasin	Banjarmasin
18	TMh	37	Politeknik Negeri Malang	Malang
19	YEF	31	Politeknik Negeri Sriwijaya	Palembang
20	Zul	59	Politeknik Negeri Padang	Padang

2. Drafting Functionality

On the first day, the training program began with an opening ceremony in the auditorium, attended by the Vice Director, Head of LP3M, Department Head, Program Coordinator, and lecturers from PPNS. After the opening session, participants proceeded to the Postgraduate Computer Laboratory to begin the drafting activities. As shown in Figure 2(a), the CSWA program coordinator provided a brief overview of the training objectives and implementation. This was followed by a session led by the main trainer from PT. Metric Sistem Integrasi. During this stage, participants were introduced to the SolidWorks interface, including essential toolbars such as the workspace, menu bar, standard toolbar, panel bar, navigation bar, and status bar. All participants were then trained to use the sketch toolbar to create simple components, as illustrated in Figure 2(b).

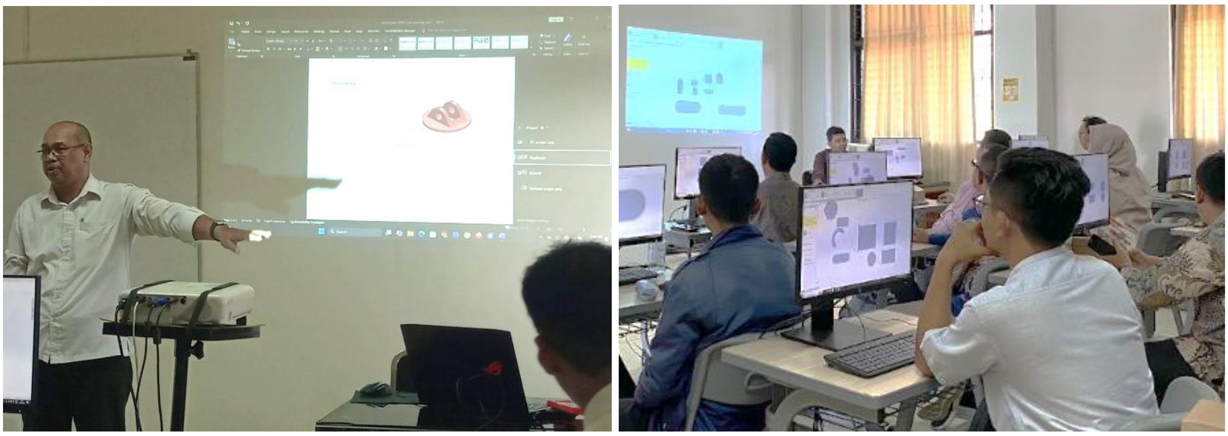

Figure 2. (a) Program Introduction and (b) SolidWorks Program Overview

3. Basic Part Creation and Modification

Participants then proceeded with basic part modeling, following step-by-step instructions. The first task was to create a sheet metal part, as shown in Figure 3(a). The instructor emphasized the importance of setting the center point and ensuring that the unit system (MMGS: Millimeter, Gram, Second) was correctly configured. The part was initially created from the front view in 2D, utilizing line functions to define its shape. It was then extruded backward to add depth. Next, a rectangular shape was sketched on the top view and extruded upward. To verify accuracy, participants used the mass property's function. Those whose mass properties values differed from the expected results were instructed to identify and correct discrepancies in their design.

