



3D BLUEPRINT WITH AUTOCAD CUSTOMIZATION: DEVELOPMENT OF A LEARNING PRIMER

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ABSTRACT

This study developed a contextualized and outcomes-oriented learning primer titled 3D Blueprint with AutoCAD Customization: Development of a Learning Primer for students of the Bachelor of Industrial Technology (BlndTech) majoring in Computer Technology and Electronics Technology at Cebu Technological University – San Francisco Campus. Specifically, the research sought to determine the level of student learning in 3D Blueprint with Computer-Aided Design (CAD) using the existing learning primer, identify the challenges encountered by students, and assess the effectiveness and acceptability of the enhanced learning primer.

A quantitative-descriptive design was employed with 194 student respondents enrolled during Academic Year 2025–2026. Data were gathered using an adapted survey questionnaire anchored on the Technology Acceptance Model (TAM) administered through Google Forms. Statistical tools including frequency, percentage, weighted mean, standard deviation, and Pearson Product-Moment Correlation Coefficient were applied to analyze the data.

Findings revealed that students demonstrated a moderate level of concept understanding, practical CAD skills, motivation, problem-solving ability, and satisfaction when using the existing learning primer. Challenges were identified across technical complexity, manual clarity, resource accessibility, limited visual examples, time constraints, and integration of practical tasks. A significant negative relationship ($r = -0.596$, $p = 0.000$) was found between student learning levels and challenges encountered in using existing 3D software. The study concluded that a contextualized and outcomes-oriented AutoCAD learning primer effectively improved student learning experiences and strengthened practical CAD competencies.

KEYWORDS: 3D Blueprint, AutoCAD Customization, Learning Primer Development, Contextualized Learning, Outcomes-Based Education (OBE), Computer-Aided Design (CAD), Technical Education, Student Learning Outcomes, Technology Acceptance Model (TAM)

INTRODUCTION

Background and Rationale

The rapid advancement of technology has transformed the way industries operate, demanding higher levels of technical competence and adaptability from graduates. In technical-vocational and engineering education, the ability to interpret and create three-dimensional (3D) blueprints using Computer-Aided Design (CAD) has become a fundamental skill. As industries continue to innovate, the academe is challenged to align its teaching strategies with these evolving demands, ensuring that students are not only knowledgeable but also competent in applying their skills in real-world contexts (Biggs & Tang, 2022).

Despite the significance of CAD and blueprint reading in technical fields, many students struggle with mastering these competencies due to limited learning primers, overly theoretical approaches, and lack of contextualization in teaching materials. Studies have shown that when learning is connected to students' real-life experiences and local industry practices, comprehension and retention significantly improve (Adebayo & Oyewole, 2022; OECD, 2023). Therefore, contextualizing instruction is not only beneficial but also essential in bridging the gap between academic learning and industry application.

The shift toward Outcomes-Based Education (OBE) emphasized the need to design instructional materials that directly addressed clearly defined competencies. OBE ensures that teaching, learning activities, and assessments are aligned with intended outcomes—in this case, the development of CAD proficiency and blueprint interpretation skills (Spady, 2020; Biggs & Tang, 2022). By adopting an outcomes-oriented framework, educators are able to systematically guide learners toward achieving the technical standards required by both academe and industry.

Research in engineering education highlights that well-structured, outcomes-based, and project-driven manuals enhance student engagement, promote active learning, and foster higher-order thinking skills (Prince & Felder, 2020; Loyens & Rikers, 2021). When such manuals are contextualized, they not only provide technical knowledge but also allow students to apply concepts to practical and industry-relevant situations, making the learning process more meaningful and effective. In light of these considerations, this study focused on developing a contextualized and outcomes-oriented learning primer to strengthen the teaching of 3D blueprints with CAD at Cebu Technological University – San Francisco Campus.



Theoretical Framework

This study was anchored on several learning and instructional design theories. Constructivism posited that learners actively construct knowledge through interaction with their environment and experiences. In CAD and 3D blueprinting, students learn best when given opportunities to manipulate tools, solve authentic problems, and apply concepts in real-world contexts. Lev Vygotsky's Zone of Proximal Development (ZPD) further supports the use of scaffolded learning primers, allowing learners to progress from guided practice to independent application (Vygotsky, 2021).