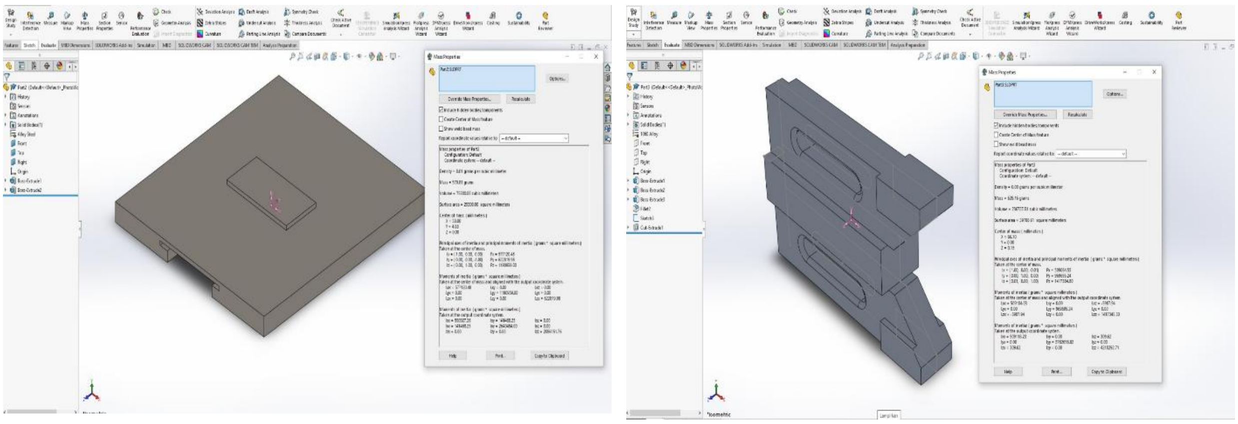

Figure 3. Basic Part Modeling: (a) Sheet Metal Part and (b) Tool Block

Participants continued with the Tool Block modeling task, as illustrated in Figure 3(b). Given that the part has symmetrical dimensions, they could simplify the process by sketching only half of the shape and then using the mirror tool to generate the other half. The process began with creating a half-rectangle sketch from the center point in the front view. Once the sketch was complete, participants applied the extrude boss function to give the part thickness. They then created the top section of the block using the same extrusion technique. To complete the design, they added a central hole using the extrude cut function and refined the edges with fillet application. Finally, the mirror tool was used to replicate the symmetrical features, ensuring the part's accuracy. To verify the correctness of their models, participants compared their mass properties values with the instructor's reference. Any discrepancies were identified and corrected by ensuring the proper material settings were applied.

4. Intermediate Part Creation and Modification

On the second day, participants worked on creating an intermediate-level part, specifically a wheel, as shown in Figure 4. The process began with sketching half of the wheel, which was then mirrored to form a complete solid shape without any hollow sections. To refine the part, precise holes were created using the extrude cut function, while the revolve boss feature was applied to shape the profile accurately. Once completed, the final wheel part matched the reference image. To verify its accuracy, participants checked the mass properties to ensure that the material and dimensions were correctly set.