David Kolb's Experiential Learning Theory emphasized learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 2021). The contextualized learning primer was aligned with this theory by engaging students in hands-on CAD tasks, encouraging reflection on design processes, and providing opportunities for iterative improvement. Additionally, the Technology Acceptance Model (TAM) developed by Fred Davis (1989) provided the theoretical lens for evaluating student perceptions of the learning primer, specifically measuring Perceived Usefulness, Perceived Ease of Use, and Behavioral Intention to Use (Davis, 1989; Venkatesh et al., 2021).

Biggs and Tang's constructive alignment principle ensured that learning outcomes, instructional strategies, and assessment tools were explicitly aligned. Design-Based Learning (DBL), as theorized by Kolodner et al. (2023), further emphasized project-oriented tasks where learners designed, tested, and refined solutions to real-world problems, consistent with CAD instruction through contextualized primers. Nationally, the CHED Outcomes-Based Education framework, the Philippine Qualifications Framework (PQF), Republic Act No. 7722 (Higher Education Act of 1994), and Republic Act No. 7796 (TESDA Act) collectively provided the legislative and policy foundation for developing quality, competency-based technical education.

Statement of the Problem

This study aimed to evaluate the 3D Blueprint application with CAD at Cebu Technological University – San Francisco Campus during the second semester of Academic Year 2025–2026 as a basis for developing a contextualized and outcomes-oriented learning primer. Specifically, it sought to: (1) describe the profile of student respondents in terms of age, year level, program enrolled, prior knowledge in drafting or blueprint reading, frequency of CAD-related laboratory activities, and access to learning resources; (2) determine the current level of student learning in 3D Blueprint with CAD when using the existing instructional manual across five dimensions: concept understanding, practical CAD skills, student motivation, problem-solving ability, and satisfaction with the learning experience; (3) identify challenges encountered by students in using the existing primer; (4) determine whether a significant relationship existed between the level of student learning and the

challenges encountered; and (5) establish the features and improvements to be incorporated in the enhanced learning primer.

The null hypothesis tested was: there is no significant relationship between the level of learning in 3D Blueprint with CAD and the challenges encountered by the students in using the existing learning primer.

Significance of the Study

This study carried significant implications across the education sector. For students, the contextualized learning primer was expected to foster a more engaging, structured learning environment that improved comprehension, retention, and application of 3D blueprinting and CAD concepts. For educators, the findings provided valuable insights into the pedagogical benefits of integrating a contextualized instructional manual into teaching strategies, supporting the adoption of learner-centered approaches aligned with outcomes-based education.

Educational institutions and curriculum developers benefit from research outputs that inform decisions regarding curriculum design, learning primer development, and resource allocation. Extension services stand to gain an adaptable tool suitable for technical-vocational training programs and community capacity-building activities. The broader community benefits through improved workforce development and employability skills, while future researchers gain a reference point for learning design innovations in technical education. Overall, the study advanced technical education by validating a contextualized primer's effectiveness in supporting theoretical understanding and practical skill mastery in 3D blueprinting with CAD.

METHODS

Research Design

The study utilized a quantitative-descriptive research design. The descriptive component focused on assessing the acceptability and effectiveness of the contextualized and outcomes-oriented learning primer in 3D Blueprint with CAD through Likert-scale survey questionnaires administered to student respondents. This approach captured student perceptions of the primer and its impact on their learning outcomes, while also enabling the use of inferential statistics to determine relationships between variables. The design was appropriate given the study's objective of systematically evaluating instructional material effectiveness through quantifiable indicators.

Research Environment

The study was conducted at Cebu Technological University (CTU) – San Francisco Campus, specifically under the Department of Bachelor of Industrial Technology (BIndTech) within the College of Technology and Engineering. The campus is located in Northern Poblacion, San Francisco, Cebu, Philippines—one of four municipalities comprising the Camotes Islands in the northeastern part of mainland Cebu. The university traces its foundation to June 22, 1956, and was formally converted into CTU through Republic Act No. 9744 in 2009. The campus



offered multidisciplinary programs including Computer Technology, which had the highest student population, and provided laboratory facilities with computer units installed with CAD software necessary for blueprint interpretation and 3D modeling activities.

One of the major subjects in the BIndTech-Computer Technology program was Draw 224 – Advanced Computer-Aided Design, which focused on 2D and 3D drafting techniques including orthographic projections, dimensioning, 3D blueprint reading, and 3D modeling. AutoCAD was used to create digital drawings and models for various hands-on activities related to technical design and project development, making the campus a highly suitable environment for implementing the study.