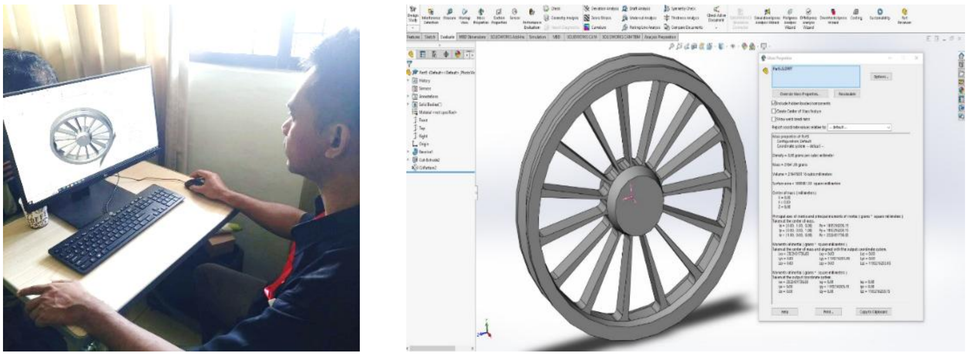

Figure 4. Wheel Part Modeling

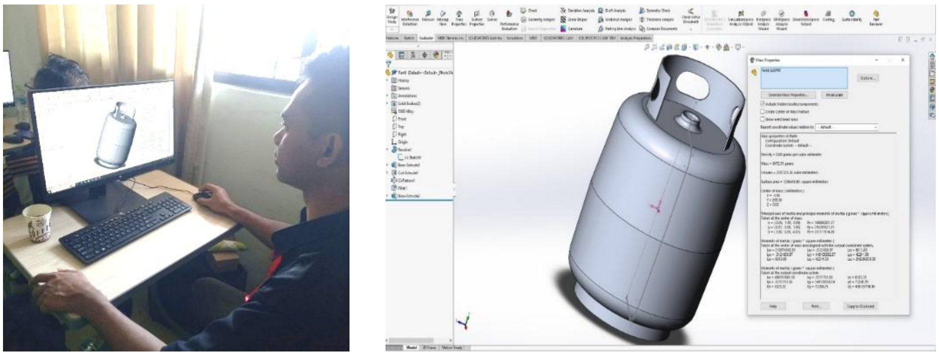

Figure 5. Tank Part Modeling

The next intermediate part was a tank, as illustrated in Figure 5. The base structure of the tank was created by designing a central cylindrical body. Since the upper and lower halves of the cylinder were identical, participants could construct only half of the model, ensuring that the inner cavity and wall thickness of 4 mm were correctly defined, as per Figure 5. After modeling the base cylinder, additional components were created, representing modifications to the original design. These included the tank handle, inlet pipe, and bottom support structure. The extrude cut and revolve boss functions were applied to precisely shape the handle holes, ensuring proper alignment. To confirm the accuracy of the final model, participants used mass properties analysis, ensuring that the material and structural integrity were correctly defined.

5. Advanced Part Creation and Modification

On the third day, participants worked on advanced part modeling, focusing on a connector that required a high level of precision in each design step (Figure 6). The process began with placing the center point and ensuring that the MMGS unit system was correctly configured. Participants then created an initial front-view sketch before transitioning to the top view to design the stepped cavity and mounting holes for component attachment.

The fundamental modeling techniques applied in this process included sketch offset, extrude boss, and extrude cut, all of which are essential for mastering 3D modeling (Celume & Korda, 2022; Rahimi & Shute, 2021; Venkatesh et al., 2023). To ensure that the final design met the required specifications, participants checked the mass properties after assigning the appropriate material. This analysis included key parameters such as weight and balance.

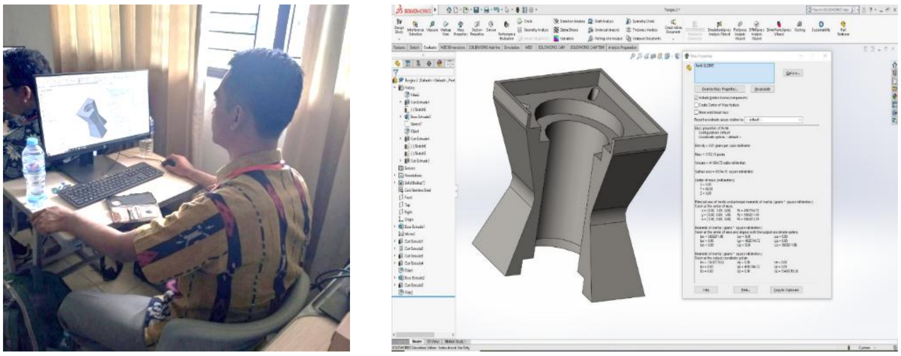

Figure 6. Connector Part Modeling

In cases where mass properties deviations were detected, participants were required to identify and correct errors iteratively, ensuring that all parts met the specified dimensions and design intent (Haasler, 2020; Setiyawami et al., 2020). This iterative approach not only enhanced technical skills but also deepened participants' understanding of how design choices impact functionality and the overall manufacturing process. Additionally, this method encouraged critical thinking and problem-solving skills, which are essential for meeting industry standards.

Participants then proceeded to create two additional advanced parts: a hydraulic cylinder and a machine project component, as illustrated in Figure 7. These parts required extensive modifications and detailed instructions to complete. For the machine project part (Figure 7b), participants needed to define multiple planes to accommodate angled surfaces, ensuring precise alignment in the design. Meanwhile, the hydraulic cylinder part (Figure 7a) involved drilling holes for the locking mechanism and applying chamfers and fillets to achieve the desired mechanical properties. Some participants encountered mass properties discrepancies, which required them to review and correct previous modeling steps to ensure accuracy. While mass properties analysis is an effective method for verifying the volume of a model, it does not confirm the positioning and alignment of individual features. As a result, participants were encouraged to double-check key dimensions and refine their models accordingly.

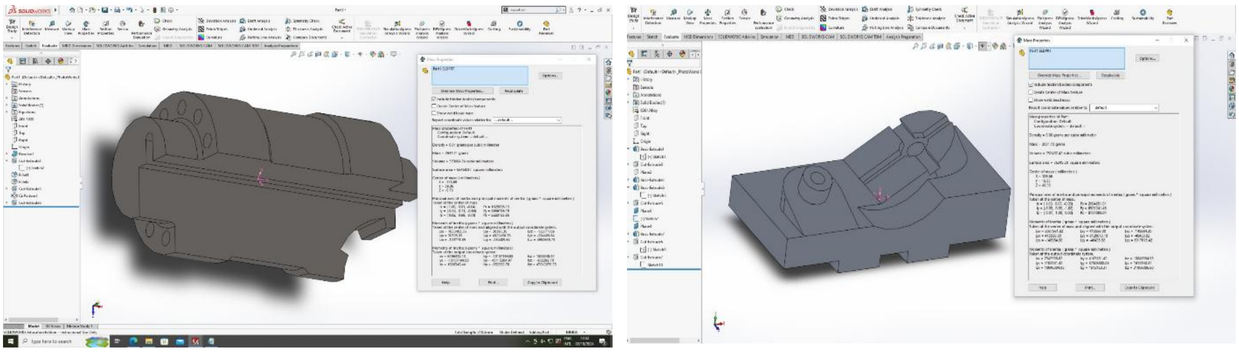

Figure 7. Advanced Part Modeling and Modifications: (a) Hydraulic Cylinder Half and (b) Machine Project Part

6. Assembly Creation

On the fourth day of the training, participants practiced assembly modeling using predefined parts, including a connecting rod and a linkage (Figure 8). This process required essential skills for accurately assembling components, emphasizing a deep understanding of SolidWorks' Mate Property Manager features. Key mating techniques that participants needed to master included: (1) Coincident Mate – Aligns two components to occupy the same position. (2) Parallel Mate – Ensures that two planes remain parallel to each other. (3) Tangent Mate – Positions two surfaces in contact along a shared curve. And (4) Concentric Mate – Aligns components along the same circular axis. Additionally, participants had to apply principles of distance and angle constraints to ensure that the assembly met design specifications, particularly in terms of center of gravity and mass balance. By understanding and implementing these techniques, participants could verify that their assembly models were not only mechanically precise but also met industry standards in terms of stability and component functionality.