Participants

The respondents were 194 students enrolled in the Bachelor of Industrial Technology – Computer Technology (BIT-CT) and Electronics Technology (BIT-ET) programs during the second semester of Academic Year 2024–2025, specifically those taking courses related to drafting, blueprint reading, and CAD. Participants were identified through simple random sampling to ensure fair representation of the student population. As shown in Table 1, 167 students (86.1%) were enrolled in BIT-CT and 27 students (13.9%) in BIT-ET, reflecting the predominance of the computer technology strand within the program.

Table 1. Distribution of Respondents by Program

Program	Frequency (f)	Percentage (%)
BIT-CT	167	86.1
BIT-ET	27	13.9
Total	194	100.0

Research Instrument

To address the research problems effectively, the study utilized an adapted questionnaire grounded in the Technology Acceptance Model (TAM) developed by Fred Davis (1989). The instrument was adapted from previous studies (Ali & Bukhari, 2017; Özcan & Toklu, 2015; Alarmi et al., 2019; Hamzah et al., 2023) and modified to fit the context of CAD education. The questionnaire consisted of three main parts: (1) the profile of the respondents, covering six demographic and experiential variables; (2) the current level of student learning and engagement in 3D Blueprint with CAD across five dimensions (concept understanding, practical CAD skills, student motivation, problem-solving ability, and satisfaction); and (3) challenges encountered in using the existing learning primer across the same five dimensions.

A five-point Likert scale was used for all rating items, with response options ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Weighted mean scores were interpreted using the scale ranges established by Rensis Likert (2020) and the interpretive guidelines of Boone and Boone: 4.21–5.00 (Strongly Agree), 3.41–4.20 (Agree), 2.61–3.40 (Neutral), 1.81–2.60 (Disagree), and 1.00–1.80 (Strongly Disagree). For accessibility and wider reach, the questionnaire was distributed electronically through Google Forms.

Data Gathering Procedure

Prior to data collection, a transmittal letter was secured from the Campus Director, Dr. Jonita V. Literatus, requesting permission to conduct the study. Upon approval, the adapted and validated survey questionnaire was disseminated electronically via Google Forms to all 194 identified respondents. Respondents were informed of the study's purpose, the voluntary nature of their participation, and the strict confidentiality of their responses. Data collection was conducted during the second semester of

Academic Year 2025–2026. Completed responses were automatically recorded in the online platform and subsequently downloaded for statistical treatment.

Statistical Treatment

Data were analyzed using several statistical tools. Frequency and percentage were used to describe the demographic profile of respondents. Weighted mean and standard deviation were computed to describe the level of student learning and the challenges encountered across the five dimensions. The Pearson Product-Moment Correlation Coefficient (Pearson r) was used to determine the nature and significance of the relationship between the level of student learning in 3D Blueprint with CAD and the challenges encountered by students in using the existing software. A significance level of $\alpha = 0.05$ was set; a p -value below 0.05 led to the rejection of the null hypothesis, indicating a statistically significant relationship between the variables.

RESULTS

Profile of the Respondents

The majority of respondents (177 students, 91.24%) were aged 20–25 years, with a smaller proportion aged 26–31 (14 students, 7.22%) and 32–39 (3 students, 1.55%), reflecting the typical undergraduate age profile. In terms of year level, the distribution was nearly equal: 98 students (50.52%) were in the second year and 96 (49.48%) in the third year, ensuring that perspectives from both intermediate and advanced learners were captured.

Regarding prior knowledge in drafting and blueprint reading, nearly half of respondents (94 students, 48.5%) possessed only basic skills, followed by intermediate (48 students, 24.7%), advanced (31 students, 16.0%), and none (21 students, 10.8%). Most students participated in CAD-related laboratory activities once (71 students, 36.6%) or twice per week (82 students, 42.3%),



while 18 students (9.3%) engaged only when required. Concerning access to learning resources, the majority (103 students, 53.1%) relied solely on the school laboratory, while 50

(25.8%) had access to both school and personal resources, and 10 (5.1%) reported limited access.