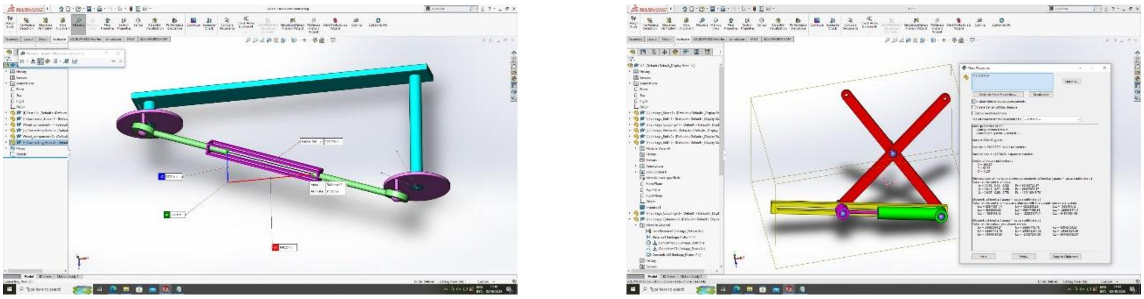

Figure 8. Assembly Modeling Using Predefined Parts: (a) Connecting Rod and (b) Linkage

7. Implementation of the International Certification Exam

On the fifth day, all participants registered for an account through the 3DEXPERIENCE® Certification Center. This account was also used to manage certificates, exam credits, and account modifications. After completing the registration, participants installed the TesterPro Client application required for the examination. Once the accounts were set up, participants logged in, selected the SolidWorks certification category, entered their voucher code, and began the exam. The test lasted for 180 minutes (3 hours) and consisted of 14 questions, each with varying scores and difficulty levels. While each participant received a unique set of questions, some shared similar characteristics in terms of complexity. An example of the test interface is shown in Figure 8.

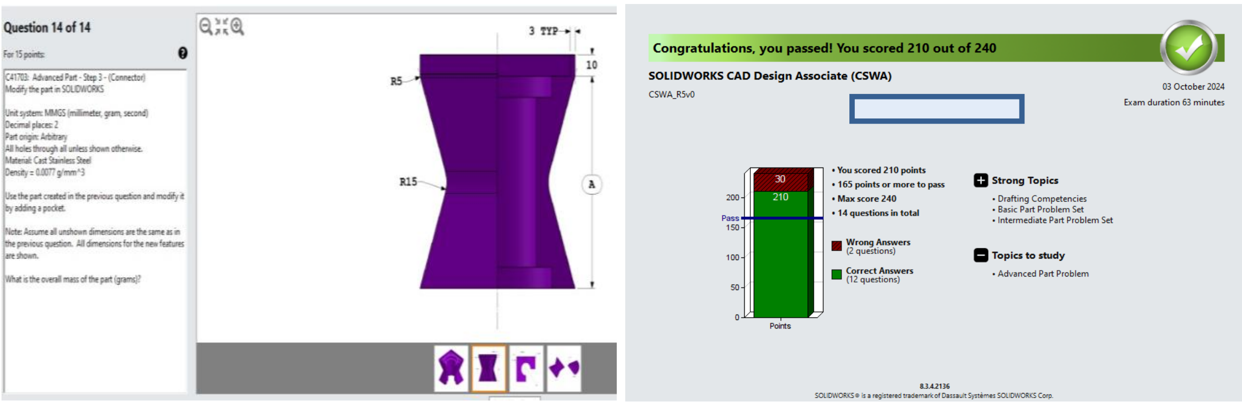

Figure 8. Examination Interface and Test Results Display

After completing the test, participants could immediately view their exam scores on the screen. Those who achieved a score of 165 or higher were considered passing and were awarded an official CSWA certificate, as shown in Figure 9.

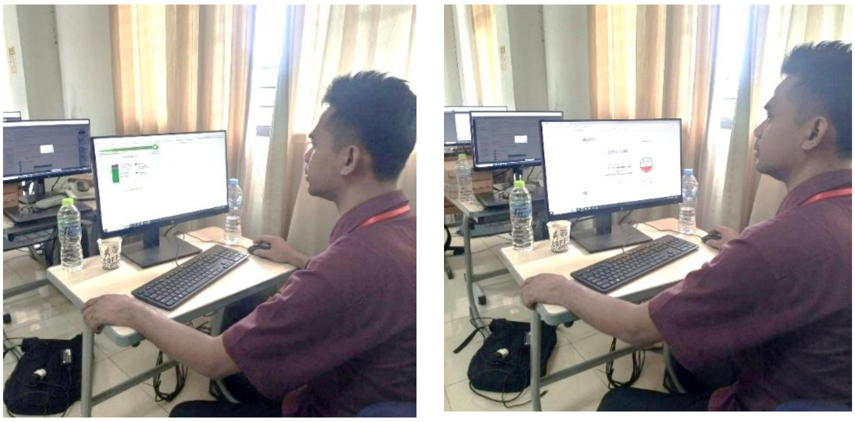

Figure 9. Certification Exam Process: (a) Passing Results and (b) CSWA Certificate

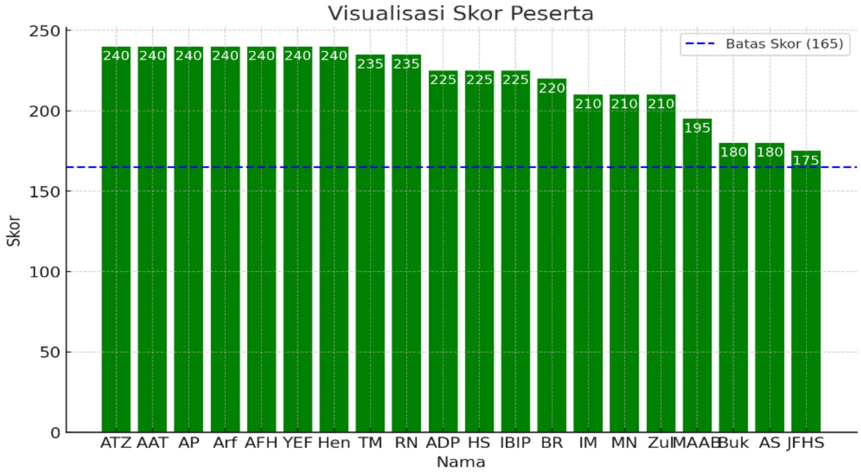

Figure 10. SolidWorks Certification Results for All CSWA Participants

The overall exam results for all CSWA participants are summarized in Figure 10. The success of the Certified SolidWorks Associate (CSWA) training program was confirmed by the international certification results, where all participants successfully passed with scores ranging from 175 to 240. Notably, seven participants achieved a perfect score, highlighting the effectiveness of the training in enhancing technical competencies (Nurlaela et al., 2019; Ray et al., 2018). Beyond demonstrating an improvement in SolidWorks proficiency, these results boosted participants' confidence, as the international certification serves as formal recognition of their skills. Additionally, obtaining the CSWA certification contributes to the enhancement of Key Performance Indicators (KPIs) for higher education institutions, further strengthening the credibility of vocational lecturers as experts in technical design education (Desselle et al., 2019). Furthermore, the CSWA certification serves as a foundation for participants to pursue higher certification levels, such as the Certified SolidWorks Professional (CSWP). This progression supports continuous professional development, which is essential in the competitive fields of education and industry.

CONCLUSION

The implementation of this community service program demonstrates that the Certified SolidWorks Associate (CSWA) training and certification is an effective means of enhancing the technical competencies of vocational lecturers in technical drawing, aligning their skills with industry demands. The program successfully strengthened lecturers' proficiency in SolidWorks software, which had a positive impact on both teaching quality in the classroom and their ability to prepare students for industry requirements. By obtaining international certification, lecturers gained greater confidence and contributed to the improvement of Key Performance Indicators (KPIs) in higher education, particularly in terms of teaching professionalism. The broader impact of this program on the targeted community is the enhanced quality of vocational graduates, equipping them with stronger technical design skills and improving their competitiveness in the industry. However, this training program faced certain limitations, including the high cost of software licenses and limited training duration, which affected the depth of material coverage. Therefore, it is recommended that similar programs be conducted regularly and include advanced certification levels, such as the Certified SolidWorks Professional (CSWP), to further strengthen lecturers' skills in a more comprehensive and in-depth manner.

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