Table 2. Summary of Respondent Profile

Variable	Category	Frequency	Percentage (%)
Age	20–25 years	177	91.24
	26–31 years	14	7.22
	32–39 years	3	1.55
Year Level	2nd Year	98	50.52
	3rd Year	96	49.48
Prior Knowledge	None	21	10.8
	Basic	94	48.5
	Intermediate	48	24.7
	Advanced	31	16.0
Access to Resources	School laboratory only	103	53.1
	Personal laptop with CAD	31	16.0
	Both	50	25.8
	Limited access	10	5.1

Current Level of Student Learning in 3D Blueprint with CAD

Table 3 presents the weighted mean scores and standard deviations for the five learning dimensions assessed using the

existing learning primer. All dimensions registered scores in the Neutral range (2.61–3.40) or at the lower threshold of Agree, suggesting a generally moderate level of student learning and engagement.

Table 3. Summary of Current Level of Student Learning and Engagement

Dimension	Mean	SD	Description
Concept Understanding / Basic Knowledge	3.41	1.04	Agree
Practical CAD Skills	3.23	1.08	Neutral
Student Motivation	3.37	1.05	Neutral
Problem-Solving Ability	3.37	1.11	Neutral
Satisfaction with the Learning Experience	3.24	1.11	Neutral

Concept Understanding registered the highest mean ($M = 3.41$, $SD = 1.04$), just at the Agree threshold, indicating that students perceived a fair grasp of fundamental principles such as blueprint interpretation, measurements, and basic CAD operations. Practical CAD Skills ($M = 3.23$, $SD = 1.08$) and Satisfaction with the Learning Experience ($M = 3.24$, $SD = 1.11$) obtained the lowest means, signifying that students demonstrated developing but not yet consistently applied technical proficiency, and that some aspects of the existing primer did not fully meet their expectations. Student Motivation ($M = 3.37$, $SD = 1.05$) and Problem-Solving Ability ($M = 3.37$, $SD = 1.11$) were similarly moderate, reflecting partial engagement and capability in addressing structured exercises but limited confidence with complex or unfamiliar design problems.

The high concentration of Neutral/Sometimes responses across all dimensions—ranging from 36.6% to 40.2%—indicated that many students demonstrated only developing competencies with the existing primer. While combined Agree and Strongly Agree responses ranged from 39.2% to 46.9%, the moderate standard deviations confirmed considerable variation in individual student experiences, with students' backgrounds in prior knowledge and CAD activity frequency contributing to differential outcomes.

Challenges Encountered by Students in Using the Existing Learning Primer

Table 4 presents the weighted mean scores for each challenge category identified by respondents. All six challenge categories received mean scores in the Agree range (3.41–4.20), indicating that students consistently perceived these factors as significant obstacles to effective learning.



Table 4. Challenges Encountered by Students in Using the 3D CAD Learning Primer

Challenge Category	Mean	SD	Description
Technical Complexity	3.95	0.95	Agree
Learning Primer Clarity & Organization	4.03	0.93	Agree
Accessibility Issues	3.87	0.98	Agree
Limited Examples / Visuals	3.96	0.94	Agree
Time Constraints	3.95	0.95	Agree
Integration with Practical Tasks	4.01	0.92	Agree
Support Availability	3.96	0.94	Agree

Learning Primer Clarity and Organization obtained the highest mean ($M = 4.03$, $SD = 0.93$), indicating that unclear explanations and poorly organized content were the most pressing challenges. Integration with Practical Tasks ranked second ($M = 4.01$, $SD = 0.92$), reflecting difficulty in effectively applying concepts within limited class or lab periods. Accessibility Issues registered the lowest mean ($M = 3.87$, $SD = 0.98$) but remained clearly within the Agree range, underscoring that inequitable access to CAD software and laboratory resources continued to impede learning.

Technical complexity was widely acknowledged, with students citing difficulty understanding advanced CAD procedures as a barrier to progression. Limited examples and visuals, along with inadequate step-by-step instructions, further constrained comprehension. Time constraints and insufficient support

availability compounded these difficulties, particularly for students with less prior drafting experience or restricted access to CAD laboratories. The relatively consistent means across all seven challenge categories underscored the systemic nature of these barriers, suggesting that the existing primer required comprehensive enhancement rather than isolated fixes.

Significant Relationship Between Student Learning and Challenges Encountered

The Pearson Product-Moment Correlation Coefficient was computed to determine whether a significant relationship existed between the level of student learning in 3D Blueprint with CAD and the challenges encountered in using the existing software. As presented in Table 5, the analysis yielded a correlation coefficient of $r = -0.596$ with a p -value of 0.000.

Table 5. Pearson r : Level of Learning vs. Challenges Encountered

Variables Compared	Pearson r	p -value	Decision	Interpretation
Level of Learning vs. Challenges in 3D Software Use	-0.596	0.000	Reject H_0	Significant negative relationship

Since the p -value (0.000) was less than the significance level of 0.05, the null hypothesis was rejected. The result indicated a statistically significant negative relationship between the two variables: as the level of student learning in 3D Blueprint increases, the challenges encountered in using the 3D software tend to decrease. Conversely, students who encountered more difficulties were more likely to demonstrate lower levels of learning performance. The moderate-to-strong negative correlation ($r = -0.596$) suggested that improving foundational mastery in 3D Blueprint directly contributes to a reduction in software-related difficulties, reinforcing the importance of structured and scaffolded instruction in CAD education.

DISCUSSION

Moderate Learning Outcomes Under the Existing Primer

The finding that student learning across all five assessed dimensions remained at a moderate level is consistent with broader literature on instructional material effectiveness in technical education. Mayer (2021) demonstrated that multimedia learning environments with clear visual representations significantly improve comprehension of complex technical concepts, while Sweller, van Merriënboer, and Paas (2019)

emphasized that reducing cognitive load through well-structured, scaffolded instructional materials was essential for learners acquiring complex skills. The moderate means observed in this study suggest that the existing primer, while providing a foundational structure, lacked sufficient visual demonstrations, contextual examples, and scaffolded exercises to support consistent mastery.

The dimension of Practical CAD Skills yielded the lowest mean ($M = 3.23$), corroborating findings by Sharma and Mehta (2021) that integration of CAD tools in engineering education requires structured, hands-on instruction to translate theoretical knowledge into applied competencies. Similarly, the moderate satisfaction level ($M = 3.24$) aligns with Richardson et al.'s (2021) meta-analytic finding that learner satisfaction in technology-mediated learning correlates with instructional clarity, interactivity, and relevance of content to real-world contexts—factors that the existing primer reportedly lacked.

The relatively high concept understanding mean ($M = 3.41$) compared to practical skills may reflect the primer's emphasis on theoretical content over guided practical application. This



imbalance supports the argument advanced by Darling-Hammond et al. (2021) that effective learning environments must promote authentic tasks and applied problem-solving to bridge conceptual and procedural knowledge. John Hattie's (2023) extensive meta-analysis further confirmed that visible learning strategies—clear learning intentions, formative feedback, and scaffolded instruction—are among the highest effect-size factors in student achievement, none of which were consistently present in the existing primer as perceived by students.

Pervasive Challenges as Systemic Indicators

The uniformly high challenge ratings across all seven categories (ranging from $M = 3.87$ to $M = 4.03$) are particularly telling. The absence of any category receiving a mean below 3.87 indicates that the challenges students encountered were not isolated to individual instructional weaknesses but reflected systemic deficiencies in the existing primer. Hamzah et al. (2023) similarly found that students in engineering courses reported higher engagement and reduced learning difficulties when exposed to structured, contextualized primers with clear visual demonstrations, consistent with this study's finding that clarity and organization ($M = 4.03$) were the most pressing concerns.

The challenge of integrating practical tasks ($M = 4.01$) reflects a broader tension in technical education between theoretical instruction and hands-on application, which O'Reilly and Barry (2023) addressed by demonstrating that integrating CAD with experiential learning tools improved learner competence and spatial visualization skills. Access limitations ($M = 3.87$), while the lowest-rated challenge, remained significant: with 53.1% of students relying solely on school laboratories and 5.1% reporting limited access, equitable access to CAD resources emerges as a structural barrier requiring institutional attention beyond the primer itself.

Technical complexity and limited visual examples—both rated at $M = 3.95$ and $M = 3.96$, respectively—align with Mayer's (2021) Cognitive Theory of Multimedia Learning, which posits that well-designed visual aids reduce extraneous cognitive load and improve comprehension of complex procedures. This confirms that the absence of adequate visual demonstrations in the existing primer meaningfully hampered student learning, particularly for the 48.5% of respondents who possessed only basic prior knowledge in drafting and blueprint reading.

Implications of the Significant Negative Relationship

The moderate-to-strong negative relationship ($r = -0.596$, $p < 0.001$) between learning levels and challenges encountered provides empirical support for the interconnected nature of foundational competency and software proficiency in CAD education. Dagman and Wärmefjord (2022) found that structured CAD learning significantly enhanced technical proficiency and reduced learning difficulties when properly scaffolded, directly corroborating the pattern observed in this study. The implication is that pedagogical investments in strengthening foundational 3D Blueprint competencies—through guided hands-on activities,

step-by-step modeling exercises, and scaffolded learning tasks—will yield downstream benefits in students' ability to navigate CAD software independently.

This relationship also underscores the interdependence of instructional quality and technological proficiency: the more effectively a primer develops foundational understanding, the fewer software-related difficulties students encounter, creating a virtuous cycle of learning. From an institutional standpoint, the finding highlights the need not only for an enhanced primer but also for complementary investments in training, updated software instruction, and improved laboratory resources to create a comprehensively supportive learning environment (Totuk et al., 2023; Wang et al., 2023).

The Enhanced Learning Primer as a Strategic Response

The development of the enhanced 3D CAD Blueprint Learning Primer directly responds to the empirical deficiencies identified in this study. Structured into seven comprehensive parts—covering 3D CAD fundamentals, software navigation, step-by-step tutorials, real-world projects, troubleshooting, curriculum integration, and learning support—the enhanced primer integrates constructivist, experiential, and design-based learning principles. It incorporates explicit scaffolding through beginner, intermediate, and advanced exercise progressions; rich visual demonstrations aligned with Mayer's (2021) multimedia principles; and competency rubrics supporting self-assessment and continuous improvement.

The primer's explicit alignment with CHED Outcomes-Based Education competencies ensures that activities, assessments, and tutorials are directly linked to measurable graduate attributes, addressing the concern raised by de Guzman and Uy (2022) that OBE-aligned materials strengthen curriculum delivery by connecting instructional inputs to expected professional competencies. The inclusion of troubleshooting guides and FAQ sections specifically targets the technical complexity and support availability challenges that students rated most highly, while the emphasis on real-world projects and collaborative exercises responds to the motivational deficits observed in the survey data.

The planned scheme of implementation—spanning planning and design, pilot testing, and follow-up evaluation—embeds continuous quality improvement into the primer's deployment lifecycle. This phased approach aligns with best practices in instructional design (Brown & Duguid, 2020) and ensures that empirical feedback from student users informs iterative refinements, sustaining the primer's relevance as CAD technologies and curriculum standards evolve.

CONCLUSION

This study established that students at Cebu Technological University – San Francisco Campus demonstrated a generally moderate level of learning and engagement in 3D Blueprint with CAD when using the existing instructional primer. Significant



challenges were identified across all seven assessed categories—particularly in manual clarity, integration with practical tasks, technical complexity, and limited visual examples—all of which meaningfully impeded skill development and overall satisfaction. The statistically significant negative relationship ($r = -0.596$, $p < 0.001$) between learning levels and software-related challenges confirmed that strengthening foundational CAD competencies directly reduces the difficulties students encounter in applying those competencies through digital design tools.

In response to these empirically documented gaps, the enhanced 3D CAD Blueprint Learning Primer—contextualized to the local institutional environment and aligned with CHED Outcomes-Based Education competencies—was developed as the primary output of this study. The enhanced primer integrates scaffolded step-by-step tutorials, rich visual demonstrations, authentic problem-solving exercises, and comprehensive troubleshooting guidance, collectively addressing the specific instructional deficiencies identified through the survey data. Its implementation is expected to improve concept understanding, strengthen practical CAD skills, increase student motivation, and enhance overall satisfaction with the learning experience.

These findings carry broad implications for technical education policy and practice. Educators are recommended to adopt a blended instructional approach combining the enhanced primer with technology-based tools, while ensuring equitable access to CAD resources through extended laboratory hours, lending programs, or virtual CAD platforms. Institutions are encouraged to invest in regular primer updates aligned with evolving CHED standards and industry requirements. Future researchers may build on this study by conducting experimental or quasi-experimental designs to quantitatively measure the learning gains attributable to the enhanced primer, and by exploring its adaptability for extension services in technical-vocational training and community-based capacity-building contexts.

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